1642

FD 09 /01
Investigation into the Levels of Environmental Contaminants in Scottish Marine and Freshwater Fin Fish and Shellfish

A. Fernandes, F. Smith, R Petch, N Brereton, E. Bradley, S Panton, M Carr and M.Rose

Authorised Signatories:

A Fernandes	M Rose
OPHA Organic Contaminants	OPHA Organic Contaminants

October 2009

Food and Environment Research Agency
Sand Hutton
YORK
YO41 1LZ

Opinions and interpretations are outside the scope of UKAS accreditation. Measurements for all reported analyses are UKAS accredited apart from PFOS, PCNs, deca-BDE/BB, Me-Hg and Phthalates which are outside the scope of accreditation.

Investigation into the Levels of Environmental Contaminants in Scottish Marine and Freshwater Fin Fish and Shellfish

Report Number:	FD 09 /01
Authors:	*A Fernandes, F Smith, R Petch, E. Bradley, N. Brereton, S Panton, M Carr and M.Rose
Date:	October 2009
Sponsor:	Food Standards Agency Scotland Environmental Contaminants 6th Floor St Magnus House 25, Guild Street Aberdeen AB11 6NJ
Sponsor's Project Number:	S14040
FERA Contract Number:	S6OT
FERA File Reference:	FLN 8888
Principal Workers:	M Carr, K Harmannij, M Miller, E Greene, F Smith, S Panton, R Petch, J Holland, D Clarke, D Speck N. Brereton & A. Fernandes
Team Leader:	M Rose
Distribution:	1. Dr Jacqui McElhiney 2. Dr M Rose 3. Dr A Fernandes 4. FLN 8888 5. FERA Information Centre

SUMMARY

1. Marine and freshwater fish bio-accumulate environmental contaminants, and coastal and river waters are recognised sinks for these chemicals. This study characterises a range of existing and emerging contaminants in the flesh of fish and shellfish species with a view to determine current levels of occurrence and to allow estimation of consumer exposure.

2. A range of fish species from marine and freshwater habitats were obtained comprising 32 marine samples, 16 freshwater samples and 5 marine shellfish samples. These were analysed for the following contaminants:

- Heavy Metals
- Polybrominated biphenyls (PBBs)
- Brominated dioxins (PBDD/Fs)
- Polybrominated diphenylethers (PBDEs)
- Chlorinated Dioxins (PCDD/Fs)
- Polychlorinated biphenyls (PCBs)
- Polychlorinated naphthalenes (PCNs)
- Phthalates

Additionally some of the samples were also analysed for perfluorinated compounds (PFOS) and polycyclic aromatic hydrocarbons (PAHs).

3. The methodologies used for the analyses are largely UKAS accredited to the ISO 17025 standard and where applicable (e.g. dioxins and PCBs) follow EU commission regulations for quality criteria. Equivalent criteria were followed for those analytes not directly covered by accreditation. For chlorinated dioxins and PCBs, the concentrations of each sample have also been reported as toxic equivalents (TEQs). A similar approach was used for the PBDD/Fs and relevant PBBs, but the limitations of this interim measure must be recognised, i.e. the analogous chlorinated TEF values used, provide only an indicative estimate of toxicity (TEQ) for these brominated contaminants.

4. For the organic contaminants it is clear that no fish or shellfish samples in this study breach the existing regulated limits - for dioxin and PCB WHO-TEQ for example, the highest level was detected in a sample of roach with a concentration of 3.5 ng/kg against a maximum permitted value of 8 ng/kg. For the heavy metals, some expected minor excursions beyond the maximum limits for mercury occur in ling and blue ling (ling is known to bio-accumulate the metal), with measured values of 0.7 mg/kg and 0.6 mg/kg against a limit of 0.5 mg/kg.

5. The results of this study confirm the occurrence of a wide range of environmental contaminants in these species and underline the ubiquity and persistence of these compounds. This is evident from the occurrence of both, legacy contaminants (PBBs, PCNs and PCBs), as well as more recently introduced chemicals (deca-BDE and PFCs).

6. Fresh-water fish generally show higher levels of the major contaminants investigated (apart from arsenic and mercury) than marine species or shellfish. This is remarkable given that many of the fresh-water samples received were made up of a number of small sized fish (average 15-20 cms in length) that would be unlikely to be consumed. Given the bio-accumulative nature of these contaminants, it is probable that larger (and older) fish within the same locations would tend to show higher levels of contamination.

7. This report represents the first study of such a comprehensive set of contaminants in fish and as such is unique. The data will allow estimation of dietary intake for consumers of these foods, but considerable uncertainty would remain within these estimates, given the observations made in this study, particularly for the freshwater fish. The data also provides information on the current background levels of these emerging and existing contaminants. A parallel study on freshwater fish from uncontrolled waterways in other parts of the UK is currently underway. The combined information from these two sets of complementary data may allow more refined estimates of human exposure.

LIST OF CONTENTS

SUMMARY	3
GLOSSARY	6
INTRODUCTION	7
EXPERIMENTAL	15
RESULTS AND DISCUSSION	30
REFERENCES	43
Table 1. Sample information	50
Table 2. Concentrations of heavy metals, (& speciated As and Hg)	52
Table 3. Concentrations of PCDDs and PCDFs	56
Table 4. Concentrations of non-ortho PCBs	69
Table 5. Concentrations of ortho- PCBs	77
Table 6. Summary of dioxin and PCB WHO-TEQ	103
Table 7. Concentrations of PBDD/Fs and non-ortho PBBs	109
Table 8. Concentrations of PBDEs and ortho- PBBs	121
Table 9. Concentrations of PCNs	129
Table 10. Concentrations of Phthalates	135
Table 11. Concentrations of PFCs	141
Table 12. Concentrations of PAHs	142
Table 13. Results of Reference Material Analysis	144
Table 14. Summary of Contaminant Concentrations	149
Table 15. Ranking of samples	150
Annexe 1 Marine Scotland Report – Sample collection	151

GLOSSARY

Σ PBDD/F TEQ	Sum of WHO-TEQ for individual PBDD/F congeners
Σnon-*ortho* PBB TEQ	Sum of WHO-TEQ for individual non-*ortho* PBB congeners
BDE	Brominated Diphenylether
BCR	Community Bureau of Reference
BFR	Brominated Flame Retardant
CRM	Certified Reference Material
EFSA	European Food Safety Authority
GC-HRMS	Gas chromatography - high resolution mass spectrometry
HPLC-MS/MS	LC-MS in multiple reaction monitoring mode
IUPAC	International Union of Pure and Applied Chemistry
LC-MS	High Pressure Liquid Chromatography - mass spectrometry
PAHs	Polycyclic aromatic hydrocarbons
PCB/PBB	Polychlorinated biphenyl/ Polybrominated biphenyl
PBDE	Polybrominated Diphenylether
PBDD/F	Polybrominated dibenzo-*p*-dioxin/ furan
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/ furan
PFC	Perfluorinated compound
PTMI	Provisional tolerable monthly intake
PTV	Programmed temperature vaporisation
RM	Reference Material
SCF	EU Scientific Committee on Food
TDI	Tolerable Daily Intake
TDS	Total diet survey
TEF	Toxic Equivalence Factor
TEQ	Toxic equivalence
WHO	World Health Organisation
%U	Percentage Uncertainty

INTRODUCTION

Environmental contamination in fish and shellfish

Marine and aquatic environments are recognised sinks for a range of environmental contaminants, and uptake and bioaccumulation by various fish and shellfish species has been widely documented. In particular, marine shellfish have a recognised potential for bio-accumulating contaminants and some species such as mussels, are commonly used as early indicators of local pollution. Consequently, marine fish and shellfish have been shown to make a significant contribution to human exposure of a range of environmental contaminants. Aquatic species also show a similar potential for contaminant bio-accumulation and there have been a number of reports of elevated contaminant levels in river and lake species such as trout, pike, carp, perch etc. In many parts of the world, including the European Union, fish caught from rivers and other fresh waters are often included in the diet. Within the UK however, it is unclear as to what extent these potential foods contribute to human exposure, due to lack of current knowledge on contaminant levels in the various species and the extent to which these species are consumed by certain sub-groups of the population such as anglers and others.

Heavy Metals

Some trace elements and in particular, heavy metals are established toxic contaminants. Some elements, such as copper, chromium, selenium and zinc are essential to health but may be toxic at high levels of exposure. Other elements have no known beneficial biological function and long-term, high-level exposures may be harmful to health. Environmental sources are the main contributors to contamination of food which is the major source of the overall exposure of consumers to metals and other elements, although other routes may also be significant (for example, oral exposure via the drinking water, inhalation exposure via the occupational setting). The presence of metals and other elements in food and the environment can also be the result of contamination by certain agricultural practices (e.g. cadmium from phosphate fertilisers), manufacturing and packaging processes (e.g. aluminium and tin in canned foods) and endogenous sources (e.g. as in ground waters in certain parts of the world). Furthermore, certain food groups naturally accumulate some elements and consequently contain high concentrations of these elements compared to other foods. For example, fish and shellfish are known to accumulate arsenic and mercury and cereals can accumulate cadmium. Metals and other elements may enter marine and aquatic environments and bio-accumulate in species at any point during growth and harvesting. There have been many surveys of sea-fish for trace elements but fewer conducted on freshwater fish or on deep sea fish and very few that have been conducted with simultaneous analysis for organic contaminants. Heavy metals may be present in waterways as a result of the geology of the region, for example naturally occurring lead or zinc are found in some areas. These and other potentially toxic elements may also be found in the location of certain industries, as a result of unauthorised discharge, or as a result of other anthropogenic activity.

In the UK, the FSA recently conducted a study of metals and other elements as part of the total diet study (FSA 2009). The results of the study indicated that current population dietary exposures to most of the metals and elements investigated did not raise specific concern for the health of consumers. However further investigation on some of the elements was recommended as well as continued efforts to reduce dietary exposure to inorganic arsenic and to lead.

Dioxins and PCBs

Dioxins and PCBs are recognised environmental and food contaminants that are known to bio-accumulate in fish and shellfish. The extent of this accumulation is evident by the levels of these contaminants detected in various studies. In the UK Total Diet Studies (TDS) (FSA 2003) carried out over the last 2 decades, fish (including shellfish) has consistently been one of the highest dioxin and PCB containing food groups. Reports from other recent studies on the levels in fish and shellfish also support this observation (FSA 2006, Health Canada 2005, FSAI 2002, Fernandes et al 2004B). Specific surveys on marine and farmed fish and shellfish (FSA 2006a, FSAI 2002, Hites et al 2004, Hashimoto et al 1998, Jacobs et al 2002, Fernandes et al 2008, 2009, 2009B) confirmed the relatively high concentrations of dioxins and PCBs in marine species, and also showed that fish with a high lipid content, or oily fish, and bottom feeding fish such as plaice, contained a higher concentration of the contaminants as compared to other, white fish. Shellfish species, particularly oysters, crabs, mussels, whelks, etc. also showed relatively high concentrations of dioxins and PCBs. Human dietary exposure can therefore be significantly influenced by the fish and shellfish component of the diet, particularly in high level consumers and low body-weight individuals. Dioxin levels in fish and shellfish species used for food have been regulated by the EU following the introduction of maximum permitted levels (MPLs) in 2002 (Council Regulation 2375/2001) and amended in 2006 (Council Regulation 1881/2006)

BFRs and Brominated dioxins

Brominated contaminants commonly refer to a range of additive and reactive brominated flame retardant chemicals (BFRs), and brominated dioxins and furans (PBDD/Fs). BFRs are used specifically to slow down or inhibit the initial phase of a developing fire. PBDEs (polybrominated diphenyl ethers) are mass produced BFRs that are incorporated into a number of commonly used commercial materials such as plastics, rubbers, textiles and electronic components. Polybrominated biphenyls (PBBs) were previously used for the same purpose but their use has been banned since the 1970s. The use of BFRs has undoubtedly saved lives and reduced human injuries (Spiegelstein 2001, Emsley et al 2002), and figures of 20% reductions in fire deaths directly attributable to flame retardants have been quoted. PBDEs are mixed with other ingredients when flame retardant materials are produced and as this is an open-ended application, the chemical is available to diffuse out of materials into the environment. This process can occur over the lifetime of the material - during manufacture, use, and disposal. The occurrence of BFRs in environmental compartments such as water, sediments and biota (Hale et al 2001, D'Silva et al 2004, Covaci et al 2005, Webster et al 2008) accompanies an increasing amount of evidence that suggests that these chemicals may cause potential detrimental human health effects (Darnerud 2003, Hakk and Letcher 2003, D'Silva 2004). Emerging toxicological data shows that PBDEs can cause liver and neurodevelopmental toxicity and affect thyroid hormone levels. In recent years the EU has carried out a comprehensive risk assessment under the Existing Substances Regulation (793/93/EEC) of commercial PBDE products. The outcome was ban on the use of Penta-and OctaBDE since 2004. The situation with regard to another mixture - deca-BDE remains fluid - in 2008, the European Court of Justice (ECJ) annulled the exemption to the EU Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment 2002/95/EC, commonly referred to as the Restriction of Hazardous Substances Directive or RoHS Directive as of 30 June 2008 that was granted in 2005 for Deca-BDE.

There is very little information on the occurrence of other emerging brominated contaminants such as the polybrominated dibenzo-p-dioxins and polybrominated dibenzofurans (PBDD/Fs) in food. This is perhaps unsurprising given the relatively recent recognition of the global environmental distribution of these pollutants and the difficulties associated with making valid measurements. PBDD/Fs are inadvertent by-products of incineration processes and have physico-chemical properties that are similar to their chlorinated analogues. They originate from similar anthropogenic sources as chlorinated dioxins, such as incineration, or chemical manufacture e.g. PBDD/F are formed as by-products during the manufacture of PBDEs. Studies of incineration processes (Weber et al 2002, D'Silva et al 2004) show that the formation of these compounds are consistent with "de novo" hypothesis and are thus governed by the occurrence of bromine or chlorine sources in incinerator feed. There are studies (Barontini et al 2001, Weber and Kuch 2002) to show that the incineration of products containing BFRs as well as thermolysis of BFR material such as PBDEs is an important source of PBDD/F emissions. PBDD/Fs can also be formed from PBDEs, during thermal processing procedures such as extrusion, moulding and recycling, and degradation. It has also been demonstrated that PBDD/Fs can be formed during ultra-violet irradiation of decabromodiphenyl ether (Olsman et al 2002). Recently, there have been reports that some lower brominated PBDD congeners (tri- tetra-) may be produced through biogenic formation in the marine environment and bio-accumulate in some marine species (Malmvarn et al 2005, Haglund et al 2007). As the utilisation of BFRs continues to increase, a corresponding increase in PBDD/Fs levels can be expected. Studies on the toxicity of PBDD/Fs are limited but both, in vivo and in vitro studies demonstrate AhR agonist properties and dioxin-like effects (Birnbaum et al 2003, Environment Health Criteria 205). Although there are a number of methods reported for the analysis of dioxins, PCBs and PBDEs (Gilpin et al 2003, Krokos et al 1997, Fernandes et al 2004) very few methods exist for the determination of PBDD/Fs (Ashizuka et al 2004, Fernandes et al 2008). To date there is only a limited amount of available data on the occurrence of these compounds in foods (Fernandes et al 2009, Fernandes et al 2009c).

General observations from a recent study on fish and shellfish (FSA 2006b) showed the occurrence of both, BFRs and PBDD/Fs. PBDEs, particularly congeners 47, 49, 66, 99, 100, 153, 183 and 209 were detected in most of the samples apart from canned products. Lower brominated dioxins and furans were also detected in a number of samples, with tri-bromo analogues occurring at significant levels particularly in shellfish, as was observed in later studies on shellfish from Scotland (Fernandes et al 2008) and other parts of the UK (Fernandes et al 2009). This is an important observation as tri-brominated dioxins and furans have been reported to have a greater toxicological significance than their chlorinated counterparts (Behnisch et al 2003). The greater frequency of detection of PBDFs relative to PBDDs reflects the environmental occurrence and emission profiles for brominated dioxins and furans, which both show higher levels of the furans.

Chlorinated Naphthalenes

PCNs are industrial chemicals, produced over most of the last century, although manufacture is currently banned and use limited. They were sold as technical mixtures (e.g. Halowax in the US, Nibren in Germany, Seekay in the UK, etc) of the commercial PCN product in mineral oil. However, PCNs can also be formed through industrial thermodynamic processes such as incineration, and formation pathways resulting from *de novo* synthesis during combustion have been documented (Iino et al 1999, Takasuga et al 2004). The halogenated aromatic structure provides strong chemical stability and the molecule is resistant to attack by strong acids. PCNs are hydrophobic compounds that possess high thermal stability, good weather resistance, good electrical insulating properties and low flammability. They were therefore commonly used as dielectrics in electrical equipment. Unfortunately, the properties of physical and chemical stability are also responsible for the persistence of PCNs in environmental and biotic media.

All chloronaphthalene congeners are planar and lipophilic compounds, structurally similar to the highly toxic 2,3,7,8-tetrachlorodibenzo-p-dioxin molecule, and can contribute to an aryl hydrocarbon (Ah) receptor-mediated mechanism of toxicity, including a combination of toxic responses such as mortality, embryotoxicity, hepatotoxicity, immunotoxicity, dermal lesions, teratogenicity and carcinogenicity (Blankenship et al 1999, Blankenship et al 2000, Engwall et al 1994, Hanberg et al 1990, Villeneuve et al 2000). In humans, severe skin reactions (chloracne) and liver disease have both been reported after occupational exposure to PCNs. Other symptoms found in workers include cirrhosis of the liver, irritation of the eyes, fatigue, headache, anaemia, haematuria, anorexia, and nausea.

PCNs have been detected in several environmental compartments including biota. They have been measured in fish from the Great Lakes, in species such as trout, carp, bass, and pike, from low to sub-ppb levels of total PCN (Kannan et al 2000). Fish from the Detroit river showed concentrations of up to 31.4 ppb (Van de Plassche and Schwegler 2005) while harbour porpoises from the west coast of Sweden showed concentrations of up to 730 ng/kg wet weight in blubber, nuchal fat and liver (Ishaq et al 1999). A range of fish species from the Baltic sea and three Finnish lakes were measured with levels ranging from 1 – 170 ng/kg whole weight for samples from the Baltic sea and 2 – 66 ng/kg whole weight for samples from the lakes (Isosaari et al 2006). At present there is very little information on dietary exposure of humans to PCNs, but two surveys of foods have been carried out in Spain. These studies measured PCN homologue totals and showed that the highest concentrations were in fats and oils, cereals, fish, dairy products and meat. Within the UK, a study on food, targeting specific PCN congeners based on toxicity and occurrence, found that the highest levels of occurrence were in fish and shellfish (Fernandes et al 2009D).

Phthalates

Phthalates are a class of similar multifunctional chemicals used in a variety of consumer and personal care products. High-molecular-weight phthalates e.g. di-2-ethylhexyl phthalate (DEHP) and butylbenzyl phthalate (BBzP) are primarily used as plasticizers in the manufacture of flexible vinyl, which is used in consumer products, flooring and wall coverings, food contact applications, and medical devices (Hauser et al 2006). Manufacturers use low-molecular-weight phthalates e.g. diethyl phthalate (DEP) and dibutyl phthalate (DBP) in personal care products (e.g. perfumes, lotions, cosmetics), as solvents and plasticizers for cellulose acetate, and in making lacquers, varnishes, and coatings, including those used to provide timed release in some pharmaceuticals.

As environmental contaminants, phthalates are reported to be ubiquitous and persistent in the environment and have been detected in environmental media including rain water, water, soil and sediments, indoor air/dust and aquatic systems including biota. As industrial chemicals they have been produced in large volumes for additive plasticizer applications. It is reported that they are no longer used in plastic food packaging but they may be used in adhesives or inks applied to such materials. Phthalates are lipophilic compounds and are known to accumulate in fatty tissues. They have been detected in foods, in particular fatty foods, and phthalate metabolites have been observed in breast milk and urine. Studies on biological effects of phthalates have focused on endocrine disruption and reproductive toxicity. A number of phthalates cause wasting of the testes in animals and decreased sperm counts in mice. Target organs for many phthalates appear to be within the mammalian reproductive system.

These chemicals are now known to be widespread marine contaminants and can be found even in remote marine locations. Bioaccumulation in bird eggs, fish and seals has also been documented. It is reported that exposure to phthalates is likely to be causing adverse effects in wildlife in heavily contaminated waters and sediments near industrial discharges containing phthalates (Phthalate briefing WWF 2006).

Perfluorinated Compounds

PFOS and related perfluorinated compounds (PFCs) are industrial chemicals that are now understood to be Persistent Organic Pollutants (POPs). These compounds are widely used in the production of non-stick coatings, in water repellent and stain resistant coatings for fabrics and furnishings, in fire fighting foams and other applications. PFCs may bio-accumulate up the food chain through utilisation or disposal routes, or enter directly into food through primary contamination events. The assimilation pathway is different to other POPs since these compounds are not as lipophilic, and are in fact quite polar. Early information on occurrence in European environmental and food samples (mainly fish) confirms the presence of PFOS in fish particularly in the liver (EFSA 2008). Similarly investigations into Japanese foods (Guruge 2008) reported cattle, pig and chicken livers to contain mean PFOS concentrations of 34, 54 and 67 µg/kg, respectively, with the highest individual PFOS value at 92 µg/kg in a chicken liver. Studies on shellfish taken from South China and Japan showed PFOS levels in oysters from Tokyo bay at 3 µg/kg. PFOS has been shown to bio-accumulate in fish and a kinetic bio-concentration factor has been estimated to be in the range 1000 – 4000. The time to reach 50% clearance in fish has been estimated to be around 100 days.

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) can be found in shellfish, but are usually metabolised in other fish species. They can be found in fish prepared for consumption, as a result of processing –eg. Smoked fish are known to contain elevated levels of PAHs. Some PAH compounds have been shown to be genotoxic and carcinogenic, the most studied of which (benzo[a]pyrene, or B[a]P) is regulated in a range of foods including shellfish, within the EU (SCF Opinion 2005, Commission Regulation 208/2005). There are also plans to consider the regulation of other PAHs in the future. The major sources of environmental PAHs are combustion processes and industrial, particularly petrochemical, activity. Filter feeding shellfish species appear unable to bio-transform PAHs, as other marine and terrestrial animal do, and as such tend to bio-accumulate these contaminants. The proximity of sources mentioned and additionally, coastal industry, effluent from rivers flowing through industrial areas and commercial shipping lanes, to the areas where shellfish are harvested, undoubtedly influence the levels of bioaccumulation. In a recent study on bivalve molluscs including mussels, oysters and scallops, the FSA reported positive detection of most PAH compounds in samples taken in England and Wales (FSA 2005). However in comparison to a study carried out about a decade earlier, reported levels were significantly lower and no sample showed levels above the 10 μg/kg EU limit for B[a]P in shellfish.

Study Objectives

A major obstacle to the risk assessment of human exposure to some of these contaminants is the acute shortage of reliable occurrence data. This is particularly true for contaminants such as PBDD/Fs, phthalates, PCNs and PFOS where analytical accessibility is limited due to the difficulties encountered in making reliable measurements. This is mainly because food matrices are more analytically challenging than environmental matrices (for which relatively more data is available), and the requirement for measurements to be sufficiently sensitive to make the risk assessment meaningful. This study addresses these issues. In addition to allowing the assessment of risk, the data it will generate will complement and extend the available knowledge on the occurrence of these contaminants in marine fish and shellfish. In particular, it will complement similar data that is available for shellfish species commercially produced in Scotland. Additionally, it will provide information on contaminants that are present in freshwater fish species that may be consumed by anglers or other sub-groups of the population.

EXPERIMENTAL

Sampling

In the first phase of sampling 32 samples of marine fish including deep-water species were collected from Scottish waters during 2008. Additionally 5 samples of mussels were also collected. In the latter half of 2008 a further 16 samples of freshwater species were collected from rivers, canals and other fresh waters. On receipt at the laboratory each sample was given a unique laboratory reference number and the sample details were logged into a database. The samples were stored frozen (-20°C) prior to analysis.

Details of the sampling plan (including location of the sampling sites) constructed in conjunction with the FSA and the Fisheries Research Services (FRS) laboratory are included in Annexe 1(Robinson 2009).

The samples were dissected to exclude non-edible parts and the tissue obtained from this process was homogenised by mincing and blending. Sub-samples were taken for the analysis of metals, phthalates and PFCs. Where required sub-samples were freeze-dried and the resulting powders were thoroughly mixed before taking sub-sampling again for the analysis of dioxins, PCBs and other organic contaminants.

Fat Determinations

Fat determinations were performed by a UKAS (ISO 17025) accredited laboratory on sub-samples of the freeze-dried and homogenised samples using a standard method (British Standards Institute 1970).

Analytes

The majority of samples (except where limited by weight) were determined for the following analytes:

Heavy Metals – Cr, Mn, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Hg, Pb (inorganic arsenic and methyl mercury were also determined in different sub-groups of the samples.

Dioxins - all 17, 2378-Cl substituted PCDDs and PCDFs,

PCBs - non-*ortho*-substituted PCBs - IUPAC numbers 77, 81, 126 and 169
ortho-substituted PCBs -IUPAC numbers 18, 28, 31, 47, 49, 51, 52, 99, 101, 105, 114, 118, 123, 128, 138, 153, 156, 157, 167, 180, 189, 33, 41, 44, 60, 61, 74, 66, 87, 110, 129, 141, 149, 151, 170, 183, 185, 187, 191, 193, 194, 201, 202, 203, 206, 208 and 209

Brominated dioxins - 2,3,7-T_3BDD, 2,3,8-T_3BDF, 2,3,7,8-Br substituted PBDD/Fs: and 10 tetra – hexa brominated congeners (note that this includes only 1 hexa-Br as no standards were available for the other 3 congeners)

PBDE congeners: IUPAC numbers 17, 28, 47, 49, 66, 71, 77, 85, 99, 100, 119, 126, 138, 153, 154 and 183.

PBB congeners: IUPAC numbers 15, 49, 52, 77, 101, 126, 169, and 153.

PBDE 209 and PBB 209 (deca bromo compounds)

PCNs - PCN-52/60, 53, 66/67, 68, 69, 71/72, 73, 74, & 75

Phthalates - Dimethyl phthalate, diethyl phthalate, diisopropyl phthalate, diallyl phthalate, diisobutyl phthalate, di-n-butyl phthalate, dipentyl phthalate, di-n-hexyl phthalate, benzyl butyl phthalate, dicyclohexyl phthalate, di-(2-ethylhexyl) phthalate, di-n-heptyl phthalate, di-n-octyl phthalate, n-Octyl n-decyl phthalate, diisononyl phthalate, diisodecyl phthalate and di-n-decyl phthalate (diisononyl and diisodecyl phthalate are isomeric mixes rather than individual compounds)

A set of 26 PAHs including those deemed by EFSA to be of toxicological significance, and those prioritised by the US EPA, were analysed in the 5 shellfish samples.

Where sufficient quantity of sample allowed a set of 5 freshwater and 5 marine samples were analysed for perfluorinated compounds.

Reference Standards

Reference standards for PCDD/Fs, PCBs, PBDD/Fs, PBBs, PBDEs, PAHs, PCNs and $^{13}C_{12}$ materials for use as internal standards were sourced from either Cambridge Isotope Laboratories (Andover, MA, USA) or from Wellington Laboratories (Guelph, Ontario, Canada) as solutions in n-nonane, iso-octane, methanol or toluene with a specified 10% tolerance on concentration. Deca-BB was obtained as an iso-octane solution from Accustandard and deca-BDE was obtained as a toluene solution from Wellington. Standards for the other analytes measured, are detailed within the procedures.

PROCEDURES

Heavy Metals - Sample digestion and measurement

1 – 2 g (fresh weight) of each sample was weighed into alloted quartz digestion vessels and a mixture (4:1) of nitric acid and hydrochloric acid added (5.0 ml). The vessels were

sealed and the contents digested using a high pressure microwave digestion system (Anton Paar ‘Multiwave’). Reagent blanks, certified reference materials and a spiked blank were also taken through the procedure. The resulting solutions were transferred to pre-marked acid-clean plastic test tubes and diluted to 10 ml with deionised water (18MΩ).

Seven calibration standards from certified stocks, in an acid matrix to match that of the samples, were prepared to cover the expected concentration range for each element. The digest solutions and standards were diluted further with internal standard (indium or rhodium) in dilute nitric acid (1 %v/v). Measurements were made using either a Perkin Elmer Elan 6000 ICP-MS instrument or an Agilent 7500ce ICP-MS instrument. The element concentrations in the diluted samples were calculated from the response curve of the standards at the beginning of each run. The concentrations of 12 elements were determined (Cr, Mn, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Hg and Pb). Details of the methodology used for the speciation studies on arsenic and mercury (mercury speciation carried out at the University of Pau, France) have been reported earlier (Garraud et al 2007, Rose et al 2007)

Quality Control (Metals)

The analytical procedure is accredited to the ISO17025 standard. The criteria used to assess data included checks on instrument drift, spike recovery, replicate agreement, limits of detection and certified reference material values.

The LOD was defined as three times the standard deviation of the signal from reagent blanks (which had been taken through the entire analytical procedure) when subsequently corrected for sample weight and dilution. The LOQ was defined as ten times the standard deviation of the signal from reagent blanks (which had been taken through the entire analytical procedure) when subsequently corrected for sample weight and dilution.

Analyses included re-measurement of a calibration standard at the end of each ICP-MS run. In order to pass this check, the re-measured standard had to be within ± 20 % of the initial value.

Data were accepted if the recovery of spike for each analyte was within the range 60 to 140 % with at least 75 % of these recoveries lying within the range 80-120 %. Replicate values for a given sample had to have a relative standard deviation of <20 % or a standard deviation of <LOQ, whichever was greater.

Results for reference materials (Table 13) had to be within the certified range, or 40% of the quoted value, whichever was greater. Where indicative values were shown on certificates, measured concentrations had to be within a factor of 2 of the quoted value. Data were accepted if results for at least two of the three reference materials passed the criteria above.

PCDD/Fs, PCBs, PBDD/Fs, PBDEs, PBBs and deca-BB/BDE

The PCDD/F internal standard solution contained nominal concentrations of 2 ng/ml of each of fifteen $^{13}C_{12}$ labelled 2,3,7,8-substituted internal standards. These compounds were labelled analogues of all the PCDDs and PCDFs of interest except for 1,2,3,7,8,9-HxCDD and OCDF. The PCB internal standard solution contained nominal concentrations of 200 ng/ml of eight $^{13}C_{12}$ labelled ortho-substituted PCBs (IUPAC numbers 28, 52, 101, 118, 138, 153, 180 and 194) and nominal concentrations of 2 ng/ml of four $^{13}C_{12}$ labelled non-ortho-PCBs (IUPAC numbers 77, 81, 126 and 169). The internal standard solution for the brominated dioxins contained nominal concentrations of 10 ng/ml each of five $^{13}C_{12}$ labelled 2,3,7,8-substituted internal standards (one each for tetra- and penta-Br substituted dioxin and furan, and one hexa-Br substituted dioxin). The internal standard solution for the PBBs and PBDEs contained nominal concentrations of 100 ng/ml of $^{13}C_{12}$ labelled PBBs (IUPAC numbers 52, 77 126 and 153), 100 ng/ml of $^{13}C_{12}$ labelled PBDEs (IUPAC numbers 28, 47, 99, 153, 154 and 183) and 300 ng/ml of $^{13}C_{12}$ labelled Deca-BDE.

The internal sensitivity standard solution used for ortho-PCB measurement contained $^{13}C_{12}$ -PCB 202 and $^{13}C_{12}$ -PCB 77 at a nominal concentration of 100 ng/ml. The internal sensitivity standard used for the PCDD/Fs and non-ortho PCBs contained $^{13}C_{12}$ -1,2,3,4-tetrachlorodibenzo-p-dioxin and $^{13}C_{12}$ - 1,2,3,7,8,9-hexachloro-dibenzo-p-dioxin, each at a nominal concentration of 4 ng/ml. The internal sensitivity standard solution used for PBDD/Fs PBBs and PBDEs contained $^{13}C_{12}$ -PCB 202 and $^{13}C_{12}$ -PBDE 139 at a nominal concentration of 100 ng/ml. All internal and sensitivity standard solutions were prepared in n-nonane.

Dichloromethane, methanol, toluene, hexane and n-nonane were purchased as doubly glass distilled (Rathburn, Scotland) and assessed for lack of contamination before use. Alumina (Sigma Chemical Company, USA) was activated by baking overnight in a muffle furnace at 450^{o} C. All other chemicals employed were Analytical Reagent grade materials.

Reagents, including base-modified and acid-modified silica gel, were prepared as previously reported (Fernandes et al 2004) and were assessed for contamination prior to use. All equipment was scrupulously cleaned and thoroughly rinsed with dichloromethane prior to use. Care was taken to avoid airborne contamination of containers by keeping vials capped even when empty and covering flasks and concentration tubes with cleaned aluminium foil.

The extraction, purification and analysis of samples for PCDD/Fs, PCBs, PBDEs was carried out as previously reported (Fernandes et al 2004). More details of the procedure used for the PBBs and PBDD/Fs have also been published elsewhere (Fernandes et al 2007). In brief, aliquots of the samples were fortified with the internal standard solutions described above and extracted by solvent action. The crude extract obtained was quantitatively transferred into an apparatus containing modified silicas followed by activated carbon on glass fibres where the analytes were fractionated on the basis of their planarity.

The two fractions containing i) ortho-PCBs ortho-PBBs and PBDEs, ii) non-ortho-PCBs, non-ortho-PBBs, PCDD/Fs and PBDD/Fs were purified using acid hydrolysis and activated alumina. Where required, fractions were further purified using acid hydrolysis and alumina. The extracts were concentrated and the appropriate sensitivity standard was added to each fraction prior to instrumental analysis.

GC-HRMS determination of PCDD/Fs, non-ortho PCBs, PBDD/Fs, PBDEs, PBBs and deca-BB/BDE

GC-high resolution mass spectrometry was performed on either one of two Micromass Autospec Ultima instruments fitted with a Hewlett Packard 6890N gas chromatograph and a CTC Analytics PAL GC autosampler or a CTC A200SE autosampler. The gas chromatograph was fitted with a 60m J&W DB-5 MS fused silica capillary column. For PCDD/Fs and non-ortho-PCBs the oven temperature programme consisted of a 5 minute isothermal period at 60°C followed by heating at 120°C/min to 140°C and then at 15°C/min to 210°C followed by 3°C/min to 280°C with a final isothermal period of 10 min. The GC-MS interface was set to 220°C. Injections were made with a PTV injector using a temperature programme which consisted of a 3 minute isothermal period at 40°C followed by heating at 12°C/sec to 320°C, hold for 3 min and then at 12°C/sec to 350°C. For the PBDD/Fs and non-ortho PBBs, the oven temperature programme consisted of a 5 minute isothermal period at 80°C followed by heating at 14°C/min to 220°C for 1 min, then at 3°C/min to 280°C for 1 min, then 6°C/min to 310°C for 9 min, followed by 20°C/min to 330°C with a final isothermal period of 3 min. The GC-MS interface was set to 280°C. Injections were made with a PTV injector using a temperature programme which consisted of a 3 minute isothermal period at 60°C followed by heating at 12°C/sec to 320°C, hold for 3 min and then at 12°C/sec to 350°C. Electron ionisation was used and the mass spectrometer was operated at a resolution of at least 9000 (based on peak width at 10 % of peak height) with focussing optimised prior to each run. Selected ion monitoring was employed, using the two most intense ions in the molecular ion cluster for each homologue. These conditions were used to monitor PCDD/Fs and non-ortho-PCBs in one run, PBDD/Fs and non-ortho-PBBs in a second run, with the ortho substituted PBBs and PBDEs measured in a third run using the following oven temperature programme: 4 minute isothermal period at 60°C followed by heating at 11.3°C/min to 150°C for 1 min, then at 20°C/min to 230°C for 1 min, then 2°C/min to 270°C for 1 min, then 10°C/min to 310°C for 7 min followed by 20°C/min to 330°C with a final isothermal period of 4 min.

Decabromo analytes were measured in a separate run using a 15 m ZB5-MS column (Zebron, Phenomenex) operated using the following oven temperature programme: 3 min at 60°C, 20°C/min to 205°C for 21 min, then 66°C/min to 325°C for 10 min. The

PTV injector in constant flow mode used the following transfer programme: 3 min at 60°C, 12°C/sec to 320°C for 3 min, then 12°C/sec to 350°C.

Ortho-PCBs

Ortho substituted PCBs were measured by GC-unit resolution mass spectrometry, performed on an Agilent GC-MS system, (6890N GC coupled to a 5973 MSInert, fitted with an Agilent 7683 autosampler). Chromatographic separation was effected, using a 60m J&W DB-5 capillary column. Sample introduction was carried out via a PTV injector typically programmed with a 1 minute isothermal period at 50°C followed by heating at 10°C/sec to 150°C then 10°C/sec to 260°C, hold for 1 min, then at 10°C/sec to 320°C for 40 min. The gas chromatograph temperature programme consisted of a 4 min isothermal period at 60°C followed by heating at 20°C/min to 180°C for 9 min, then at 0.5°C/min to 190°C and finally at 5.0°C/min to 280°C with an isothermal period of 5 min. The mass spectrometer was operated in electron ionisation mode. Selected ion monitoring was used, and the two most intense ions in the molecular ion cluster were measured for each ^{13}Carbon labelled PCB and native PCB homologue group.

Data handling

Data reduction for all GC-MS analyses, and processing to calculate the mass of each compound present was performed using Masslynx 3.5 software supplied by Micromass. These data were transcribed to Microsoft Excel for collation and quantitation of concentration data.

Quality control

The methodology used for the determination of PCDD/F, PCBs, PBDD/Fs, PBDEs and PBBs has been accredited (UKAS) to the ISO17025 standard. The scope of the accreditation covers all congeners except deca-BDE/BB. Apart from PCDD/Fs and PCBs, there are no universal acceptance criteria for data quality, so quality control for the accompanying data has followed the criteria currently used for chlorinated dioxins and PCBs (Commission Directive 2002/69/EC). Further, the methodology used for brominated analytes is essentially the same as that used for chlorinated dioxins and PCBs – featuring the extensive use of ^{13}Carbon labelled analyte surrogates and measurement by high resolution mass spectrometry. Basic method quality data for PBDEs and PBDD/Fs using essentially the same method as that successfully used over several years for chlorinated dioxins and PCBs has been published before (Fernandes et al 2004).

The GC-MS analytical run of each batch of purified sample extracts was preceded by the analysis of a standard reference solution used to check system performance and calibration validity. The reference standard solution was also analysed during and at the end of the analytical run. All integrated chromatograms were scrutinised to assess chromatographic peak shape, resolution and signal-to-noise. Additionally, lock-mass traces were examined for evidence of ionisation suppression and isotope ratios were compared with theoretical abundances.

Sample extraction and purification was carried out in batches that included a full method blank. The blank was assessed for internal standard recoveries and for the presence of native analytes.

The quality control samples for PCDD/Fs and PCBs were reference materials prepared by the BCR (Maier et al 1995): - "RM 534, PCDDs and PCDFs in spiked milk powder-higher level" and "CRM 350, PCBs in mackerel oil" (Griepink et al 1988). Results obtained for certified congeners in these samples were in good agreement with the certified values. In the absence of reference materials for the brominated dioxins and PBBs, a number of different food matrices ranging from milk to fish were fortified with native analytes and analysed using the methodology described. Results obtained for these were in good agreement with fortification levels (Table 13). Additionally, the CRMs described above for chlorinated dioxins and PCBs analysis (Griepink et al 1988) was also investigated for brominated analytes. Where analytes were detectable (PBDEs and PBBs), data for the reference material analysed showed consistency during the course of the work.

The Food and Environment Research Agency regularly participates in inter-comparison exercises, where these are available, for e.g. most recently, in 2003, 2005 and 2007 rounds of the inter-comparison exercise – "Dioxins in Food" (Norwegian Institute of Public Health 2003, 2005, 2007, 2009) and FAPAS (FAPAS 2003). In all cases results reported by the laboratory were in excellent agreement with consensus data. There are currently no exercises running for brominated dioxins or PBBs in food, but there are exercises for the determination of PBDEs in biota (Quasimeme 2004). For participation to date, results reported by the laboratory were in excellent agreement with consensus data. Additionally, the “Dioxins in Food” inter-comparison for 2005, 2007 and 2009 has also included measurements for PBDEs in fish matrices. Results reported for these fish based matrices were in agreement with consensus data.

PCNs

Extraction and Purification

An aliquot of the prepared, homogenized sample was fortified with a known amount (in typically 50 µL) of $^{13}C_{12}$ labeled PCN internal standard mix. The size of the aliquot was dependent on the proportion of lipid present and typically the equivalent of 2-5 g of lipid weight was taken for analysis. The fortified sample was left to equilibrate for an hour and then blended with 200 ml hexane and 75 g acid modified silica gel (prepared by roller mixing 1:1, H_2SO_4: Silica, for min. 6 hours). The mixture was quantitatively transferred to the top of a multi-layer column (70 x 600 mm) packed from top to bottom with; 30 g of anhydrous sodium sulphate, 50 g of acid modified silica gel, 10 g of sodium sulphate and silanised glass wool. The column was plugged with 2 glass fibre frits and connected in series to a carbon column (20 x 95 mm containing 0.1 g of activated carbon dispersed on 1 g of glass fibre) and an outflow reservoir. The columns were eluted with dichloromethane:hexane (40:60 v/v, 400 ml) and hexane (100 ml) to waste. The carbon column was disconnected and reverse eluted with 100 ml of toluene to yield a fraction containing the PCNs.

The toluene extract was concentrated using a TurboVap II™ (Zymark Corporation) apparatus at an evaporation temperature of < 30°C and solvent exchanged to ~0.5 ml of hexane. The concentrate was treated with 37N sulphuric acid (5 drops) and mixed by rotary shaking. The mixture was allowed to stand for 15 minutes to allow the aqueous acid and organic layers to separate. The bottom aqueous layer was discarded and the process was repeated. The organic layer was chromatographed on two micro-columns (6mm x 100mm) in series, the upper column packed with acid modified silica gel (~3.5 cm) and eluted directly on to the lower column containing activated (~7 cm) alumina. The columns were eluted with 15 ml of hexane to waste followed by disposal of the silica column and elution of the alumina column with 30 ml of dichloromethane:hexane (30:70). This eluate was concentrated with the addition of the $^{13}C_{12}$ labelled internal sensitivity standard contained in the keeper solvent to approximately 25 µl.

Measurement and Quantitation

Individual PCN congeners were analysed by high resolution gas chromatography – high resolution mass spectrometry (HRGC-HRMS). These measurements were performed on either one of two Micromass Autospec Ultima instruments fitted with a Hewlett Packard 6890N gas chromatograph and a CTC Analytics PAL GC autosampler or a CTC A200S autosampler. The gas chromatograph was fitted with a 60m x 0.25mm i.d. J&W DB-5 MS fused silica capillary column and operated in constant flow (~1ml/min helium) mode. The PCNs were monitored in a single run using a GC oven temperature programme consisting of a 5 minute isothermal period at 60°C followed by heating at 24°C/min to 180°C for 2 min, then at 5°C/min to 250°C for 2 min, followed by 10°C/min to 300°C with a final isothermal period of 8 min.

The GC-MS interface was set to 280°C. 10 µl injections were made with a PTV injector using a temperature programme which consisted of a 3 minute isothermal period at 60°C followed by heating at 12°C/sec to 320°C, for 3 min, then at 12°C/sec to 340°C to the end of the run.

The mass spectrometer was operated in electron ionisation (EI) mode at a mass resolution of ~10K (at 10% peak height). Selected ion monitoring (SIM) was used to record the two most intense ions in the molecular ion cluster for each homologue group. An acceleration voltage of 7kV was used with an electron energy of ~ 35-38eV and a trap current of 400- 450 µA.

Quantification was carried out on the basis of stable isotope dilution of the ^{13}C labelled surrogates and internal standardisation. MassLynx™ software was used for targeting and quantitation of all the analytes.

Quality control (PCNs)

Measurement was carried out by HRGC-HRMS and limits of detection are typically of the order of ~0.1 ng/kg on a whole weight basis but can be lower for some individual congeners. Determination using this methodology is considerably aided by the use of ^{13}Carbon labelled PCN congeners and replicate measurements on the same matrix have shown an average precision of <10%, ranging from 1 to ~16%, as defined by the co-efficient of variation. The accuracy of the measurement has been confirmed by the successful analysis of fortified food matrices, returning concentrations that were in good agreement with the fortified values. There are no available reference materials (RMs) for PCNs, but the use of CRM 350 (Griepink et al 1988), a fish oil matrix that is used for other similar contaminants was investigated for use as an in-house RM during the course of this work. CRM 350 did contain appreciable amounts of PCNs the concentrations of which were established by the simultaneous analysis of PCN fortified samples. The results of these reference material analyses are given in Table 13.

Phthalates

Extraction and measurement

15 g aliquots of the sample matrix were internally standardised (at the 0.2 mg/kg sample level) and extracted by shaking for 4 hours with a 1:1 (v:v) mix of acetonitrile:dichloromethane (15 ml). The mixture was centrifuged and the solvent layer transferred to a clean glass vial. The solvent extracts were stored in a freezer overnight to precipitate any extracted fat. The solvent was decanted from the solidified fat and evaporated to dryness with heating at 60°C (no nitrogen flow). The residue was reconstituted in acetonitrile (1 ml) and transferred to a glass vial for analysis.

The resulting extracts were analysed by GC-MS using an Agilent MSD 5973Inert, operated in selected ion monitoring (SIM) mode with electron impact ionisation. Separation was carried out using a ZB-5ms column (5% phenyl 95% dimethyl polysiloxane, Agilent, UK), 30 m x 0.25 mm i.d. x 0.25 µm d.f. Following injection the oven was held at an initial temperature of 80°C for 3 minutes, the column was programmed at 10°C/min to 320°C and held for 5 minutes. Helium was used as the carrier gas at a flow rate of 1.0 ml/minute. Samples injections of 1 µl were made using an Agilent 7863 Series autosampler fitted with a 10 µl syringe. Injections were made in splitless mode with a splitless time of 20 seconds and an inlet temperature of 280°C. The GC-MS interface transfer line was held at 280°C. Quantitation was carried out using calibration graphs that were constructed by plotting the peak area ratios against the concentration of the phthalate diesters in the solution (converted to units of µg/kg – equivalent in the foodstuff).

Quality control (Phthalates)

The calibration was linear over the concentration ranges investigated (equivalent to 0 to 0.5 mg/kg of foodstuff for all analytes apart from diisononyl phthalate and diisodecyl phthalate where the range was 0 to 6.5 mg/kg). The correlation coefficients (r^2) were better than 0.995 in all cases.

The limits of quantification (LOQ) were dependent on the individual phthalate and food matrix. The target LOQ of 0.05 mg/kg in the foodstuff was met for the majority of the analytes. For diisononyl phthalate the LOQ was in the range 88 to 385 µg/kg and for diisodecyl phthalate was in the range 167 to 714 µg/kg.

The repeatability (RSD, %) of the analysis was < 20% when replicate portions (n = 8) of spiked foods were analysed. Reproducibility was assessed using a second analyst to extract and analyse replicate portions (n = 3) of the foods spiked as for the repeatability studies. Confirmation criteria for the phthalate diesters were established using retention time and ion ratios.

An in-house reference material used to validate the analysis of food matrices - UHT milk spiked with sixteen of the seventeen phthalate diesters, was characterised. n-Octyl n-decyl phthalate was not included as a pure standard could not be obtained.

Sample extractions (PFOS)

This procedure has been described elsewhere in more detail (Lloyd et al 2009). Briefly, quadruple 1-10 g portions of each homogenised sample were weighed out into Falcon tubes (50 ml). The appropriate volumes of internal standard (IS) and standard addition mixtures were added, to prepare two unspiked portions, one overspiked at the reporting level (1 µg/kg) and one portion at 10-times the reporting level (10 µg/kg. The fish portions were homogenised for 1-3 mins as required in 20 ml of methanol with an Ultra Turrax (T25 basic with S25N blade). When homogenised, more methanol was added (*ca.* 40 ml in total) and mixed, while withdrawing the Ultra Turrax blade. Samples were agitated overnight (16h), then centrifuged (15 min, RCF 5311). The supernatant methanol extracts were evaporated under a nitrogen stream (80^{o}C, in silyanised glass vials) just to dryness, and the residues were re-dissolved in aqueous KOH (25 ml, 0.01 M, sonication 10 min). The aqueous extracts were then re-centrifuged (15 min, RCF 5311). When required, the supernatants were poured in one continuous gentle movement, without breaking up the floating materials (fat), or disturbing the sediment, into a funnel connected onto the top of a preconditioned SPE cartridge (weak anion exchange). The cartridges were loaded at a constant drip rate, by increasing from gravity feed to full vacuum as required. After loading, the cartridges were washed with ammonium acetate (2 x 6 ml, 25 mM, pH 4.5) and eluted with basic methanol (4 ml, 0.1% ammonia). The eluates were reduced under a stream of nitrogen gas (60^{o}C), just to dryness and the residues taken up in methanol (400 µl, sonication 10 min). Extracts were transferred into silyanised glass microvials (300 µl) for LC-MS/MS determination.

PFOS LC-MS/MS measurement

Analysis was undertaken by LC-MS/MS. A CTC Pal autosampler (Presearch, UK) and an HP1100 HPLC system with column oven (Agilent, UK) were coupled to an API4000 triple quadrupole mass spectrometer (MDS Sciex Instruments, UK). The guard cartridge was C_8. The HPLC column (5 µm, 60A, 2.1 x 150 mm) was Fluorosep RP Octyl phase, thermostatically held at 30^{o}C in the column oven. The injection volume was generally 10 µl. The gradient programme (methanol: aqueous ammonium formate, 5 mM, pH 4) was: 10% methanol increasing to 30% at 0.1 min (linear gradient), to 75% at 7 min and 100% methanol at 10 min, this was held for 5 min (column washing), then decreased to 10% methanol at 15.1 min, this was held 4.9 min at 10% methanol (column re-conditioning). The eluate was diverted to the mass spectrometer between 7 and 19.5 min, and from 0-7 and 19.5-20 min it was discarded by valve switching to waste, in order to protect the ion source. Analyst 1.4.2 software was used for instrument control, file acquisition and peak integration. The MS detector in multiple MRM mode with a Turbo Ion Spray source was used for quantitative analysis. Data acquisition was conducted in one simultaneous acquisition schedule without separation into chromatographic acquisition windows. Instrumental parameters were optimised by infusion of standard solutions directly into the MS detector (1 µg/ml in 1:1 methanol:

aqueous ammonium formate (5 mM, pH 4). The Turbo Ion Spray (TIS) conditions were; turbo-gas 50 psi, curtain-gas 12 psi, nebuliser-gas 50 psi, desolvation temperature 450^{o}C. An Excel spreadsheet was used to calculate PFC concentrations from the standard additions.

Quality control (PFOS)

The use of LC-MS/MS in multiple MRM mode contributes much to the specificity of the measurement process for these compounds. Determination is aided by the use of ^{13}Carbon labelled and deuterated PFC compounds as internal standards. Each food sample was analysed in duplicate throughout the entire extraction method to ensure that advantageous point contamination was not mistaken for the presence of any native PFC. For a specific analyte to be considered present in a sample extract the following criteria must be met: i) the relative retention times of the analyte must be comparable to those of a retention time marker, an internal standard, and to authentic analytical standards of each analyte; ii) the peak must have the correct mass transition, maximising at the correct retention time; iii) the signal to noise ratio of any peak must be greater than 3:1. In order to prove the absence of a given PFC, the internal standard must be present in all extracts, the blank extract must show no signal at the retention time of the target PFC, whilst the overspiked extracts must show a peak for the target PFC at the required retention time.

PAHs

Extraction and Purification

Reference standards for PAHs and ^{13}C labelled surrogates used as internal standards were purchased from LGC Standards (Welwyn Garden City, Herts) and Qm_x (Thaxted, Essex) as solutions in n-nonane, iso-octane or hexane with a specified 10% tolerance on concentration. The internal standard solution used contained nominal concentrations of 200 pg/µl of each of nine ^{13}C labelled analogues of the selected PAH compounds. Sensitivity standard solution contained ^{13}C PCB 52 and ^{13}C PCB 202 at a nominal concentration of 200 pg/µl. All internal and sensitivity standard solutions were in n-nonane

Cyclohexane, dichloromethane, methanol and n-nonane were purchased as doubly glass distilled (Rathburn, Scotland). The adsorbent used for chromatographic purification was Silica 60A, Spherical (YMC, Japan) and was used after activating overnight at 450°C and then deactivating with water (5% w/w), keeping the container sealed except when withdrawing material for use. All other chemicals employed were analytical reagent grade materials.

All equipment was scrupulously cleaned and thoroughly rinsed with dichloromethane prior to use. Care was taken to avoid airborne contamination of containers by keeping vials capped even when empty and covering flasks and concentration tubes with cleaned aluminium foil.

Samples were fortified with ^{13}C labelled internal standards, saponified with methanolic potassium hydroxide and extracted with cyclohexane. Crude extracts were purified by partitioning into dimethyl formamide followed by application to silica gel columns. The concentrations of PAHs were determined using gas chromatography with mass spectrometric detection (GC-MS) and quantified with reference to the ^{13}C labelled internal standards.

GC-LRMS determination of PAHs

GC-low resolution mass spectrometry was performed on a MSD5973 *inert* quadrupole instrument (Agilent Technologies, Strathaven) coupled to a 6890N Network gas chromatograph system fitted with a 7683 series autosampler or a Thermo Finnigan Trace GC-MS fitted with an AS 2000 autosampler. Chromatographic separation was performed using a 60m J&W DB-5 capillary column. Sample introduction was carried out via a PTV injector with the following programme; 50°C, hold 1min; 10°C/sec to 320°C, hold 40 min.. The oven temperature programme consisted of a 2.5 min isothermal period at 60°C followed by heating at 7°C/min to 215°C with a 5 min isothermal period then at 2°C/min to 260°C with a 3 min isothermal period and finally at 3.5°C/min to 340°C with an isothermal period of 15 min. Electron ionisation was used. The detector was operated at a setting of 1600 EM Volts or equivalent. Selected ion monitoring was used, and the two most intense ions from the molecular ion cluster were measured for each homologue. The raw data obtained from these measurements was processed to calculate the mass of each PAH compound using Masslynx 3.5 software supplied by Micromass. Results were exported into Excel for additional processing

Quality control (PAH measurements)

Each auto-sampled GC-MS run was preceded by analysis of a standard reference solution used to check system performance and calibration validity. All integrated chromatograms were scrutinised to assess chromatographic peak shape, resolution and signal-to-noise ratio.

The analytical procedure used is UKAS accredited to the ISO 17025 standard. Extracts were prepared in batches of 12 including at least one full method blank and at least one reference material. The blank was assessed for internal standard recoveries and for the presence of native PAHs. Blank analyses were deemed satisfactory in all cases.

The quality control sample was a reference material prepared by the BCR, (CRM458, PAHs in spiked coconut oil) (Luther et al 1997) which had 6 congeners with concentrations assigned by the BCR. Results for this CRM are given in Table 13.

RESULTS AND DISCUSSION

A list of samples including a description and CSL sample number is given in Table 1. More detail on the samples, including sampling locations and other parameters are given in Annexe 1 (Robinson 2009).

Analyte concentrations are presented in Tables 2–12. Data were rounded to two decimal places or fewer, as appropriate. For regulated contaminants, measurement uncertainty has been estimated in particular for PCDD/Fs, PCBs and PAHs but also for PBDD/Fs, PBDEs and PBBs as per the Eurachem guide (Ellison et al 2000). The estimate takes into account contributory parameters such as the individual uncertainties associated with fat content, sample size, results of the analysis of fortified samples, and limits of detection. Typical uncertainties, for example, for dioxins are of the order of 20% at the 1 ng/kg fat level, but can rise to around 200% at the limit of detection (typically 0.01 ng/kg fat, but dependent on the fat content and sample size). In perspective, this is the same degree of uncertainty achieved by FERA in recent international inter-comparison exercises (Norwegian Institute of Public Health, FAPAS, Quasimeme) where measurements were made at similar concentrations and results reported by the laboratory were in excellent agreement with consensus data.

The reporting limits (quoted as "<") for all analytes are estimated as a dynamic parameter and are therefore the limits of determination that prevail during the course of the measurement. For PCDD/Fs, PCBs, metals and PAHs, the limits are consistent with the requirements of EU regulations. The limits for the PBDD/Fs and PCNs were typically as low as sub-ng/kg (parts per trillion) levels on a fat weight basis, and typically as low as 0.01 μg/kg for PBDE and PBB measurements. For PFCs the LOD was set at 1 μg/kg. In general, for all analytes, the limits are either better, or equivalent to those reported in the literature.

Concentrations of chlorinated dioxins and furans and dioxin-like PCBs are normally reported as a toxic equivalent (TEQ), which is calculated by multiplying the concentration of each congener of interest by its toxicity equivalency factor (TEF). The TEFs are based on the toxicity of each congener relative to 2,3,7,8-TCDD. The World Health Organisation (WHO) defined a set of TEFs in 1998 (Van den berg et al 1998), but conducted a review and revised some of the values in 2005 (Van den berg et al 2006). Current EU regulations stipulate the use of the 1998 TEFs and these must therefore be used in assessing TEQ levels against regulatory limits. The data in the tables for PBDD/Fs and non-ortho PBBs is also supplemented by the addition of toxic equivalent values (TEQs). The application of analogous chlorinated dioxin and PCB toxic equivalent factors (TEFs) to estimate toxicity (TEQs) arising from PBDD/Fs and non-ortho PBBs is limited because a full and specific set of TEFs for these brominated contaminants has not yet been established, and are unlikely to be identical to the chlorinated analogues. The approach has been suggested (WHO 1998) as both chlorinated and brominated dioxins show similar biological effects such as induction of aryl hydrocarbon hydroxylase (AHH)/EROD activity and other toxic responses such as wasting syndrome, thymic atrophy and liver toxicity in a range of test animals (Behnisch et al 2003). The estimation of TEQ for the brominated contaminants is thus an interim measure, until specific TEF values that cover all the brominated congeners that show dioxin-like toxicity become available in the literature. The toxicities for these compounds continue to be studied (Birnbaum et al 2005) and potencies of some congeners, relative to 2,3,7,8-TCDD have been reported (Behnisch et al 2003, Hornung et al 1997, Olsman et al 2007) in the literature.

This report represents the first study of such a comprehensive set of contaminants in fish and as such is unique. The analysis of such a range of contaminants maximises the amount of information obtained from individual samples and may allow a greater range of correlation analysis than would otherwise be possible. The occurrence of these contaminants is discussed below and makes reference to individual results tables (Tables 2-12) as well as to Table 14 which summarises the occurrence (whole weight) of the principal contaminants based on frequency and levels of occurrence.

Heavy Metals

The concentrations of heavy metals in mg/kg of whole weight tissue are given in Table 2, with a summary for arsenic, cadmium, lead and mercury given in Table 14. Some metals such as manganese, zinc, copper, selenium and mercury were detected in all or most of the samples, irrespective of marine or freshwater origin. In general, silver, nickel and lead showed the lowest frequency of detection. The occurrence of arsenic showed a significant distinction between marine and freshwater species, with considerably higher values (mean 13.6; range 0.5-79 mg/kg) in the marine species contrasting with more than an order of magnitude lower (mean 0.2; range 0.04-1.3 mg/kg) values for the freshwater species. However most of this was found to be present in the less toxic organic form, as the inorganic component only amounted to a maximum of 2% contribution (herring) to the total arsenic, for the subset (n=27) of samples that were subjected to speciated analysis of arsenic (Table 2). The various species of marine ray showed the highest arsenic concentrations (29-79 mg/kg). The corresponding range of arsenic concentrations from an earlier study (FSA 2005) on a range of more commonly consumed fish was 0.12 mg/kg for surimi to 20.17 mg/kg for skate. In this study the two samples of skate investigated showed levels of 16.9 and 25.8 mg/kg, showing close agreement with the data from the earlier study. Concentrations of mercury ranged from <0.003 mg/kg to 0.75 mg/kg for a sample of ling. In contrast to arsenic, most of the mercury present in a sub-set of largely marine fish (Table 2) was found to occur as the more toxic organic form of the contaminant. (Note that the methyl mercury measurements were carried out by a different laboratory with good agreement of the levels of total mercury measured by both laboratories). The difference between marine and freshwater species was less marked with freshwater species showing a range of 0.03 mg/kg to 0.45 mg/kg for a sample of pike. Mercury is regulated by the EC (Commission Regulation EC 1881/2006 as amended by 629/2008) with a general limit of 0.5 mg/kg for fish. Three samples of marine fish showed mercury concentrations that were above this limit. In the case of the sample of torsk, the value of 0.54 mg/kg is within the bounds of uncertainty of the measurement (17%), but the samples of ling and blue ling showed levels of 0.746 mg/kg and 0.629 mg/kg respectively. These species are known to accumulate higher levels of mercury (Victorian Govt 2008, Robinson 2009). For the two other metals that are regulated in fish - cadmium and lead, the highest levels of occurrence in this study were seen primarily in the shellfish. The levels of cadmium were lower (0.10-0.22 mg/kg) than lead (0.24-1.55 mg/kg) with the levels of regulation set at 1.0 and 1.5 mg/kg shellfish for cadmium and lead respectively. Occurrence at this limit for lead was seen in a single sample of shellfish (Mussels, Ardmore-Table 2) which is within the bounds of measurement uncertainty (13%). Similarly, the sample of black scabbard fish returned a value of 0.059 mg/kg for cadmium (measurement uncertainty - 20%), the regulated limit for which is 0.05 mg/kg. The fish species that have shown exceedances are not widely retailed in the UK and are therefore not commonly consumed by the general population.

Dioxins and PCBs

Fish show a marked tendency to bio-accumulate persistent organic contaminants and the fish and shellfish samples analysed for dioxins and PCBs showed near universal detection of all analysed congeners of these contaminants (Tables 3-6, and summary Table 14). The few instances of lack of detection were usually caused by low available sample weight or congeners which do not normally tend to occur (1,2,3,7,8,9-HxCDF, 1,2,3,4,7,8,9,HpCDF and the higher chlorinated PCBs – 206, 208 and 209). This occurrence is not remarkable – in the TDS studies carried out by the FSA fish is one of the highest dioxin and PCB containing food groups and also the one with the slowest tendency to decline over time (Fernandes et al 2004B). In common with the other persistent organic pollutants measured in this work, the fresh-water species consistently showed higher average concentrations than the marine fish or the shellfish. At an average level of 1.12 ngWHO-TEQ/kg whole weight for dioxins and dioxin-like PCBs, the concentrations in freshwater fish were significantly higher than the marine species (0.34 ng/kg and 0.14 ng/kg WHO-TEQ for marine fish and shellfish respectively). As observed in other studies on fish and shellfish in the UK (Fernandes et al 2008, 2009, 2009B), the contribution to WHO-TEQ for the fish species arises mainly from dioxin-like PCBs (~70–82 %) whereas for the shellfish, dioxins contribute a larger proportion (~60%). These values are remarkably similar to the literature values. The most prominent non dioxin-like PCBs- (NDL PCBs) the Σ ICES-6 compounds (PCBs 28, 52, 101, 153, 138 and 180) are also summarised in Table 14 for the marine and freshwater samples. The European Food Safety Authority (EFSA) has recently reviewed the toxicity of these PCBs and the European Commission is in the process of proposing limits for them in food (EFSA 2005). For fish, in general, the concentrations of the ICES-6 PCBs closely follow PCB WHO-TEQ values (correlation co-efficient – 0.97-0.99 for this data), so unsurprisingly the average concentrations are similarly higher for the freshwater fish (14.7 μg/kg) compared to the marine fish (4.43 μg/kg) and shellfish (0.61μg/kg).

The dioxin and PCB WHO-TEQ content of fish has been regulated by the EC since 2002, with maximum permitted limits set at 4ng/kg WHO-TEQ on a whole weight basis for dioxins and 8 ng/kg WHO-TEQ for combined dioxin and PCB WHO-TEQ (Council regulation 118/2006). With a maximum detected dioxin and PCB WHO-TEQ of 3.5 ng/kg for a sample of Roach from the Forth and Clyde canal, it is clear that none of the fish or shellfish in this study breach these limits.

Brominated contaminants

PBDEs were detected in all the samples investigated and confirm the findings of earlier studies on fish and Scottish shellfish (Table 8). The occurrence profiles for fish generally reflect the congeners present in the most commonly used commercial PBDE mixture – Penta-BDE, with BDE-47 and BDE-99 generally dominating the profile with other prominent congeners- BDEs 49, 66 100, 153 and 154. In a few species, particularly marine fish such as spurdog and skate, BDEs 99/100 are the most prominent congeners either as a result of selective uptake or metabolism. In the shellfish samples however, the highest levels of occurrence are for BDE-209 rising to an order of magnitude greater than BDE-47. Mussels in the UK are known to show significant levels of BDE-209, irrespective of location (Fernandes et al 2009), but the average concentration at 0.26 μg/kg is 5-fold higher than the average observed for Scottish mussels in an earlier study (Fernandes et al 2008). This may indicate an increase in the environmental burdens of BDE-209 which would not be unusual as the use of the commercial mixture from which this congener derives was banned some years later (2008) than the other PBDE mixtures (RoHS directive 30 June 2008). However it would be prudent to note that the sample numbers were limited in both studies discussed and additionally, the average BDE-209 levels from the earlier study on Scottish shellfish did not investigate samples from the locations investigated here.

PBBs generally showed relatively low levels of occurrence (Tables 7 and 8). The most frequently detected congeners were PBB 49 and PBB 52 and these occurred typically in the range <0.001 – 0.003 μg/kg whole. The non-ortho substituted PBBs (congeners PBB77, PBB126 and PBB169) were also measured and of these PBB 77 was the most frequently detected. The relative concentrations of the flame retardants – PBBs (low levels) and PBDEs (higher levels) is consistent with the greater and more recent usage of PBDEs in the UK. The low levels of PBBs observed are likely to arise from long range marine and aerial transport as observed in the detection of this contaminant in tissue from Arctic polar bear (D'Silva et al 2006).

As with most foods investigated to date, the fish and shellfish species studied here show a higher frequency of occurrence of brominated furans compared to the brominated dioxins. Some brominated dioxins congeners, notably the penta- and hexa-brominated congeners were not detected in any of the samples which is consistent with the environmental occurrence of these compounds. However the tri-bromo dioxins (and furans) were detected, particularly in the shellfish, confirming earlier observations of their occurrence (Malmvern et al 2005, Fernandes et al 2009). A biogenically mediated formation mechanism has been proposed for the tri- and tetra-brominated dioxins (Haglund et al 2007), but the occurrence of a fuller range of non-laterally substituted furans at tri-, tetra- and penta- levels of halogenation suggest anthropogenic sources as well. In order to allow comparison with other studies, a toxic equivalent (TEQ) has been calculated for the PBDD/Fs (Table 7), using analogous chlorinated dioxin TEFs. The average TEQ value for the freshwater fish (0.03 ng/kg) was higher than the marine fish or the shellfish

Polychlorinated Naphthalenes

PCNs were measured in 52 of the 53 samples of fish and shellfish due to insufficient sample material for the remaining sample. PCNs were detected in all samples (Tables 9 and 14). Fish are known to bio-accumulate PCNs and the frequency of detection was observed for specific congeners rather than the species of fish or shellfish. The most abundant congeners were PCNs 52/60, 53 and the toxicologically significant PCNs 66/67, 68 and 69. Additionally, in the freshwater fish, PCN 71/72 also occurred to a significant extent. The more highly chlorinated congeners, particularly 74 and 75 were less frequently detected.

In common with the other lipophilic and persistent contaminants, PCNs were most abundant in the freshwater fish occurring at ~ an order of magnitude higher levels than the shellfish and ~3 fold higher average concentrations than the marine fish. Among the marine fish, the highest levels were all observed in the 3 samples of spurdog, suggesting species-selective bioaccumulation, whereas in the freshwater fish the highest levels occurred in samples of roach and perch from the Forth and Clyde canal.

The levels of PCNs observed in this study are broadly similar to the few, recently reported levels (Domingo et al 2003, Isosaari et al 2006, Fernandes et al 2009). In a recent study on PCNs in food in the UK, the highest levels were observed in retail fish and shellfish samples and the reported mean of 19.9 ng/kg whole weight compares with the average value of 22 ng/kg for freshwater fish in this study and 7.64ng/kg for marine fish. However, 10% of the samples in this study (both marine and freshwater) showed levels (37-103 ng/kg) that were at or above the maximum value reported for the food study (37 ng/kg). In another recent study in Spain, the reported sum of PCNs in fish was 39 ng/kg. However it should be noted that this literature value quoted refers to homologue totals as opposed to the sum of 11 congeners reported in this work. The choice of congeners selected in this study was based principally on the toxicological characteristics of individual PCN congeners and the levels of patterns of occurrence.

Phthalates

Fourteen phthalate compounds and 2 isomeric phthalate mixtures were determined in the fish and shellfish samples (Table 10). These analytes were detected infrequently and where detected, in some instances were usually below the limit of quantitation. To some extent the limited availability of sample material resulted in higher limits of detection than normally targeted. Occurrence was most commonly observed in the marine fish samples. Diethyl phthalate, diisopropyl phthalate, diisobutyl phthalate, di-n-butyl phthalate and di-(2-ethylhexyl) phthalate were the most commonly detected compounds. Where identified or tentatively identified, levels ranged from 16 µg/kg for di-n-butyl phthalate to 217 µg/kg for di-(2-ethylhexyl) phthalate. Additionally the diisononyl phthalate mixture was also identified in a sample of Torsk at 2409 µg/kg. The other compounds, diallyl phthalate, di-n-pentyl phthalate, benzyl butyl phthalate, dicyclohexyl phthalate, di-n-heptyl phthalate, di-n-octyl phthalate and di-n-decyl phthalate were not detected in any of the samples at typical LODs of 1-10 ug/kg but varying as per availability of sample. Similarly apart from the sample of Torsk, the isomeric mixes diisononyl phthalate and diisodecyl phthalate were not detected in any of the samples. In general, the concentrations of phthalates observed in these samples are similar in comparison to other foods. A study in the Netherlands (Peijnenburg W and Struij 2006) found that levels of di-n-butyl phthalate in fish were often below the LOD. Nevertheless, mean values around 1.8 µg/kg were found for both di-(2-ethylhexyl) phthalate and di-n-butyl phthalate. A more recent study from Taiwan (Huang et al 2008) analysed dried fish samples, reporting levels ranging from <50 µg/kg to 254 mg/kg dw for a set of 6 phthalates. The highest levels were observed for di-(2-ethylhexyl) phthalate, whilst dimethyl phthalate showed low concentrations or was not detected.

Perfluorinated compounds

A sub-set of 5 marine fish samples and 5 fresh-water fish samples were analysed for perfluorinated compounds. The selection of the samples was based mainly on the availability of sample material. The results for these analyses are given in Table 11. Of the 11 perfluorinated compounds that were targeted for analysis, two, -perfluorodecanoic acid (PFDeA, at 1-2 µg/kg) and perfluorooctane sulphonate (PFOS at 2-8 µg/kg) were detected and these were mainly in samples of freshwater fish. One sample of marine fish (Spurdog) also showed the occurrence of PFOS (3 μg/kg). There is very little literature data available to compare these results. One study on the levels of PFCs in the blood of fishes from wastewater outflows (Li et al 2008) reported that PFOS was the most abundant PFC detected and was found at levels of mean concentrations ranging from 5.74 to 64.2 ng/ml blood serum in species such as carp, catfish and tilapia. A Belgian study (De Voogt et al, 2008) on dietary food items reported a PFOS level of 2.6 μg/kg in cod, and in the UK, a recent study on occurrence of PFCs in different foods (Clarke et al 2009) showed comparable levels of occurrence in samples of retail fish.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs were detected in all the mussel samples analysed (Table 12). The sample from Nigg Bay, Inverness, showed the highest levels, but in general the concentrations for the various compounds were in a similar range to earlier data reported for mussels sampled in Scotland in 2006 (Fernandes et al 2006). The concentrations of benzo[a]pyrene detected in the samples did not exceed the MPL of 10 μg/kg specified in EU regulations (Commission regulation (EC) N. 208/2005). Fluoranthene, pyrene, benzo(b)fluoranthene and benzo(e)pyrene were generally the compounds that occurred to the greatest extent in the samples studied. Among the toxicologically significant compounds highlighted by the SCF (SCF 2002), some of the higher molecular weight PAHs (anthanthrene, dibenzopyrenes) were generally not detectable (< 0.1 μg/kg).

Contaminants in marine species

The samples of marine fish comprised 23 species, which showed varying amounts of contaminant loading. In general, higher concentrations of the more toxic heavy metals were observed with relatively lower concentrations of organic contaminants. The various species of ray and skate were characterised by relatively lower concentrations of organic contaminants (see ranking in Table 15) but some of the highest levels of Arsenic found in this study. Similarly, some of the dogfish family also showed relatively higher levels of arsenic as well as mercury, and low levels of organic contaminants, with the exception of the samples of spurdog which amongst the marine species also showed the highest concentrations of organic contaminants. The contamination pattern observed in most rays and dogfish was also seen in samples of Torsk and Ling/Blue Ling, the latter species in particular, which showed the highest mercury concentrations. Horse mackerel/mackerel and black scabbard showed significant levels of Cadmium and moderately high levels of organic contaminants as well. The general pattern for marine fish was not observed in the sample of herring which showed low levels of the more toxic metals, but relatively high levels of organic contaminants. Most of the other marine fish species showed relatively low levels of organic contaminants (see Table 15).

The five samples of marine mussels showed the highest concentrations of cadmium and lead, of all the samples analysed. However, concentrations of arsenic were relatively low and mercury levels were among the lowest recorded in the study. The sample taken at Ardmore on the Clyde showed the highest levels of contamination, although organic contaminants ranged from moderately high to low (Table 15).

Contaminants in freshwater species

Although limited by the number of freshwater samples (16 samples covering 5 species – Table 1), the general observation on the freshwater species was that the predominant contaminants appeared to be organic. Zinc levels were high, but most of the heavy metals studied including the more toxic elements such as arsenic and mercury, occurred at very low levels. This was true for all of the 5 species studied (trout, perch, pike, roach and eel), except for eels which showed relatively higher concentrations of cadmium and a pike sample which showed a higher concentration of mercury.

Eels and roach generally showed the highest concentrations of dioxins, PCBs PBDEs and brominated dioxins. The highest concentrations of PCNs were also observed in the samples of roach, but this may be related to location, as the 3 roach samples were taken from the same stretch of water (Forth and Clyde canal, see Annexe 1 for locations) from which a sample of perch also showed high levels of PCNs. This view may be reinforced by the sample of pike from this location, which showed a similar ranking (Table 15) for organic contaminants to the pike sample from Loch Achray, despite the smaller size of the former (the sample was made of several juveniles with a maximum length of 15 cms). A similar observation on the influence of location may be made for the 6 samples of brown trout. Among the freshwater samples, this species showed the lowest contaminant concentrations except for the sample from the river Eden, which showed relatively high levels of PBDEs. The other sample from the river Eden (eel) showed the highest PBDE concentration in the study. In general, samples taken from locations in the Southwest (Lochar water, Water of Girvan, Kirtle water) showed lower concentrations. Given the small number of samples per species, the above discussion is at best, indicative of contamination amongst species, as size, age, location, sex, season etc may all influence contaminant loading.

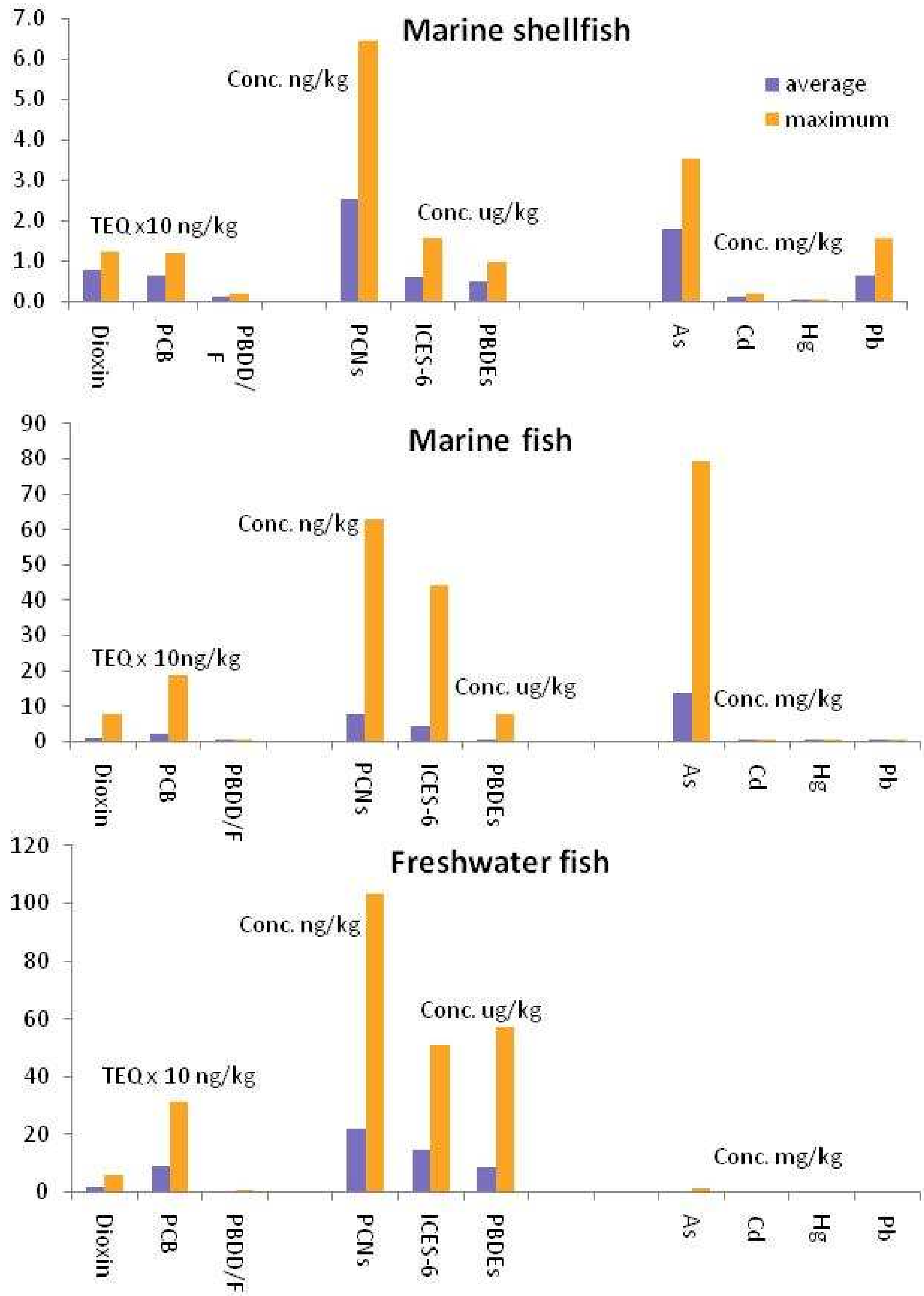
Concluding Remarks

The results of this study confirm the occurrence of a wide range of environmental contaminants in fish and shellfish and underline the ubiquity and persistence of these compounds. This is evident from the occurrence of both, legacy contaminants such as the PBBs, PCNs, PCBs and metals, as well as more recently introduced chemicals such as deca-BDE and the PFCs. All of these contaminants elicit toxic responses in both, animals and humans, and the mechanisms and magnitude of these responses has led to some of these contaminants being regulated or near-regulated. (The absence of regulation for the others may simply result from a lack of toxicological information or data). For the organic contaminants, it is clear that no fish or shellfish samples in this study breach the existing regulated limits - for dioxin and PCB WHO-TEQ for example, the maximum levels detected were in a freshwater sample of roach with a concentration of 3.5 ng/kg against a maximum permitted value of 8 ng/kg (Table 14). For the heavy metals some minor excursions beyond the maximum limits occur, in particular for mercury, in a few species of marine fish, although these are not widely retailed within the UK.

It is also clear that for the major contaminants, fresh-water fish show higher levels of contamination (apart from heavy metals, especially arsenic and mercury which occur at relatively higher levels in marine fish) than the marine species (Figure 1 and Table 14). The ranking of all samples (Table 15) based on the concentrations of the major organic contaminants (dioxins, dioxin-like PCBs, PBDEs, brominated dioxins, non-dioxin-like PCBs and PCNs) confirms this view, as fresh-water fish samples generally showed the highest scores. This is remarkable given that unlike most of the marine fish samples, many of the fresh-water samples received were made up of a number of small sized fish (average 15-20 cm in length) that would be unlikely to be consumed. The size of fish within a species taken from different locations, e.g. brown trout or eels, failed to show a correlation with the levels of contamination. The ranking in Table 15 also indicates that some species may show higher levels of bio-accumulation – spurdog and herring from among the marine species, and eel and roach from the freshwater fish. It is likely therefore that occurrence in fish, and freshwater fish in particular, is influenced by location, in addition to the type of species and size e.g. the highest levels of PBDEs were seen in the relatively small-sized fish from the river Eden, and the highest levels of PCNs were observed in the samples of roach and perch from the Forth and Clyde canal. It is likely, given the bio-accumulative nature of these contaminants, that larger and older fish, within the same location would tend to show higher levels of contamination, but the limited number of samples did not allow this aspect to be investigated.

This data may be used to estimate levels of dietary intake for those members of the population who consume these fish and shellfish, but considerable uncertainty would remain within these estimates, given the observations made above, particularly for the freshwater fish. The data also provide an essential measure of the background levels of contamination for a wide range of emerging and existing contaminants. A parallel study funded by the Food Standards Agency, that investigates a similar range of contaminants in freshwater fish from uncontrolled waterways in other parts of the UK, is currently underway. This will provide a second set of data on freshwater fish within the UK. The two sets of complementary data will provide a better picture of contemporary contamination levels and may allow more refined estimates of human exposure.

Figure 1: Average and maximum occurrence of major contaminants by type of fish/shellfish
(Note: 1.TEQ Values scaled, 2. Units vary, depending on contaminant)



REFERENCES

Ashizuka Y, Nakagawa R, Hori T Tobiishi K Lida T (2005) Determination of PBDEs and PBDD/Fs in marine products. *Journal of Agric. and food Chem,* **53**, 3807-3813.

Barontini F Cozzani V Cuzzola A Petarca L *Rapid communications in mass spectrometry,* 15, (2001), 690-698.

Behnisch P, Hosoe K and Sakai S (2003) Brominated dioxin-like compounds: in vitro assessment in comparison to classical dioxin-like compounds and other polyaromatic compounds. *Environ. Int*. **29,** 861-877

Birnbaum L, Staskal D and Diliberto J, (2003) Health Effects of PBDDs and PBDFs *Environment International* **29**, 855-860

Blankenship A., Kannan K., Villalobos S., Villeneuve D., Falandysz J., Imagawa T., Jakobsson E., Giesy J. P. (1999): Relative potencies of Halowax mixtures and individual polychlorinated naphthalenes (PCNs) to induce Ah receptor-mediated responses in the rat hepatoma H4IIE-luc cell bioassay. *Organohalogen Compounds,* **42,** 217-220.

Blankenship A., Kannan K., Villalobos S., Villeneuve D., Falandysz J., Imagawa T., Jakobsson E., Giesy J. P. (2000): Relative potencies of Halowax mixtures and individual polychlorinated naphthalenes (PCNs) to induce Ah receptor-mediated responses in the rat hepatoma H4IIE-Luc cell bioassay. *Environ. Sci. Technol.* **34(15),** 3153-3158.

British Standards Institute, London, (1970), Methods of test for meat and meat products, Determination of total fat content, BS4401, Part 4

Clarke D, Bailey V, Routledge A, Lloyd A, Mortimer D and Gem M.(2009) Dietary intake estimate for perfluorooctanesulphonic acid (PFOS) and other perfluorocompounds (PFCs) in English retail foods following determination using standard addition LC-MS/MS. *Food Additives and contaminants* (in preprartion)

Commission Directive 2002/69/EC of 26/07/2002 establishing requirements for the methods of analysis of dioxins and dioxin-like PCBs in food stuffs, Official Journal of the European Communities, L 209, 2002, p5-14

Commission regulation (EC) N. 466/2001 setting maximum levels for certain contaminants in foodstuffs *Official Journal of the European Communities,* L77/1 16.3.2001, p1-13

Commission regulation (EC) N. 221/2002 amending regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs *Official Journal of the European Communities*, L37/4 7.2.2002, p1-6

Commission regulation (EC) N. 208/2005 amending regulation (EC) No 466/2001 as regards polycyclic aromatic hydrocarbons, 4 February 2005

Council Regulation (EC) No 2375/2001 of 29/11/2001 amending Commission Regulation No 466/2001 setting Maximum levels for certain contaminants in foodstuffs, *Official Journal of the European Communities*, L321 06.12.2001, p1-5

Council Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs *Official Journal of the European Union*, L364/5-24, 20.12.2006

Covaci A Bervoets L, Hoff P, Voorspoels S, Voets J et al (2005) PBDEs in freshwater fish and mussels from Flanders, Belgium. J. Environ. Monit., **7(2)** , 132-6

Darnerud P, (2003). Toxic effects of brominated flame retardants in man and in wildlife *Environment International*, **29**, 841-853.

De Voogt P, Van der Wielen F, Westerveld J, D'Hollander W and Bervoets L (2008) Determination of PFCs in food and dust. *Organohalogen compounds* **70** 714-717.

D'Silva K Fernandes A and Rose M (2004) Brominated Organic Micropollutants – Igniting the flame retardant issue. *Critical Reviews in Env Sci and Tech,* **34(2)** p141-207

D'Silva K Fernandes A and Rose M (2006) Halogenated organic contaminants in polar bears (*Ursus maritimus*). Proceedings, First network conference on persistent organic pollutants, Birmingham, March 2006.

EFSA -European Food Safety Authority (2005) Opinion of the Scientific Panel on contaminants in the food chain [CONTAM] related to the presence of non dioxin-like polychlorinated biphenyls (PCB) in feed and food 2005; EFSA-Q-2003-114, available at www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620803980.htm

EFSA opinion (2008) "Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts" (Question No EFSA-Q-2004-163) Available at: www.vwa.nl/cdlpub/servlet/CDLServlet?p_file_id=32444

Ellison, S., Rosslein, M. and Williams, A. (2000) *Quantifying Uncertainty in Analytical Measurement*. Eurachem/CITAC Guide

Emsley A, Lim L. and Stevens G. (2002). International fire statistics and the potential benefits of fire counter-measures. Paper presented at Flame Retardants 2002. Interscience Communications Limited, London.

Engwall M., Brundstrom B., Jakobsson E. (1994): Ethoxyresorufin O-deethylase (EROD) and arylhydrocarbon hydroxylase (AHH) - inducing potency and lethality of chlorinated naphthalenes in chicken (*Gallus domesticus*) and eider duck (*Somateria mollissima*) embryos. *Arch. Toxicol*. **68**, 37-42.

Environmental Health Criteria 205: Polybrominated Dibenzo-p-dioxins and Dibenzofurans. World Health Organisation, Geneva, Switzerland (1998).

FAPAS® (2003), Environmental Contaminants Report 0614. Series 6, Round 14. FAPAS, Central Science Laboratory, Sand Hutton, York, UK.

Fernandes A White S, DSilva K and Rose M (2004), Simultaneous Determination of PCDDs, PCDFs, PCBs and PBDEs in Food, *Talanta*, **63**, 1147-1155

Fernandes A, Gallani B, Gem M, S White S, and Rose M (2004B) Trends in the dioxins and PCB content of the UK diet, *Organohalogen compounds*, **66**, 2053 - 2060

Fernandes A, Smith F, Driffield M, White S and Rose M (2006) Brominated and Chlorinated contaminants and PAHs in shellfish flesh from Scottish Innshore and Offshore harvesting areas. (2006) Report to the Food Standards Agency, Scotland. CSL Report FD 06/04

Fernandes A, Dicks P, Mortimer D, Gem M, Smith F, Driffield M, White S and Rose M (2008) Brominated and Chlorinated Dioxins and Brominated Flame Retardants in Scottish Shellfish: Methodology, Occurrence and Human Dietary Exposure *Molecular Nutrition and Food Research*, **52(2)**, 238-249

Fernandes A, Smith F, Carr M, Panton S and Rose M (2008B) Investigation of the occurrence of polychlorinated naphthalenes and chlorinated paraffins in food. (2006) Report to the Food Standards Agency, CSL Report FD 08/03

Fernandes A, Mortimer D, Dicks P, Gem M, Smith F, and Rose M (2009) Brominated dioxins (PBDD/Fs), PBBs and PBDEs in Marine Shellfish in the UK. *Food Additives and Contaminants,* 26(6) 918-927

Fernandes A, Mortimer D.N., Rose, M., Knowles, T.G & Gem, M. (2009B) The Occurrence of Dioxins (PCDDs, PCDFs) and PCBs in Wild, Farmed and Processed Fish, and Shellfish *Food Additives and Contaminants B*, **2(1)**, 15-20

Fernandes A, Tlustos C, Smith F, Carr M, Petch R and Rose M (2009C) Polybrominated diphenylethers (PBDEs) and Brominated dioxins (PBDD/Fs) in Irish Food of Animal Origin *Food Additives and Contaminants B,* **2(1)**, 86-94

Fernandes A, Mortimer D., Gem M., Dicks P, Smith F., S Rose M, Panton S, and Carr M (2009D). Polychlorinated Naphthalenes (PCNs): Congener specific analysis, occurrence in food and dietary exposure in the UK *Environ. Sci. Technol.*, 2010, 44 (9), pp 3533–3538

Food Safety Authority of Ireland (2002), Summary of Investigation of Dioxins Furans and PCBs in Farmed Salmon, Wild Salmon, Farmed Trout and Fish Oil Capsules. Available at www.fsai.ie/surveillance/food/surveillance_food_summarydioxins.asp

Food Standards Agency, (2003), Dioxins and dioxin-like PCBs in the UK diet: 2001 total diet study samples, Food Surveillance Info. Sheet No. 38/2003, FSA, London

Food Standards Agency, (2005), Polycyclic aromatic hydrocarbons in shellfish. Food Surveillance Information Sheet No. 83/2005, FSA, London

Food Standards Agency (2006a) Dioxins and PCBs in wild and farmed fish and shellfish. Food Safety Information Sheet 03/06 Available at:

http://www.food.gov.uk/science/surveillance/fsisbranch2006/fsis0306

Food Standards Agency (2006b) Brominated chemicals in farmed and wild fish and shellfish and fish oil dietary supplements Food Safety Information Sheet 04/06. Available at:http://www.food.gov.uk/science/surveillance/fsisbranch2006/fsis0406

Food Standards Agency (2006c) Brominated chemicals: UK dietary intakes. Food Surveillance Information Sheet 10/06 available at www.food.gov.uk/multimedia/pdfs/fsis1006.pdf

Food Standards Agency (2009) Survey on measurement of the concentrations of metals and other elements from the 2006 UK total diet study. Food Surveillance Information Sheet No. 01/2009, FSA, London

Garraud H, Vacchina V, Seby F, Dumont J, Sirot V, Guerin T, Leblanc J (2007) Analytical methodologies for the speciation of trace metals in seafood samples in a benefit/risk approach (CALIPSO study) *Annales de Toxicol. Analytique*, **19(1)**, 71-80

Gilpin R, Wagel D and Solch J, in A Schecter and T Gasiewicz, eds. Dioxins and Health, 2nd Edition, Wiley and Sons Inc Hoboken, New Jersey, USA, (2003), pp55 –88.

Griepink B, Wells Dand Ferreira M (1988), The certification of the contents (mass fraction) of chlorobiphenyls (IUPAC Nos 28, 52, 101, 118, 138, 153 and 180) in two fish oils: cod-liver oil CRM No 349; mackerel oil CRM No 350, Report EUR11520EN, CEE, Community Bureau of Reference.

Guruge, K. S., Manage, P. M., Yamanaka, N., Miyazaki, S., Taniyasu, S., and Yamashita, N., 2008. Species-specific concentration of perfluoroalkyl contaminants in farm and pet animals in Japan. *Chemosphere*, **73**, S210-S215.

Haglund P, Malmvarn A, Bergek S, Bignert A, Kautsky L, Nakano T, Wiberg K and Asplund L (2007), Brominated dibenzo-p-dioxins: A new class of marine toxins *Env Sci and Technol*, **41**, 3069-3074

Hakk H.and Letcher R, (2003) Metabolism in the toxicokinetics and fate of brominated flame retardants—a review, *Environment International*, **29**, 801-828

Hale R, Laguardia M, Harvey E, Mainor M, Duff W, Gaylor M. (2001) PBDE flame retardants in Virginia freshwater fishes (USA). *Env Sci and Technol,* **35**, 4585-4591

Hanberg A, Waern F, Asplund L, Haglund P, Safe S. (1990): Swedish dioxin survey: determination of 2,3,7,8-TCDD toxic equivalent factors for some polychlorinated biphenyls and naphthalenes using biological tests. *Chemosphere* **20**, 1161-1164.

Hashimoto S, Hyeon-Seo C and Morita M (1998) PCDDs and PCDFs in shellfish from the south coast of Korea. Chemosphere, **37(5**) 951-959.

Hauser, R, Meeker JD, Duty S, Silva MJ and Calafat AM 2006. Altered Semen Quality in Relation to Urinary Concentrations of Phthalate Monoester and Oxidative Metabolites. *Epidemiology* **17** p682-691

Health Canada. Fish and Seafood survey, Available at:
www.hc-sc.gc.ca/food-aliment/ cs-ipc/fr-ra/e_seafood_survey.html - 19k - 1 Mar 2005

Hites R, Foran J, Carpenter D, Hamilton M, Knuth B, Schwager S (2004). Global assessment of organic contaminants in farmed salmon. *Science* **303**: p226

Hornung L, Zabel E and Peterson R (1996), TEFs of PBDD/F, PBB and PBDE congeners based on rainbow trout early life stage mortality.
Toxicology and Applied Pharmacology, **140,** 227- 234

Huang P, Tien C, Sun Y, Hsieh C and Lee C (2008). Occurrence of phthalates in sediment and biota: Relationship to aquatic factors and the biota-sediment accumulation factor. *Chemosphere*, **73(4)** 539-544

Iino F, Imagawat T, Takeuchi M and Sadakata (1999) De novo synthesis mechanism of polychlorinated dibenzofurans from polycyclic aromatic hydrocarbons and the characteristic isomers of polychlorinated naphthalenes
Environmental Science & Technology **33,** 1038-1043

Ishak R, Karlson K and Naf C (1999) Tissue distribution of (PCNs) and non-*ortho* chlorinated biphenyls (non-*ortho* CBs) in harbour porpoises (*Phocoena phocoena*) from Swedish waters *Chemosphere* **41**(12), 1913-1925

Isosaari P et al (2006) Dioxins, PCBs PCNs and PBDEs in edible fish caught from the Baltic sea and lakes in Finland *Env Pollution*, **141**, 213-225

Jacobs M, Covaci A and Schepens P (2002) Investigation of selected Organic Pollutants in Farmed Atlantic Salmon, Salmon Aquaculture feed and fish oil componenets of the feed. *Environ. Sci. Technol*., **36**, 2797-2805

Kannan, K., Yamashita, N., Imagawa, T. et al. (2000) Polychlorinated naphthalenes and polychlorinated biphenyls in fishes from Michigan waters including the Great Lakes *Environmental Science & Technology* **34,** 566-572

Li Xuemei, Yeung L, Xu M, Taniyasu S, Lam P, Yamashita N and Dai J (2008). PFOS and other fluorochemicals in fish blood collected near the outfall of wastewater treatment plant (WWTP) in Beijing. *Environmental Pollution* 156(3) 1298-1303

Lloyd A, Bailey V, Routledge A and Clarke D (2009) Mass spectral studies towards more reliable measurement of PFCs in foos using LC-TMS. *Rapid Communications in Mass spectrometry*. **23** 2923-2938

Luther W, Win T, Vaessen H, Van de Kamp C, Jekel Jacob A, Boenke A, 1997, The certification of the mass fraction of Pyrene, Chrysene, Benzo[k]fluoranthene, Benzo[a]pyrene, Benzo[ghi]perylene and Indeno[1,2,3-cd]pyrene in two coconut oil reference materials (CRM458 and CRM459). Report EUR17545EN, Commission of the European Communities, Community Bureau of Reference

Maier E Van Cleuvenbergen R Kramer G Tuinstra L and Pauwels J (1995), BCR (non-certified) reference materials for dioxins and furans in milk powder, *Fresenius Journal of Analytical Chem.*, 352, 179-183.

Malmvarn A, Zebuhr Y, Jensen S, Kautsky L, Greyerz E, Nakano T & Asplund L (2005) Identification of PBDDs in blue mussels (mytilus edulis) from the Baltic sea. *Env Sci and Technol*, **39**, p 8235-8242

Norwegian Institute of Public Health Oslo, Norway, (2003) "Interlaboratory Comparison on dioxins in food – Fourth round of an International Study" Rapport 2003:12, ISBN 82-8082-049-3

Norwegian Institute of Public Health, Oslo, Norway, (2005) "Interlaboratory Comparison on dioxins in food – Sixth round of an International Study" Rapport 2005:7 ISBN 82-8082-145-7

Norwegian Institute of Public Health, Oslo, Norway, (2007) "Interlaboratory Comparison on dioxins in food – Eight round of an International Study" Rapport 2007:7 ISBN 978-82-8082-216-1

Norwegian Institute of Public Health, Oslo, Norway, (2009) "Interlaboratory Comparison on dioxins in food – Eight round of an International Study" (in press)

Olsman H et al (2002) Formation of dioxin-like compounds as photoproducts of DeBDE during UV-irradiation, Organohalogen Compounds, 58, (2002), 41-44.

Olsman H, Engwall M, Kammann U, Klempt M, Otte J, Van Bavel B, and Hollert H (2007) Relative differences in Ah Receptor-mediated response for 18 polybrominated and mixed halogenated dibenzo-p-dioxins and furans in cell lines from four different species. *Env Toxicol. and Chem*. **26(11)**, p 2448-2454

Peijnenburg W and Struij J (2006) Occurrence of phthalate esters in the environment of the Netherlands. *Ecotoxicol Env. Safety,* **63(2),** 204-15

Phthalate briefing – World wildlife fund (1996)
http://www.ngo.grida.no/wwfneap/Publication/briefings/Phthalates.pdf

Quasimeme Round 37 exercise 618, Data Assessment report. (Nov 2004) Quasimeme Project Office, Aberdeen ,UK

Rose M, Lewis J,langford N, Baxter M, Origgi S, Barber M, Macbain H, Thomas K (2007) Arsenic in seaweed-forms, concentration and dietary exposure, *Food and Chem Tech* , **45,** 1263-1267

RoHS Directive. Restriction of Hazardous Substances Directive of 30 June 2008. SI 2008 No. 37.

SCF (2002) .Opinion of the Scientific Committee on Food on the risk to human health of Polycyclic Aromatic Hydrocarbons in food, SCF/CS/CNTM/PAH/29 Final, 2002

So, M. K., Taniyasu, S., Lam, P. K. S., Zheng, G. J., Giesy, J. P., and Yamashita, N. A, 2006. Alkaline digestion and solid phase extraction methods for perfluorinated compounds in mussels and oysters from South China and Japan. *Arch. Environ. Contam. Toxicol.*, **50**, 240-248

Spiegelstein M , (2001) Proceedings, BFR 2001, Stockholm, (p41) .
Pubs.AB Firmatryck, Stockholm

Takasuga T, Inoue T, Ohi E, Kumar K (2004)
Formation of PCNs, PCDD/Fs and organochlorine pesticides in thermal processes and their occurrence in air. *Arch Environ, Contam Toxicol* 46 419-431)

Van den Berg M., Birnbaum L., Bosveld A.T.C., Brunström B., Cook P., Feeley M., Giesy J.P., Hanberg A., Hasegawa R., Kennedy S.W et al (1998) Toxic Equivalency Factors (TEFs) for PCBs PCDDs and PCDFs for humans and wildlife. *Environmental Health Perspectives*, **106**, 775-792

Van den Berg, M.; Birnbaum, L. S.; Denison, M.; De Vito, M. ;Farland, W.; Feeley, M.; Fiedler, H.; Hakansson, H.; Hanberg, A.; Haws, L.; Rose, M.; Safe, S.; Schrenk, D.; Tohyama, C.; Tritscher, A.; Tuomisto, J.; Tysklind, M.; Walker, N.; Peterson, R. E. (2006). The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. *Toxicol. Sci.* ***93***, 223–241.

Van de Plassche E and Schwegler A (2005)
"PCNs" (Royal Haskoning, The Netherlands). Available at:
www.unece.org/env/popsxg/docs/2005/EU%20polychlorinated%20napthalenes.pdf

Victoria Govt. Department of Health (2008) Mercury in fish factsheet. Available at:
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Mercury_in_fish

Villeneuve D. L., Khim J. S., Kannan K., Falandysz J., Blankenship A. L., Nikiforov V., Giesy J. P. (2000): Relative potencies of individual polychlorinated naphthalenes to induce dioxin-like response in fish and mammalian in vitro bioassays. *Arch. Environ. Contam. Toxicol* , **39(3),** 273-81

Weber R, Kuch B, OhnoT and Sakurai T. De Novo synthesis of mixed brominated – chlorinated PXDD/PXDF. (2002), *Organohalogen Compounds*, **56,** 181.

Weber R and Kuch B., Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated–chlorinated dibenzodioxins and dibenzofurans (2002), *Environment International*, **29**, 699-710.

Webster L et al (2008) Preliminary assessment of PBDEs in the Scottish aquatic environment including the Firth of Clyde. *J Environ Monit.* **10(4)** 463-73

WHO. 1998. Polybrominated dibenzo-*p*-dioxins and dibenzofurans.
Environmental Health Criteria **205**

Table 1: Description of Samples

Marine fish	Description	Fat %
16277	1 - Spurdog, ID: C356/001, 4.63kg	14.6
16278	2 - Spurdog, ID: C356/002, 5.61kg	8.15
16279	3 - Smooth Hound, ID: C356/003, 4.00kg	0.52
16280	4 - Starry Smooth Hound, ID: C356/004, 6.25kg	0.80
16281	5 - Thornback Ray, ID: C356/005, 4.33kg	0.79
16282	6 - Skate, ID: C356/006, 5.36kg	0.79
16283	7 - Hake, ID: C356/007, 4.21kg	3.03
16284	8 - Spotted Ray, ID: C356/008, 3.67kg	0.71
16285	9 - Cuckoo Ray, ID: C356/009, 3.44kg	0.59
16286	10 - Black-Mouthed Dogfish, ID: C356/010, 2.75kg	1.01
16287	11 - Lesser Spotted Dogfish, ID: C356/011, 4.55kg	0.51
16288	12 - Black Scabbard Fish, ID: C356/012, 4.82kg	2.23
16380	Torsk, 2 whole fish, ID: C356/013, 6.08kg	0.44
16384	Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1, 510M, 2.37kg	0.32
16385	Round Nose Grenadier, Whole Fish, ID: C356/15, 5.82kg	0.39
16386	Ling, Whole fish ID: C356/014, 6.18kg	0.66
16387	Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08, (106cm, 5500g) 1.71kg	0.45
16388	Monk fish -Tails x 2 ID: C356/16, 2.73kg	0.47
16552	John Dory,ID: C356/19, 0.49kg	1.59
16553	Haddock, ID: C356/20 1008S, 0.50kg	0.50
16554	Horse Mackerel, ID: C356/21 1008S, 0.34kg	2.75
16555	Hake, ID: C356/22 1008S, 1.24kg	0.77
16556	Herring, ID: 356/23 1008S, 0.21kg	16.1
16557	Mackerel, ID: C356/24 1008S, 0.34kg	25.4
16558	Ling, C356/25 1008S, 1.45kg	0.39
16559	Cod, ID: C356/26 1008S, 2.46kg	0.35
16560	Spurdog, ID: C356/27 1008S, 2.19kg	6.42
16561	Skate, ID: C356/28 1008S, 1.38kg	0.56
16763	Torsk, C356/29 S08/226 46E1 510m, 23/7/08, 1.64kg, P08-78060, S08-031183	0.30
16764	Hake, C356/030, S08/226 46E1, 510m, 23/7/08, 1.69kg, P08-78060, S08-031184	2.23
16765	Cuckoo Ray, C356/031, 1008S, 1.18kg S08-031185	0.46
16766	Monkfish, C356/032, 1008S, 0.94kg, P08-78060, S08-031186	0.28

Table 1(cont'd): Description of Samples

Freshwater Fish	Description	Fat %
16767	Roach, Forth & Clyde Canal, C356/033 (1) P08-78060, S08-031187	2.48
16768	Perch, Forth & Clyde Canal, C356/034, Port Dundas 29.10.08, 0.70kg, P08-78060, S08-031188	1.16
16769	Pike, Forth & Clyde Canal, C356/035, Port Dundas, 0.17kg, P08-78060, S08-031189	2.80
16770	Eel, Kirtle Water, C356/037, 26-8-08, 27-8-08, 1.01kg, P08-78060, S08-031190	18.5
16771	Trout, Kirtle Water, C356/038, 0.52kg, P08-78060, S08-031191	4.24
16772	Eel, Lochar Water, C356/039, 27-8-08, 0.48kg, P08-78060, S08-031192	14.8
16773	Trout, Lochhar W, C356/040, 27-08-08, 0.87kg, P08-78060, S08-031193	1.31
16774	Eel - R Eden, C356/041, 0.26kg, P08-78060, S08-031194	16.5
16775	Trout, R Eden, C356/042, 0.24kg, P08-78060, S08-031195	8.39
16776	Trout, W of Girvan, C356/043, 0.68kg, P078060, S08-031196	2.06
16777	Pike, L Achray, C356/044, 2.26kg, P08-78060, S08-031197	1.56
16778	Eel, R Leven, C356/045, 0.32kg, P08-78060, S08-031198	13.1
16779	Trout, Clyde, C356/046, 0.82kg, P08-78060, S08-031199	3.19
16808	Trout - White Cart W, C356/036, 422.63g inc foil, P08-79260, S08-032253	7.84
16939	Roach, Forth & Clyde Canal, C356/033 (2) 465.06g 16767	3.65
16940	Roach, Forth & Clyde Canal, C356/033 (3), 347.81g	1.45

Shellfish (Mussels)

16272	Mussels - FSA Ardmore 14/5/08, 493.996g inc tin	0.44
16273	Mussels - FJAS Blackness F of F, 18/5/08, 502.33g inc tin	0.26
16274	Mussels - Inverness Football Ground, 6/6/08, 427.198g inc tin	0.30
16275	Mussels - FSA Mussels Stannergate, 17/6/08, 636.08g inc tin	0.35
16276	Mussels - Inverness Nigg Bay, 21/6/08, 474.236g inc tin	0.38

Table 2. Concentrations of heavy metals (mg/kg tissue whole weight)

Sample ID	Description	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Ag	Cd	Hg	Pb
	Marine Fish												
16277	Spurdog	0.32	0.09	<0.003	0.06	0.41	2.9	11.5	0.3	<0.005	0.007	0.455	<0.005
16278	Spurdog	0.42	0.13	<0.003	<0.05	0.27	2.5	11.4	0.4	<0.005	0.021	0.442	<0.005
16279	Smooth Hound	0.55	0.1	0.004	<0.05	0.33	2.9	16.2	0.6	<0.005	0.004	0.453	0.006
16280	Starry Smooth Hound	0.34	0.1	0.006	<0.05	0.44	3.1	22.4	1.2	0.005	0.012	0.397	0.007
16281	Thornback Ray	0.75	0.22	0.004	0.05	0.32	5.2	36.7	0.5	<0.005	0.005	0.297	<0.005
16282	Skate	<0.05	0.19	<0.003	<0.05	0.22	4.3	16.9	0.4	<0.005	0.007	0.092	<0.005
16283	Hake	0.68	0.13	<0.003	<0.05	0.24	3	2.5	0.4	<0.005	<0.003	0.106	<0.005
16284	Spotted Ray	0.6	0.26	<0.003	<0.05	0.39	5	34.4	0.4	0.005	0.011	0.302	<0.005
16285	Cuckoo Ray	0.08	0.19	0.003	<0.05	0.42	5.4	29.1	0.3	0.005	0.01	0.205	<0.005
16286	Black-Mouthed Dogfish	0.9	0.21	0.003	<0.05	0.43	3.1	21.1	0.3	<0.005	0.007	0.316	<0.005
16287	Lesser Spotted Dogfish	1.44	0.27	0.004	0.05	0.38	9.7	19.7	0.4	0.008	0.017	0.364	0.006
16288	Black Scabbard Fish	0.34	0.21	<0.003	0.06	0.19	2.8	1.41	0.6	<0.005	0.059	0.267	<0.005
16380	Torsk	0.21	0.11	<0.003	<0.05	0.15	4	1.97	0.5	<0.005	<0.003	0.539	<0.005
16384	Greater Forkbeard	0.72	0.18	0.005	0.3	0.2	8.5	8.81	0.4	<0.005	0.004	0.218	0.009
16385	Round Nose Grenadier	0.31	0.09	<0.003	<0.05	0.09	1.9	6.56	0.3	<0.005	0.007	0.176	<0.005
16386	Ling	0.07	0.03	<0.003	<0.05	0.19	5	24.1	0.4	<0.005	<0.003	0.746	<0.005
16387	Blue Ling	1.91	0.19	0.008	0.76	0.15	3.8	9.34	0.5	<0.005	<0.003	0.629	0.005
16388	Monk fish	0.92	0.08	<0.003	<0.05	0.13	3.1	9.37	0.3	<0.005	<0.003	0.213	<0.005
16552	John Dory	0.14	0.21	<0.003	<0.05	0.11	3.9	0.48	0.3	<0.005	<0.003	0.035	<0.005
16553	Haddock	<0.05	0.05	0.004	<0.05	0.24	3.3	3.65	0.3	<0.005	<0.003	0.079	0.007
	Measurement LoD	**0.05**	**0.02**	**0.003**	**0.05**	**0.05**	**0.1**	**0.04**	**0.1**	**0.005**	**0.003**	**0.005**	**0.005**

Table 2 (cont'd). Concentrations of heavy metals (mg/kg tissue whole weight)

Sample ID	Description	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Ag	Cd	Hg	Pb
	Marine Fish												
16554	Horse Mackerel	<0.05	0.14	0.014	<0.05	1.38	6.3	2.19	0.9	<0.005	0.037	0.107	<0.005
16555	Hake	<0.05	0.06	<0.003	<0.05	0.15	2.6	0.85	0.3	<0.005	<0.003	0.093	<0.005
16556	Herring	<0.05	0.3	0.005	<0.05	1.25	5.7	2.18	0.5	<0.005	0.004	0.037	<0.005
16557	Mackerel	<0.05	0.1	0.007	<0.05	0.85	6.3	1.82	0.5	<0.005	0.016	0.029	<0.005
16558	Ling	<0.05	0.04	<0.003	<0.05	0.15	3.6	3.97	0.3	<0.005	<0.003	0.113	<0.005
16559	Cod	0.95	0.15	0.005	0.4	0.26	3.9	7.43	0.3	<0.005	<0.003	0.102	<0.005
16560	Spurdog	<0.05	0.13	<0.003	<0.05	0.38	2.8	8.31	0.4	<0.005	0.007	0.301	<0.005
16561	Skate	<0.05	0.14	<0.003	<0.05	0.18	3.9	25.8	0.3	<0.005	<0.003	0.124	<0.005
16763	Torsk	0.95	0.3	0.014	0.1	0.18	5.6	3.19	0.5	<0.005	<0.003	0.404	0.009
16764	Hake	0.16	0.18	0.012	<0.05	0.28	5.7	1.04	0.3	<0.005	<0.003	0.271	<0.005
16765	Cuckoo Ray	<0.05	0.31	0.008	<0.05	0.22	4.2	79.18	0.3	<0.005	<0.003	0.126	<0.005
16766	Monkfish	<0.05	0.14	0.008	<0.05	0.23	4.4	11.52	0.2	-0.007	<0.003	0.086	<0.005
	Measurement LoD	**0.05**	**0.02**	**0.003**	**0.05**	**0.05**	**0.1**	**0.04**	**0.1**	**0.005**	**0.003**	**0.005**	**0.005**

Table 2 (cont'd). Concentrations of heavy metals (mg/kg tissue whole weight)

Sample ID	Description	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Ag	Cd	Hg	Pb
	Freshwater fish												
16767	Roach	<0.05	0.67	0.005	<0.05	0.42	17.4	0.18	0.5	<0.005	<0.003	0.066	0.011
16768	Perch	<0.05	1.86	0.009	<0.05	0.26	8.7	0.05	0.5	<0.005	<0.003	0.041	0.021
16769	Pike	<0.05	0.67	0.01	<0.05	0.47	12.1	0.27	0.4	<0.005	0.004	0.06	0.013
16770	Eel	<0.05	2.23	0.02	<0.05	0.69	19.4	0.05	0.3	<0.005	0.023	0.134	0.034
16771	Trout	<0.05	0.23	0.017	<0.05	0.78	9.9	0.04	0.2	<0.005	<0.003	0.066	<0.005
16772	Eel	<0.05	3.79	0.029	<0.05	0.45	22.7	0.05	0.5	<0.005	0.028	0.115	0.015
16773	Trout	<0.05	0.62	0.016	<0.05	1.18	7.3	<0.04	0.3	<0.005	<0.003	0.032	0.017
16774	Eel	<0.05	1.57	0.034	<0.05	0.79	21	0.08	0.4	<0.005	0.009	0.089	0.015
16775	Trout	<0.05	0.43	0.021	<0.05	0.54	12.5	0.14	0.3	<0.005	<0.003	0.029	<0.005
16776	Trout	<0.05	0.35	0.019	<0.05	0.49	15.4	0.07	0.3	<0.005	<0.003	0.16	<0.005
16777	Pike	0.15	0.68	0.003	<0.05	0.27	5.5	0.3	0.5	<0.005	0.004	0.454	<0.005
16778	Eel	<0.05	4.49	0.042	<0.05	0.54	23.7	0.08	0.7	<0.005	0.039	0.104	0.084
16779	Trout	<0.05	0.95	0.021	<0.05	0.42	9.6	<0.04	0.4	<0.005	0.005	0.07	<0.005
16808	Trout	<0.05	0.19	0.018	<0.05	0.58	9.9	1.25	0.2	<0.005	<0.003	0.03	<0.005
16939	Roach	<0.05	0.45	0.004	<0.05	0.42	19.9	0.13	0.5	<0.005	<0.003	0.041	0.006
16940	Roach	<0.05	1.05	<0.003	<0.05	0.46	21.4	0.14	0.6	<0.005	<0.003	0.065	0.009
	Shellfish (Mussels)												
16272	Ardmore	1.99	8.18	0.174	0.44	1.66	15.1	1.96	0.6	0.011	0.216	0.047	1.551
16273	Blackness Fof F	0.68	3.39	0.11	0.28	1.23	8.4	1.19	0.6	0.006	0.104	0.036	0.522
16274	Inverness Football Ground	2.54	1.71	0.056	0.23	2.2	6.7	1.08	0.3	0.008	0.105	0.027	0.242
16275	Stannergate	1.04	3.54	0.101	0.35	1.02	5.8	1.14	0.3	<0.005	0.116	0.025	0.375
16276	Inverness Nigg bay	1.32	2.07	0.08	0.41	2.11	14.5	3.53	0.6	0.011	0.121	0.029	0.445
	Measurement LoD	**0.05**	**0.02**	**0.003**	**0.05**	**0.05**	**0.1**	**0.04**	**0.1**	**0.005**	**0.003**	**0.005**	**0.005**

Table 2 (cont'd). Concentrations of heavy metals – Speciated (inorganic) Arsenic and Methyl Mercury (MeHg)
mg/kg tissue whole weight

Sample No	Description	Total As	Inorganic As	% Inorganic	Sample No.	Description	MeHg	Tol. ±
16277	Spurdog	11.5	0.149	1.29	16277	Spurdog	0.50	0.04
16278	Spurdog	11.4	0.095	0.84	16278	Spurdog	0.50	0.06
16279	Smooth Hound	16.2	<0.009	0.06	16279	Smooth Hound	0.52	0.05
16280	Starry Smooth Hound	22.4	<0.011	0.05	16280	Starry Smooth Hound	0.38	0.05
16281	Thornback Ray	36.7	0.028	0.08	16281	Thornback Ray	0.27	0.02
16282	Skate	16.9	<0.013	0.08	16284	Spotted Ray	0.29	0.03
16283	Hake	2.5	<0.006	0.25	16285	Cuckoo Ray	0.20	0.01
16284	Spotted Ray	34.4	0.019	0.06	16286	Black-Mouthed Dogfish	0.32	0.03
16285	Cuckoo Ray	29.1	<0.015	0.05	16287	Lesser Spotted Dogfish	0.41	0.03
16286	Black-Mouthed Dogfish	21.1	0.018	0.08	16288	Black Scabbard Fish	0.32	0.01
16287	Lesser Spotted Dogfish	19.7	<0.016	0.08	16380	Torsk	0.55	0.03
16380	Torsk	1.97	<0.005	0.25	16384	Greater Forkbeard	0.23	0.02
16384	Greater Forkbeard	8.81	<0.006	0.07	16385	Round Nose Grenadier	0.19	0.02
16385	Round Nose Grenadier	6.56	<0.005	0.08	16386	Ling	0.77	0.03
16386	Ling	24.1	<0.01	0.04	16387	Blue Ling	0.66	0.02
16387	Blue Ling	9.34	<0.008	0.09	16388	Monk fish	0.23	0.02
16388	Monkfish	9.37	<0.005	0.05	16560	Spurdog	0.33	0.02
16553	Haddock	3.65	<0.009	0.26	16763	Torsk	0.32	0.01
16554	Horse Mackerel	2.19	<0.016	0.71	16764	Hake	0.21	0.03
16556	Herring	2.18	0.042	1.94	16770	Eel	0.15	0.03
16558	Ling	3.97	<0.005	0.13	16776	Trout	0.14	0.04
16559	Cod	7.43	<0.008	0.1	16777	Pike	0.41	0.05
16560	Spurdog	8.31	0.059	0.7				
16561	Skate	25.8	0.019	0.08				
16763	Torsk	3.19	<0.008	0.25				
16765	Cuckoo Ray	79.2	0.039	0.05				
16766	Monkfish	11.5	<0.006	0.05				
16276	Mussels-Inverness Nigg Bay	3.53	0.089	2.53				

Table 3. Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16272		16273		16274		16275	
FERA LIMS No.	S08-015904		S08-015905		S08-015906		S08-015907	
Sample Details:	Mussels - FSA Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - FSA Mussels Stannergate, 17/6/08	
Fat % Whole	0.44		0.26		0.30		0.35	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	2.50i	30	3.32	30	<0.29	202	2.05	35
1,2,3,7,8-PeCDD	3.39	31	8.79	26	1.25i	71	6.79	27
1,2,3,4,7,8-HxCDD	2.31	43	11.93	27	1.50	71	7.07	29
1,2,3,6,7,8-HxCDD	6.98	31	20.99	25	3.28	56	22.55	25
1,2,3,7,8,9-HxCDD	5.04	27	18.35	26	3.37	30	15.27	26
1,2,3,4,6,7,8-HpCDD	105.05	24	283.78	24	39.13	25	411.81	24
OCDD	573.33	24	1247.99	24	166.12	24	2027.80	24
2,3,7,8-TCDF	46.84	24	25.44	25	12.85	27	20.50	25
1,2,3,7,8-PeCDF	15.32	25	14.53	25	4.62	35	13.06	25
2,3,4,7,8-PeCDF	21.94i	25	18.44i	26	10.23i	30	21.34	25
1,2,3,4,7,8-HxCDF	4.41	34	9.11	29	2.87	52	10.73	27
1,2,3,6,7,8-HxCDF	3.46	45	6.33	37	2.04	85	5.47	38
1,2,3,7,8,9-HxCDF	<0.46	201	<0.63	201	<0.91	201	<0.56	201
2,3,4,6,7,8-HxCDF	4.61	35	8.61	30	4.87	39	12.02	27
1,2,3,4,6,7,8-HpCDF	30.64	25	67.29	24	17.38	28	95.49	24
1,2,3,4,7,8,9-HpCDF	2.37	55	3.63i	51	1.12	136	6.99	32
OCDF	52.81	25	113.67	24	14.18	34	184.26	24
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	24.787		33.760		9.406		32.798	
Lower bound	**26.434**		**35.816**		**10.268**		**34.888**	
Upper uncertainty level	28.081		37.872		11.130		36.978	
Lower uncertainty level	24.613		33.516		8.471		32.560	
Upper bound	**26.480**		**35.879**		**10.649**		**34.944**	
Upper uncertainty level	28.347		38.242		12.827		37.328	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.108		0.087		0.028		0.114	
Lower bound	**0.115**		**0.092**		**0.031**		**0.121**	
Upper uncertainty level	0.122		0.098		0.033		0.128	
Lower uncertainty level	0.107		0.086		0.025		0.113	
Upper bound	**0.116**		**0.092**		**0.032**		**0.121**	
Upper uncertainty level	0.124		0.099		0.039		0.130	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16276		16277		16278		16279	
FERA LIMS No.	S08-015908		S08-016128		S08-016129		S08-016130	
Sample Details:	Mussels - Inverness Nigg Bay, 21/6/08		1 - Spurdog, ID: C356/001		2 - Spurdog, ID: C356/002		3 - Smooth Hound, ID: C356/003	
Fat % Whole	0.38		14.58		8.14		0.53	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	<0.25	202	0.14	38	0.60	27	1.36	60
1,2,3,7,8-PeCDD	2.12	46	0.25	54	0.73	31	3.84	33
1,2,3,4,7,8-HxCDD	1.00	103	0.10	84	0.23	43	2.01	50
1,2,3,6,7,8-HxCDD	2.54	70	0.18	135	0.51	56	5.11	28
1,2,3,7,8,9-HxCDD	2.04	35	0.05	162	0.14	63	1.58	60
1,2,3,4,6,7,8-HpCDD	21.29	28	0.24	95	0.35	73	4.06	50
OCDD	88.48	25	0.59	59	0.35	100	7.47	53
2,3,7,8-TCDF	10.54	28	1.56	27	9.08	24	7.38	37
1,2,3,7,8-PeCDF	3.58	40	0.14i	28	1.04	24	5.64	28
2,3,4,7,8-PeCDF	3.62i	56	0.64	25	2.67	24	11.72	26
1,2,3,4,7,8-HxCDF	<1.12	201	0.16	79	0.35	47	2.57	64
1,2,3,6,7,8-HxCDF	1.04	161	0.07	89	0.27	33	2.29	68
1,2,3,7,8,9-HxCDF	<0.58	201	<0.05	201	<0.05	201	0.40	127
2,3,4,6,7,8-HxCDF	2.04	77	0.11	94	0.39	35	1.92	69
1,2,3,4,6,7,8-HpCDF	6.96	43	0.19	32	0.20	31	<0.73	201
1,2,3,4,7,8,9-HpCDF	<0.75	201	<0.02	201	<0.02	201	<0.62	201
OCDF	6.21	61	0.07	62	0.06	71	<1.4	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	5.715		0.831		3.561		12.158	
Lower bound	**6.321**		**0.940**		**3.820**		**13.709**	
Upper uncertainty level	6.927		1.049		4.079		15.260	
Lower uncertainty level	5.285		0.840		3.542		12.412	
Upper bound	**6.748**		**0.950**		**3.820**		**13.723**	
Upper uncertainty level	8.211		1.060		4.098		15.034	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.022		0.121		0.290		0.064	
Lower bound	**0.024**		**0.137**		**0.311**		**0.073**	
Upper uncertainty level	0.026		0.153		0.332		0.081	
Lower uncertainty level	0.020		0.123		0.288		0.066	
Upper bound	**0.025**		**0.138**		**0.311**		**0.073**	
Upper uncertainty level	0.031		0.154		0.334		0.080	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16280		16281		16282		16283	
FERA LIMS No.	S08-016131		S08-016132		S08-016133		S08-016134	
Sample Details:	4 - Starry Smooth Hound, ID: C356/004		5 - Thornback Ray, ID: C356/005		6 - Skate, ID: C356/006		7 - Hake, ID: C356/007	
Fat % Whole	0.80		0.79		0.79		3.02	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.61	89	0.53	69	0.28	117	0.45	27
1,2,3,7,8-PeCDD	3.49	30	4.46	25	1.55	29	0.34	48
1,2,3,4,7,8-HxCDD	1.78	42	2.45	31	0.54	78	<0.04	202
1,2,3,6,7,8-HxCDD	3.10	29	5.26	25	0.97	41	0.89	38
1,2,3,7,8,9-HxCDD	0.85	75	2.87	31	0.50	99	0.21	46
1,2,3,4,6,7,8-HpCDD	1.06	118	7.61	28	1.88	58	0.32	73
OCDD	1.61	155	6.89	45	3.11	84	0.40	88
2,3,7,8-TCDF	9.66	28	17.98	24	8.52	25	10.31	24
1,2,3,7,8-PeCDF	4.45	28	8.01	24	3.05	24	2.79	24
2,3,4,7,8-PeCDF	13.18	25	12.97	24	4.02	27	1.43	24
1,2,3,4,7,8-HxCDF	2.54	48	3.53	28	0.87	60	0.42	41
1,2,3,6,7,8-HxCDF	1.63	67	2.94	26	0.89	36	0.69	26
1,2,3,7,8,9-HxCDF	<0.17	201	0.30	90	<0.12	201	<0.05	201
2,3,4,6,7,8-HxCDF	1.50	62	4.71	25	1.01	34	0.90	26
1,2,3,4,6,7,8-HpCDF	<0.51	201	2.39	30	1.17	42	0.24	29
1,2,3,4,7,8,9-HpCDF	<0.43	201	0.32	133	<0.24	201	0.04	103
OCDF	<0.98	201	<0.63	201	<0.59	201	0.05	84
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	11.337		14.615		4.594		2.770	
Lower bound	**13.029**		**15.983**		**5.353**		**2.990**	
Upper uncertainty level	14.721		17.351		6.112		3.210	
Lower uncertainty level	11.574		14.696		4.671		2.734	
Upper bound	**13.056**		**15.983**		**5.368**		**3.000**	
Upper uncertainty level	14.538		17.270		6.065		3.266	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.090		0.115		0.036		0.084	
Lower bound	**0.104**		**0.126**		**0.042**		**0.090**	
Upper uncertainty level	0.117		0.137		0.048		0.097	
Lower uncertainty level	0.092		0.116		0.037		0.083	
Upper bound	**0.104**		**0.126**		**0.043**		**0.091**	
Upper uncertainty level	0.116		0.136		0.048		0.099	

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16284		16285		16286		16287	
FERA LIMS No.	S08-016135		S08-016136		S08-016137		S08-016138	
Sample Details:	8 - Spotted Ray, ID: C356/008		9 - Cuckoo Ray, ID: C356/009		10 - Black-Mouthed Dogfish, ID: C356/010		11 - Lesser Spotted Dogfish, ID: C356/011	
Fat % Whole	0.71		0.59		1.01		0.51	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	<0.22	202	0.63	86	0.30	90	<0.38	202
1,2,3,7,8-PeCDD	2.02	29	1.97	31	1.15	29	<0.38	201
1,2,3,4,7,8-HxCDD	1.09	56	0.79	87	0.42	80	<0.83	202
1,2,3,6,7,8-HxCDD	2.76	29	1.25	48	0.99	36	<0.96	201
1,2,3,7,8,9-HxCDD	1.59	49	0.76	106	0.38	103	<0.95	202
1,2,3,4,6,7,8-HpCDD	4.32	40	1.64	104	1.40	62	<8.45	201
OCDD	28.58	27	3.78	112	2.62	79	<18.74	201
2,3,7,8-TCDF	11.43	25	7.43	27	5.98	25	1.85	87
1,2,3,7,8-PeCDF	3.88	24	2.57	25	1.99	24	0.73	193
2,3,4,7,8-PeCDF	6.73	26	5.66	28	2.59	28	0.96	148
1,2,3,4,7,8-HxCDF	1.75	45	1.02	80	0.74	57	<0.97	201
1,2,3,6,7,8-HxCDF	1.39	33	0.86	52	0.55	41	<0.99	201
1,2,3,7,8,9-HxCDF	<0.19	201	<0.2	201	<0.09	201	<0.77	201
2,3,4,6,7,8-HxCDF	2.08	28	1.02	46	0.38	53	<0.57	201
1,2,3,4,6,7,8-HpCDF	1.42	45	0.79	87	0.22	147	<1.78	201
1,2,3,4,7,8,9-HpCDF	<0.27	201	<0.33	201	<0.16	201	<1.28	201
OCDF	<0.81	201	<0.98	201	<0.47	201	<7.95	201

WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	7.424	6.012	3.327	0.486
Lower bound	**7.848**	**6.896**	**3.805**	**0.702**
Upper uncertainty level	8.272	7.780	4.283	0.918
Lower uncertainty level	6.691	6.099	3.372	1.358
Upper bound	**8.090**	**6.920**	**3.816**	**2.183**
Upper uncertainty level	9.489	7.741	4.260	3.008

WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.053	0.035	0.034	0.002
Lower bound	**0.056**	**0.041**	**0.038**	**0.004**
Upper uncertainty level	0.059	0.046	0.043	0.005
Lower uncertainty level	0.048	0.036	0.034	0.007
Upper bound	**0.058**	**0.041**	**0.039**	**0.011**
Upper uncertainty level	0.068	0.046	0.043	0.015

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16288		16380		16384		16385	
FERA LIMS No.	S08-016139		S08-019914		S08-019915		S08-019916	
Sample Details:	12 - Black Scabbard Fish, ID: C356/012		Torsk, whole fish, ID: C356/013		Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1		Round Nose Grenadier, Whole Fish, ID: C356/15	
Fat % Whole	2.23		0.44		0.32		0.39	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.99	26	0.74	101	0.62	116	0.57i	88
1,2,3,7,8-PeCDD	2.94	25	1.10	78	1.06	81	1.12	49
1,2,3,4,7,8-HxCDD	0.23	50	<0.41	202	<0.41	202	<0.53	202
1,2,3,6,7,8-HxCDD	1.84	30	1.42	56	1.24	61	2.48	55
1,2,3,7,8,9-HxCDD	0.27	45	0.44	188	<0.41	202	0.69	176
1,2,3,4,6,7,8-HpCDD	0.20	142	0.86	197	1.09	154	<5.37	201
OCDD	1.01	48	2.84	121	5.18	69	<11.92	201
2,3,7,8-TCDF	12.57	24	7.64	35	7.68	35	9.51	26
1,2,3,7,8-PeCDF	4.71	24	8.62	26	3.89	32	3.94	33
2,3,4,7,8-PeCDF	10.05	24	2.64	53	2.80	50	4.96	30
1,2,3,4,7,8-HxCDF	0.87	30	1.36	110	1.15	127	1.12	113
1,2,3,6,7,8-HxCDF	0.79	26	1.10	130	0.94	151	1.26	103
1,2,3,7,8,9-HxCDF	<0.06	201	<0.24	201	<0.24	201	<0.49	201
2,3,4,6,7,8-HxCDF	0.91	27	<0.59	201	0.62	192	2.17	42
1,2,3,4,6,7,8-HpCDF	0.09	71	<0.7	201	<0.7	201	<1.13	201
1,2,3,4,7,8,9-HpCDF	<0.02	201	<0.59	201	<0.59	201	<0.81	201
OCDF	0.08	79	<1.34	201	<1.33	201	<5.06	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	10.287		3.661		3.310		4.840	
Lower bound	**10.940**		**4.796**		**4.449**		**6.090**	
Upper uncertainty level	11.593		5.931		5.588		7.340	
Lower uncertainty level	10.230		3.990		3.638		5.339	
Upper bound	**10.950**		**4.933**		**4.568**		**6.267**	
Upper uncertainty level	11.670		5.876		5.498		7.195	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.229		0.016		0.011		0.019	
Lower bound	**0.244**		**0.021**		**0.014**		**0.024**	
Upper uncertainty level	0.258		0.026		0.018		0.029	
Lower uncertainty level	0.228		0.018		0.012		0.021	
Upper bound	**0.244**		**0.022**		**0.015**		**0.024**	
Upper uncertainty level	0.260		0.026		0.018		0.028	

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16386		16387		16388		16552	
FERA LIMS No.	S08-019917		S08-019918		S08-019919		S08-026043	
Sample Details:	Ling, Whole fish ID: C356/014		Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08, (106cm, 5500g)		Monk fish -(Tails) ID: C356/16		John Dory,ID: C356/19	
Fat % Whole	0.66		0.45		0.47		1.59	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	<0.3	202	0.48	152	0.72	64	2.15	39
1,2,3,7,8-PeCDD	0.61	79	0.97	90	0.98	49	1.58	39
1,2,3,4,7,8-HxCDD	<0.2	202	<0.42	202	<0.45	202	0.24i	177
1,2,3,6,7,8-HxCDD	0.82	84	2.30	39	2.07	56	1.02	73
1,2,3,7,8,9-HxCDD	<0.1	202	0.63	136	<0.51	202	0.30	71
1,2,3,4,6,7,8-HpCDD	<0.46	201	0.97	177	<4.55	201	0.87	115
OCDD	1.14	122	2.33	149	<10.1	201	1.58	93
2,3,7,8-TCDF	4.42	40	6.98	37	2.44	41	16.26	26
1,2,3,7,8-PeCDF	2.57	29	4.56	30	0.46	167	1.91	33
2,3,4,7,8-PeCDF	1.67	31	3.78	41	3.73	31	6.62	25
1,2,3,4,7,8-HxCDF	0.38	175	1.75	88	1.69	66	0.76	95
1,2,3,6,7,8-HxCDF	0.36	130	1.69	89	1.12	98	0.73	70
1,2,3,7,8,9-HxCDF	<0.16	201	<0.24	201	<0.41	201	<0.17	201
2,3,4,6,7,8-HxCDF	0.38	123	2.03	64	1.41	50	0.76	68
1,2,3,4,6,7,8-HpCDF	0.35	150	<0.72	201	1.03	188	0.40	142
1,2,3,4,7,8,9-HpCDF	<0.13	201	<0.6	201	<0.69	201	<0.14	201
OCDF	<0.56	201	<1.37	201	<4.29	201	<0.59	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	1.875		3.790		3.712		8.163	
Lower bound	**2.213**		**5.116**		**4.471**		**9.155**	
Upper uncertainty level	2.551		6.442		5.230		10.147	
Lower uncertainty level	1.933		4.109		4.019		8.236	
Upper bound	**2.565**		**5.195**		**4.662**		**9.174**	
Upper uncertainty level	3.197		6.281		5.305		10.112	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.012		0.017		0.017		0.130	
Lower bound	**0.015**		**0.023**		**0.021**		**0.145**	
Upper uncertainty level	0.017		0.029		0.025		0.161	
Lower uncertainty level	0.013		0.019		0.019		0.131	
Upper bound	**0.017**		**0.023**		**0.022**		**0.146**	
Upper uncertainty level	0.021		0.028		0.025		0.160	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16553		16554		16555		16556	
FERA LIMS No.	S08-026044		S08-026045		S08-026046		S08-026047	
Sample Details:	Haddock, ID: C356/20 1008S		Horse Mackerel, ID: C356/21 1008S		Hake, ID: C356/22 1008S		Herring, ID: 356/23 1008S	
Fat % Whole	0.50		2.75		0.77		16.10	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	<0.92	202	<0.2	202	0.85	109	0.33	50
1,2,3,7,8-PeCDD	<0.71	201	0.49	66	1.97	43	1.14	26
1,2,3,4,7,8-HxCDD	<0.61	202	<0.13	202	<0.3	202	0.20	48
1,2,3,6,7,8-HxCDD	1.07i	192	<0.22	201	4.02	35	0.84	29
1,2,3,7,8,9-HxCDD	<0.46	202	0.11	130	1.32i	34	0.15	37
1,2,3,4,6,7,8-HpCDD	<1.43	201	<0.3	201	2.00	74	0.22	94
OCDD	3.42	125	0.76	118	1.60	130	0.28	110
2,3,7,8-TCDF	2.70	168	3.25	38	27.85	25	7.61	24
1,2,3,7,8-PeCDF	0.71	173	0.94	37	9.66	25	1.44	25
2,3,4,7,8-PeCDF	0.51i	201	2.31	26	6.99	25	4.52	24
1,2,3,4,7,8-HxCDF	<1.02	201	<0.22	201	2.84	43	0.33	49
1,2,3,6,7,8-HxCDF	<0.71	201	<0.15	201	2.94	34	0.41	34
1,2,3,7,8,9-HxCDF	<0.51	201	<0.11	201	<0.4	201	<0.04	201
2,3,4,6,7,8-HxCDF	<0.71	201	<0.15	201	3.44	31	0.53	31
1,2,3,4,6,7,8-HpCDF	<0.82	201	<0.17	201	1.22	70	0.09	135
1,2,3,4,7,8,9-HpCDF	<0.41	201	<0.09	201	<0.2	201	<0.03	201
OCDF	<1.74	201	<0.37	201	<0.85	201	<0.12	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	0.474		1.699		9.477		4.414	
Lower bound	**0.668**		**2.028**		**11.071**		**4.812**	
Upper uncertainty level	0.862		2.357		12.665		5.210	
Lower uncertainty level	1.644		1.748		9.638		4.425	
Upper bound	**2.727**		**2.332**		**11.143**		**4.816**	
Upper uncertainty level	3.810		2.916		12.648		5.207	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.002		0.047		0.073		0.711	
Lower bound	**0.003**		**0.056**		**0.085**		**0.775**	
Upper uncertainty level	0.004		0.065		0.098		0.839	
Lower uncertainty level	0.008		0.048		0.074		0.713	
Upper bound	**0.014**		**0.064**		**0.086**		**0.776**	
Upper uncertainty level	0.019		0.080		0.097		0.839	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16557		16558		16559		16560	
FERA LIMS No.	S08-026048		S08-026049		S08-026050		S08-026051	
Sample Details:	Mackerel, ID: C356/24 1008S		Ling, ID: C356/25 1008S		Cod, ID: C356/26 1008S		Spurdog, ID: C356/27 1008S	
Fat % Whole	25.43		0.39		0.35		6.42	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.04	56	0.57i	78	0.84	33	0.39	28
1,2,3,7,8-PeCDD	0.06	71	0.89	97	0.59	66	0.68	27
1,2,3,4,7,8-HxCDD	<0.01	202	<0.3	202	<0.13	202	0.20	39
1,2,3,6,7,8-HxCDD	<0.03	201	1.04	64	3.11	26	0.62	26
1,2,3,7,8,9-HxCDD	<0.03	202	<0.73	202	0.73	91	0.13	96
1,2,3,4,6,7,8-HpCDD	<0.05	201	<1.1	201	1.11	90	0.47	45
OCDD	0.11	165	4.02	105	1.61	114	0.40	93
2,3,7,8-TCDF	1.34	25	7.57	38	5.98	29	4.82	24
1,2,3,7,8-PeCDF	0.07	89	2.35	59	4.93	26	0.77	27
2,3,4,7,8-PeCDF	0.31	31	1.51i	87	3.07	30	2.16	24
1,2,3,4,7,8-HxCDF	0.03	71	<0.31	201	2.20	25	0.37	26
1,2,3,6,7,8-HxCDF	<0.03	201	<1.25	201	2.14	35	0.33	39
1,2,3,7,8,9-HxCDF	<0.01	201	<0.31	201	<0.25	201	<0.03	201
2,3,4,6,7,8-HxCDF	0.02	103	0.73i	86	2.20	27	0.39	28
1,2,3,4,6,7,8-HpCDF	0.02	103	0.52	110	1.45	29	0.17	34
1,2,3,4,7,8,9-HpCDF	<0.01	201	<0.31	201	<0.14	201	<0.03	201
OCDF	<0.06	201	<1.48	201	<0.64	201	<0.13	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	0.324		2.394		4.350		2.682	
Lower bound	**0.398**		**3.272**		**4.873**		**2.881**	
Upper uncertainty level	0.472		4.150		5.396		3.080	
Lower uncertainty level	0.343		2.847		4.387		2.683	
Upper bound	**0.409**		**3.576**		**4.913**		**2.884**	
Upper uncertainty level	0.475		4.305		5.439		3.085	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.082		0.009		0.015		0.172	
Lower bound	**0.101**		**0.013**		**0.017**		**0.185**	
Upper uncertainty level	0.120		0.016		0.019		0.198	
Lower uncertainty level	0.087		0.011		0.015		0.172	
Upper bound	**0.104**		**0.014**		**0.017**		**0.185**	
Upper uncertainty level	0.121		0.017		0.019		0.198	

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16561		16763		16764		16765	
FERA LIMS No.	S08-026052		S08-031183		S08-031184		S08-031185	
Sample Details:	Skate, ID: C356/28 1008S		Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08		Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08		Cuckoo Ray, ID: C356/031, 1008S	
Fat % Whole	0.56		0.30		2.23		0.46	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.76	45	1.05	34	0.52	35	0.55	64
1,2,3,7,8-PeCDD	6.45	26	1.42	43	0.54	35	2.53	35
1,2,3,4,7,8-HxCDD	2.60	30	<0.31	202	<0.07	202	1.62	37
1,2,3,6,7,8-HxCDD	4.94	26	2.59	28	1.46	25	3.95	27
1,2,3,7,8,9-HxCDD	1.59	68	0.83	107	0.33	50	1.70	70
1,2,3,4,6,7,8-HpCDD	6.45	34	3.08	49	0.78	43	6.40	35
OCDD	8.08	43	38.12	25	0.75	78	8.74	43
2,3,7,8-TCDF	21.31	25	12.93	26	10.31	24	9.17	30
1,2,3,7,8-PeCDF	8.29	26	6.77	26	3.45	24	3.76	35
2,3,4,7,8-PeCDF	17.27	24	5.05	28	2.31	25	7.55	27
1,2,3,4,7,8-HxCDF	5.12	25	1.29	30	0.61	46	2.33i	28
1,2,3,6,7,8-HxCDF	2.88	38	1.54	54	1.10	32	1.98	53
1,2,3,7,8,9-HxCDF	<0.22	201	<0.18	201	<0.04	201	<0.24	201
2,3,4,6,7,8-HxCDF	6.13	25	1.29	36	1.46	28	2.09	32
1,2,3,4,6,7,8-HpCDF	5.41	25	1.08	38	0.58	48	2.93	28
1,2,3,4,7,8,9-HpCDF	<0.36	201	<0.18	201	<0.1	201	<0.24	201
OCDF	1.33	155	1.79	100	<0.22	201	<1.12	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	19.332		6.783		3.610		8.466	
Lower bound	**20.836**		**7.426**		**3.928**		**9.421**	
Upper uncertainty level	22.340		8.069		4.246		10.376	
Lower uncertainty level	19.261		6.758		3.598		8.536	
Upper bound	**20.862**		**7.477**		**3.940**		**9.448**	
Upper uncertainty level	22.463		8.196		4.282		10.360	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.109		0.020		0.081		0.039	
Lower bound	**0.117**		**0.022**		**0.088**		**0.043**	
Upper uncertainty level	0.126		0.024		0.095		0.048	
Lower uncertainty level	0.108		0.020		0.080		0.039	
Upper bound	**0.117**		**0.022**		**0.088**		**0.043**	
Upper uncertainty level	0.126		0.025		0.096		0.047	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16766		16767		16768		16769	
FERA LIMS No.	S08-031186		S08-031187		S08-031188		S08-031189	
Sample Details:	Monkfish, ID: C356/032, 1008S		Roach, Forth & Clyde Canal, ID: C356/033		Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08		Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas	
Fat % Whole	0.28		2.48		1.16		2.80	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	1.00	56	3.88	26	2.08	27	0.84	103
1,2,3,7,8-PeCDD	1.81	60	3.66	24	1.58	31	<0.42	201
1,2,3,4,7,8-HxCDD	0.56	128	0.25	48	0.15	149	<0.28	202
1,2,3,6,7,8-HxCDD	3.36	33	1.17	26	1.10	31	0.59	168
1,2,3,7,8,9-HxCDD	0.87	202	0.32	85	0.26	202	<0.35	202
1,2,3,4,6,7,8-HpCDD	5.60	53	0.68	64	1.43	60	3.77	41
OCDD	7.41	71	1.10	73	2.77	58	23.78	28
2,3,7,8-TCDF	3.55	78	65.45	24	23.16	24	13.69	28
1,2,3,7,8-PeCDF	3.05	55	80.22	24	8.99	24	2.65	58
2,3,4,7,8-PeCDF	5.17	38	10.26	24	6.52	25	1.54	94
1,2,3,4,7,8-HxCDF	4.17	27	0.82i	26	1.65	25	<0.8	201
1,2,3,6,7,8-HxCDF	2.80	59	0.44	55	0.85	57	<0.45	201
1,2,3,7,8,9-HxCDF	<0.37	201	0.11	112	<0.11	201	<0.24	201
2,3,4,6,7,8-HxCDF	4.36	29	0.60	29	0.63	42	<0.7	201
1,2,3,4,6,7,8-HpCDF	3.86	29	0.29	42	0.78	35	1.71	41
1,2,3,4,7,8,9-HpCDF	<0.62	201	<0.06	201	<0.11	201	<0.49	201
OCDF	<1.76	201	<0.27	201	<0.53	201	3.39	75
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	6.554		21.956		9.265		2.605	
Lower bound	**7.610**		**23.607**		**10.172**		**3.228**	
Upper uncertainty level	8.666		25.258		11.079		3.851	
Lower uncertainty level	6.679		22.122		9.303		2.782	
Upper bound	**7.653**		**23.607**		**10.184**		**3.935**	
Upper uncertainty level	8.627		25.092		11.065		5.088	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.018		0.544		0.107		0.073	
Lower bound	**0.021**		**0.585**		**0.118**		**0.090**	
Upper uncertainty level	0.024		0.626		0.128		0.108	
Lower uncertainty level	0.019		0.548		0.108		0.078	
Upper bound	**0.021**		**0.585**		**0.118**		**0.110**	
Upper uncertainty level	0.024		0.622		0.128		0.142	

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16770		16771		16772		16773	
FERA LIMS No.	S08-031190		S08-031191		S08-031192		S08-031193	
Sample Details:	Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08		Trout, Kirtle Water, ID:C356/038		Eel, Lochar Water, ID: C356/039, 27-8-08		Trout, Lochhar W, ID: C356/040, 27-08-08	
Fat % Whole	18.48		4.24		14.83		1.31	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.07i	63	0.59	28	0.22	37	0.18	42
1,2,3,7,8-PeCDD	0.32	25	0.57	25	0.26	28	0.25	29
1,2,3,4,7,8-HxCDD	0.14	50	0.21	46	0.13i	53	<0.03	202
1,2,3,6,7,8-HxCDD	0.31	27	0.32i	30	0.43	28	0.14	49
1,2,3,7,8,9-HxCDD	0.07	145	<0.07	202	0.13	96	<0.07	202
1,2,3,4,6,7,8-HpCDD	0.44	47	0.44	64	0.34	69	0.14	159
OCDD	0.65	52	0.60	74	0.68	58	0.57	68
2,3,7,8-TCDF	<0.13	201	3.94	26	<0.15	201	0.74	47
1,2,3,7,8-PeCDF	0.23i	50	1.17	27	0.62	31	0.36	41
2,3,4,7,8-PeCDF	0.38	29	1.57	25	0.48	27	0.42	28
1,2,3,4,7,8-HxCDF	0.24	41	0.27i	44	0.34	34	0.10i	84
1,2,3,6,7,8-HxCDF	0.11	44	0.29	32	0.20	38	<0.05	201
1,2,3,7,8,9-HxCDF	<0.02	201	<0.06	201	<0.01	201	<0.01	201
2,3,4,6,7,8-HxCDF	0.22i	44	0.15i	84	0.18i	61	0.08	127
1,2,3,4,6,7,8-HpCDF	0.24	71	0.21	117	0.30	71	0.14	145
1,2,3,4,7,8,9-HpCDF	<0.03	201	<0.07	201	<0.03	201	<0.06	201
OCDF	<0.1	201	<0.14	201	<0.12	201	0.16	152
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	0.631		2.345		0.820		0.690	
Lower bound	**0.707**		**2.528**		**0.898**		**0.767**	
Upper uncertainty level	0.783		2.711		0.976		0.844	
Lower uncertainty level	0.645		2.338		0.831		0.689	
Upper bound	**0.723**		**2.542**		**0.915**		**0.783**	
Upper uncertainty level	0.801		2.746		0.999		0.877	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.117		0.099		0.122		0.009	
Lower bound	**0.131**		**0.107**		**0.133**		**0.010**	
Upper uncertainty level	0.145		0.115		0.145		0.011	
Lower uncertainty level	0.119		0.099		0.123		0.009	
Upper bound	**0.134**		**0.108**		**0.136**		**0.010**	
Upper uncertainty level	0.148		0.116		0.148		0.011	

i - indicative value

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16774		16775		16776		16777	
FERA LIMS No.	S08-031194		S08-031195		S08-031196		S08-031197	
Sample Details:	Eel - R Eden, ID: C356/041		Trout, R Eden, ID: C356/042		Trout, W of Girvan, ID: C356/043		Pike, L Achray, ID: C356/044	
Fat % Whole	16.45		8.39		2.06		1.56	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.25	35	0.40	30	0.40	36	2.25	26
1,2,3,7,8-PeCDD	0.82	24	0.65	25	0.59	26	6.22	24
1,2,3,4,7,8-HxCDD	0.18	51	<0.09	202	<0.1	202	1.71	27
1,2,3,6,7,8-HxCDD	0.59i	26	0.21	37	0.30	41	5.60	24
1,2,3,7,8,9-HxCDD	0.12	103	<0.08	202	<0.11	202	1.22	30
1,2,3,4,6,7,8-HpCDD	0.51	49	0.27	92	0.48	83	2.22	29
OCDD	0.91	48	0.38	108	1.13	60	0.58	106
2,3,7,8-TCDF	0.20	162	4.27	25	6.98	25	24.40	24
1,2,3,7,8-PeCDF	1.29	26	1.32	26	2.41	26	8.56	24
2,3,4,7,8-PeCDF	0.70	27	1.45	25	1.70	25	22.65	24
1,2,3,4,7,8-HxCDF	0.28	43	0.17	64	0.46	42	3.13	24
1,2,3,6,7,8-HxCDF	0.11	60	0.11	60	0.23	50	2.87	24
1,2,3,7,8,9-HxCDF	<0.01	201	<0.03	201	<0.05	201	0.12	29
2,3,4,6,7,8-HxCDF	0.16	79	0.13i	95	0.21	89	2.87	25
1,2,3,4,6,7,8-HpCDF	0.26	88	0.16	152	0.25	146	0.87	46
1,2,3,4,7,8,9-HpCDF	<0.04	201	<0.04	201	<0.06	201	<0.09	201
OCDF	0.20	132	<0.14	201	<0.21	201	<0.2	201
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	1.515		2.142		2.548		23.067	
Lower bound	**1.656**		**2.334**		**2.786**		**24.446**	
Upper uncertainty level	1.797		2.526		3.024		25.825	
Lower uncertainty level	1.512		2.132		2.540		23.201	
Upper bound	**1.658**		**2.355**		**2.813**		**24.447**	
Upper uncertainty level	1.804		2.578		3.086		25.693	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.249		0.180		0.053		0.359	
Lower bound	**0.272**		**0.196**		**0.058**		**0.380**	
Upper uncertainty level	0.296		0.212		0.062		0.402	
Lower uncertainty level	0.249		0.179		0.052		0.361	
Upper bound	**0.273**		**0.198**		**0.058**		**0.380**	
Upper uncertainty level	0.297		0.216		0.064		0.400	

Table 3 (cont'd). Concentrations of PCDDs and PCDFs (dioxins)

FERA Sample No.	16778		16779		16808		16939		16940	
FERA LIMS No.	S08-031198		S08-031199		S08-032253		S09-002037		S09-002038	
Sample Details:	Eel, R Leven, ID: C356/045		Trout, Clyde, ID: C356/046		Trout - White Cart W, ID: C356/036		Roach, Forth & Clyde Canal, ID: C356/033 (Part-2)		Roach, Forth & Clyde Canal, ID: C356/033 (Part-3)	
Fat % Whole	13.08		3.19		7.84		3.65		1.45	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
2,3,7,8-TCDD	0.16	45	0.94	29	0.25	48	1.11	30	1.82	45
1,2,3,7,8-PeCDD	0.63	25	2.66	24	0.44	33	0.74	34	1.54	50
1,2,3,4,7,8-HxCDD	0.44	31	0.92	27	<0.05	202	0.20	65	<0.22	202
1,2,3,6,7,8-HxCDD	2.84	24	3.52	24	0.19	68	0.35	67	0.70	114
1,2,3,7,8,9-HxCDD	0.41	43	0.27	27	0.07	38	0.15	37	<0.17	202
1,2,3,4,6,7,8-HpCDD	4.58	25	1.81	26	0.45	43	2.87	26	<0.51	201
OCDD	3.68	26	4.12	27	1.42	39	10.58	25	2.50	116
2,3,7,8-TCDF	<0.18	201	8.92	24	5.25	24	23.50	24	32.69	24
1,2,3,7,8-PeCDF	0.34	48	2.05	26	0.77	33	37.31	24	18.94	25
2,3,4,7,8-PeCDF	1.04	25	3.07	25	1.56	27	2.46	27	3.76	38
1,2,3,4,7,8-HxCDF	0.66	28	0.75	40	<0.1	201	0.36	97	<0.64	201
1,2,3,6,7,8-HxCDF	0.28	32	0.58	30	0.13	66	0.19	88	<0.28	201
1,2,3,7,8,9-HxCDF	<0.04	201	<0.04	201	<0.03	201	<0.05	201	<0.17	201
2,3,4,6,7,8-HxCDF	0.24	55	0.35	67	0.12	152	0.26	118	<0.56	201
1,2,3,4,6,7,8-HpCDF	0.63	45	0.56	28	0.26	33	0.83	28	<0.22	201
1,2,3,4,7,8,9-HpCDF	<0.05	201	<0.08	201	<0.06	201	<0.11	201	<0.39	201
OCDF	0.16	177	0.51	78	0.18	168	1.40	44	<0.97	201
WHO-TEQ ng/kg FAT weight										
Lower uncertainty level	1.723		6.379		1.881		6.840		7.760	
Lower bound	**1.866**		**6.793**		**2.092**		**7.485**		**9.526**	
Upper uncertainty level	2.009		7.207		2.303		8.130		11.292	
Lower uncertainty level	1.723		6.343		1.870		6.823		8.271	
Upper bound	**1.889**		**6.797**		**2.110**		**7.491**		**9.742**	
Upper uncertainty level	2.055		7.251		2.350		8.159		11.213	
WHO-TEQ ng/kg WHOLE weight										
Lower uncertainty level	0.225		0.204		0.148		0.250		0.113	
Lower bound	**0.244**		**0.217**		**0.164**		**0.273**		**0.138**	
Upper uncertainty level	0.263		0.230		0.181		0.297		0.164	
Lower uncertainty level	0.225		0.202		0.147		0.249		0.120	
Upper bound	**0.247**		**0.217**		**0.166**		**0.273**		**0.141**	
Upper uncertainty level	0.269		0.231		0.184		0.298		0.163	

Table 4. Concentrations of non-ortho PCBs

FERA Sample No.	16272		16273		16274		16275		16276		16277		16278	
FERA LIMS No.	S08-015904		S08-015905		S08-015906		S08-015907		S08-015908		S08-016128		S08-016129	
Sample Details:	Mussels - FSA Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - FSA Mussels Stannergate, 17/6/08		Mussels - Inverness Nigg Bay, 21/6/08		1 - Spurdog, ID: C356/001		2 - Spurdog, ID: C356/002	
Fat % Whole	0.44		0.26		0.30		0.35		0.38		14.58		8.14	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	2997.73	24	1042.53	25	452.32	27	843.58	25	701.26	25	53.96	25	121.90	24
PCB81	113.82	24	138.62	24	26.99	30	47.58	26	39.11	27	12.16	24	26.97	24
PCB126	166.59	24	193.21	24	51.23	26	113.53	24	84.35	25	17.80	24	70.78	24
PCB169	12.42	29	81.15	24	9.65	35	21.70	26	11.33	33	4.35	24	11.35	24
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	16.979		20.116		5.228		11.580		8.562		1.818		7.162	
Lower bound	**17.094**		**20.251**		**5.267**		**11.659**		**8.622**		**1.830**		**7.210**	
Upper uncertainty level	17.209		20.386		5.306		11.738		8.682		1.842		7.258	
Lower uncertainty level	16.979		20.116		5.228		11.580		8.562		1.818		7.162	
Upper bound	**17.094**		**20.251**		**5.267**		**11.659**		**8.622**		**1.830**		**7.210**	
Upper uncertainty level	17.209		20.386		5.306		11.738		8.682		1.842		7.258	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.074		0.052		0.016		0.040		0.032		0.265		0.583	
Lower bound	**0.075**		**0.052**		**0.016**		**0.040**		**0.033**		**0.267**		**0.587**	
Upper uncertainty level	0.075		0.053		0.016		0.041		0.033		0.269		0.591	
Lower uncertainty level	0.074		0.052		0.016		0.040		0.032		0.265		0.583	
Upper bound	**0.075**		**0.052**		**0.016**		**0.040**		**0.033**		**0.267**		**0.587**	
Upper uncertainty level	0.075		0.053		0.016		0.041		0.033		0.269		0.591	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16279		16280		16281		16282		16283		16284		16285	
FERA LIMS No.	S08-016130		S08-016131		S08-016132		S08-016133		S08-016134		S08-016135		S08-016136	
Sample Details:	3 - Smooth Hound, ID: C356/003		4 - Starry Smooth Hound, ID: C356/004		5 - Thornback Ray, ID: C356/005		6 - Skate, ID: C356/006		7 - Hake, ID: C356/007		8 - Spotted Ray, ID: C356/008		9 - Cuckoo Ray, ID: C356/009	
Fat % Whole	0.53		0.80		0.79		0.79		3.02		0.71		0.59	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	104.67	42	38.25	71	77.06	30	16.93	81	70.47	25	42.94	49	17.17	130
PCB81	15.22	30	4.15	52	1.94	60	0.85	120	3.07	26	1.31	108	1.91	90
PCB126	29.29	27	41.20	25	53.33	24	22.26	24	78.89	24	61.27	24	51.75	24
PCB169	9.89	26	14.00	24	16.02	24	4.78	24	22.91	24	18.82	24	13.03	24
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	3.018		4.235		5.464		2.261		8.076		6.278		5.271	
Lower bound	**3.040**		**4.264**		**5.501**		**2.276**		**8.130**		**6.320**		**5.307**	
Upper uncertainty level	3.062		4.293		5.538		2.291		8.184		6.362		5.343	
Lower uncertainty level	3.018		4.235		5.464		2.261		8.076		6.278		5.271	
Upper bound	**3.040**		**4.264**		**5.501**		**2.276**		**8.130**		**6.320**		**5.307**	
Upper uncertainty level	3.062		4.293		5.538		2.291		8.184		6.362		5.343	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.016		0.034		0.043		0.018		0.244		0.045		0.031	
Lower bound	**0.016**		**0.034**		**0.043**		**0.018**		**0.245**		**0.045**		**0.031**	
Upper uncertainty level	0.016		0.034		0.044		0.018		0.247		0.045		0.031	
Lower uncertainty level	0.016		0.034		0.043		0.018		0.244		0.045		0.031	
Upper bound	**0.016**		**0.034**		**0.043**		**0.018**		**0.245**		**0.045**		**0.031**	
Upper uncertainty level	0.016		0.034		0.044		0.018		0.247		0.045		0.031	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16286		16287		16288		16380		16384		16385		16386	
FERA LIMS No.	S08-016137		S08-016138		S08-016139		S08-019914		S08-019915		S08-019916		S08-019917	
Sample Details:	10 - Black-Mouthed Dogfish, ID: C356/010		11 - Lesser Spotted Dogfish, ID: C356/011		12 - Black Scabbard Fish, ID: C356/012		Torsk, whole fish, ID: C356/013		Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1		Round Nose Grenadier, Whole Fish, ID: C356/15		Ling, Whole fish ID: C356/014	
Fat % Whole	1.01		0.51		2.23		0.44		0.32		0.39		0.66	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	52.59	31	34.43	157	162.21	24	104.58	41	50.78	72	18.20	189	55.66	42
PCB81	5.11	29	<7.37	201	12.12	24	5.13	56	2.06	128	<4.69	201	3.74	44
PCB126	24.96	24	7.25	59	150.31	24	116.19	24	51.60	25	14.81	29	58.73	28
PCB169	5.84	24	2.04	85	54.78	24	32.17	24	15.98	25	37.36	24	18.76	25
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	2.543		0.732		15.497		11.872		5.289		1.836		6.020	
Lower bound	**2.560**		**0.749**		**15.600**		**11.952**		**5.325**		**1.856**		**6.067**	
Upper uncertainty level	2.577		0.766		15.703		12.032		5.361		1.876		6.114	
Lower uncertainty level	2.543		0.737		15.497		11.872		5.289		1.842		6.020	
Upper bound	**2.560**		**0.750**		**15.600**		**11.952**		**5.325**		**1.857**		**6.067**	
Upper uncertainty level	2.577		0.763		15.703		12.032		5.361		1.872		6.114	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.026		0.004		0.345		0.052		0.017		0.007		0.040	
Lower bound	**0.026**		**0.004**		**0.347**		**0.053**		**0.017**		**0.007**		**0.040**	
Upper uncertainty level	0.026		0.004		0.350		0.053		0.017		0.007		0.040	
Lower uncertainty level	0.026		0.004		0.345		0.052		0.017		0.007		0.040	
Upper bound	**0.026**		**0.004**		**0.347**		**0.053**		**0.017**		**0.007**		**0.040**	
Upper uncertainty level	0.026		0.004		0.350		0.053		0.017		0.007		0.040	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16387		16388		16552		16553		16554		16555		16556	
FERA LIMS No.	S08-019918		S08-019919		S08-026043		S08-026044		S08-026045		S08-026046		S08-026047	
Sample Details:	Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08, (106cm, 5500g)		Monk fish -(Tails) ID: C356/16		John Dory,ID: C356/19		Haddock, ID: C356/20 1008S		Horse Mackerel, ID: C356/21 1008S		Hake, ID: C356/22 1008S		Herring, ID: 356/23 1008S	
Fat % Whole	0.45		0.47		1.59		0.50		2.75		0.77		16.10	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	27.23	133	36.38	83	518.90	24	66.24	93	21.42	63	264.02	26	82.39	25
PCB81	<1.32	201	<3.97	201	10.48	28	3.11	140	0.99	94	4.84	50	2.36	27
PCB126	37.63	25	36.88	25	126.07	25	<13.92	201	31.17	31	260.51	25	33.09	25
PCB169	24.84	24	10.26	26	19.42	25	3.57	132	7.05	28	85.66	24	8.39	24
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	3.976		3.760		12.765		0.043		3.163		26.752		3.378	
Lower bound	**4.014**		**3.794**		**12.854**		**0.043**		**3.190**		**26.934**		**3.401**	
Upper uncertainty level	4.052		3.828		12.943		0.043		3.217		27.116		3.424	
Lower uncertainty level	3.986		3.769		12.765		1.358		3.163		26.752		3.378	
Upper bound	**4.014**		**3.795**		**12.854**		**1.435**		**3.190**		**26.934**		**3.401**	
Upper uncertainty level	4.042		3.821		12.943		1.512		3.217		27.116		3.424	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.018		0.018		0.203		0.000		0.087		0.206		0.544	
Lower bound	**0.018**		**0.018**		**0.204**		**0.000**		**0.088**		**0.208**		**0.548**	
Upper uncertainty level	0.018		0.018		0.205		0.000		0.089		0.209		0.551	
Lower uncertainty level	0.018		0.018		0.203		0.007		0.087		0.206		0.544	
Upper bound	**0.018**		**0.018**		**0.204**		**0.007**		**0.088**		**0.208**		**0.548**	
Upper uncertainty level	0.018		0.018		0.205		0.008		0.089		0.209		0.551	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16557		16558		16559		16560		16561		16763		16764	
FERA LIMS No.	S08-026048		S08-026049		S08-026050		S08-026051		S08-026052		S08-031183		S08-031184	
Sample Details:	Mackerel, ID: C356/24 1008S		Ling, ID: C356/25 1008S		Cod, ID: C356/26 1008S		Spurdog, ID: C356/27 1008S		Skate, ID: C356/28 1008S		Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08		Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08	
Fat % Whole	25.43		0.39		0.35		6.42		0.56		0.30		2.23	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	34.90	26	103.83	78	55.04	66	111.97	25	34.25	158	113.50	47	140.27	24
PCB81	2.57	26	6.00	106	3.59	79	32.08	24	<2.14	201	5.45	71	7.70	25
PCB126	10.82	24	55.70	25	60.08	24	53.67	24	58.69	24	115.65	24	120.46	24
PCB169	0.75	25	17.28	24	19.29	24	10.79	24	15.25	24	25.46	24	34.55	24
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	1.086		5.714		6.166		5.453		5.971		11.752		12.324	
Lower bound	**1.093**		**5.754**		**6.207**		**5.489**		**6.025**		**11.831**		**12.406**	
Upper uncertainty level	1.100		5.794		6.248		5.525		6.079		11.910		12.488	
Lower uncertainty level	1.086		5.714		6.166		5.453		5.984		11.752		12.324	
Upper bound	**1.093**		**5.754**		**6.207**		**5.489**		**6.025**		**11.831**		**12.406**	
Upper uncertainty level	1.100		5.794		6.248		5.525		6.066		11.910		12.488	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.276		0.022		0.022		0.350		0.034		0.035		0.275	
Lower bound	**0.278**		**0.023**		**0.022**		**0.353**		**0.034**		**0.036**		**0.277**	
Upper uncertainty level	0.280		0.023		0.022		0.355		0.034		0.036		0.279	
Lower uncertainty level	0.276		0.022		0.022		0.350		0.034		0.035		0.275	
Upper bound	**0.278**		**0.023**		**0.022**		**0.353**		**0.034**		**0.036**		**0.277**	
Upper uncertainty level	0.280		0.023		0.022		0.355		0.034		0.036		0.279	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16765		16766		16767		16768		16769		16770		16771	
FERA LIMS No.	S08-031185		S08-031186		S08-031187		S08-031188		S08-031189		S08-031190		S08-031191	
Sample Details:	Cuckoo Ray, ID: C356/031, 1008S		Monkfish, ID: C356/032, 1008S		Roach, Forth & Clyde Canal, ID: C356/033		Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08		Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas		Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08		Trout, Kirtle Water, ID:C356/038	
Fat % Whole	0.46		0.28		2.48		1.16		2.80		18.48		4.24	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	60.75	99	187.01	55	20855.46	24	11056.66	24	1279.58	25	7.93	76	225.75	24
PCB81	3.60	133	13.64	59	1238.25	24	652.31	24	140.89	27	0.59	78	14.47	24
PCB126	55.73	25	32.01	28	599.35	24	307.33	24	79.44	32	15.30	24	33.03	24
PCB169	15.97	24	10.46	26	14.25	24	10.24	24	2.03	98	5.38	24	4.85	25
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	5.700		3.300		61.876		31.794		8.021		1.574		3.354	
Lower bound	**5.739**		**3.326**		**62.287**		**32.006**		**8.106**		**1.585**		**3.376**	
Upper uncertainty level	5.778		3.352		62.698		32.218		8.191		1.596		3.398	
Lower uncertainty level	5.700		3.300		61.876		31.794		8.021		1.574		3.354	
Upper bound	**5.739**		**3.326**		**62.287**		**32.006**		**8.106**		**1.585**		**3.376**	
Upper uncertainty level	5.778		3.352		62.698		32.218		8.191		1.596		3.398	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.026		0.009		1.534		0.368		0.225		0.291		0.142	
Lower bound	**0.026**		**0.009**		**1.544**		**0.370**		**0.227**		**0.293**		**0.143**	
Upper uncertainty level	0.026		0.009		1.554		0.373		0.229		0.295		0.144	
Lower uncertainty level	0.026		0.009		1.534		0.368		0.225		0.291		0.142	
Upper bound	**0.026**		**0.009**		**1.544**		**0.370**		**0.227**		**0.293**		**0.143**	
Upper uncertainty level	0.026		0.009		1.554		0.373		0.229		0.295		0.144	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16772		16773		16774		16775		16776		16777		16778	
FERA LIMS No.	S08-031192		S08-031193		S08-031194		S08-031195		S08-031196		S08-031197		S08-031198	
Sample Details:	Eel, Lochar Water, ID: C356/039, 27-8-08		Trout, Lochhar W, ID: C356/040, 27-08-08		Eel - R Eden, ID: C356/041		Trout, R Eden, ID: C356/042		Trout, W of Girvan, ID: C356/043		Pike, L Achray, ID: C356/044		Eel, R Leven, ID: C356/045	
Fat % Whole	14.83		1.31		16.45		8.39		2.06		1.56		13.08	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	10.45	70	129.41	25	18.88	45	273.10	24	443.19	24	278.78	24	31.23	35
PCB81	0.53	101	7.01	25	1.39	47	15.59	24	31.07	24	27.55	24	4.39	28
PCB126	11.31	24	9.22	25	27.24	24	22.84	24	57.28	24	173.50	24	52.53	24
PCB169	6.88	24	1.61	29	10.19	24	2.63	27	7.40	25	41.09	24	10.75	24
WHO-TEQ ng/kg FAT weight														
Lower uncertainty level	1.193		0.945		2.809		2.323		5.810		17.674		5.328	
Lower bound	**1.201**		**0.952**		**2.828**		**2.339**		**5.849**		**17.792**		**5.364**	
Upper uncertainty level	1.209		0.959		2.847		2.355		5.888		17.910		5.400	
Lower uncertainty level	1.193		0.945		2.809		2.323		5.810		17.674		5.328	
Upper bound	**1.201**		**0.952**		**2.828**		**2.339**		**5.849**		**17.792**		**5.364**	
Upper uncertainty level	1.209		0.959		2.847		2.355		5.888		17.910		5.400	
WHO-TEQ ng/kg WHOLE weight														
Lower uncertainty level	0.177		0.012		0.462		0.195		0.120		0.275		0.697	
Lower bound	**0.178**		**0.012**		**0.465**		**0.196**		**0.121**		**0.277**		**0.702**	
Upper uncertainty level	0.179		0.013		0.468		0.198		0.122		0.279		0.706	
Lower uncertainty level	0.177		0.012		0.462		0.195		0.120		0.275		0.697	
Upper bound	**0.178**		**0.012**		**0.465**		**0.196**		**0.121**		**0.277**		**0.702**	
Upper uncertainty level	0.179		0.013		0.468		0.198		0.122		0.279		0.706	

Table 4(cont'd). Concentrations of non-ortho PCBs

FERA Sample No.	16779		16808		16939		16940	
FERA LIMS No.	S08-031199		S08-032253		S09-002037		S09-002038	
Sample Details:	Trout, Clyde, ID: C356/046		Trout - White Cart W, ID: C356/036		Roach, Forth & Clyde Canal, ID: C356/033 (Part-2)		Roach, Forth & Clyde Canal, ID: C356/033 (Part-3)	
Fat % Whole	3.19		7.84		3.65		1.45	
ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PCB77	196.60	25	213.66	24	8028.72	24	13840.67	24
PCB81	16.27	30	11.07	31	415.34	24	744.36	24
PCB126	37.92	25	54.83	24	193.33	24	283.00	24
PCB169	6.96	24	8.66	24	5.03	25	7.07	32
WHO-TEQ ng/kg FAT weight								
Lower uncertainty level	3.856		5.555		20.093		29.622	
Lower bound	**3.883**		**5.592**		**20.228**		**29.829**	
Upper uncertainty level	3.910		5.629		20.363		30.036	
Lower uncertainty level	3.856		5.555		20.093		29.622	
Upper bound	**3.883**		**5.592**		**20.228**		**29.829**	
Upper uncertainty level	3.910		5.629		20.363		30.036	
WHO-TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.123		0.436		0.733		0.430	
Lower bound	**0.124**		**0.439**		**0.738**		**0.433**	
Upper uncertainty level	0.125		0.442		0.743		0.436	
Lower uncertainty level	0.123		0.436		0.733		0.430	
Upper bound	**0.124**		**0.439**		**0.738**		**0.433**	
Upper uncertainty level	0.125		0.442		0.743		0.436	

Table 5. Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16272		16273		16274		16275	
FERA LIMS No.	S08-015904		S08-015905		S08-015906		S08-015907	
Sample Details:	Mussels - FSA Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - FSA Mussels Stannergate, 17/6/08	
Fat % Whole	0.44		0.26		0.30		0.35	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	1.67	135	2.09	147	<1.42	201	<1.36	201
PCB28	5.28	76	7.35	74	3.13	156	3.40	139
PCB31	3.80	86	7.62i	201	2.33	173	2.44	159
PCB33	2.00	133	3.21	113	<1.67	201	1.80	179
PCB41	7.24	30	5.61	40	2.75	65	2.76	63
PCB44	2.75	54	6.37	37	1.04	161	1.36	120
PCB52	13.93	40	12.34	55	5.17	112	6.40	88
PCB56/60	10.39	36	6.59	62	2.29	155	3.92	89
PCB61/74	11.67	39	7.40	69	3.04	150	4.16	107
PCB66	28.61	38	18.27i	201	7.54	146	10.97	98
PCB99	23.76	24	14.93	27	6.17	36	9.81	29
PCB101	46.31	30	31.10	45	10.58	108	18.57	62
PCB87	17.27	27	8.64	42	3.00	98	6.64	47
PCB105	14.49	25	29.94i	24	2.42	60	5.60	33
PCB110	44.05	26	25.67	35	6.54	95	16.17	43
PCB114	1.18	41	<1.38	201	<1.0	201	0.84	62
PCB118	46.44	26	19.74	38	7.58	76	18.33	37
PCB123	1.38	26	1.02	30	0.33	54	0.48	41
PCB128	12.42	24	5.97	27	1.96	41	5.00	27
PCB129	1.25	32	0.40	93	<0.5	201	0.52	66
PCB138	123.39	24	65.73	26	26.25	35	45.31	28
PCB156	5.11	24	2.50	25	1.17	27	2.32	25
PCB157	2.06i	25	2.54i	25	0.46	42	1.04i	28
PCB167	4.36	24	5.26	24	0.88	30	1.88	25
PCB141	1.57	48	1.16	81	0.58	147	0.68	120
PCB149	76.26	25	63.59	26	19.75	40	26.50	33
PCB151	20.45	25	10.29	32	5.33	44	5.96	40
PCB153	146.36	24	69.60	27	31.84	36	46.15	30
PCB170	5.47	24	3.83	26	1.75i	31	1.80i	30
PCB180	21.33	24	12.66	25	8.17	27	7.28	27
PCB183	41.13	24	29.50	24	10.92	25	9.65	25
PCB185	<0.62	201	0.67	24	<0.25	201	<0.12	201
PCB187	111.95	24	54.59	24	29.84	25	36.42	24
PCB189	0.72i	24	0.76	24	<0.67	201	<0.8	201
PCB191	1.15	27	0.80	33	<0.54	201	0.36	50
PCB193	<1.87	201	<1.02	201	<0.79	201	<0.36	201
PCB194	2.06	25	1.47	27	1.00	29	0.84	30
PCB201	<0.66	201	0.62	38	0.25	68	0.48	41
PCB202	4.16	24	3.88	24	0.92	29	2.24	25
PCB203	1.74	25	3.16	24	0.58	36	1.00	29
PCB206	<0.46	201	<3.03	201	<1.88	201	<0.4	201
PCB208	<0.26	201	<0.31	201	<0.5	201	<1.52	201
PCB209	<0.36	201	2.85	30	<1.0	201	<0.24	201

i - indicative value

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16272	16273	16274	16275
FERA LIMS No.	S08-015904	S08-015905	S08-015906	S08-015907
Sample Details:	Mussels - FSA Ardmore 14/5/08	Mussels - Blackness F of F, 18/5/08	Mussels - Inverness Football Ground, 6/6/08	Mussels - FSA Mussels Stannergate, 17/6/08
Fat % Whole	0.44	0.26	0.30	0.35
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	9.793	7.316	1.692	4.111
Lower bound	10.520	7.720	1.860	4.560
Upper uncertainty level	11.247	8.124	2.028	5.009
Lower uncertainty level	9.793	6.966	1.891	4.124
Upper bound	10.520	8.410	2.420	4.640
Upper uncertainty level	11.247	9.854	2.949	5.156
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.043	0.019	0.005	0.014
Lower bound	0.046	0.020	0.006	0.016
Upper uncertainty level	0.049	0.021	0.006	0.017
Lower uncertainty level	0.043	0.018	0.006	0.014
Upper bound	0.046	0.022	0.007	0.016
Upper uncertainty level	0.049	0.025	0.009	0.018

FERA Sample No.	16276		16277		16278		16279	
FERA LIMS No.	S08-015908		S08-016128		S08-016129		S08-016130	
Sample Details:	Mussels - Inverness Nigg Bay, 21/6/08		1 - Spurdog, ID: C356/001		2 - Spurdog, ID: C356/002		3 - Smooth Hound, ID: C356/003	
Fat % Whole	0.38		14.58		8.14		0.53	
ug/kg fat weight	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U
PCB18	<1.42	201	0.28	32	0.40	28	0.47	163
PCB28	3.42	144	2.85	24	4.61	24	3.65	39
PCB31	2.30	176	1.58	25	2.59	24	1.38	68
PCB33	1.75	192	0.27	44	0.48	35	0.69	130
PCB41	2.38	74	3.28	25	5.99	24	2.36	32
PCB44	1.04	161	5.34	26	9.67	25	1.63	24
PCB52	4.42	131	7.79	25	13.64	24	0.91	72
PCB56/60	2.50	142	2.01	25	4.69	24	2.36	35
PCB61/74	3.17	144	5.99	24	16.13	24	6.22	24
PCB66	8.01	138	9.16	24	22.95	24	9.27	25
PCB99	6.18	36	22.99i	201	44.77	24	13.93	24
PCB101	11.10	103	23.25	24	62.38	24	8.11	24
PCB87	3.01	97	5.12	24	11.53	24	1.32	25
PCB105	2.71	55	5.97	24	18.15	24	5.09	24
PCB110	6.22	100	11.73	24	29.95	24	5.88	24
PCB114	<0.5	201	1.16i	24	1.26i	24	0.69	29
PCB118	9.52	62	23.16	24	76.30	24	18.96	24
PCB123	0.21	80	0.29i	25	0.65	24	0.19	26
PCB128	2.42	36	5.68	24	18.27	24	5.66	24
PCB129	<0.17	201	0.18	33	0.23i	29	0.35	24
PCB138	25.46	35	62.70	24	198.26	24	55.52	24
PCB156	1.21	27	2.13	24	8.77	24	2.52	24
PCB157	0.54	38	0.72	24	2.50	24	1.04	24
PCB167	1.00	29	1.24	24	4.73	24	1.70	25
PCB141	<0.42	201	5.55	24	12.38	24	1.19	26
PCB149	13.48	53	35.74	24	65.11	24	15.18	24
PCB151	3.21	67	9.18	24	13.22	24	0.63	30
PCB153	26.51	40	73.63	24	212.95	24	66.52	24
PCB170	<1.67	201	10.55	24	24.55	24	10.25	24
PCB180	2.38	48	20.39	24	52.79	24	21.31	24
PCB183	6.18	27	4.70	24	20.36	24	11.32	24
PCB185	<0.25	201	0.60	24	1.33	24	0.50	24
PCB187	15.11	27	25.39	24	82.64	24	40.21	24
PCB189	<0.92	201	0.24	25	0.74	24	0.31	25
PCB191	0.17	97	2.25	24	5.23	24	1.82	24
PCB193	<0.13	201	0.39	24	1.05	24	0.41	24
PCB194	0.42	45	2.95	24	6.75	24	4.37	24
PCB201	0.25	68	3.87	24	7.75	24	6.54	24
PCB202	0.92	29	0.18	26	1.56	24	2.36	24
PCB203	0.38	48	1.79	24	5.87	24	4.97	24
PCB206	<2.3	201	<0.18	201	3.95	26	1.73	25
PCB208	<0.33	201	<0.08	201	0.14	131	0.44	36
PCB209	<1.09	201	<0.01	201	0.12	29	0.47	24

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16276	16277	16278	16279
FERA LIMS No.	S08-015908	S08-016128	S08-016129	S08-016130
Sample Details:	Mussels - Inverness Nigg Bay, 21/6/08	1 - Spurdog, ID: C356/001	2 - Spurdog, ID: C356/002	3 - Smooth Hound, ID: C356/003
Fat % Whole	0.38	14.58	8.14	0.53
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	1.943	4.694	14.994	4.320
Lower bound	2.130	4.980	15.900	4.600
Upper uncertainty level	2.317	5.266	16.806	4.880
Lower uncertainty level	1.934	4.694	14.994	4.320
Upper bound	2.470	4.980	15.900	4.600
Upper uncertainty level	3.006	5.266	16.806	4.880
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.007	0.684	1.220	0.023
Lower bound	0.008	0.726	1.294	0.024
Upper uncertainty level	0.009	0.768	1.368	0.026
Lower uncertainty level	0.007	0.684	1.220	0.023
Upper bound	0.009	0.726	1.294	0.024
Upper uncertainty level	0.011	0.768	1.368	0.026

FERA Sample No.	16280		16281		16282		16283	
FERA LIMS No.	S08-016131		S08-016132		S08-016133		S08-016134	
Sample Details:	4 - Starry Smooth Hound, ID: C356/004		5 - Thornback Ray, ID: C356/005		6 - Skate, ID: C356/006		7 - Hake, ID: C356/007	
Fat % Whole	0.80		0.79		0.79		3.02	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	0.33	159	0.44	174	<0.36	201	0.70	25
PCB28	1.02	80	1.23	60	0.44	147	2.39	25
PCB31	0.50	122	0.68	103	<0.32	201	1.20	25
PCB33	<0.3	201	0.49	125	<0.28	201	0.20	65
PCB41	0.37	95	0.32	189	<0.28	201	3.13	26
PCB44	0.54	24	0.61	24	0.32	25	7.86	25
PCB52	0.67	70	0.70	75	0.32	152	7.85	25
PCB56/60	0.39	115	0.59	62	0.18	179	1.57	26
PCB61/74	1.13	24	0.70	44	0.24	103	4.70	25
PCB66	1.24	48	1.88	33	0.38	108	6.17	25
PCB99	2.54	25	2.39	24	0.87i	25	13.63	24
PCB101	1.26	31	1.14	33	0.44	60	17.88	24
PCB87	0.24	41	0.21	45	0.10	83	5.17	24
PCB105	1.04	25	1.67	24	0.40	31	3.95	24
PCB110	0.82	32	0.27	64	0.18	92	8.40	24
PCB114	0.15	58	0.32i	35	<0.06	201	0.44i	25
PCB118	3.89	24	4.18	24	1.37	26	15.88	24
PCB123	0.04	55	0.06	41	<0.02	201	0.26	25
PCB128	1.09	25	1.33	25	0.36	33	3.32	24
PCB129	<0.04	201	<0.08	201	<0.04	201	0.60	25
PCB138	10.96	24	11.62	24	3.27	24	35.10	24
PCB156	0.52	24	0.63	24	0.22	25	1.35	24
PCB157	0.22	25	0.27	25	0.08	35	0.42	24
PCB167	0.30	36	0.40	31	0.16	55	0.77	24
PCB141	0.11	77	0.08	103	0.12	71	5.81	24
PCB149	2.06	25	0.82	26	0.52	28	28.71	24
PCB151	0.11	77	0.21	45	0.18	50	8.27	24
PCB153	12.83	24	14.73	24	4.44	24	36.69	24
PCB170	2.04	24	1.88	24	0.59	27	4.91	24
PCB180	3.71	24	3.78	24	1.47	24	8.44	24
PCB183	1.69	24	1.67	24	0.48	24	2.22	24
PCB185	<0.04	201	<0.04	201	<0.02	201	0.48	24
PCB187	6.95	24	6.70	24	1.29	25	10.58	24
PCB189	<0.07	201	0.13	28	0.04i	55	0.13	28
PCB191	0.35	24	0.44	24	0.10	31	1.07	24
PCB193	0.07	37	0.08	35	<0.04	201	0.16	27
PCB194	0.78	24	0.97	24	0.30	25	0.83	24
PCB201	1.17	24	1.01	24	0.24	25	0.85	24
PCB202	0.37	24	0.68	24	0.18	26	0.10	31
PCB203	1.04	24	0.89	24	0.34	24	0.47	25
PCB206	<0.15	201	0.74	26	<0.73	201	<1.04	201
PCB208	<0.65	201	<0.59	201	<0.1	201	<0.09	201
PCB209	<1.26	201	0.27	25	<0.48	201	<0.02	201

i - indicative value

Table 5 (cont’d). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16280	16281	16282	16283
FERA LIMS No.	S08-016131	S08-016132	S08-016133	S08-016134
Sample Details:	4 - Starry Smooth Hound, ID: C356/004	5 - Thornback Ray, ID: C356/005	6 - Skate, ID: C356/006	7 - Hake, ID: C356/007
Fat % Whole	0.80	0.79	0.79	3.02
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	0.862	1.138	0.307	2.946
Lower bound	0.950	1.220	0.330	3.130
Upper uncertainty level	1.038	1.302	0.353	3.314
Lower uncertainty level	0.849	1.138	0.287	2.946
Upper bound	0.950	1.220	0.360	3.130
Upper uncertainty level	1.051	1.302	0.433	3.314
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.007	0.009	0.002	0.089
Lower bound	0.008	0.010	0.003	0.094
Upper uncertainty level	0.008	0.010	0.003	0.100
Lower uncertainty level	0.007	0.009	0.002	0.089
Upper bound	0.008	0.010	0.003	0.094
Upper uncertainty level	0.008	0.010	0.003	0.100

FERA Sample No.	16284		16285		16286		16287	
FERA LIMS No.	S08-016135		S08-016136		S08-016137		S08-016138	
Sample Details:	8 - Spotted Ray, ID: C356/008		9 - Cuckoo Ray, ID: C356/009		10 - Black-Mouthed Dogfish, ID: C356/010		11 - Lesser Spotted Dogfish, ID: C356/011	
Fat % Whole	0.71		0.59		1.01		0.51	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	<0.5	201	<0.59	201	<0.28	201	<0.63	201
PCB28	1.30	72	0.63	170	0.74	72	1.16	176
PCB31	0.78	115	<0.53	201	0.47	109	<0.82	201
PCB33	0.55	144	<0.46	201	<0.22	201	<0.5	201
PCB41	0.58	137	<0.46	201	0.30	149	<0.88	201
PCB44	0.89	24	0.92	24	1.30	24	<2.33	201
PCB52	1.39	53	0.79	102	1.69	33	<1.7	201
PCB56/60	0.64	73	0.46	116	0.80	40	0.75	71
PCB61/74	0.91	44	0.69	63	1.49	27	1.32	155
PCB66	1.69	41	1.18	61	2.07	28	<2.08	201
PCB99	4.10	24	3.45	24	3.83	24	2.99	75
PCB101	2.77	27	3.95	26	5.51	24	<3.02	201
PCB87	0.61	31	0.89	29	1.24	24	<0.69	201
PCB105	1.47	25	1.51	26	1.66	24	1.32	53
PCB110	1.25	30	1.09	34	1.93	25	<1.51	201
PCB114	0.19	67	0.20i	74	0.20i	38	<0.38	201
PCB118	6.13	24	5.30	24	6.31	24	4.34	65
PCB123	0.14	28	0.13	28	0.16	27	0.13	95
PCB128	2.16	24	1.91	25	1.68	24	1.23	39
PCB129	<0.14	201	<0.16	201	0.31	31	0.13	28
PCB138	20.40	24	17.93	24	18.92	24	12.89	40
PCB156	1.03	24	0.82	24	0.78	24	0.60	31
PCB157	0.36	24	0.36	24	0.31	25	0.22	60
PCB167	0.67	30	0.59	34	0.52	26	0.31	87
PCB141	0.39	39	0.92	28	1.21	24	0.63	83
PCB149	3.88	24	4.34	24	6.51	24	2.67	152
PCB151	0.91	27	<0.07	201	1.68	24	<0.63	201
PCB153	26.02	24	23.62	24	22.58	24	15.31	44
PCB170	3.66	24	2.86	24	2.65	24	2.23	29
PCB180	8.07	24	6.55	24	6.15	24	4.06	27
PCB183	3.41	24	2.57	24	2.71	24	1.57	29
PCB185	<0.03	201	<0.03	201	0.16	27	<0.03	201
PCB187	12.31	24	11.05	24	10.53	24	6.23	30
PCB189	0.17	27	0.16i	27	0.11	30	0.09	135
PCB191	0.64	24	0.63	24	0.77	24	1.32	25
PCB193	0.11	30	<0.16	201	0.11	30	0.09	135
PCB194	1.25	24	1.32	24	0.94	24	0.75	29
PCB201	1.22	24	1.64	24	1.52	24	1.10	26
PCB202	0.64	24	0.99	24	0.75	24	0.53	33
PCB203	1.27	24	1.35	24	1.07	24	0.85	24
PCB206	0.91	27	0.79	30	0.71	25	<0.63	201
PCB208	<0.03	201	<0.01	201	<0.06	201	<0.13	201
PCB209	<0.61	201	<0.69	201	<0.22	201	<0.16	201

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16284	16285	16286	16287
FERA LIMS No.	S08-016135	S08-016136	S08-016137	S08-016138
Sample Details:	8 - Spotted Ray, ID: C356/008	9 - Cuckoo Ray, ID: C356/009	10 - Black-Mouthed Dogfish, ID: C356/010	11 - Lesser Spotted Dogfish, ID: C356/011
Fat % Whole	0.71	0.59	1.01	0.51
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	1.454	1.283	1.370	0.884
Lower bound	1.590	1.410	1.470	1.000
Upper uncertainty level	1.726	1.537	1.570	1.116
Lower uncertainty level	1.454	1.283	1.370	0.920
Upper bound	1.590	1.410	1.470	1.190
Upper uncertainty level	1.726	1.537	1.570	1.460
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.010	0.008	0.014	0.005
Lower bound	0.011	0.008	0.015	0.005
Upper uncertainty level	0.012	0.009	0.016	0.006
Lower uncertainty level	0.010	0.008	0.014	0.005
Upper bound	0.011	0.008	0.015	0.006
Upper uncertainty level	0.012	0.009	0.016	0.007

FERA Sample No.	16288		16380		16384		16385	
FERA LIMS No.	S08-016139		S08-019914		S08-019915		S08-019916	
Sample Details:	12 - Black Scabbard Fish, ID: C356/012		Torsk, whole fish, ID: C356/013		Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1		Round Nose Grenadier, Whole Fish, ID: C356/15	
Fat % Whole	2.23		0.44		0.32		0.39	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	0.15	58	0.47	155	<0.29	201	<0.4	201
PCB28	3.15	25	1.45	77	0.71	151	0.95	137
PCB31	2.26	24	1.04i	201	<0.38	201	<0.52	201
PCB33	0.08	177	0.50	166	<0.26	201	<0.32	201
PCB41	2.63	28	1.24	45	0.32	152	<0.56	201
PCB44	5.83	27	2.28	24	1.44	24	<1.47	201
PCB52	12.76	24	3.29	30	2.24	35	2.84	79
PCB56/60	3.27	25	1.10	60	0.41	143	0.65	55
PCB61/74	9.76	24	3.23	33	0.79	92	2.84	51
PCB66	13.49	24	4.00	30	1.80	46	1.69	157
PCB99	21.49	24	13.75	24	6.86	24	9.66	28
PCB101	34.24	24	11.35	24	4.83	25	4.41	90
PCB87	9.47	24	1.39	25	0.68	30	0.87	104
PCB105	9.12	24	4.41	24	2.21	24	3.89	26
PCB110	5.91	25	2.76	25	1.44	29	1.89	103
PCB114	0.59i	25	<0.30	201	<0.15	201	0.44i	112
PCB118	35.58	24	16.65	24	8.80	24	14.05	27
PCB123	0.36	24	0.30	25	0.09	33	0.16	55
PCB128	6.74	24	5.51	24	2.74	24	3.75	25
PCB129	1.41	24	0.50	24	0.18	26	0.50	24
PCB138	87.98	24	54.90	24	24.84	24	44.49	24
PCB156	3.61	24	2.43	24	1.12	24	1.92	24
PCB157	1.19	24	0.80	24	0.41	24	0.73	26
PCB167	1.95	24	1.75	25	0.79	28	0.56	37
PCB141	9.51	24	3.88	24	1.44	25	2.58	27
PCB149	38.16	24	11.85	24	6.09	24	8.59	38
PCB151	11.76	24	5.63	24	2.68	24	3.61	33
PCB153	97.81	24	80.02	24	41.21	24	49.21	25
PCB170	15.11	24	12.83	24	5.36	24	8.08	24
PCB180	33.69	24	22.99	24	13.04	24	20.48	24
PCB183	11.86	24	7.58	24	5.27	24	8.18	24
PCB185	1.32	24	0.56	24	0.21	26	<0.14	201
PCB187	49.96	24	15.41	24	10.36	24	18.79	24
PCB189	0.33	25	0.36	24	0.12	29	0.30i	36
PCB191	2.98	24	2.16	24	0.94	24	1.71	24
PCB193	0.41	24	0.41	24	0.21	26	0.30	36
PCB194	4.13	24	3.44	24	1.62	24	2.58	24
PCB201	7.08	24	2.73	24	1.41	24	3.29	24
PCB202	1.15	24	0.59	24	0.56	24	1.29	25
PCB203	3.63	24	2.99	24	1.65	24	2.68	24
PCB206	2.20	32	<2.93	201	<0.88	201	1.37	33
PCB208	<0.11	201	<1.01	201	<0.06	201	<0.34	201
PCB209	0.05i	47	<0.21	201	0.15	27	1.05	25

i - indicative value

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16288	16380	16384	16385
FERA LIMS No.	S08-016139	S08-019914	S08-019915	S08-019916
Sample Details:	12 - Black Scabbard Fish, ID: C356/012	Torsk, whole fish, ID: C356/013	Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1	Round Nose Grenadier, Whole Fish, ID: C356/15
Fat % Whole	2.23	0.44	0.32	0.39
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	6.832	3.617	1.795	2.984
Lower bound	**7.250**	**3.800**	**1.890**	**3.390**
Upper uncertainty level	7.668	3.983	1.985	3.796
Lower uncertainty level	6.832	3.286	1.635	2.984
Upper bound	**7.250**	**3.950**	**1.970**	**3.390**
Upper uncertainty level	7.668	4.614	2.305	3.796
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.152	0.016	0.006	0.012
Lower bound	**0.161**	**0.017**	**0.006**	**0.013**
Upper uncertainty level	0.171	0.018	0.006	0.015
Lower uncertainty level	0.152	0.014	0.005	0.012
Upper bound	**0.161**	**0.017**	**0.006**	**0.013**
Upper uncertainty level	0.171	0.020	0.007	0.015

FERA Sample No.	16386		16387		16388		16552	
FERA LIMS No.	S08-019917		S08-019918		S08-019919		S08-026043	
Sample Details:	Ling, Whole fish ID: C356/014		Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08,		Monk fish -(Tails) ID: C356/16		John Dory,ID: C356/19	
Fat % Whole	0.66		0.45		0.47		1.59	
ug/kg fat weight	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U
PCB18	<0.33	201	<0.36	201	<0.34	201	1.02	73
PCB28	0.73	147	0.88	125	<0.55	201	3.74	38
PCB31	0.46	188	0.42	201	<0.45	201	2.43	44
PCB33	<0.26	201	<0.42	201	<0.27	201	1.01	60
PCB41	0.87	108	0.70	73	<0.48	201	5.16	30
PCB44	1.88	132	1.63	24	<1.27	201	12.99	31
PCB52	2.57	73	2.54	34	<0.93	201	15.22	27
PCB56/60	0.77	41	0.60	103	0.15	188	4.43	25
PCB61/74	2.49	49	2.30	24	0.62	179	6.48	29
PCB66	3.05	75	1.96	44	<1.13	201	15.62	28
PCB99	10.24	26	6.83	24	<0.72	201	23.92	24
PCB101	10.65	38	4.75	25	<1.65	201	34.90	26
PCB87	2.26	40	1.18	26	<0.38	201	4.76	29
PCB105	2.84	26	2.60	24	0.81	48	4.76	25
PCB110	3.66	49	1.60	28	<0.82	201	18.40	25
PCB114	0.43i	96	0.45	36	<0.21	201	<0.21	201
PCB118	13.11	26	9.19	24	0.91	160	24.27	25
PCB123	0.28	32	0.06	41	0.03	201	0.50	27
PCB128	3.43	24	2.42	24	1.13	30	5.66	24
PCB129	0.68	24	0.33	25	<0.09	201	0.89	24
PCB138	49.48	24	27.56	24	11.59	31	69.98	24
PCB156	1.60	24	1.15	24	0.67	25	1.75	24
PCB157	0.64	26	0.42	24	0.24	35	0.64	26
PCB167	1.20	26	0.54	33	0.38	44	1.37	26
PCB141	2.60	26	2.21	24	<0.14	201	2.85	26
PCB149	15.94	27	6.14	24	2.35	97	37.30	25
PCB151	4.35	28	3.02	24	0.99	73	10.27	25
PCB153	62.01	24	32.19	24	19.74	28	72.30	24
PCB170	7.42	24	4.68	24	2.44	25	4.20	24
PCB180	17.94	24	12.21	24	5.40	24	7.19	24
PCB183	7.58	24	4.38	24	2.47	24	3.67	24
PCB185	0.49	24	0.30	25	0.14	28	0.50	24
PCB187	25.97	24	12.27	24	6.40	26	26.21	24
PCB189	0.20	38	0.15	27	0.10	65	0.24	35
PCB191	1.75	24	1.09	24	0.58	26	1.67	24
PCB193	0.30	31	0.18	26	0.10	65	0.26	33
PCB194	1.85	24	1.90	24	0.75	25	1.04	24
PCB201	3.00	24	3.20	24	0.79	25	1.36	24
PCB202	1.35	24	1.00	24	0.41	28	1.44	24
PCB203	1.96	24	1.99	24	0.96	24	1.06	24
PCB206	<1.7	201	1.48	25	<0.48	201	0.43	69
PCB208	<0.15	201	0.15	83	<0.07	201	<0.1	201
PCB209	<0.08	201	0.21	26	0.27	33	0.26	33

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16386	16387	16388	16552
FERA LIMS No.	S08-019917	S08-019918	S08-019919	S08-026043
Sample Details:	Ling, Whole fish ID: C356/014	Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08,	Monk fish -(Tails) ID: C356/16	John Dory,ID: C356/19
Fat % Whole	0.66	0.45	0.47	1.59
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	2.671	2.071	0.569	3.974
Lower bound	**2.990**	**2.220**	**0.640**	**4.190**
Upper uncertainty level	3.309	2.369	0.711	4.406
Lower uncertainty level	2.671	2.071	0.583	3.556
Upper bound	**2.990**	**2.220**	**0.750**	**4.290**
Upper uncertainty level	3.309	2.369	0.917	5.024
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.018	0.009	0.003	0.063
Lower bound	**0.020**	**0.010**	**0.003**	**0.066**
Upper uncertainty level	0.022	0.011	0.003	0.070
Lower uncertainty level	0.018	0.009	0.003	0.056
Upper bound	**0.020**	**0.010**	**0.004**	**0.068**
Upper uncertainty level	0.022	0.011	0.004	0.080

FERA Sample No.	16553		16554		16555		16556	
FERA LIMS No.	S08-026044		S08-026045		S08-026046		S08-026047	
Sample Details:	Haddock, ID: C356/20 1008S		Horse Mackerel, ID: C356/21 1008S		Hake, ID: C356/22 1008S		Herring, ID: 356/23 1008S	
Fat % Whole	0.50		2.75		0.77		16.10	
ug/kg fat weight	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U
PCB18	<1.02	201	0.33	135	0.80	127	0.43	40
PCB28	<1.63	201	1.08	69	5.74	37	1.76	27
PCB31	<1.33	201	1.03	59	3.22	47	1.15	28
PCB33	<0.82	201	0.33	106	<0.4	201	0.30	47
PCB41	<1.43	201	1.33	51	6.41	32	1.49	27
PCB44	<3.78	201	3.46	52	15.10	34	3.25	29
PCB52	<2.76	201	3.74	40	17.62	28	3.62	26
PCB56/60	<0.41	201	0.85	32	4.49	25	1.46	24
PCB61/74	<1.63	201	2.11	41	12.33	27	1.99	27
PCB66	<3.37	201	2.57	61	18.96	29	3.58	27
PCB99	<1.74	201	6.16	27	33.29	24	4.35	24
PCB101	<4.9	201	10.57	31	54.22	25	8.00	25
PCB87	<1.12	201	2.62	30	11.78	26	1.83	25
PCB105	<0.51	201	2.15	26	12.38	24	1.74	24
PCB110	<2.45	201	5.15	31	23.61	26	4.73	25
PCB114	<0.61	201	0.28i	96	1.20i	55	0.16	55
PCB118	<2.14	201	8.18	26	49.56	24	6.20	24
PCB123	<0.1	201	0.16	35	0.97	26	0.14	28
PCB128	<0.31	201	2.60	24	12.85	24	1.65	24
PCB129	<0.01	201	0.61	24	1.95	24	0.29	25
PCB138	<3.37	201	33.47	24	148.49	24	17.15	24
PCB156	0.10	201	1.38	24	5.17	24	0.53	24
PCB157	<0.1	201	0.53	25	2.00	24	0.23	25
PCB167	<0.2	201	0.89	25	3.39	25	0.39	24
PCB141	<0.41	201	2.99	25	10.65	24	1.21	24
PCB149	<3.27	201	14.65	26	66.12	24	10.35	24
PCB151	<1.02	201	4.25	26	19.16	24	2.68	24
PCB153	<4.59	201	41.21	24	156.25	24	15.76	24
PCB170	<0.36	201	7.29	24	13.95	24	1.24	24
PCB180	0.46	180	16.11	24	28.35	24	2.36	24
PCB183	0.20	201	5.18	24	13.60	24	1.24	24
PCB185	<0.01	201	0.57	24	<1.02	201	0.18	26
PCB187	<0.92	201	22.30	24	59.74	24	7.06	24
PCB189	<0.1	201	0.31	27	0.55	30	0.05	47
PCB191	<0.1	201	1.68	24	4.07	24	0.45	24
PCB193	<0.1	201	0.28	28	0.77	27	0.06	41
PCB194	<0.15	201	3.15	24	3.82	24	0.32	25
PCB201	<0.1	201	4.62	24	5.36	24	0.59	24
PCB202	<0.1	201	1.42	24	3.34	24	0.32	25
PCB203	0.15	27	2.97	24	4.52	24	0.45	24
PCB206	<0.41	201	1.53	27	1.90	32	0.17	43
PCB208	<0.2	201	0.18i	26	0.40	24	<0.03	201
PCB209	<0.1	201	0.21i	30	1.25	25	0.08i	35

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16553	16554	16555	16556
FERA LIMS No.	S08-026044	S08-026045	S08-026046	S08-026047
Sample Details:	Haddock, ID: C356/20 1008S	Horse Mackerel, ID: C356/21 1008S	Hake, ID: C356/22 1008S	Herring, ID: 356/23 1008S
Fat % Whole	0.50	2.75	0.77	16.10
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	0.000	1.951	9.736	1.176
Lower bound	**0.050**	**2.180**	**10.560**	**1.280**
Upper uncertainty level	0.100	2.409	11.384	1.384
Lower uncertainty level	0.358	1.951	9.736	1.176
Upper bound	**0.690**	**2.180**	**10.560**	**1.280**
Upper uncertainty level	1.022	2.409	11.384	1.384
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.000	0.054	0.075	0.189
Lower bound	**0.000**	**0.060**	**0.081**	**0.206**
Upper uncertainty level	0.001	0.066	0.088	0.223
Lower uncertainty level	0.002	0.054	0.075	0.189
Upper bound	**0.003**	**0.060**	**0.081**	**0.206**
Upper uncertainty level	0.005	0.066	0.088	0.223

FERA Sample No.	16557		16558		16559		16560	
FERA LIMS No.	S08-026048		S08-026049		S08-026050		S08-026051	
Sample Details:	Mackerel, ID: C356/24 1008S		Ling, ID: C356/25 1008S		Cod, ID: C356/26 1008S		Spurdog, ID: C356/27 1008S	
Fat % Whole	25.43		0.39		0.35		6.42	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	0.16	35	<0.42	201	0.34	109	0.25	40
PCB28	0.34	30	1.20	142	1.11	69	2.72	24
PCB31	0.29	27	0.73	144	0.43	110	1.26	25
PCB33	0.14	37	<0.42	201	0.20	182	0.12	71
PCB41	0.26	33	0.78	189	0.73	91	1.88	25
PCB44	0.79	25	1.83	83	1.52	48	2.73	24
PCB52	0.82	24	1.98	58	2.02	33	4.78	24
PCB56/60	0.29	25	0.68	94	0.59	53	2.39	24
PCB61/74	0.39	24	1.46	49	1.39	31	7.64	24
PCB66	0.67	25	2.19	53	1.89	34	11.75	24
PCB99	0.96	24	4.59	24	3.95	24	27.16	24
PCB101	1.86	24	5.43	26	5.11	24	37.18	24
PCB87	0.50	24	1.31	28	1.16	25	4.76	24
PCB105	0.36	24	1.93	26	1.68	25	11.72	24
PCB110	0.87	24	2.56	29	2.05	25	17.68	24
PCB114	0.05	47	<0.21	201	0.25i	76	0.92	24
PCB118	1.40	24	7.00	25	6.18	24	48.82	24
PCB123	0.03	71	0.10	31	0.11	30	0.60	24
PCB128	0.40	24	1.88	24	1.82	24	16.02	24
PCB129	0.10	31	0.26	25	0.23	25	<0.16	201
PCB138	5.34	24	18.79	24	18.09	24	168.80	24
PCB156	0.17	27	0.99	24	0.75	24	6.15	24
PCB157	0.06	41	0.37	24	0.32	25	2.01	24
PCB167	0.14	28	0.78	24	0.55	24	4.23	24
PCB141	0.61	24	1.25	24	1.09	24	9.31	24
PCB149	2.90	24	5.27	24	3.32	24	66.20	24
PCB151	0.95	24	1.83	24	1.66	24	9.91	24
PCB153	6.10	24	22.76	24	21.41	24	168.96	24
PCB170	1.18	24	3.50	24	2.66	24	21.23	24
PCB180	1.92	24	5.64	24	4.18	24	33.67	24
PCB183	0.70	24	2.56	24	2.18	24	10.36	24
PCB185	0.10	31	<0.1	201	0.14	28	0.87	24
PCB187	2.91	24	6.21	24	6.64	24	60.52	24
PCB189	0.02	103	0.21	26	0.11	30	0.66	24
PCB191	0.21	26	0.68	24	0.61	24	5.30	24
PCB193	0.03	71	0.16	27	0.11	30	0.86	24
PCB194	0.26	25	1.25	24	0.91	24	3.72	24
PCB201	0.36	24	0.89	24	1.02	24	4.61	24
PCB202	0.08	35	0.37	24	0.50	24	0.54	24
PCB203	0.24	25	1.72	24	1.07	24	3.27	24
PCB206	<0.8	201	1.15	29	1.05	26	0.91	24
PCB208	<0.03	201	<2.19	201	<0.05	201	0.02	103
PCB209	<0.01	201	0.31	25	0.34	24	0.02	103

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16557	16558	16559	16560
FERA LIMS No.	S08-026048	S08-026049	S08-026050	S08-026051
Sample Details:	Mackerel, ID: C356/24 1008S	Ling, ID: C356/25 1008S	Cod, ID: C356/26 1008S	Spurdog, ID: C356/27 1008S
Fat % Whole	25.43	0.39	0.35	6.42
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	0.288	1.524	1.335	10.146
Lower bound	**0.320**	**1.610**	**1.470**	**10.760**
Upper uncertainty level	0.352	1.696	1.605	11.374
Lower uncertainty level	0.288	1.428	1.335	10.146
Upper bound	**0.320**	**1.720**	**1.470**	**10.760**
Upper uncertainty level	0.352	2.012	1.605	11.374
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.073	0.006	0.005	0.652
Lower bound	**0.081**	**0.006**	**0.005**	**0.691**
Upper uncertainty level	0.089	0.007	0.006	0.731
Lower uncertainty level	0.073	0.005	0.005	0.652
Upper bound	**0.081**	**0.007**	**0.005**	**0.691**
Upper uncertainty level	0.089	0.008	0.006	0.731

FERA Sample No.	16561		16763		16764		16765	
FERA LIMS No.	S08-026052		S08-031183		S08-031184		S08-031185	
Sample Details:	Skate, ID: C356/28 1008S		Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08		Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08		Cuckoo Ray, ID: C356/031, 1008S	
Fat % Whole	0.56		0.30		2.23		0.46	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	0.54	110	0.40	127	0.56	32	0.47	138
PCB28	0.72	163	1.91i	57	2.90	25	1.94	69
PCB31	0.43	169	0.74	87	1.93	25	0.87	95
PCB33	0.32	183	0.37	137	0.13	110	0.59	111
PCB41	<0.5	201	3.33i	35	3.65	24	0.79	141
PCB44	<0.5	201	2.52	42	10.36	24	1.90	63
PCB52	0.43	169	3.11	31	11.56	24	1.66	54
PCB56/60	<0.22	201	0.89	47	2.05	24	0.43	114
PCB61/74	0.32	140	2.96	27	7.55	24	0.63	80
PCB66	0.54	135	3.45	30	8.98	24	0.99	84
PCB99	0.40i	42	8.90	24	18.56	24	2.25	25
PCB101	<0.22	201	8.96	24	32.04	24	3.00	29
PCB87	<0.07	201	1.88	25	9.01	24	0.67	34
PCB105	0.76	30	4.62	24	6.64	24	1.07	28
PCB110	<0.14	201	3.20	25	13.54	24	0.95	41
PCB114	<0.14	201	0.55	50	0.71	24	<0.16	201
PCB118	2.56	26	15.00	24	28.81	24	3.87	25
PCB123	<0.04	201	<0.25	201	0.29	25	<0.01	201
PCB128	0.87	24	4.03	24	6.48	24	1.19	24
PCB129	<0.04	201	0.37	24	1.23	24	0.16	27
PCB138	5.62	24	42.37	24	78.07	24	12.29	24
PCB156	0.43	24	1.29i	24	2.98	24	0.63	24
PCB157	0.14	28	0.55	24	0.95	24	0.28	25
PCB167	0.29	25	1.20i	24	1.75	24	0.40	24
PCB141	<0.04	201	3.11	24	7.50	24	0.59	24
PCB149	0.22	68	6.90	24	33.70	24	3.24	24
PCB151	0.04	55	3.39	24	11.28	24	0.08	35
PCB153	7.03	24	51.08i	24	88.54	24	15.38	24
PCB170	1.77i	25	12.56	24	13.09	24	2.17	25
PCB180	1.95	25	16.26	24	25.78	24	4.07	24
PCB183	0.50	24	3.60	24	9.19	24	1.38	24
PCB185	<0.01	201	<0.01	201	0.93	24	<0.04	201
PCB187	1.12	27	9.82	24	38.40	24	6.40	24
PCB189	<0.11	201	<0.01	201	0.34	24	<0.16	201
PCB191	0.11	30	<0.01	201	2.81	24	0.43	24
PCB193	<0.29	201	<0.09	201	0.41	24	<0.08	201
PCB194	<0.54	201	1.85i	24	3.49	24	0.87	24
PCB201	<0.18	201	<2.46	201	5.21	24	1.19	24
PCB202	<0.22	201	0.25	25	1.38	24	0.47	24
PCB203	0.68i	24	3.66	24	3.73	24	0.79	24
PCB206	<2.88	201	<3.08	201	1.64	24	1.94	25
PCB208	<28.91	201	<0.28	201	0.19	26	<0.47	201
PCB209	<1.3	201	<0.01	201	0.45	24	<0.71	201

i - indicative value

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16561	16763	16764	16765
FERA LIMS No.	S08-026052	S08-031183	S08-031184	S08-031185
Sample Details:	Skate, ID: C356/28 1008S	Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08	Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08	Cuckoo Ray, ID: C356/031, 1008S
Fat % Whole	0.56	0.30	2.23	0.46
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	0.580	2.886	5.610	0.893
Lower bound	**0.620**	**3.170**	**5.950**	**0.950**
Upper uncertainty level	0.660	3.454	6.290	1.007
Lower uncertainty level	0.549	2.824	5.610	0.826
Upper bound	**0.700**	**3.200**	**5.950**	**1.050**
Upper uncertainty level	0.851	3.576	6.290	1.274
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.003	0.009	0.125	0.004
Lower bound	**0.003**	**0.010**	**0.133**	**0.004**
Upper uncertainty level	0.004	0.010	0.141	0.005
Lower uncertainty level	0.003	0.008	0.125	0.004
Upper bound	**0.004**	**0.010**	**0.133**	**0.005**
Upper uncertainty level	0.005	0.011	0.141	0.006

FERA Sample No.	16766		16767		16768		16769	
FERA LIMS No.	S08-031186		S08-031187		S08-031188		S08-031189	
Sample Details:	Monkfish, ID: C356/032, 1008S		Roach, Forth & Clyde Canal, ID: C356/033		Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08		Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas	
Fat % Whole	0.28		2.48		1.16		2.80	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	1.68	64	56.63	24	9.55	24	13.09	32
PCB28	6.73	38	347.45	24	239.71	24	60.90	25
PCB31	2.30	59	64.35	24	120.47	24	38.27	26
PCB33	1.68	64	52.80	24	19.08	24	9.46	46
PCB41	3.49	55	337.11	24	203.78	24	64.42	25
PCB44	6.85	35	624.33i	24	415.42i	24	18.40	27
PCB52	6.23	31	456.33	24	330.45	24	76.92	24
PCB56/60	1.06	74	185.32	24	109.58	24	37.43	27
PCB61/74	2.24	41	283.96	24	196.67	24	68.16	25
PCB66	2.86	49	502.05	24	314.29	24	117.67	25
PCB99	2.43i	26	184.78	24	154.26	24	30.52	24
PCB101	2.30	40	406.85	24	306.53	24	50.70	25
PCB87	0.44	60	142.37	24	100.07	24	14.49	25
PCB105	0.44	60	88.95	24	62.73	24	15.33	24
PCB110	0.93	59	372.70	24	254.16	24	50.39	24
PCB114	<0.25	201	6.94	24	5.09	24	2.03	32
PCB118	1.18	49	292.56	24	228.06	24	41.41	24
PCB123	<0.01	201	3.13	24	2.51	24	1.92	28
PCB128	0.69	24	40.42	24	32.75	24	8.03	24
PCB129	<0.06	201	17.03	24	11.74	24	2.16	24
PCB138	5.48	25	336.78	24	304.32	24	50.46	24
PCB156	0.37	24	22.96	24	18.17	24	3.07	24
PCB157	0.19	26	6.14	24	5.03	24	0.91	24
PCB167	0.25	25	9.13i	24	8.30	24	1.26	26
PCB141	0.25	25	55.60	24	43.08	24	6.32	25
PCB149	1.87	27	232.39	24	206.61	24	34.01	25
PCB151	0.87	24	46.97	24	60.52	24	6.63	25
PCB153	9.28	24	279.84	24	258.30	24	35.48	25
PCB170	1.25	31	46.25	24	36.34	24	3.63	25
PCB180	1.99	27	86.92	24	64.89	24	9.01	24
PCB183	1.12	24	31.37	24	29.41	24	4.26	25
PCB185	<0.06	201	6.95	24	6.46	24	1.05	24
PCB187	4.80	24	75.52	24	110.58	24	12.12	24
PCB189	<0.31	201	1.08	24	0.89	24	<0.14	201
PCB191	0.31	25	5.29	24	5.91	24	0.94	28
PCB193	<0.12	201	2.34	24	1.88	24	0.28	25
PCB194	<0.56	201	14.92	24	10.16	24	1.61	24
PCB201	0.81	24	20.38	24	17.81	24	2.72	24
PCB202	0.44	24	3.34	24	4.05	24	0.66	24
PCB203	0.75	24	17.60	24	14.04	24	2.30	24
PCB206	<1.12	201	7.40	24	6.02	24	<1.26	201
PCB208	<0.5	201	1.57	24	1.11	24	<0.1	201
PCB209	<0.5	201	1.17	24	0.84	24	<0.03	201

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16766	16767	16768	16769
FERA LIMS No.	S08-031186	S08-031187	S08-031188	S08-031189
Sample Details:	Monkfish, ID: C356/032, 1008S	Roach, Forth & Clyde Canal, ID: C356/033	Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08	Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas
Fat % Whole	0.28	2.48	1.16	2.80
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	0.408	53.460	41.167	8.275
Lower bound	**0.440**	**56.680**	**43.650**	**8.880**
Upper uncertainty level	0.472	59.900	46.133	9.485
Lower uncertainty level	0.467	53.460	41.167	8.145
Upper bound	**0.600**	**56.680**	**43.650**	**8.900**
Upper uncertainty level	0.733	59.900	46.133	9.655
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.001	1.325	0.476	0.232
Lower bound	**0.001**	**1.405**	**0.505**	**0.249**
Upper uncertainty level	0.001	1.485	0.534	0.266
Lower uncertainty level	0.001	1.325	0.476	0.228
Upper bound	**0.002**	**1.405**	**0.505**	**0.249**
Upper uncertainty level	0.002	1.485	0.534	0.270

FERA Sample No.	16770		16771		16772		16773	
FERA LIMS No.	S08-031190		S08-031191		S08-031192		S08-031193	
Sample Details:	Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08		Trout, Kirtle Water, ID:C356/038		Eel, Lochar Water, ID: C356/039, 27-8-08		Trout, Lochhar W, ID: C356/040, 27-08-08	
Fat % Whole	18.48		4.24		14.83		1.31	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	0.54	81	3.57	29	0.45	114	7.60	36
PCB28	1.50	65	9.57	27	1.11	98	19.40	33
PCB31	0.62	109	3.41	36	0.47	168	6.16	58
PCB33	0.28	166	1.65	45	<0.27	201	3.58	67
PCB41	3.59	31	4.73	31	1.37	64	8.94	45
PCB44	0.46	61	1.29	35	0.33	94	2.76	50
PCB52	10.14	26	12.46	26	2.32	55	19.89	34
PCB56/60	0.75	61	2.55	33	0.46	107	5.22	45
PCB61/74	2.60	30	4.66	27	0.88	66	6.79	41
PCB66	2.75	38	7.43	28	1.20	85	11.58	42
PCB99	10.20	24	8.33	24	1.98	29	9.79	28
PCB101	10.36	24	18.02	24	2.46	36	28.14	26
PCB87	4.47	24	6.61	24	0.80	33	10.24	25
PCB105	9.25	24	5.72	24	1.43	25	4.77	26
PCB110	22.97	24	15.55	24	4.10	27	22.83	25
PCB114	0.67	28	0.51	36	0.15	83	0.56	92
PCB118	27.74	24	18.27	24	4.66	26	17.23	26
PCB123	0.41	24	0.25	25	0.10	31	0.43	30
PCB128	4.54	24	3.00	24	1.12	24	2.35	26
PCB129	1.32	24	0.87	24	0.29	25	1.14	25
PCB138	37.05	24	23.29	24	17.03	24	24.93	25
PCB156	2.77	24	1.72	24	0.78	24	1.23	25
PCB157	0.70	24	0.43	24	0.21	26	0.33	34
PCB167	1.08	24	0.78	24	0.45	25	0.65	32
PCB141	4.21	24	2.70	24	2.27	24	4.43	25
PCB149	11.72	24	10.77	24	6.63	24	18.39	25
PCB151	1.40	24	2.25	24	1.06	26	4.14	26
PCB153	25.81	24	17.79	24	16.26	24	22.07	26
PCB170	3.36	25	2.04	30	3.37	26	2.51	57
PCB180	5.42	24	3.84	24	7.83	24	6.56	24
PCB183	1.98	24	1.33	24	2.65	24	2.47	24
PCB185	0.12	29	0.33	25	0.12	29	0.52	28
PCB187	9.11	24	4.91	24	16.94	24	8.60	24
PCB189	0.11	30	0.08	35	0.09	33	0.09	92
PCB191	0.66	24	0.40	24	0.95	24	0.63	24
PCB193	0.16	27	0.11	30	0.19	26	0.14	62
PCB194	0.84	28	0.68	33	1.55	25	1.28	51
PCB201	1.35	24	0.87	24	2.50	24	1.93	24
PCB202	0.22	25	0.17	27	0.37	24	0.36	24
PCB203	0.99	24	0.76	24	1.67	24	1.59	24
PCB206	0.45	149	0.81	116	0.99i	82	<1.63	201
PCB208	0.09i	201	0.21i	117	0.12i	168	<0.43	201
PCB209	0.11	60	0.28	37	0.08	79	0.23	124

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16770	16771	16772	16773
FERA LIMS No.	S08-031190	S08-031191	S08-031192	S08-031193
Sample Details:	Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08	Trout, Kirtle Water, ID:C356/038	Eel, Lochar Water, ID: C356/039, 27-8-08	Trout, Lochhar W, ID: C356/040, 27-08-08
Fat % Whole	18.48	4.24	14.83	1.31
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	5.478	3.519	1.083	2.933
Lower bound	**5.830**	**3.770**	**1.200**	**3.320**
Upper uncertainty level	6.182	4.021	1.317	3.707
Lower uncertainty level	5.478	3.519	1.083	2.933
Upper bound	**5.830**	**3.770**	**1.200**	**3.320**
Upper uncertainty level	6.182	4.021	1.317	3.707
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	1.012	0.149	0.161	0.038
Lower bound	**1.078**	**0.160**	**0.178**	**0.043**
Upper uncertainty level	1.143	0.171	0.195	0.049
Lower uncertainty level	1.012	0.149	0.161	0.038
Upper bound	**1.078**	**0.160**	**0.178**	**0.043**
Upper uncertainty level	1.143	0.171	0.195	0.049

FERA Sample No.	16774		16775		16776		16777	
FERA LIMS No.	S08-031194		S08-031195		S08-031196		S08-031197	
Sample Details:	Eel - R Eden, ID: C356/041		Trout, R Eden, ID: C356/042		Trout, W of Girvan, ID: C356/043		Pike, L Achray, ID: C356/044	
Fat % Whole	16.45		8.39		2.06		1.56	
ug/kg fat weight	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U	ug/kg fat	% U
PCB18	0.60	93	2.51	33	7.34	27	3.97	32
PCB28	1.94	62	5.97	32	24.41	25	11.24	29
PCB31	0.91	93	2.54	43	8.10	29	3.84	42
PCB33	0.29	201	1.11	61	3.50	36	1.75	57
PCB41	4.32	31	2.97	40	10.55	28	5.15	36
PCB44	0.73	50	0.82	48	3.46	28	1.62	39
PCB52	10.15	27	6.60	31	19.58	26	10.56	30
PCB56/60	1.27	47	2.00	37	4.51	31	2.76	38
PCB61/74	3.26	30	3.00	32	8.03	27	5.03	30
PCB66	3.83	36	4.93	33	12.52	28	8.69	30
PCB99	8.02	24	3.21	27	8.36	25	13.74	24
PCB101	10.64	25	7.48	26	19.34	25	23.14	24
PCB87	3.65	24	2.47	25	6.05	24	5.96	24
PCB105	6.08	24	1.66	25	5.60	24	6.62	24
PCB110	18.17	24	6.19	25	13.75	25	13.96	24
PCB114	0.51	33	0.23	65	0.55	47	0.60	41
PCB118	19.55	24	5.59	25	20.10	24	25.66	24
PCB123	0.35	24	0.22	25	0.34	27	0.74	24
PCB128	3.56	24	1.01	25	3.75	24	7.04	24
PCB129	0.84	24	0.35	24	0.92	24	1.66	24
PCB138	39.77	24	11.36	24	38.10	24	88.34	24
PCB156	2.02	24	0.58	24	2.21	24	4.28	24
PCB157	0.46	24	0.14	28	0.57	25	1.20	24
PCB167	0.61	25	0.24	29	1.10	24	2.60	24
PCB141	5.43	24	1.99	24	4.63	24	10.21	24
PCB149	16.12	24	7.94	24	15.33	24	33.09	24
PCB151	2.54	24	2.10	24	3.50	24	9.05	24
PCB153	36.74	24	10.80	25	35.32	24	94.63	24
PCB170	5.13	25	1.64	32	5.22	26	17.37	24
PCB180	10.59	24	3.69	24	11.58	24	33.25	24
PCB183	6.01	24	1.82	24	3.57	24	11.57	24
PCB185	0.33	25	0.37	24	0.71	24	2.10	24
PCB187	16.73	24	4.38	24	14.14	24	33.78	24
PCB189	0.06	41	<0.04	201	0.18	33	0.57	24
PCB191	0.65	24	0.22	25	1.13	24	3.20	24
PCB193	0.16	27	0.07	37	0.26	28	0.74	24
PCB194	1.10	27	0.40	47	2.31	26	5.25	24
PCB201	3.21	24	0.93	24	2.75	24	6.85	24
PCB202	0.91	24	0.26	25	0.44	24	1.41	24
PCB203	2.61	24	0.78	24	2.25	24	6.00	24
PCB206	0.71	118	<0.63	201	1.20i	119	2.33	61
PCB208	0.21	107	<0.12	201	<0.34	201	0.52	73
PCB209	0.11	77	0.11	77	0.25	54	1.39	25

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16774	16775	16776	16777
FERA LIMS No.	S08-031194	S08-031195	S08-031196	S08-031197
Sample Details:	Eel - R Eden, ID: C356/041	Trout, R Eden, ID: C356/042	Trout, W of Girvan, ID: C356/043	Pike, L Achray, ID: C356/044
Fat % Whole	16.45	8.39	2.06	1.56
WHO-TEQ ng/kg FAT weight				
Lower uncertainty level	3.841	1.104	3.985	5.995
Lower bound	**4.110**	**1.220**	**4.300**	**6.430**
Upper uncertainty level	4.379	1.336	4.615	6.865
Lower uncertainty level	3.841	1.097	3.985	5.995
Upper bound	**4.110**	**1.230**	**4.300**	**6.430**
Upper uncertainty level	4.379	1.363	4.615	6.865
WHO-TEQ ng/kg WHOLE weight				
Lower uncertainty level	0.632	0.093	0.082	0.093
Lower bound	**0.676**	**0.102**	**0.089**	**0.100**
Upper uncertainty level	0.720	0.112	0.095	0.107
Lower uncertainty level	0.632	0.092	0.082	0.093
Upper bound	**0.676**	**0.103**	**0.089**	**0.100**
Upper uncertainty level	0.720	0.114	0.095	0.107

FERA Sample No.	16778		16779		16808		16939		16940	
FERA LIMS No.	S08-031198		S08-031199		S08-032253		S09-002037		S09-002038	
Sample Details:	Eel, R Leven, ID: C356/045		Trout, Clyde, ID: C356/046		Trout – White Cart W, ID: C356/036		Roach, Forth & Clyde Canal, ID: C356/033		Roach, Forth & Clyde Canal, ID: C356/033)	
Fat % Whole	13.08		3.19		7.84		3.65		1.45	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PCB18	1.03	61	4.32	26	1.61	32	29.46	24	51.58	24
PCB28	40.01	24	11.37	25	4.40	28	166.11	24	231.87	24
PCB31	17.54	24	3.85	30	2.29	33	48.92	24	56.66	25
PCB33	0.58	110	1.69	42	1.06	49	31.32	24	42.40	25
PCB41	39.50	24	4.45	30	2.92	33	145.17	24	239.36	24
PCB44	12.11	24	1.59	33	1.03	38	54.72	24	79.16	24
PCB52	56.98	24	8.33	25	6.82	25	190.27	24	254.29	24
PCB56/60	14.53	24	2.36	38	1.99	37	96.01	24	183.05	24
PCB61/74	31.41	24	4.03	28	3.57	28	140.30	24	252.81	24
PCB66	47.15	24	6.80	29	6.13	28	239.77	24	464.19	24
PCB99	34.37	24	4.76	24	7.59	24	71.83	24	110.48	24
PCB101	41.80	24	7.12	25	13.58	24	154.59	24	205.97	24
PCB87	15.78	24	1.97	25	3.51	24	52.08	24	65.21	24
PCB105	27.24	24	2.23	24	2.74	24	32.79	24	44.56	24
PCB110	61.89	24	4.13	25	8.23	24	128.39	24	179.68	24
PCB114	1.79	25	0.24	35	0.26	33	2.53	24	4.07	25
PCB118	89.89	24	7.73	24	10.65	24	116.09	24	154.09	24
PCB123	1.01	24	0.28	28	0.52	25	3.98	24	5.30	24
PCB128	15.90	24	2.15	24	2.60	24	18.08	24	21.47	24
PCB129	3.94	24	0.31	25	0.38	24	6.62	24	7.72	24
PCB138	131.95	24	19.27	24	27.67	24	136.98	24	165.14	24
PCB156	9.63	24	0.97	24	0.94	24	9.50	24	10.27	24
PCB157	2.40	24	0.29	25	0.31	25	2.32	24	2.78	24
PCB167	4.46	24	0.62	24	0.59	24	4.54	24	5.14	24
PCB141	15.25	24	1.69	24	2.26	24	24.64	24	26.55	24
PCB149	39.38	24	5.37	25	14.54	24	92.79	24	103.27	24
PCB151	4.27	24	1.43	24	4.09	24	18.17	24	20.09	24
PCB153	94.49	24	23.84	24	27.11	24	117.11	24	140.78	24
PCB170	14.83	24	3.49	24	2.16	24	17.90	24	17.76	24
PCB180	24.79	24	9.40	24	4.74	24	34.69	24	39.23	24
PCB183	8.93	24	4.59	24	2.04	24	13.32	24	16.36	24
PCB185	0.38	24	0.51	24	0.23	25	3.24	24	4.13	24
PCB187	40.00	24	9.62	24	10.36	24	31.14	24	35.69	24
PCB189	0.51	24	0.16	27	0.11	30	0.49	24	0.53	24
PCB191	2.63	24	0.72	24	0.68	24	2.08	24	2.50	24
PCB193	0.66	24	0.21	26	0.12	29	0.84	24	1.01	24
PCB194	4.16	24	2.30	24	0.61	24	6.41	24	6.71	24
PCB201	6.19	24	2.96	24	0.85	24	7.87	24	10.50	24
PCB202	0.56	24	0.50	24	0.35	24	1.29	24	3.31	24
PCB203	3.92	24	2.66	24	0.62	24	6.33	24	9.40	24
PCB206	3.21	37	1.11	24	0.26i	33	3.20	24	5.16	25
PCB208	0.24	103	0.17	27	0.28	25	0.34	24	1.12	24
PCB209	0.15	58	0.42	24	<0.02	201	0.23	25	0.48	24

Table 5 (cont'd). Concentrations of *ortho*-substituted PCBs

FERA Sample No.	16778	16779	16808	16939	16940
FERA LIMS No.	S08-031198	S08-031199	S08-032253	S09-002037	S09-002038
Sample Details:	Eel, R Leven, ID: C356/045	Trout, Clyde, ID: C356/046	Trout - White Cart W, ID: C356/036	Roach, Forth & Clyde Canal, ID: C356/033 (Part-2)	Roach, Forth & Clyde Canal, ID: C356/033 (Part-3)
Fat % Whole	13.08	3.19	7.84	3.65	1.45
WHO-TEQ ng/kg FAT weight					
Lower uncertainty level	17.736	1.683	2.021	21.273	27.381
Lower bound	**18.820**	**1.800**	**2.160**	**22.560**	**29.060**
Upper uncertainty level	19.904	1.917	2.299	23.847	30.739
Lower uncertainty level	17.736	1.683	2.021	21.273	27.381
Upper bound	**18.820**	**1.800**	**2.160**	**22.560**	**29.060**
Upper uncertainty level	19.904	1.917	2.299	23.847	30.739
WHO-TEQ ng/kg WHOLE weight					
Lower uncertainty level	2.320	0.054	0.159	0.776	0.397
Lower bound	**2.462**	**0.057**	**0.169**	**0.823**	**0.422**
Upper uncertainty level	2.604	0.061	0.180	0.870	0.446
Lower uncertainty level	2.320	0.054	0.159	0.776	0.397
Upper bound	**2.462**	**0.057**	**0.169**	**0.823**	**0.422**
Upper uncertainty level	2.604	0.061	0.180	0.870	0.446

Table 6. Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16272	16273	16274	16275	16276
FERA LIMS No.	S08-015904	S08-015905	S08-015906	S08-015907	S08-015908
Sample Details:	Mussels - FSA Ardmore 14/5/08	Mussels - Blackness F of F, 18/5/08	Mussels - Inverness Football Ground, 6/6/08	Mussels - FSA Mussels Stannergate, 17/6/08	Mussels - Inverness Nigg Bay, 21/6/08
Fat % Whole	0.44	0.26	0.30	0.35	0.38
WHO TEQ ng/kg FAT					
Dioxin	26.480	35.879	10.649	34.944	6.748
non ortho-PCB	17.094	20.251	5.267	11.659	8.622
ortho-PCB	10.520	8.410	2.420	4.640	2.470
Sum WHO TEQs Lower uncertainty level	51.385	60.598	15.590	48.264	15.781
Sum WHO-TEQ	**54.094**	**64.540**	**18.336**	**51.243**	**17.840**
Sum WHO TEQs Upper uncertainty level	56.803	68.482	21.082	54.222	19.899
WHO TEQ ng/kg WHOLE					
Dioxin	0.117	0.093	0.032	0.122	0.026
non ortho-PCB	0.075	0.053	0.016	0.041	0.033
ortho-PCB	0.046	0.022	0.007	0.016	0.009
Sum WHO TEQs Lower uncertainty level	0.226	0.158	0.047	0.169	0.060
Sum WHO-TEQ	**0.238**	**0.168**	**0.055**	**0.179**	**0.068**
Sum WHO TEQs Upper uncertainty level	0.250	0.178	0.063	0.190	0.076

FERA Sample No.	16277	16278	16279	16280	16281
FERA LIMS No.	S08-016128	S08-016129	S08-016130	S08-016131	S08-016132
Sample Details:	1 - Spurdog, ID: C356/001	2 - Spurdog, ID: C356/002	3 - Smooth Hound, ID: C356/003	4 - Starry Smooth Hound, ID: C356/004	5 - Thornback Ray, ID: C356/005
Fat % Whole	14.58	8.14	0.53	0.80	0.79
WHO TEQ ng/kg FAT					
Dioxin	0.950	3.820	13.723	13.056	15.983
non ortho-PCB	1.830	7.210	3.040	4.264	5.501
ortho-PCB	4.980	15.900	4.600	0.950	1.220
Sum WHO TEQs Lower uncertainty level	7.353	25.699	19.750	16.658	21.298
Sum WHO-TEQ	**7.760**	**26.930**	**21.363**	**18.270**	**22.704**
Sum WHO TEQs Upper uncertainty level	8.167	28.161	22.976	19.882	24.110
WHO TEQ ng/kg WHOLE					
Dioxin	0.139	0.311	0.073	0.104	0.126
non ortho-PCB	0.267	0.587	0.016	0.034	0.043
ortho-PCB	0.726	1.294	0.024	0.008	0.010
Sum WHO TEQs Lower uncertainty level	1.072	2.092	0.105	0.133	0.168
Sum WHO-TEQ	**1.131**	**2.192**	**0.113**	**0.146**	**0.179**
Sum WHO TEQs Upper uncertainty level	1.191	2.292	0.122	0.159	0.190

Table 6 (cont'd). Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16282	16283	16284	16285	16286
FERA LIMS No.	S08-016133	S08-016134	S08-016135	S08-016136	S08-016137
Sample Details:	6 - Skate, ID: C356/006	7 - Hake, ID: C356/007	8 - Spotted Ray, ID: C356/008	9 - Cuckoo Ray, ID: C356/009	10 - Black-Mouthed Dogfish, ID: C356/010
Fat % Whole	0.79	3.02	0.71	0.59	1.01
WHO TEQ ng/kg FAT					
Dioxin	5.368	3.000	8.090	6.920	3.816
non ortho-PCB	2.276	8.130	6.320	5.307	2.560
ortho-PCB	0.360	3.130	1.590	1.410	1.470
Sum WHO TEQs Lower uncertainty level	7.218	13.756	14.422	12.654	7.285
Sum WHO-TEQ	**8.004**	**14.260**	**16.000**	**13.637**	**7.846**
Sum WHO TEQs Upper uncertainty level	8.790	14.764	17.578	14.620	8.407
WHO TEQ ng/kg WHOLE					
Dioxin	0.042	0.091	0.057	0.041	0.039
non ortho-PCB	0.018	0.246	0.045	0.031	0.026
ortho-PCB	0.003	0.095	0.011	0.008	0.015
Sum WHO TEQs Lower uncertainty level	0.057	0.415	0.102	0.075	0.074
Sum WHO-TEQ	**0.063**	**0.431**	**0.114**	**0.080**	**0.079**
Sum WHO TEQs Upper uncertainty level	0.069	0.446	0.125	0.086	0.085

FERA Sample No.	16287	16288	16380	16384	16385
FERA LIMS No.	S08-016138	S08-016139	S08-019914	S08-019915	S08-019916
Sample Details:	11 - Lesser Spotted Dogfish, ID: C356/011	12 - Black Scabbard Fish, ID: C356/012	Torsk, whole fish, ID: C356/013	Greater Forkbeard, ID: C356/18, S08/226	Round Nose Grenadier, Whole Fish, ID: C356/15
Fat % Whole	0.51	2.23	0.44	0.32	0.39
WHO TEQ ng/kg FAT					
Dioxin	2.183	10.950	4.933	4.568	6.267
non ortho-PCB	0.750	15.600	11.952	5.325	1.857
ortho-PCB	1.190	7.250	3.860	1.970	3.390
Sum WHO TEQs Lower uncertainty level	3.015	32.560	19.074	10.561	10.166
Sum WHO-TEQ	**4.123**	**33.800**	**20.745**	**11.863**	**11.514**
Sum WHO TEQs Upper uncertainty level	5.231	35.040	22.416	13.165	12.862
WHO TEQ ng/kg WHOLE					
Dioxin	0.011	0.244	0.022	0.015	0.024
non ortho-PCB	0.004	0.348	0.053	0.017	0.007
ortho-PCB	0.006	0.162	0.017	0.006	0.013
Sum WHO TEQs Lower uncertainty level	0.015	0.726	0.084	0.034	0.040
Sum WHO-TEQ	**0.021**	**0.754**	**0.091**	**0.038**	**0.045**
Sum WHO TEQs Upper uncertainty level	0.027	0.781	0.099	0.042	0.050

Table 6 (cont'd). Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16386	16387	16388	16552	16553
FERA LIMS No.	S08-019917	S08-019918	S08-019919	S08-026043	S08-026044
Sample Details:	Ling, Whole fish ID: C356/014	Blue Ling, ID: C356/17,	Monk fish - (Tails) ID: C356/16	John Dory,ID: C356/19	Haddock, ID: C356/20 1008S
Fat % Whole	0.66	0.45	0.47	1.59	0.50
WHO TEQ ng/kg FAT					
Dioxin	2.565	5.195	4.662	9.174	2.727
non ortho-PCB	6.067	4.014	3.795	12.854	1.435
ortho-PCB	2.990	2.220	0.750	4.290	0.690
Sum WHO TEQs Lower uncertainty level	10.624	10.165	8.371	24.557	3.360
Sum WHO-TEQ	**11.622**	**11.429**	**9.207**	**26.318**	**4.852**
Sum WHO TEQs Upper uncertainty level	12.620	12.693	10.043	28.079	6.344
WHO TEQ ng/kg WHOLE					
Dioxin	0.017	0.023	0.022	0.146	0.014
non ortho-PCB	0.040	0.018	0.018	0.204	0.007
ortho-PCB	0.020	0.010	0.004	0.068	0.003
Sum WHO TEQs Lower uncertainty level	0.070	0.046	0.039	0.390	0.017
Sum WHO-TEQ	**0.077**	**0.051**	**0.043**	**0.418**	**0.024**
Sum WHO TEQs Upper uncertainty level	0.083	0.057	0.047	0.446	0.032

FERA Sample No.	16554	16555	16556	16557	16558
FERA LIMS No.	S08-026045	S08-026046	S08-026047	S08-026048	S08-026049
Sample Details:	Horse Mackerel, ID: C356/21 1008S	Hake, ID: C356/22 1008S	Herring, ID: 356/23 1008S	Mackerel, ID: C356/24 1008S	Ling, ID: C356/25 1008S
Fat % Whole	2.75	0.77	16.10	25.43	0.39
WHO TEQ ng/kg FAT					
Dioxin	2.332	11.143	4.816	0.409	3.576
non ortho-PCB	3.190	26.934	3.401	1.093	5.754
ortho-PCB	2.180	10.560	1.280	0.320	1.720
Sum WHO TEQs Lower uncertainty level	6.862	46.126	8.979	1.717	9.990
Sum WHO-TEQ	**7.702**	**48.637**	**9.497**	**1.822**	**11.050**
Sum WHO TEQs Upper uncertainty level	8.542	51.148	10.015	1.927	12.110
WHO TEQ ng/kg WHOLE					
Dioxin	0.064	0.086	0.775	0.104	0.014
non ortho-PCB	0.088	0.207	0.548	0.278	0.022
ortho-PCB	0.060	0.081	0.206	0.081	0.007
Sum WHO TEQs Lower uncertainty level	0.189	0.355	1.446	0.437	0.039
Sum WHO-TEQ	**0.212**	**0.375**	**1.529**	**0.463**	**0.043**
Sum WHO TEQs Upper uncertainty level	0.235	0.394	1.612	0.490	0.047

Table 6 (cont'd). Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16559	16560	16561	16763	16764
FERA LIMS No.	S08-026050	S08-026051	S08-026052	S08-031183	S08-031184
Sample Details:	Cod, ID: C356/26 1008S	Spurdog, ID: C356/27 1008S	Skate, ID: C356/28 1008S	Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08	Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08
Fat % Whole	0.35	6.42	0.56	0.30	2.23
WHO TEQ ng/kg FAT					
Dioxin	4.913	2.884	20.862	7.477	3.940
non ortho-PCB	6.207	5.489	6.025	11.831	12.406
ortho-PCB	1.470	10.760	0.700	3.200	5.950
Sum WHO TEQs Lower uncertainty level	11.888	18.281	25.794	21.334	21.532
Sum WHO-TEQ	**12.590**	**19.133**	**27.587**	**22.508**	**22.296**
Sum WHO TEQs Upper uncertainty level	13.292	19.985	29.380	23.682	23.060
WHO TEQ ng/kg WHOLE					
Dioxin	0.017	0.185	0.117	0.022	0.088
non ortho-PCB	0.022	0.352	0.034	0.035	0.277
ortho-PCB	0.005	0.691	0.004	0.010	0.133
Sum WHO TEQs Lower uncertainty level	0.042	1.174	0.144	0.064	0.480
Sum WHO-TEQ	**0.044**	**1.228**	**0.154**	**0.068**	**0.497**
Sum WHO TEQs Upper uncertainty level	0.047	1.283	0.165	0.071	0.514

FERA Sample No.	16765	16766	16767	16768	16769
FERA LIMS No.	S08-031185	S08-031186	S08-031187	S08-031188	S08-031189
Sample Details:	Cuckoo Ray, ID: C356/031, 1008S	Monkfish, ID: C356/032, 1008S	Roach, Forth & Clyde Canal, ID: C356/033	Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08	Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas
Fat % Whole	0.46	0.28	2.48	1.16	2.80
WHO TEQ ng/kg FAT					
Dioxin	9.448	7.653	23.607	10.184	3.935
non ortho-PCB	5.739	3.326	62.287	32.006	8.106
ortho-PCB	1.050	0.600	56.680	43.650	8.900
Sum WHO TEQs Lower uncertainty level	15.061	10.446	137.458	82.264	18.948
Sum WHO-TEQ	**16.237**	**11.579**	**142.574**	**85.840**	**20.941**
Sum WHO TEQs Upper uncertainty level	17.413	12.712	147.690	89.416	22.934
WHO TEQ ng/kg WHOLE					
Dioxin	0.043	0.021	0.585	0.118	0.110
non ortho-PCB	0.026	0.009	1.545	0.371	0.227
ortho-PCB	0.005	0.002	1.406	0.506	0.249
Sum WHO TEQs Lower uncertainty level	0.069	0.029	3.409	0.954	0.531
Sum WHO-TEQ	**0.075**	**0.032**	**3.536**	**0.996**	**0.586**
Sum WHO TEQs Upper uncertainty level	0.080	0.036	3.663	1.037	0.642

Table 6 (cont'd). Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16770	16771	16772	16773	16774
FERA LIMS No.	S08-031190	S08-031191	S08-031192	S08-031193	S08-031194
Sample Details:	Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08	Trout, Kirtle Water, ID: C356/038	Eel, Lochar Water, ID: C356/039, 27-8-08	Trout, Lochhar W, ID: C356/040, 27-08-08	Eel – R Eden ID: C356/041
Fat % Whole	18.48	4.24	14.83	1.31	16.45
WHO TEQ ng/kg FAT					
Dioxin	0.723	2.542	0.915	0.783	1.658
non ortho-PCB	1.585	3.376	1.201	0.952	2.828
ortho-PCB	5.830	3.770	1.200	3.320	4.110
Sum WHO TEQs Lower uncertainty level	7.697	9.211	3.107	4.568	8.162
Sum WHO-TEQ	**8.138**	**9.688**	**3.316**	**5.055**	**8.596**
Sum WHO TEQs Upper uncertainty level	8.579	10.165	3.525	5.542	9.030
WHO TEQ ng/kg WHOLE					
Dioxin	0.134	0.108	0.136	0.010	0.273
non ortho-PCB	0.293	0.143	0.178	0.012	0.465
ortho-PCB	1.077	0.160	0.178	0.043	0.676
Sum WHO TEQs Lower uncertainty level	1.422	0.391	0.461	0.060	1.343
Sum WHO-TEQ	**1.504**	**0.411**	**0.492**	**0.066**	**1.414**
Sum WHO TEQs Upper uncertainty level	1.585	0.431	0.523	0.073	1.485

FERA Sample No.	16775	16776	16777	16778	16779
FERA LIMS No.	S08-031195	S08-031196	S08-031197	S08-031198	S08-031199
Sample Details:	Trout, R Eden, ID: C356/042	Trout, W of Girvan, ID: C356/043	Pike, L Achray, ID: C356/044	Eel, R Leven, ID: C356/045	Trout, Clyde, ID: C356/046
Fat % Whole	8.39	2.06	1.56	13.08	3.19
WHO TEQ ng/kg FAT					
Dioxin	2.355	2.813	24.447	1.889	6.797
non ortho-PCB	2.339	5.849	17.792	5.364	3.883
ortho-PCB	1.230	4.300	6.430	18.820	1.683
Sum WHO TEQs Lower uncertainty level	5.552	12.335	46.870	24.787	10.199
Sum WHO-TEQ	**5.924**	**12.962**	**48.669**	**26.073**	**12.363**
Sum WHO TEQs Upper uncertainty level	6.296	13.589	50.468	27.359	12.961
WHO TEQ ng/kg WHOLE					
Dioxin	0.198	0.058	0.381	0.247	0.217
non ortho-PCB	0.196	0.120	0.278	0.702	0.124
ortho-PCB	0.103	0.089	0.100	2.462	0.054
Sum WHO TEQs Lower uncertainty level	0.466	0.254	0.731	3.242	0.325
Sum WHO-TEQ	**0.497**	**0.267**	**0.759**	**3.410**	**0.394**
Sum WHO TEQs Upper uncertainty level	0.528	0.280	0.787	3.579	0.413

Table 6 (cont'd). Summary of dioxin and PCB WHO-TEQ (Upper bound)

FERA Sample No.	16808	16939	16940
FERA LIMS No.	S08-032253	S09-002037	S09-002038
Sample Details:	Trout - White Cart W, ID: C356/036	Roach, Forth & Clyde Canal, ID: C356/033 (Part-2)	Roach, Forth & Clyde Canal, ID: C356/033 (Part-3)
Fat % Whole	7.84	3.65	1.45
WHO TEQ ng/kg FAT			
Dioxin	2.110	7.491	9.742
non ortho-PCB	5.592	20.228	29.829
ortho-PCB	2.021	21.273	27.381
Sum WHO TEQs Lower uncertainty level	7.424	26.917	37.893
Sum WHO-TEQ	**9.723**	**48.992**	**66.952**
Sum WHO TEQs Upper uncertainty level	10.140	51.081	70.309
WHO TEQ ng/kg WHOLE			
Dioxin	0.165	0.273	0.141
non ortho-PCB	0.438	0.738	0.433
ortho-PCB	0.158	0.776	0.397
Sum WHO TEQs Lower uncertainty level	0.582	0.982	0.549
Sum WHO-TEQ	**0.762**	**1.788**	**0.971**
Sum WHO TEQs Upper uncertainty level	0.795	1.864	1.019

Table 7: Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16272		16273		16274		16275	
FERA LIMS No.	S08-015904		S08-015905		S08-015906		S08-015907	
Sample Details:	Mussels - FSA Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - FSA Mussels Stannergate, 17/6/08	
Fat % Whole	0.44		0.26		0.30		0.35	
PBDD/F ng/kg fat weight	**ng/kg fat**	% U	**ng/kg fat**	% U	**ng/kg fat**	% U	**ng/kg fat**	% U
237-TriBDD	1.88	43	1.17i	81	10.77	27	5.83	29
2378-TetraBDD	<0.2	201	<0.27	201	0.37	137	<0.24	201
12378-PentaBDD	<0.86	202	<1.17	202	<1.08	202	<1.21	202
123478/123678-HexaBDD	<1.25	201	<2.2	201	<2.37	201	<2.13	201
123789-HexaBDD	<1.32	202	<1.79	202	<2.12	202	<1.77	202
238-TriBDF	14.89	25	4.80	41	3.12	54	6.75	32
2378-TetraBDF	4.51i	27	3.32i	32	1.54i	49	1.53i	48
12378-PentaBDF	1.58i	111	<1.57	201	<1.08	201	<1.04	201
23478-PentaBDF	1.68	112	1.44	177	<1.16	201	<1.17	201
123478-HexaBDF	8.70	53	<2.78	201	<2.58	201	<2.49	201
1234678-HeptabromoBDF	129.69	24	47.64	27	25.61	31	93.24	25
TEQ ng/kg FAT weight								
Lower uncertainty level	3.184		1.247		0.558		1.071	
Lower bound	3.537		1.528		0.780		1.085	
Upper uncertainty level	3.890		1.809		1.002		1.099	
Lower uncertainty level	2.589		1.810		1.701		1.804	
Upper bound	4.854		3.724		3.201		3.811	
Upper uncertainty level	7.119		5.638		4.701		5.818	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.014		0.003		0.002		0.004	
Lower bound	0.015		0.004		0.002		0.004	
Upper uncertainty level	0.017		0.005		0.003		0.004	
Lower uncertainty level	0.011		0.005		0.005		0.006	
Upper bound	0.021		0.010		0.010		0.013	
Upper uncertainty level	0.031		0.015		0.014		0.020	
PBB ng/kg fat weight	**ng/kg fat**	% U	**ng/kg fat**	% U	**ng/kg fat**	% U	**ng/kg fat**	% U
PBB77	1.55	141	2.56	117	1.37	201	2.61	104
PBB126	0.96	152	<0.99	201	<0.91	201	<0.88	201
PBB169	<0.86	201	<0.99	201	<1.46	201	<0.88	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.092		<0.001		<0.001		<0.001	
Lower bound	0.100		<0.001		<0.001		<0.001	
Upper uncertainty level	0.108		<0.001		<0.001		<0.001	
Lower uncertainty level	0.094		0.102		0.102		0.093	
Upper bound	0.100		0.110		0.110		0.100	
Upper uncertainty level	0.106		0.118		0.118		0.107	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Upper bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16276		16277		16278		16279	
FERA LIMS No.	S08-015908		S08-016128		S08-016129		S08-016130	
Sample Details:	Mussels - Inverness Nigg Bay, 21/6/08		1 - Spurdog, ID: C356/001		2 - Spurdog, ID: C356/002		3 - Smooth Hound, ID: C356/003	
Fat % Whole	0.38		14.58		8.14		0.53	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	3.54	35	<0.08	202	<0.08	202	<0.19	202
2378-TetraBDD	<0.37	201	<0.03	201	<0.03	201	<0.19	201
12378-PentaBDD	<1.08	202	<0.13	202	<0.14	202	<1.24	202
123478/123678-HexaBDD	<1.83	201	<0.09	201	<0.19	201	<1.21	201
123789-HexaBDD	<1.67	202	<0.1	202	<0.19	202	<1.43	202
238-TriBDF	2.00	79	0.10i	182	<0.09	201	<0.92	201
2378-TetraBDF	0.92i	76	0.07i	62	0.12i	41	1.08	73
12378-PentaBDF	<1.08	201	<0.08	201	<0.09	201	<0.74	201
23478-PentaBDF	<1.17	201	0.15	135	0.23	99	<0.68	201
123478-HexaBDF	<2.83	201	<0.13	201	<0.14	201	<1.86	201
1234678-HeptabromoBDF	23.37	32	<0.05	201	<0.21	201	<4.4	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.326		0.062		0.093		0.100	
Lower bound	0.326		0.082		0.127		0.108	
Upper uncertainty level	0.326		0.102		0.161		0.116	
Lower uncertainty level	1.435		0.140		0.185		1.131	
Upper bound	3.048		0.279		0.356		2.409	
Upper uncertainty level	4.661		0.418		0.527		3.687	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.001		0.009		0.008		0.001	
Lower bound	0.001		0.012		0.010		0.001	
Upper uncertainty level	0.001		0.015		0.013		0.001	
Lower uncertainty level	0.005		0.020		0.015		0.006	
Upper bound	0.012		0.041		0.029		0.013	
Upper uncertainty level	0.018		0.061		0.043		0.020	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	1.46	189	0.15	175	0.47	64	<1.02	201
PBB126	<0.92	201	<0.07	201	<0.08	201	<1.12	201
PBB169	<0.92	201	<0.06	201	<0.08	201	<0.68	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.093		0.009		0.009		0.111	
Upper bound	0.100		0.010		0.010		0.120	
Upper uncertainty level	0.107		0.011		0.011		0.129	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Upper bound	<0.001		0.001		0.001		0.001	
Upper uncertainty level	<0.001		0.001		0.001		0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16280		16281		16282		16283	
FERA LIMS No.	S08-016131		S08-016132		S08-016133		S08-016134	
Sample Details:	4 - Starry Smooth Hound, ID: C356/004		5 - Thornback Ray, ID: C356/005		6 - Skate, ID: C356/006		7 - Hake, ID: C356/007	
Fat % Whole	0.80		0.79		0.79		3.02	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	0.24	111	<0.17	202	<0.16	202	<0.08	202
2378-TetraBDD	<0.13	201	<0.17	201	<0.16	201	<0.03	201
12378-PentaBDD	<0.78	202	<0.59	202	<0.48	202	<0.14	202
123478/123678-HexaBDD	<0.69	201	<1.23	201	<1.15	201	<0.17	201
123789-HexaBDD	<1.0	202	<0.93	202	<0.87	202	<0.11	202
238-TriBDF	<0.64	201	<0.34	201	<0.32	201	<0.09	201
2378-TetraBDF	0.87	64	<0.27	201	0.28	89	<0.04	201
12378-PentaBDF	<0.52	201	<0.59	201	<0.55	201	<0.07	201
23478-PentaBDF	<0.48	201	<0.42	201	0.65	78	<0.11	201
123478-HexaBDF	<1.3	201	<1.35	201	<1.27	201	<0.14	201
1234678-HeptabromoBDF	<3.08	201	<1.18	201	<1.11	201	<0.04	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.084		<0.001		0.216		<0.001	
Lower bound	0.087		<0.001		0.353		<0.001	
Upper uncertainty level	0.090		<0.001		0.490		<0.001	
Lower uncertainty level	0.749		0.636		0.713		0.126	
Upper bound	1.593		1.389		1.361		0.275	
Upper uncertainty level	2.437		2.142		2.009		0.424	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.001		<0.001		0.002		<0.001	
Lower bound	0.001		<0.001		0.003		<0.001	
Upper uncertainty level	0.001		<0.001		0.004		<0.001	
Lower uncertainty level	0.006		0.005		0.006		0.004	
Upper bound	0.013		0.011		0.011		0.008	
Upper uncertainty level	0.019		0.017		0.016		0.013	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	0.82	175	<1.27	201	<1.19	201	0.19	139
PBB126	<0.69	201	<0.44	201	<0.28	201	<0.07	201
PBB169	<0.48	201	<3.0	201	<2.81	201	<0.07	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.065		0.065		0.056		0.009	
Upper bound	0.070		0.070		0.060		0.010	
Upper uncertainty level	0.075		0.075		0.064		0.011	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.001		0.001		<0.001		<0.001	
Upper bound	0.001		0.001		<0.001		<0.001	
Upper uncertainty level	0.001		0.001		0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16284		16285		16286		16287	
FERA LIMS No.	S08-016135		S08-016136		S08-016137		S08-016138	
Sample Details:	8 - Spotted Ray, ID: C356/008		9 - Cuckoo Ray, ID: C356/009		10 - Black-Mouthed Dogfish, ID: C356/010		11 - Lesser Spotted Dogfish, ID: C356/011	
Fat % Whole	0.71		0.59		1.01		0.51	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.22	202	<0.26	202	<0.13	202	<0.26	202
2378-TetraBDD	<0.22	201	<0.26	201	<0.13	201	<0.26	201
12378-PentaBDD	<0.66	202	<0.79	202	<0.38	202	<0.89	202
123478/123678-HexaBDD	<1.59	201	<1.91	201	<0.91	201	<1.92	201
123789-HexaBDD	<1.2	202	<1.45	202	<0.69	202	<1.98	202
238-TriBDF	<0.44	201	<0.53	201	<0.25	201	<0.45	201
2378-TetraBDF	<0.3	201	<0.2	201	0.27	71	<0.83	201
12378-PentaBDF	<0.77	201	<0.99	201	<0.44	201	<0.83	201
23478-PentaBDF	<0.33	201	<0.43	201	0.64i	64	0.89	146
123478-HexaBDF	<1.75	201	<2.11	201	<1.0	201	<1.72	201
1234678-HeptabromoBDF	<1.53	201	<1.84	201	<0.88	201	<1.21	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		0.279		0.121	
Lower bound	<0.001		<0.001		0.347		0.445	
Upper uncertainty level	<0.001		<0.001		0.415		0.769	
Lower uncertainty level	0.725		0.870		0.611		1.108	
Upper bound	1.583		1.900		1.148		2.294	
Upper uncertainty level	2.441		2.930		1.685		3.480	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		0.003		0.001	
Lower bound	<0.001		<0.001		0.004		0.002	
Upper uncertainty level	<0.001		<0.001		0.004		0.004	
Lower uncertainty level	0.005		0.005		0.006		0.006	
Upper bound	0.011		0.011		0.012		0.012	
Upper uncertainty level	0.017		0.017		0.017		0.018	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<1.64	201	<1.97	201	<0.94	201	<1.09	201
PBB126	<0.38	201	<0.46	201	<0.22	201	<0.64	201
PBB169	<3.88	201	<4.67	201	<2.23	201	<0.64	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.074		0.083		0.037		0.065	
Upper bound	0.080		0.090		0.040		0.070	
Upper uncertainty level	0.086		0.097		0.043		0.075	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.001		<0.001		<0.001		<0.001	
Upper bound	0.001		0.001		<0.001		<0.001	
Upper uncertainty level	0.001		0.001		<0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16288		16380		16384		16385	
FERA LIMS No.	S08-016139		S08-019914		S08-019915		S08-019916	
Sample Details:	12 - Black Scabbard Fish, ID: C356/012		Torsk, whole fish, ID: C356/013		Greater Forkbeard, ID: C356/18,		Round Nose Grenadier, Whole Fish, ID: C356/15	
Fat % Whole	2.23		0.44		0.32		0.39	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.1	202	<0.3	202	<0.18	202	<0.16	202
2378-TetraBDD	<0.04	201	<0.12	201	<0.12	201	0.18	179
12378-PentaBDD	<0.19	202	<1.07	202	<1.06	202	<0.63	202
123478/123678-HexaBDD	<0.22	201	<0.98	201	<1.0	201	<1.22	201
123789-HexaBDD	<0.2	202	<1.36	202	<1.35	202	<1.26	202
238-TriBDF	0.12	185	<0.88	201	<0.87	201	0.51i	112
2378-TetraBDF	<0.03	201	<0.36	201	<0.41	201	<0.53	201
12378-PentaBDF	<0.12	201	<0.71	201	<0.71	201	<0.53	201
23478-PentaBDF	<0.13	201	<0.71	201	2.41	59	<0.41	201
123478-HexaBDF	<0.27	201	<1.78	201	<1.77	201	<1.32	201
1234678-HeptabromoBDF	<0.05	201	<4.21	201	<4.18	201	<0.77	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		0.849		0.019	
Lower bound	<0.001		<0.001		1.205		0.180	
Upper uncertainty level	<0.001		<0.001		1.561		0.341	
Lower uncertainty level	0.171		0.948		1.523		0.708	
Upper bound	0.374		2.071		2.915		1.482	
Upper uncertainty level	0.577		3.194		4.307		2.256	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		0.003		<0.001	
Lower bound	<0.001		<0.001		0.004		0.001	
Upper uncertainty level	<0.001		<0.001		0.005		0.001	
Lower uncertainty level	0.004		0.004		0.005		0.003	
Upper bound	0.008		0.009		0.009		0.006	
Upper uncertainty level	0.013		0.014		0.014		0.009	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	0.17	190	<0.97	201	<0.97	201	0.79	176
PBB126	<0.09	201	<0.95	201	<0.94	201	<0.45	201
PBB169	<0.08	201	<0.65	201	<0.65	201	<0.47	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.009		0.093		0.093		0.046	
Upper bound	0.010		0.100		0.100		0.050	
Upper uncertainty level	0.011		0.107		0.107		0.054	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Upper bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16386		16387		16388		16552	
FERA LIMS No.	S08-019917		S08-019918		S08-019919		S08-026043	
Sample Details:	Ling, Whole fish ID: C356/014		Blue Ling, ID: C356/17		Monk fish -(Tails) ID: C356/16		John Dory,ID: C356/19	
Fat % Whole	0.66		0.45		0.47		1.59	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.05	202	<0.18	202	<0.19	202	<0.03	202
2378-TetraBDD	<0.1	201	<0.21	201	<0.14	201	<0.1	201
12378-PentaBDD	<0.38	202	<1.12	202	<0.48	202	<0.31	202
123478/123678-HexaBDD	<0.56	201	<1.39	201	<1.03	201	<0.59	201
123789-HexaBDD	<0.63	202	<1.39	202	<1.07	202	<0.66	202
238-TriBDF	<0.46	201	<0.9	201	<0.24	201	<0.49	201
2378-TetraBDF	0.16	164	<0.39	201	<0.45	201	<0.14	201
12378-PentaBDF	<0.4	201	<0.73	201	<0.45	201	<0.42	201
23478-PentaBDF	<0.3	201	<0.66	201	<0.34	201	<0.24	201
123478-HexaBDF	<0.89	201	<1.81	201	<0.93	201	<0.94	201
1234678-HeptabromoBDF	4.78	34	<4.29	201	<0.65	201	1.01	119
TEQ ng/kg FAT weight								
Lower uncertainty level	0.059		<0.001		<0.001		0.010	
Lower bound	0.064		<0.001		<0.001		0.010	
Upper uncertainty level	0.069		<0.001		<0.001		0.010	
Lower uncertainty level	0.427		1.024		0.534		0.364	
Upper bound	0.922		2.237		1.167		0.794	
Upper uncertainty level	1.417		3.450		1.800		1.224	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.003		0.005		0.003		0.006	
Upper bound	0.006		0.010		0.005		0.013	
Upper uncertainty level	0.009		0.016		0.008		0.019	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<0.49	201	<0.99	201	<0.59	201	<0.52	201
PBB126	<0.36	201	<0.97	201	<0.34	201	0.49i	157
PBB169	<0.26	201	<0.66	201	<0.34	201	<0.28	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		0.042	
Lower bound	<0.001		<0.001		<0.001		0.050	
Upper uncertainty level	<0.001		<0.001		<0.001		0.058	
Lower uncertainty level	0.037		0.093		0.037		0.047	
Upper bound	0.040		0.100		0.040		0.050	
Upper uncertainty level	0.043		0.107		0.043		0.053	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		0.001	
Lower bound	<0.001		<0.001		<0.001		0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		0.001	
Upper bound	<0.001		<0.001		<0.001		0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16553		16554		16555		16556	
FERA LIMS No.	S08-026044		S08-026045		S08-026046		S08-026047	
Sample Details:	Haddock, ID: C356/20 1008S		Horse Mackerel, ID: C356/21 1008S		Hake, ID: C356/22 1008S		Herring, ID: 356/23 1008S	
Fat % Whole	0.50		2.75		0.77		16.10	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.15	202	<0.08	202	0.22	52	<0.03	202
2378-TetraBDD	0.36	174	0.08	177	<0.15	201	<0.03	201
12378-PentaBDD	<0.92	202	<0.2	202	<0.45	202	<0.07	202
123478/123678-HexaBDD	<1.74	201	<0.37	201	<0.85	201	<0.12	201
123789-HexaBDD	<1.94	202	<0.41	202	<0.95	202	<0.14	202
238-TriBDF	<1.43	201	<0.3	201	<0.7	201	<0.1	201
2378-TetraBDF	<0.41	201	<0.09	201	<0.2	201	<0.03	201
12378-PentaBDF	<1.22	201	<0.26	201	<0.6	201	<0.09	201
23478-PentaBDF	1.28	113	0.44	72	0.72	100	<0.05	201
123478-HexaBDF	<2.76	201	<0.59	201	<1.35	201	<0.2	201
1234678-HeptabromoBDF	2.96	120	0.96	81	<1.6	201	<0.12	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.234		0.089		0.270		<0.001	
Lower bound	1.030		0.310		0.360		<0.001	
Upper uncertainty level	1.826		0.531		0.450		<0.001	
Lower uncertainty level	1.411		0.361		0.676		0.082	
Upper bound	2.696		0.669		1.341		0.180	
Upper uncertainty level	3.981		0.977		2.006		0.278	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.001		0.002		0.002		<0.001	
Lower bound	0.005		0.009		0.003		<0.001	
Upper uncertainty level	0.009		0.015		0.003		<0.001	
Lower uncertainty level	0.007		0.010		0.005		0.013	
Upper bound	0.013		0.018		0.010		0.029	
Upper uncertainty level	0.020		0.027		0.015		0.045	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<1.51	201	<0.32	201	<0.74	201	0.32	73
PBB126	<1.12	201	<0.24	201	<0.55	201	<0.08	201
PBB169	<0.82	201	<0.17	201	<0.4	201	<0.06	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.111		0.028		0.056		0.009	
Upper bound	0.120		0.030		0.060		0.010	
Upper uncertainty level	0.129		0.032		0.064		0.011	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.001		0.001		<0.001		0.001	
Upper bound	0.001		0.001		<0.001		0.001	
Upper uncertainty level	0.001		0.001		<0.001		0.002	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16557		16558		16559		16560	
FERA LIMS No.	S08-026048		S08-026049		S08-026050		S08-026051	
Sample Details:	Mackerel, ID: C356/24 1008S		Ling, ID: C356/25 1008S		Cod, ID: C356/26 1008S		Spurdog, ID: C356/27 1008S	
Fat % Whole	25.43		0.39		0.35		6.42	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.02	202	<0.42	202	<0.18	202	<0.04	202
2378-TetraBDD	0.03	135	<0.42	201	<0.18	201	0.04	201
12378-PentaBDD	<0.04	202	<1.2	202	<0.39	202	<0.1	202
123478/123678-HexaBDD	<0.09	201	<2.66	201	<1.84	201	<0.2	201
123789-HexaBDD	<0.1	202	<2.3	202	<1.52	202	<0.21	202
238-TriBDF	<0.06	201	<1.48	201	<0.64	201	<0.13	201
2378-TetraBDF	0.03	135	<0.63	201	<0.23	201	0.16	55
12378-PentaBDF	<0.05	201	<0.73	201	1.05i	65	<0.1	201
23478-PentaBDF	0.06	71	<0.57	201	0.95	54	0.15	58
123478-HexaBDF	<0.14	201	<3.45	201	<1.73	201	<0.29	201
1234678-HeptabromoBDF	<0.1	201	<2.3	201	<1.0	201	<0.2	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.024		<0.001		0.448		0.028	
Lower bound	0.063		<0.001		0.528		0.131	
Upper uncertainty level	0.102		<0.001		0.608		0.234	
Lower uncertainty level	0.082		1.313		0.871		0.165	
Upper bound	0.140		2.869		1.640		0.308	
Upper uncertainty level	0.198		4.425		2.409		0.451	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.006		<0.001		0.002		0.002	
Lower bound	0.016		<0.001		0.002		0.008	
Upper uncertainty level	0.026		<0.001		0.002		0.015	
Lower uncertainty level	0.021		0.005		0.003		0.011	
Upper bound	0.036		0.012		0.006		0.020	
Upper uncertainty level	0.050		0.018		0.008		0.029	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	0.08	177	<1.58	201	<0.69	201	0.59	50
PBB126	<0.02	201	<0.47	201	<0.45	201	<0.05	201
PBB169	<0.04	201	<1.98	201	<0.64	201	<0.09	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		0.065		0.046		0.009	
Upper bound	<0.001		0.070		0.050		0.010	
Upper uncertainty level	<0.001		0.075		0.054		0.011	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		0.001	
Upper bound	<0.001		<0.001		<0.001		0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16561		16763		16764		16765	
FERA LIMS No.	S08-026052		S08-031183		S08-031184		S08-031185	
Sample Details:	Skate, ID: C356/28 1008S		Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08		Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08		Cuckoo Ray, ID: C356/031, 1008S	
Fat % Whole	0.56		0.30		2.23		0.46	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.29	202	<0.25	202	<0.04	202	<0.32	202
2378-TetraBDD	<0.29	201	<0.25	201	<0.02	201	<0.32	201
12378-PentaBDD	<0.94	202	<0.62	202	<0.18	202	<0.75	202
123478/123678-HexaBDD	<1.44	201	<1.23	201	<0.2	201	<1.58	201
123789-HexaBDD	<1.59	202	<1.35	202	<0.22	202	<1.74	202
238-TriBDF	<1.02	201	<0.87	201	<0.14	201	<1.12	201
2378-TetraBDF	0.72	103	0.37	169	<0.06	201	<0.4	201
12378-PentaBDF	0.54	187	<0.43	201	<0.12	201	<0.55	201
23478-PentaBDF	0.68	109	0.59i	108	<0.11	201	1.07	79
123478-HexaBDF	<2.38	201	<2.03	201	<0.29	201	<2.61	201
1234678-HeptabromoBDF	<1.59	201	11.55	33	<0.69	201	<1.74	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.331		0.342		<0.001		0.325	
Lower bound	0.439		0.448		<0.001		0.535	
Upper uncertainty level	0.547		0.554		<0.001		0.745	
Lower uncertainty level	1.134		0.909		0.158		1.173	
Upper bound	2.226		1.800		0.345		2.283	
Upper uncertainty level	3.318		2.691		0.532		3.393	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.002		0.001		<0.001		0.001	
Lower bound	0.002		0.001		<0.001		0.002	
Upper uncertainty level	0.003		0.002		<0.001		0.003	
Lower uncertainty level	0.006		0.003		0.004		0.005	
Upper bound	0.013		0.005		0.008		0.010	
Upper uncertainty level	0.019		0.008		0.012		0.016	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<1.09	201	0.99	189	0.23	141	<1.2	201
PBB126	0.36	163	0.43	119	<0.16	201	<0.59	201
PBB169	<0.72	201	<0.62	201	<0.11	201	<0.79	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.033		0.038		<0.001		<0.001	
Lower bound	0.040		0.040		<0.001		<0.001	
Upper uncertainty level	0.047		0.042		<0.001		<0.001	
Lower uncertainty level	0.038		0.048		0.019		0.065	
Upper bound	0.040		0.050		0.020		0.070	
Upper uncertainty level	0.042		0.052		0.021		0.075	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Upper bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16766		16767		16768		16769	
FERA LIMS No.	S08-031186		S08-031187		S08-031188		S08-031189	
Sample Details:	Monkfish, ID: C356/032, 1008S		Roach, Forth & Clyde Canal, ID: C356/033		Perch, Forth & Clyde Canal, ID:C356/034,		Pike, Forth & Clyde Canal, ID: C356/035,	
Fat % Whole	0.28		2.48		1.16		2.80	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.5	202	<0.08	202	<0.15	202	<0.14	202
2378-TetraBDD	<0.5	201	<0.08	201	<0.15	201	<0.28	201
12378-PentaBDD	<1.49	202	<0.19	202	<0.3	202	<0.87	202
123478/123678-HexaBDD	<2.49	201	<0.38	201	<0.74	201	<1.68	201
123789-HexaBDD	<2.74	202	<0.42	202	<0.82	202	<1.47	202
238-TriBDF	<1.76	201	<0.27	201	<0.53	201	<0.49	201
2378-TetraBDF	0.81	155	0.21	98	1.99	31	0.80	74
12378-PentaBDF	1.81	99	<0.2	201	<0.35	201	<0.84	201
23478-PentaBDF	1.56i	83	0.33i	65	0.46	86	<0.94	201
123478-HexaBDF	<4.11	201	<0.63	201	<1.23	201	<1.99	201
1234678-HeptabromoBDF	<2.74	201	<0.42	201	<0.82	201	<1.33	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.755		0.147		0.330		0.074	
Lower bound	0.952		0.186		0.429		0.080	
Upper uncertainty level	1.149		0.225		0.528		0.086	
Lower uncertainty level	2.031		0.324		0.622		1.065	
Upper bound	3.903		0.613		1.184		2.269	
Upper uncertainty level	5.775		0.902		1.746		3.473	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.002		0.004		0.004		0.002	
Lower bound	0.003		0.005		0.005		0.002	
Upper uncertainty level	0.003		0.006		0.006		0.002	
Lower uncertainty level	0.006		0.008		0.007		0.030	
Upper bound	0.011		0.015		0.014		0.064	
Upper uncertainty level	0.016		0.022		0.020		0.097	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<1.89	201	1.00	63	1.73	69	<0.88	201
PBB126	<0.5	201	0.17i	97	<0.17	201	<0.7	201
PBB169	<1.25	201	<0.19	201	<0.37	201	<0.7	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		0.019		<0.001		<0.001	
Lower bound	<0.001		0.020		<0.001		<0.001	
Upper uncertainty level	<0.001		0.021		<0.001		<0.001	
Lower uncertainty level	0.056		0.019		0.019		0.074	
Upper bound	0.060		0.020		0.020		0.080	
Upper uncertainty level	0.064		0.021		0.021		0.086	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		0.001		<0.001		<0.001	
Lower uncertainty level	<0.001		<0.001		<0.001		0.002	
Upper bound	<0.001		<0.001		<0.001		0.002	
Upper uncertainty level	<0.001		0.001		<0.001		0.002	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16770		16771		16772		16773	
FERA LIMS No.	S08-031190		S08-031191		S08-031192		S08-031193	
Sample Details:	Eel, Kirtle Water, ID: C356/037,		Trout, Kirtle Water, ID:C356/038		Eel, Lochar Water, ID: C356/039, 27-8-08		Trout, Lochhar W, ID: C356/040, 27-08-08	
Fat % Whole	18.48		4.24		14.83		1.31	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.02	202	<0.03	202	<0.03	202	<0.11	202
2378-TetraBDD	<0.03	201	<0.06	201	<0.03	201	0.20	142
12378-PentaBDD	<0.1	202	<0.13	202	<0.11	202	<0.47	202
123478/123678-HexaBDD	<0.16	201	<0.23	201	<0.19	201	<0.79	201
123789-HexaBDD	<0.15	202	<0.2	202	<0.17	202	<0.72	202
238-TriBDF	<0.09	201	0.17i	143	<0.1	201	1.41	66
2378-TetraBDF	<0.07	201	0.65	37	<0.08	201	1.05	67
12378-PentaBDF	<0.14	201	<0.19	201	<0.17	201	<0.69	201
23478-PentaBDF	0.14	187	0.21i	164	<0.15	201	<0.61	201
123478-HexaBDF	<0.37	201	<0.35	201	<0.17	201	<0.79	201
1234678-HeptabromoBDF	<0.08	201	<0.11	201	<0.17	201	<0.45	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.004		0.122		<0.001		0.154	
Lower bound	0.070		0.170		<0.001		0.305	
Upper uncertainty level	0.136		0.218		<0.001		0.456	
Lower uncertainty level	0.131		0.220		0.131		0.707	
Upper bound	0.283		0.449		0.286		1.349	
Upper uncertainty level	0.435		0.678		0.441		1.991	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.001		0.005		<0.001		0.002	
Lower bound	0.013		0.007		<0.001		0.004	
Upper uncertainty level	0.025		0.009		<0.001		0.006	
Lower uncertainty level	0.024		0.009		0.019		0.009	
Upper bound	0.052		0.019		0.042		0.018	
Upper uncertainty level	0.080		0.029		0.065		0.026	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<0.11	201	1.01	40	0.15	175	1.35	85
PBB126	<0.12	201	<0.09	201	<0.07	201	<0.25	201
PBB169	<0.11	201	<0.12	201	<0.1	201	<0.43	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.009		0.009		0.009		0.028	
Upper bound	0.010		0.010		0.010		0.030	
Upper uncertainty level	0.011		0.011		0.011		0.032	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.002		<0.001		0.001		<0.001	
Upper bound	0.002		<0.001		0.001		<0.001	
Upper uncertainty level	0.002		<0.001		0.002		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16774		16775		16776		16777	
FERA LIMS No.	S08-031194		S08-031195		S08-031196		S08-031197	
Sample Details:	Eel - R Eden, ID: C356/041		Trout, R Eden, ID: C356/042		Trout, W of Girvan, ID: C356/043		Pike, L Achray, ID: C356/044	
Fat % Whole	16.45		8.39		2.06		1.56	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.03	202	<0.03	202	<0.09	202	<0.05	202
2378-TetraBDD	<0.04	201	<0.04	201	<0.06	201	0.35	42
12378-PentaBDD	<0.12	202	<0.13	202	<0.2	202	<0.19	202
123478/123678-HexaBDD	<0.24	201	<0.22	201	<0.34	201	<0.32	201
123789-HexaBDD	<0.18	202	<0.2	202	<0.31	202	<0.29	202
238-TriBDF	0.14	159	0.94	35	0.96	46	0.39i	95
2378-TetraBDF	0.12	135	1.97	26	0.83	41	7.09	24
12378-PentaBDF	<0.18	201	<0.19	201	<0.3	201	<0.28	201
23478-PentaBDF	<0.16	201	<0.17	201	<0.26	201	0.45i	114
123478-HexaBDF	<0.18	201	<0.19	201	<0.3	201	<0.28	201
1234678-HeptabromoBDF	<0.1	201	<0.13	201	<0.23	201	<0.16	201
TEQ ng/kg FAT weight								
Lower uncertainty level	0.011		0.194		0.081		0.959	
Lower bound	0.012		0.197		0.083		1.284	
Upper uncertainty level	0.013		0.200		0.085		1.609	
Lower uncertainty level	0.149		0.248		0.276		1.040	
Upper bound	0.322		0.524		0.585		1.579	
Upper uncertainty level	0.495		0.800		0.894		2.118	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	0.002		0.016		0.002		0.015	
Lower bound	0.002		0.017		0.002		0.020	
Upper uncertainty level	0.002		0.017		0.002		0.025	
Lower uncertainty level	0.025		0.021		0.006		0.016	
Upper bound	0.053		0.044		0.012		0.025	
Upper uncertainty level	0.081		0.067		0.018		0.033	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	0.15	188	0.53	61	1.31	44	5.49	25
PBB126	<0.08	201	<0.1	201	<0.12	201	<0.12	201
PBB169	<0.11	201	<0.12	201	<0.19	201	<0.18	201
TEQ ng/kg FAT weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.009		0.009		0.009		0.009	
Upper bound	0.010		0.010		0.010		0.010	
Upper uncertainty level	0.011		0.011		0.011		0.011	
TEQ ng/kg WHOLE weight								
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.002		0.001		<0.001		<0.001	
Upper bound	0.002		0.001		<0.001		<0.001	
Upper uncertainty level	0.002		0.001		<0.001		<0.001	

Table 7 (cont'd): Concentrations of PBDD/Fs and non-*ortho* substituted PBBs

FERA Sample No.	16778		16779		16808		16939		16940	
FERA LIMS No.	S08-031198		S08-031199		S08-032253		S09-002037		S09-002038	
Sample Details:	Eel, R Leven, ID: C356/045		Trout, Clyde, ID: C356/046		Trout - White Cart W, ID: C356/036		Roach, Forth & Clyde Canal, ID: C356/033		Roach, Forth & Clyde Canal, ID: C356/033	
Fat % Whole	13.08		3.19		7.84		3.65		1.45	
PBDD/F ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
237-TriBDD	<0.03	202	<0.02	202	<0.03	202	<0.03	202	<0.11	202
2378-TetraBDD	<0.04	201	0.23	42	<0.03	201	<0.06	201	<0.22	201
12378-PentaBDD	<0.13	202	<0.11	202	<0.09	202	<0.15	202	<0.59	202
123478/123678-HexaBDD	<0.24	201	<0.27	201	<0.21	201	<0.36	201	<1.35	201
123789-HexaBDD	<0.22	202	<0.23	202	<0.18	202	<0.32	202	<1.18	202
238-TriBDF	<0.14	201	0.41	46	<0.06	201	<0.14	201	<0.39	201
2378-TetraBDF	<0.09	201	2.28	24	0.15	47	<0.06	201	<0.22	201
12378-PentaBDF	<0.19	201	<0.13	201	<0.1	201	<0.18	201	<0.67	201
23478-PentaBDF	<0.17	201	0.28	96	<0.12	201	<0.18	201	<0.67	201
123478-HexaBDF	<0.23	201	<0.17	201	<0.18	201	<0.2	201	<0.9	201
1234678-HeptabromoBDF	<0.11	201	<0.12	201	<0.08	201	<0.14	201	<0.51	201
TEQ ng/kg FAT weight										
Lower uncertainty level	<0.001		0.460		0.014		<0.001		<0.001	
Lower bound	<0.001		0.598		0.015		<0.001		<0.001	
Upper uncertainty level	<0.001		0.736		0.016		<0.001		<0.001	
Lower uncertainty level	0.157		0.522		0.122		0.185		0.709	
Upper bound	0.344		0.783		0.258		0.404		1.549	
Upper uncertainty level	0.531		1.044		0.394		0.623		2.389	
TEQ ng/kg WHOLE weight										
Lower uncertainty level	<0.001		0.015		0.001		<0.001		<0.001	
Lower bound	<0.001		0.019		0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		0.024		0.001		<0.001		<0.001	
Lower uncertainty level	0.021		0.017		0.010		0.007		0.010	
Upper bound	0.045		0.025		0.020		0.015		0.022	
Upper uncertainty level	0.069		0.033		0.031		0.023		0.035	
PBB ng/kg fat weight	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**	**ng/kg fat**	**% U**
PBB77	<0.15	201	1.34	32	0.29	80	0.50	80	<1.38	201
PBB126	<0.07	201	<0.11	201	<0.12	201	<0.15	201	<0.56	201
PBB169	<0.12	201	<0.11	201	<0.13	201	<0.15	201	<0.56	201
TEQ ng/kg FAT weight										
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.009		0.009		0.009		0.019		0.056	
Upper bound	0.010		0.010		0.010		0.020		0.060	
Upper uncertainty level	0.011		0.011		0.011		0.021		0.064	
TEQ ng/kg WHOLE weight										
Lower uncertainty level	<0.001		<0.001		<0.001		<0.001		<0.001	
Lower bound	<0.001		<0.001		<0.001		<0.001		<0.001	
Upper uncertainty level	<0.001		<0.001		<0.001		<0.001		<0.001	
Lower uncertainty level	0.001		<0.001		0.001		0.001		0.001	
Upper bound	0.001		<0.001		0.001		0.001		0.001	
Upper uncertainty level	0.001		<0.001		0.001		0.001		0.001	

Table 8: Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16272		16273		16274		16275		16276		16277		16278	
FERA LIMS No.	S08-015904		S08-015905		S08-015906		S08-015907		S08-015908		S08-016128		S08-016129	
Sample Details:	Mussels - FSA Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - FSA Mussels Stannergate, 17/6/08		Mussels - Inverness Nigg Bay, 21/6/08		1 - Spurdog, ID: C356/001		2 - Spurdog, ID: C356/002	
Fat % Whole	0.44		0.26		0.30		0.35		0.38		14.58		8.14	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs														
BDE-17	1.88	11	0.74	15	0.25	34	0.60	17	0.22	38	0.02	101	0.06	35
BDE-28	1.15	17	0.58	39	0.25	81	0.68	31	0.23	88	0.53	11	1.64	11
BDE-47	63.79	11	20.44	14	6.85	29	19.90	14	6.58	30	10.40	11	23.99	11
BDE-49	11.20	11	4.72	11	1.00	19	3.42	11	1.00	19	1.44	11	2.29	11
BDE-66	2.90	11	1.07	20	0.39	42	1.22	17	0.37	44	1.08	11	5.53	11
BDE-71	0.12	20	0.04	51	<0.01	200	0.04	51	<0.01	200	<0.01	200	0.01	200
BDE-77	0.10	41	0.03	200	<0.03	200	0.04	150	<0.03	200	0.04	51	0.19	15
BDE-85	2.27i	11	0.96i	12	0.20	23	0.57	13	0.21i	22	<0.01	200	<0.02	200
BDE-99	43.71	11	16.16	11	4.67	14	11.26	11	3.69	16	3.34	12	5.45	11
BDE-100	22.25	11	8.35	11	2.03	13	6.99	11	2.25	13	4.53	10	13.21	10
BDE-119	0.33	12	0.18	15	0.04	51	0.18	15	<0.04	200	0.13	19	0.46	11
BDE-126	0.01	200	<0.01	200	<0.01	200	<0.04	200	<0.01	200	<0.01	200	<0.01	200
BDE153	1.95	12	0.85	18	0.33	38	0.54	25	0.24	51	0.98	11	2.70	11
BDE138	0.35	12	0.26	19	<0.04	200	0.18	25	<0.03	200	<0.01	200	<0.01	200
BDE 154	2.54	11	1.32	12	0.30i	23	0.75i	13	0.15i	41	1.46	11	3.58	11
BDE-183	0.51	11	0.41	12	0.14	18	0.22	14	0.12	20	0.01	200	<0.01	200
PBBs														
PBB-15	<0.01	202	<0.02	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	0.01	202	0.05	49	<0.01	202	0.02	104	<0.01	202	0.03	72	0.09	36
PBB-52	0.04	104	0.14	51	<0.03	202	0.04	153	<0.03	202	0.10	35	0.39	29
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.02	104
PBB-101	0.02	104	0.04	58	<0.02	202	<0.02	202	<0.01	202	0.09	36	0.20	30
PBB-153	0.08	38	0.14	32	<0.03	202	<0.06	202	<0.02	202	0.26	29	0.40	29
Deca-Br														
BDE-209	65.89		45.90		29.55		217.46		15.92		0.19		0.27	
BB-209	0.27		0.48		0.29		<0.17		1.87		<0.05		<0.05	

i - indicative value

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16279		16280		16281		16282		16283		16284		16285	
FERA LIMS No.	S08-016130		S08-016131		S08-016132		S08-016133		S08-016134		S08-016135		S08-016136	
Sample Details:	3 - Smooth Hound, ID: C356/003		4 - Starry Smooth Hound, ID: C356/004		5 - Thornback Ray, ID: C356/005		6 - Skate, ID: C356/006		7 - Hake, ID: C356/007		8 - Spotted Ray, ID: C356/008		9 - Cuckoo Ray, ID: C356/009	
Fat % Whole	0.53		0.80		0.79		0.79		3.02		0.71		0.59	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs														
BDE-17	0.25	19	0.03	134	<0.01	200	<0.01	200	0.03	67	<0.01	200	<0.01	200
BDE-28	0.67	21	0.13	62	0.16	39	<0.03	200	0.41	12	0.14	58	0.22	47
BDE-47	30.54	11	4.84	22	1.75	18	0.45	54	8.52	11	2.45	17	2.32	20
BDE-49	0.83	18	0.11	73	0.09	90	<0.04	200	2.22	11	0.13	78	0.14	86
BDE-66	0.79	21	0.12	84	0.04	200	<0.04	200	0.37	15	<0.05	200	0.13	108
BDE-71	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE-77	0.06	35	0.01	200	<0.01	200	<0.01	200	0.01	200	<0.02	200	<0.02	200
BDE-85	<0.01	200	<0.01	200	0.07i	30	0.01i	200	<0.01	200	0.07	58	0.07	58
BDE-99	2.97	15	0.68	34	0.31	72	0.16	125	1.26	22	0.23	122	0.29	118
BDE-100	8.19	11	1.18	12	0.65	16	0.09	67	1.76	11	0.89	15	1.48	13
BDE-119	0.23	14	0.04	51	<0.01	200	<0.01	200	0.22	14	0.02	101	0.10	23
BDE-126	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE153	2.34	12	0.51	19	0.08	125	<0.04	200	0.13	19	<0.06	200	0.13	108
BDE138	<0.04	200	<0.03	200	<0.04	200	<0.04	200	<0.01	200	<0.05	200	<0.07	200
BDE 154	4.75	11	0.80	12	0.22	29	<0.03	200	1.52	11	0.10	61	0.56	18
BDE-183	0.03	200	0.02	200	0.13	19	<0.01	200	0.01	200	0.02	200	<0.02	200
PBBs														
PBB-15	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.06	44	0.01	202	<0.01	202
PBB-52	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.09	36	0.01	202	<0.01	202
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-101	<0.03	202	<0.02	202	<0.01	202	<0.02	202	0.04	58	<0.01	202	<0.02	202
PBB-153	<0.05	202	<0.02	202	<0.01	202	<0.01	202	0.03	72	<0.01	202	<0.01	202
Deca-Br														
BDE-209	1.04		0.87		1.58		4.43		0.68		1.95		1.66	
BB-209	<0.37		<0.26		0.15		0.15		<0.05		0.27		0.26	

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16286		16287		16288		16380		16384		16385		16386	
FERA LIMS No.	S08-016137		S08-016138		S08-016139		S08-019914		S08-019915		S08-019916		S08-019917	
Sample Details:	10 - Black-Mouthed Dogfish, ID: C356/010		11 - Lesser Spotted Dogfish, ID: C356/011		12 - Black Scabbard Fish, ID: C356/012		Torsk, whole fish, ID: C356/013		Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1		Round Nose Grenadier, Whole Fish, ID: C356/15		Ling, Whole fish ID: C356/014	
Fat % Whole	1.01		0.51		2.23		0.44		0.32		0.39		0.66	
ug/kg fat weight	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U
PBDEs														
BDE-17	0.02	101	<0.01	200	0.02	101	0.03	134	0.04	101	<0.01	200	<0.01	200
BDE-28	0.40	14	0.08	125	0.25	13	0.71	20	0.14	86	0.64	14	0.54	18
BDE-47	3.29	12	1.18	34	9.69	11	11.11	16	3.72	35	3.79	12	6.20	16
BDE-49	0.81	13	0.09	134	1.48	11	1.13	14	0.55	21	0.45	21	0.67	18
BDE-66	0.42	18	0.08	101	0.65	12	0.10	120	0.19	64	0.30	23	0.04	200
BDE-71	<0.01	200	<0.01	200	<0.01	200	<0.01	200	0.02	101	<0.01	200	<0.01	200
BDE-77	0.01	200	<0.01	200	0.02	101	<0.01	200	0.02	101	<0.01	200	<0.01	200
BDE-85	0.06	35	<0.05	200	0.03	67	<0.01	200	0.01i	200	<0.03	200	0.05	41
BDE-99	0.75	24	0.74	52	1.68	20	0.32	94	0.89	35	1.23	22	<0.25	200
BDE-100	1.03	12	0.29	43	2.38	11	2.33	11	1.15	14	1.27	12	1.31	12
BDE-119	0.10	23	0.05	41	0.27	13	0.09	25	0.07	30	0.12	20	0.07	30
BDE-126	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.03	200	<0.01	200	<0.01	200
BDE153	0.20	32	0.24	67	0.56	11	0.11	92	0.26	40	0.33	32	0.08	125
BDE138	<0.03	200	<0.03	200	<0.01	200	<0.04	200	<0.04	200	<0.03	200	<0.05	200
BDE 154	0.67	12	0.10	81	2.96	11	1.23	12	0.82	13	1.54	11	1.16	12
BDE-183	0.01	200	0.09	112	<0.01	200	<0.03	200	0.11	56	<0.03	200	<0.04	200
PBBs														
PBB-15	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	<0.01	202	0.01	202	0.08	38	0.05	49	0.04	58	0.03	72	0.04	58
PBB-52	0.02	104	<0.01	202	0.10	35	0.07	40	0.06	44	0.03	72	0.05	49
PBB-80	<0.01	202	<0.01	202	<0.01	202	0.01	202	0.02	104	<0.01	202	<0.01	202
PBB-101	0.02	104	<0.01	202	0.17	31	0.09	72	0.06	104	0.06	44	0.06	44
PBB-153	<0.01	202	0.02	104	0.23	30	<0.07	202	0.09i	36	0.08	38	0.05	85
Deca-Br														
BDE-209	1.60		1.35		0.46		2.49		2.97		2.45		<0.73	
BB-209	<0.09		<0.79		<0.05		<0.35		<0.35		<0.5		<0.72	

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16387		16388		16552		16553		16554		16555		16556	
FERA LIMS No.	S08-019918		S08-019919		S08-026043		S08-026044		S08-026045		S08-026046		S08-026047	
Sample Details:	Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08, (106cm, 5500g)		Monk fish - (Tails) ID: C356/16		John Dory,ID: C356/19		Haddock, ID: C356/20 1008S		Horse Mackerel, ID: C356/21 1008S		Hake, ID: C356/22 1008S		Herring, ID: 356/23 1008S	
Fat % Whole	0.45		0.47		1.59		0.50		2.75		0.77		16.10	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs														
BDE-17	<0.02	200	0.01	200	0.06i	35	<0.03	200	0.07	30	0.11i	21	0.02	101
BDE-28	0.52	25	0.06	101	0.35	25	<0.12	200	0.25	19	2.09	12	0.41	12
BDE-47	3.04	44	3.26	12	6.87	15	<1.11	200	4.49	15	46.79	11	7.65	11
BDE-49	0.23	45	0.20	32	1.80	12	<0.15	200	1.01	12	20.68	11	3.98	10
BDE-66	0.08	175	0.02	200	0.17	48	<0.11	200	0.22	21	0.96	15	0.35	12
BDE-71	<0.01	200	<0.01	200	<0.01	200	<0.02	200	<0.01	200	<0.01	200	0.02	101
BDE-77	<0.01	200	<0.01	200	0.01	200	<0.01	200	<0.01	200	<0.01	200	0.02	101
BDE-85	<0.05	200	<0.02	200	0.03	67	<0.03	200	0.05	41	0.21	14	0.02	101
BDE-99	0.31	97	0.62	34	0.73	75	<0.79	200	0.29	118	4.48	20	1.68	13
BDE-100	0.99	15	1.43	11	1.86	11	<0.11	200	0.97	11	15.70	11	2.05	11
BDE-119	0.04	51	0.04	51	0.07i	30	<0.03	200	0.08i	27	0.57i	11	0.06i	35
BDE-126	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE153	0.09	112	0.21	40	0.15	67	<0.16	200	0.15	41	0.08	200	0.25	13
BDE138	<0.04	200	<0.02	200	<0.06	200	<0.16	200	<0.03	200	<0.08	200	<0.01	200
BDE 154	1.13	12	0.52	13	0.65	14	<0.09	200	1.11	11	5.32	11	0.73	11
BDE-183	<0.03	200	<0.03	200	<0.05	200	<0.13	200	<0.03	200	<0.06	200	0.01	200
PBBs														
PBB-15	<0.01	202	<0.01	202	<0.01	202	<0.03	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	0.03	72	0.02	104	0.09	36	<0.01	202	0.03	72	0.31	29	0.02	104
PBB-52	0.04	58	0.02	104	0.36	29	<0.03	202	0.03	72	0.49	29	0.12	33
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.02	104	<0.01	202
PBB-101	0.07	90	0.02	104	0.06	44	<0.03	202	0.03	72	0.07	40	0.04	58
PBB-153	<0.06	202	0.03	72	0.03	136	<0.07	202	0.02i	202	0.07i	90	0.03	72
Deca-Br														
BDE-209	1.81		6.23		0.84		<2.25		<0.48		<1.1		0.53	
BB-209	<0.36		<0.43		<0.76		<2.22		<0.47		<1.09		<0.16	

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16557		16558		16559		16560		16561		16763		16764	
FERA LIMS No.	S08-026048		S08-026049		S08-026050		S08-026051		S08-026052		S08-031183		S08-031184	
Sample Details:	Mackerel, ID: C356/24 1008S		Ling, ID: C356/25 1008S		Cod, ID: C356/26 1008S		Spurdog, ID: C356/27 1008S		Skate, ID: C356/28 1008S		Torsk, ID:C356/29 S08/226 46E1 510m, 23/7/08		Hake, ID: C356/030, S08/226 46E1, 510m, 23/7/08	
Fat % Whole	25.43		0.39		0.35		6.42		0.56		0.30		2.23	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs														
BDE-17	0.02	101	0.04	200	0.01	200	0.04	51	<0.02	200	0.03	67	0.02	101
BDE-28	0.05	41	0.49i	51	0.33	16	1.23	11	0.10	81	0.77	13	0.76	11
BDE-47	0.74	15	6.09	36	7.62	16	23.02	11	1.71	86	11.11	15	16.29	11
BDE-49	0.20	14	1.56	18	1.49	12	1.06	11	1.38	15	0.94	17	4.24	10
BDE-66	0.09	25	0.13	200	0.26	40	9.19	10	1.18	17	0.20	61	0.65	11
BDE-71	<0.01	200	<0.01	200	<0.01	200	<0.01	200	0.09	25	<0.01	200	<0.01	200
BDE-77	<0.01	200	<0.01	200	0.01	200	0.36	12	0.07i	30	<0.01	200	<0.01	200
BDE-85	<0.01	200	0.05	200	<0.01	200	0.14	18	0.25	19	0.10	41	<0.01	200
BDE-99	0.31	12	0.49	101	0.27	90	13.03	10	5.82	12	1.53	23	1.91	11
BDE-100	0.15	17	1.81	16	2.21	11	58.17	10	0.71	25	1.99	12	4.26	10
BDE-119	0.02	101	0.07	200	0.08	27	0.50	11	0.23	14	0.10	23	0.39i	12
BDE-126	<0.01	200	<0.02	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE153	0.04	51	<0.15	200	<0.06	200	7.33	10	1.11	21	0.24	76	0.23	14
BDE138	<0.01	200	<0.07	200	<0.03	200	<0.01	200	0.15	67	0.05	160	<0.01	200
BDE 154	0.08	27	0.64	35	0.71	12	6.87	10	0.36	20	1.32	11	4.39	10
BDE-183	<0.01	200	<0.1	200	<0.05	200	0.01	200	0.08	175	0.21	58	0.03	67
PBBs														
PBB-15	<0.01	202	<0.02	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	<0.01	202	0.03	202	0.04	58	0.04i	58	<0.01	202	0.04	58	0.14	32
PBB-52	<0.01	202	0.05	202	0.05	49	0.31	29	<0.01	202	0.03	72	0.16	31
PBB-80	<0.01	202	<0.01	202	<0.01	202	0.02	104	<0.01	202	<0.01	202	0.02	104
PBB-101	<0.01	202	<0.03	202	0.03	72	0.26	29	<0.01	202	0.06	44	0.06	44
PBB-153	<0.01	202	<0.02	202	<0.03	202	0.33	29	<0.01	202	<0.06	202	0.08	38
Deca-Br														
BDE-209	0.10		2.29		3.07		0.18		1.33		5.10		0.39	
BB-209	<0.05		<0.27		<0.12		<0.05		0.27		2.02		0.18	

i - indicative value

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16765		16766		16767		16768		16769		16770		16771	
FERA LIMS No.	S08-031185		S08-031186		S08-031187		S08-031188		S08-031189		S08-031190		S08-031191	
Sample Details:	Cuckoo Ray, ID: C356/031, 1008S		Monkfish, ID: C356/032, 1008S		Roach, Forth & Clyde Canal, ID: C356/033		Perch, Forth & Clyde Canal, ID: C356/034, Port Dundas 29.10.08		Pike, Forth & Clyde Canal, ID: C356/035, Port Dundas		Eel, Kirtle Water, ID: C356/037, 26-8-08, 27-8-08		Trout, Kirtle Water, ID:C356/038	
Fat % Whole	0.46		0.28		2.48		1.16		2.80		18.48		4.24	
ug/kg fat weight	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U	**ug/kg fat**	% U
PBDEs														
BDE-17	<0.01	200	<0.03	200	0.67	11	0.24	13	0.04i	150	0.02	101	0.01i	200
BDE-28	0.15	54	<0.06	200	6.96	10	2.57	11	0.70	23	0.28	13	1.05	11
BDE-47	1.49	108	2.01	126	91.03	10	65.62	11	14.72	15	23.91	11	50.90	10
BDE-49	0.08	175	0.28	86	2.79	11	4.98	11	0.84	20	1.24	11	2.43	11
BDE-66	0.08	200	<0.13	200	0.20	23	3.14	11	0.59	29	0.61	11	2.46	11
BDE-71	<0.01	200	<0.02	200	0.04	51	<0.01	200	<0.01	200	<0.01	200	0.03	67
BDE-77	<0.01	200	<0.01	200	0.02	101	0.14	18	0.03	67	0.02	101	0.10	23
BDE-85	<0.02	200	<0.07	200	0.08	27	0.08	27	0.07	143	0.02	101	0.09	25
BDE-99	0.35	120	0.91	73	0.37	29	56.89	10	8.36	21	1.75	11	28.95	10
BDE-100	0.87	21	0.82	33	11.59	10	15.52	11	2.93	12	13.40	10	8.66	10
BDE-119	<0.01	200	<0.04	200	0.31	12	0.35	12	0.05	120	0.16	16	0.14	18
BDE-126	<0.02	200	<0.02	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE153	<0.11	200	0.23	157	1.14	12	4.24	11	0.61	28	1.56	11	2.25	11
BDE138	<0.06	200	<0.09	200	<0.01	200	<0.08	200	<0.05	200	<0.01	200	0.05	41
BDE 154	0.30	23	0.42i	26	4.39	10	4.48	10	0.71	25	1.54	11	2.11	11
BDE-183	<0.08	200	<0.12	200	0.03	134	0.33	26	0.09	156	0.04	51	0.16	16
PBBs														
PBB-15	<0.02	202	<0.02	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	0.01	202	<0.01	202	0.03	72	0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-52	<0.01	202	<0.02	202	0.05	49	0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-101	<0.02	202	<0.04	202	0.03	72	0.04	58	<0.01	202	<0.01	202	<0.01	202
PBB-153	<0.02	202	<0.04	202	<0.02	202	0.08i	38	<0.03	202	<0.01	202	<0.01	202
Deca-Br														
BDE-209	1.88		2.65		<0.29		12.68		3.70		0.36		0.39	
BB-209	<0.2		<0.32		<0.05		<0.1		0.68		<0.1		<0.14	

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16772		16773		16774		16775		16776		16777		16778	
FERA LIMS No.	S08-031192		S08-031193		S08-031194		S08-031195		S08-031196		S08-031197		S08-031198	
Sample Details:	Eel, Lochar Water, ID: C356/039, 27-8-08		Trout, Lochhar W, ID: C356/040, 27-08-08		Eel - R Eden, ID: C356/041		Trout, R Eden, ID: C356/042		Trout, W of Girvan, ID: C356/043		Pike, L Achray, ID: C356/044		Eel, R Leven, ID: C356/045	
Fat % Whole	14.83		1.31		16.45		8.39		2.06		1.56		13.08	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs														
BDE-17	0.05	41	0.12i	35	0.14	18	0.54	11	<0.01	200	0.03	67	0.05	41
BDE-28	0.60	11	2.19	11	1.03	11	1.44	11	0.89	11	0.84	12	0.33	12
BDE-47	57.84	10	84.14	11	192.97	10	126.55	10	66.69	11	39.55	11	53.27	10
BDE-49	4.42	10	7.12	11	5.69	10	3.63	11	3.28	11	6.83	11	1.83	11
BDE-66	1.08	11	6.12	11	3.78	11	4.97	10	1.35	11	5.09	11	0.70	11
BDE-71	<0.01	200	0.09	25	<0.01	200	0.03	67	<0.02	200	<0.01	200	<0.01	200
BDE-77	0.05	41	0.37	12	0.08	27	0.11	21	0.05	41	0.70	11	0.01	200
BDE-85	0.03i	67	<0.02	200	<0.01	200	0.25	13	<0.01	200	0.12	20	0.06	35
BDE-99	5.87	11	72.72	10	17.78	10	85.56	10	36.57	10	49.76	10	4.89	11
BDE-100	33.17	10	15.81	11	113.24	10	23.61	10	17.49	10	12.74	10	20.20	10
BDE-119	0.63	11	0.56	11	0.97i	11	0.36i	12	0.21i	14	2.90	11	0.19i	15
BDE-126	<0.01	200	<0.01	200	<0.01	200	<0.01	200	<0.01	200	0.01	200	<0.01	200
BDE153	6.03	10	8.07	11	5.63	11	4.18	11	5.03	11	8.53	10	2.89	11
BDE138	<0.01	200	0.06	35	<0.01	200	0.11	21	0.03	67	0.45i	11	<0.01	200
BDE 154	2.89	11	4.15	11	7.42	10	3.64	11	5.77	11	11.59	10	2.88	11
BDE-183	0.04	51	0.20	32	0.13	19	0.28	13	0.22	14	0.88	11	0.05	41
PBBs														
PBB-15	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.01	202	0.30	29	<0.01	202
PBB-52	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.01	202	0.06	44	0.02	104
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202	<0.01	202	0.01	202	<0.01	202
PBB-101	<0.01	202	<0.01	202	0.02	104	<0.01	202	<0.01	202	0.13	32	0.06	44
PBB-153	<0.01	202	<0.03	202	0.02i	104	0.02i	104	<0.03	202	0.50	29	0.05	49
Deca-Br														
BDE-209	0.27		5.75		0.57		1.34		0.51		0.54		0.45	
BB-209	<0.12		<0.48		<0.12		<0.13		<0.21		<0.19		<0.13	

Table 8 (cont'd): Concentrations of PBDEs, *ortho* substituted PBBs and *deca*-brominated compounds

FERA Sample No.	16779		16808		16939		16940	
FERA LIMS No.	S08-031199		S08-032253		S09-002037		S09-002038	
Sample Details:	Trout, Clyde, ID: C356/046		Trout - White Cart W, ID: C356/036		Roach, Forth & Clyde Canal, ID: C356/033 (Part-2)		Roach, Forth & Clyde Canal, ID: C356/033 (Part-3)	
Fat % Whole	3.19		7.84		3.65		1.45	
ug/kg fat weight	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**	**ug/kg fat**	**% U**
PBDEs								
BDE-17	0.03i	67	0.13	19	0.45	11	0.88	11
BDE-28	0.63	11	0.66	11	3.64	11	5.41	11
BDE-47	10.66	11	10.63	11	50.00	11	70.39	11
BDE-49	2.24	11	3.03	11	2.06	11	2.44	12
BDE-66	1.72	11	0.52	11	0.06	67	0.07	172
BDE-71	0.01	200	0.02	101	0.03	67	0.05	41
BDE-77	0.14	18	0.03	67	<0.01	200	0.01	200
BDE-85	0.02i	101	0.04	51	<0.01	200	<0.04	200
BDE-99	15.38	11	3.27	12	<0.16	200	<0.59	200
BDE-100	3.13	11	2.31	11	6.29	11	7.62	11
BDE-119	0.51	11	0.07i	30	0.12i	20	0.19	24
BDE-126	<0.01	200	<0.01	200	<0.01	200	<0.01	200
BDE153	4.27	10	0.35	12	1.12	11	0.65	21
BDE138	0.09	25	<0.01	200	<0.01	200	<0.02	200
BDE 154	5.29	10	0.76	11	2.57	11	2.61	11
BDE-183	2.21	11	0.04	51	0.03	134	<0.06	200
PBBs								
PBB-15	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-49	0.02	104	0.07	40	0.01	202	0.02	104
PBB-52	<0.01	202	0.20	30	0.03	72	0.03i	72
PBB-80	<0.01	202	<0.01	202	<0.01	202	<0.01	202
PBB-101	0.03	72	0.06	44	0.03	72	<0.02	202
PBB-153	0.17	31	0.04	58	<0.01	202	<0.03	202
Deca-Br								
BDE-209	0.24		0.54		<0.26		<0.95	
BB-209	<0.05		<0.05		0.05		<0.15	

Table 9: Concentrations of PCNs

Marine Fish										
FERA sample No.	16277	16278	16279	16280	16281	16282	16283	16284	16285	16286
Sample Details	1 - Spurdog, Id: C356/001 4.63kg	2 - Spurdog, ID: C356/002, 5.61kg	3 - Smooth Hound, ID: C356/003, 4.00kg	4 - Starry Smooth Hound, ID: C356/004, 6.25kg	5 - Thornback Ray, ID: C356/005, 4.33kg	6 - Skate, ID: C356/006, 5.36kg	7 - Hake, ID: C356/007, 4.21kg	8 - Spotted Ray, ID: C356/008, 3.67kg	9 - Cuckoo Ray, ID: C356/009, 3.44kg	10 - Black-Mouthed Dogfish, ID: C356/010, 2.75kg
Fat %	14.58	8.14	0.53	0.8	0.79	0.79	3.02	0.72	0.59	1.01
ng/kg fat weight										
PCN 52/60	208.4	594.83	649.34	95.69	43.29	<18.4	255.15	66.43i	23.46	134
PCN 53	22.7	68.61	25.84	42.6	6.91	7.71	3.44	69.39i	9.58	60.63
PCN 66/67	7.13	41.43	22.25	8.24	20.07	5.22	34.77	16.95	11.79	4.75
PCN 68	5.0	25.12	8.93	3.73	<1.49	<1.42	9.07i	3.78i	<2.70	4.34
PCN 69	7.25	29.99	<2.75	<3.38	<3.19	<3.04	9.6i	<3.31	<5.79	<2.40
PCN 71/72	3.84	11.12	<1.64	<1.61	<0.67	<0.46	5.89i	<2.27	1.54	1.42
PCN 73	0.29	1.46	<1.49	2.12	<0.97	1.1	5.83	3.21	<1.76	1.92
PCN 74	<0.05	0.18	<1.04	<0.36	<0.34	<0.33	1.12	0.5	<0.62	<0.26
PCN 75	<0.11	<0.17	<2.15	<2.64	<2.49	<2.38	<0.62	<2.58	<4.52	<1.87
Upper Bnd Sum										
ng/kg FAT	254.8	772.9	715.4	160.4	79.4	40.1	325.5	168.4	61.8	211.6
ng/kg WHOLE	37.15	62.91	3.79	1.28	0.63	0.32	9.83	1.21	0.36	2.14

i - indicative value

Table 9 (cont'd): Concentrations of PCNs

Marine Fish

FERA sample No.	16287	16288	16380	16384	16385	16386	16387	16388	16552	16553
Sample Details	11 - Lesser Spotted Dogfish, ID: C356/011, 4.55kg	12 - Black Scabbard Fish, ID: C356/012, 4.82kg	Torsk, 2 whole fish, ID: C356/013, 6.08kg	Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1, 510M,	Round Nose Grenadier, Whole Fish, ID: C356/15, 5.82kg	Ling, Whole fish ID: C356/014, 6.18kg	Blue Ling, ID: C356/17, BLI -S0908S 230, 24/7/08, (106cm, 5500g)	Monk fish - Tails x 2 ID: C356/16, 2.73kg	John Dory,ID: C356/19, 0.49kg	Haddock, ID: C356/20 1008S, 0.50kg
Fat %	0.51	2.23	0.44	0.32	0.39	0.66	0.45	0.47	1.59	0.5
ng/kg fat weight										
PCN 52/60	183.61	448.6	190.11	40.84	174.79	148.61	216.11	85.73	272.62	37.16
PCN 53	94.21	24.67	10.83	18.79	20.72	7.0	15.2	7.46	12.56	27.61
PCN 66/67	10.27	45.7	24.77	19.43	23.8	15.05	33.9	16.61	47.44	<5.68
PCN 68	10.0	5.79	2.93	2.2	3.8i	4.12	6.94	2.55	12.47	5.81
PCN 69	5.37i	3.65i	<4.67	<2.91	2.49	3.63	5.79	4.54	17.98	<6.58
PCN 71/72	<1.57	8.11	6.04	2.84	1.98	4.48	8.31	5.14	17.17	<4.69
PCN 73	4.72	0.95	<1.42	2.32	1.58	2.0	1.86i	1.46	7.14	<3.74
PCN 74	<0.52	0.19	<0.50	0.81	<0.71	<0.33	<0.53	<0.50	1.27	<2.06
PCN 75	<3.79	<0.80	<3.64	<2.23	<1.52	<1.26	<1.70	<1.28	<2.02	<5.35
Upper Bnd Sum										
ng/kg FAT	314.1	538.5	244.91	92.37	231.39	186.48	290.34	125.27	390.67	98.68
ng/kg WHOLE	1.6	12.01	1.08	0.3	0.9	1.23	1.31	0.59	6.21	0.49

i - indicative value

Table 9 (cont'd): Concentrations of PCNs

Marine Fish

FERA sample No.	16554	16555	16556	16557	16558	16559	16560	16561	16763	16764
Sample Details	Horse Mackerel, ID: C356/21 1008S, 0.34kg	Hake, ID: C356/22 1008S, 1.24kg	Herring, ID: 356/23 1008S, 0.21kg	Mackerel, ID: C356/24 1008S,	Ling, C356/25 1008S,	Cod, ID: C356/26 1008S,	Spurdog, ID: C356/27 1008S,	Skate, ID: C356/28 1008S,	Torsk, C356/29 S08/226 46E1 510m, 23/7/08, P08-78060, S08-031183	Hake, C356/030, S08/226 46E1, 510m, 23/7/08, P08-78060, S08-031184
Fat %	2.8	0.77	16.1	25.43	0.39	0.35	6.42	0.56	0.3	2.23
ng/kg fat weight										
PCN 52/60	117.75i	862.34	111.26	18.3	145.8	196.75	451.65i	<18.5	343.3	466.1
PCN 53	3.99i	19.32	14.01	1.39	40.38	30.65	41.1i	5.84	145.36	35.67
PCN 66/67	4.69	118.54	13.24	0.64	20.99	28.93	30.1	16.85	57.13	45.99
PCN 68	1.43	49.96	9.5	0.27	11.14	10.66	10.64	<1.86	8.13	14.57
PCN 69	<1.49	59.05	8.32	<0.18	7.16	15.44	9.77	<4.32	6.91	17.11
PCN 71/72	2.59	51.4	7.27	0.24	4.87	11.33	2.64	<3.08	16.47	18.12
PCN 73	<0.84	28.46	2.05	<0.10	<2.88	6.94	1.38	<2.45	2.85	9.36
PCN 74	<0.47	5.16	0.56	<0.06	<2.79	1.11	0.19	<1.36	<0.77	1.99
PCN 75	<1.21	<1.91	<0.30	<0.14	<4.13	<2.14	<0.33	<3.47	<1.56	<0.49
Upper Bnd Sum										
ng/kg FAT	134.46	1196.14	166.51	21.32	240.14	303.95	547.8	57.73	582.48	609.4
ng/kg WHOLE	3.7	9.21	26.81	5.42	0.94	1.06	35.17	0.32	1.75	13.59

i - indicative value

Table 9 (cont'd): Concentrations of PCNs

	Marine Fish		Shellfish				
FERA sample No.	16765	16766	16272	16273	16274	16275	16276
Sample Details	Cuckoo Ray, C356/031, 1008S, 1.18kg S08-031185	Monkfish, C356/032, 1008S, 0.94kg, P08-78060, S08-031186	Mussels - Ardmore 14/5/08,	Mussels - Blackness F of F, 18/5/08,	Mussels - Inverness Football Ground, 6/6/08,	Mussels – Stannergate, 17/6/08,	Mussels - Inverness Nigg Bay, 21/6/08,
Fat %	0.5	0.28	0.44	0.26	0.3	0.35	0.38
ng/kg fat weight							
PCN 52/60	46.58	73.13	765.34i	495.0i	228.39	273.10	146.01
PCN 53	87.51	49.49	494.53i	339.95i	86.65	118.37	50.04
PCN 66/67	17.7	16.3	20.57	55.71	7.89	14.47	<3.05
PCN 68	4.59	5.87	49.90	31.37	8.71	14.55	4.27
PCN 69	<4.50	10.13	43.75	<34.5	5.51	9.87	<4.45
PCN 71/72	<3.21	7.2	74.55	44.87	10.44	19.74	4.42
PCN 73	<2.56	<4.05	9.49	30.03	<2.60	6.90	<2.41
PCN 74	<1.68	<0.78	4.21	9.33	<1.80	1.71	<1.67
PCN 75	<3.62	<6.16	<2.99	7.55	<3.75	<3.39	<3.48
Upper Bnd Sum							
ng/kg FAT	171.98	173.11	1465.33	1048.31	355.74	462.1	219.8
ng/kg WHOLE	0.79	0.48	6.45	2.73	1.07	1.62	0.84

i - indicative value

Table 9 (cont'd): Concentrations of PCNs

Freshwater Fish

FERA sample No.	16767	16768	16770	16771	16772	16773	16774	16775	16776	16777
Sample Details	Roach, Forth & Clyde Canal, C356/033, P08-78060, S08-031187	Perch, Firth & Clyde Canal, C356/034, Port Dundas 29.10.08, P08-78060, S08-031188	Eel, Kirtle Water, C356/037, 26-8-08, 27-8-08, 1.01kg, P08-78060, S08-031190	Trout, Kirtle Water, C356/038, 0.52kg, P08-78060, S08-031191	Eel, Lochar Water, C356/039, 27-8-08, 0.48kg, P08-78060, S08-031192	Trout, Lochhar W, C356/040, 27-08-08, 0.87kg, P08-78060, S08-031193	Eel - R Eden, C356/041, 0.26kg, P08-78060, S08-031194	Trout, R Eden, C356/042, 0.24kg, P08-78060, S08-031195	Trout, W of Girvan, C356/043, 0.68kg, P078060, S08-031196	Pike, L Achray, C356/044, 2.26kg, P08-78060, S08-031197
Fat %	2.48	1.16	18.48	4.24	14.83	1.31	16.45	8.39	2.06	1.56
ng/kg fat weight										
PCN 52/60	2494.68	1553.93	5.02	115.52	7.80	111.78	27.51	187.09	204.76	298.43
PCN 53	174.30	784.03	0.94	39.07	2.41	26.46	2.59	21.31	40.54	67.42
PCN 66/67	101.66	69.36	4.15	9.65	4.26	9.60	7.03	9.36	11.07	76.44
PCN 68	204.07	133.00	0.18	8.75	0.29	8.17	0.36	5.28	12.84	27.74
PCN 69	365.74	204.94	2.87	13.61	3.12	12.38	8.93	15.65	19.35	34.18
PCN 71/72	782.49	537.47	1.10	25.30	1.20	19.14	0.99	9.78	32.87	34.97
PCN 73	13.71	4.37	1.45	2.94	1.11	1.17	1.01	1.13	1.05	5.35
PCN 74	29.77	10.88	0.74	2.27	0.45	0.77	0.20	0.45	0.81	0.87
PCN 75	<0.75	<1.53	<0.08	<0.43	<0.17	<0.90	<0.19	<0.33	<0.92	<0.59
Upper Bnd Sum										
ng/kg FAT	4167.17	3299.51	16.53	217.54	20.81	190.37	48.81	250.38	324.21	545.99
ng/kg WHOLE	103.35	38.27	3.05	9.22	3.09	2.49	8.03	21.01	6.68	8.52

Table 9 (cont'd): Concentrations of PCNs

Freshwater Fish

FERA sample No.	16778	16779	16808	16939	16940	
Sample Details	Eel, R Leven, C356/045, 0.32kg, P08-78060, S08-031198	Trout, Clyde, C356/046, 0.82kg, P08-78060, S08-031199	Trout - White Cart W, C356/036, 422.63g inc foil, P08-79260, S08-032253	Roach, Forth & Clyde Canal, C356/033 (2)	Roach, Forth & Clyde Canal, C356/033 (3),	***Uncertainty %**
Fat %	13.08	3.19	7.84	3.65	1.45	
ng/kg fat weight						
PCN 52/60	18.33	233.19	135.5	889.73	1553.92	**17**
PCN 53	4.37	47.21	18.15	197.76	209.81	**67**
PCN 66/67	10.05	48.48	12.68	25.6	60.4	**14**
PCN 68	1	34.43	6.48	61.69	107.89	**45**
PCN 69	17.72	33.75	6.69	87.08	163.13	**72**
PCN 71/72	4.91	39.64	6.96	211.04	398.84	**65**
PCN 73	4.22	4.90	1.73	4.75	9.07	**44**
PCN 74	4.05	0.97	0.46	7.33	11.82	**147**
PCN 75	0.46i	<0.68	<0.28	<0.56	<2.24	**192**
Upper Bnd Sum						
ng/kg FAT	65.11	443.25	188.93	1485.54	2517.12	
ng/kg WHOLE	8.52	14.14	14.81	54.22	36.5	

*Uncertainty for fish and shellfish samples. Uncertainty for concentrations at, or approaching, the LOD, is typically ~200%

Table 10: Concentrations of Phthalates (µg/kg tissue whole weight)

	Shellfish					Marine fish				
FERA Sample No.	16272	16273	16274	16275	16276	16277	16278	16279	16280	16281
LIMS No.	S08-015904	S08-015905	S08-015906	S08-015907	S08-015908	S08-016128	S08-016129	S08-016130	S08-016131	S08-016132
Description	Mussels - FSA Ardmore 14/5/08,	Mussels - FJAS Blackness F of F, 18/5/08,	Mussels - Inverness Football Ground, 6/6/08,	Mussels - FSA Mussels Stannergate, 17/6/08,	Mussels - Inverness Nigg Bay, 21/6/08,	1 - Spurdog, ID: C356/001, 4.63kg	2 - Spurdog, ID: C356/002, 5.61kg	3 - Smooth Hound, ID: C356/003, 4.00kg	4 - Starry Smooth Hound, ID: C356/004, 6.25kg	5 - Thornback Ray, ID: C356/005, 4.33kg
ug/kg whole weight	0.44	0.26	0.3	0.35	0.38	14.58	8.14	0.53	0.8	0.79
Dimethyl phthalate	< 22	< 18	< 35	< 17	< 18	<2	<2	< 10	<2	<5
Diethyl phthalate	< 23	< 22	< 61	< 25	< 38	**44 i**	**55 i**	<5	<2	<4
Diisopropyl phthalate	< 18	< 15	< 40	< 21	< 22	**26 i**	**39 i**	<3	<2	<4
Diallyl phthalate	< 66	< 58	<147	< 97	<113	< 12	< 22	< 11	<8	< 25
Diisobutyl phthalate	< 28	**< 39**	< 43	< 31	< 30	<6	<5	<5	**< 18**	< 14
Di-n-butyl phthalate	**< 81**	**< 33**	< 33	**< 77**	**< 83**	<5	<6	<4	**< 17**	< 12
Di-n-pentyl phthalate	< 24	< 11	< 40	< 25	< 28	< 10	< 12	<4	<5	< 13
Di-n-hexyl phthalate	< 22	< 15	< 33	< 22	< 32	< 10	<6	<5	<5	< 11
Benzyl butyl phthalate	< 53	< 37	< 64	< 52	< 70	< 19	< 15	<10	<11	< 23
Dicyclohexyl phthalate	< 84	< 48	<139	< 80	< 91	<1	<9	<9	<7	< 13
Di-(2-ethylhexyl) phthalate	<118	< 65	<194	< 80	< 88	< 21	< 21	< 23	**< 64**	**<157**
Di-n-heptyl phthalate	<221	<120	<396	<163	<210	< 52	< 60	< 59	< 47	<101
Di-n-octyl phthalate	< 57	< 27	< 52	< 60	< 67	< 11	< 11	< 10	< 12	< 22
Diisononyl phthalate	<1306	< 682	<1677	<1289	<1164	< 292	< 247	< 249	< 289	< 655
Diisodecyl phthalate	<2330	<1128	<2839	<1821	<2303	< 542	< 388	< 428	< 324	<1058
Di-n-decyl phthalate	< 64	< 37	< 89	< 84	< 82	< 29	< 19	< 16	< 15	< 39

i - indicative value

<(bold) - detected, but below the given level of quantitation

Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes.

Table 10 (cont'd): Concentrations of Phthalates (µg/kg tissue whole weight)

FERA Sample No.	16282	16283	16284	16285	16286	16287	16288	16380	16384	16385
LIMS No.	S08-016133	S08-016134	S08-016135	S08-016136	S08-016137	S08-016138	S08-016139	S08-019914	S08-019915	S08-019916
Description	6 - Skate, ID: C356/006, 5.36kg	7 - Hake, ID: C356/007, 4.21kg	8 - Spotted Ray, ID: C356/008, 3.67kg	9 - Cuckoo Ray, ID: C356/009, 3.44kg	10 - Black-Mouthed Dogfish, ID: C356/010, 2.75kg	11 - Lesser Spotted Dogfish, ID: C356/011, 4.55kg	12 - Black Scabbard Fish, ID: C356/012, 4.82kg	Torsk, 2 whole fish, ID: C356/013, 6.08kg	Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1, 510M,	Round Nose Grenadier, Whole Fish, ID: C356/15, 5.82kg
ug/kg whole weight	0.79	3.02	0.72	0.59	1.01	0.51	2.23	0.44	0.32	0.39
Dimethyl phthalate	< 11	<2	<2	<3	<2	<4	<2	<1	<5	<7
Diethyl phthalate	<3	<5	<3	<2	<4	<2	**<7**	<1	<2	<3
Diisopropyl phthalate	<2	**28 i**	<2	<2	<2	<2	<2	<1	<2	<2
Diallyl phthalate	< 13	< 17	<5	<7	< 12	<8	<7	<5	<4	<5
Diisobutyl phthalate	<3	**40**	**<4**	**<7**	**17**	<2	**<6**	**< 11**	**< 17**	<2
Di-n-butyl phthalate	<4	**< 28**	**<3**	**<6**	<2	<2	**<5**	<2	**< 13**	<2
Di-n-pentyl phthalate	<4	< 10	<1	<2	<4	<2	<5	<2	<2	<2
Di-n-hexyl phthalate	<6	<8	<2	<2	<2	<2	<6	<4	<3	<2
Benzyl butyl phthalate	< 12	< 17	<5	<4	<5	<4	< 14	<7	<6	<4
Dicyclohexyl phthalate	<9	< 13	<3	<3	<3	<3	<8	<5	<5	<3
Di-(2-ethylhexyl) phthalate	< 27	**< 67**	**< 17**	**< 22**	**< 19**	**< 19**	**< 38**	< 13	<7	<6
Di-n-heptyl phthalate	< 56	< 55	<8	< 10	<8	< 14	< 17	< 22	< 14	< 11
Di-n-octyl phthalate	< 16	< 14	<6	<6	<7	<6	< 11	<8	<8	<6
Diisononyl phthalate	< 308	< 349	<46	<44	<45	<74	<76	<105	<104	<58
Diisodecyl phthalate	< 442	< 445	<63	<59	<75	<75	< 132	<182	< 139	<73
Di-n-decyl phthalate	< 21	< 26	<2	<2	<2	<2	<3	<5	<6	<4

i - indicative value

<(bold) - detected, but below the given level of quantitation

Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes

Table 10 (cont'd): Concentrations of Phthalates (µg/kg tissue whole weight)

FERA Sample No.	16386	16387	16388	16552	16553	16554	16555	16556	16557	16558
LIMS No.	S08-019917	S08-019918	S08-019919	S08-026043	S08-026044	S08-026045	S08-026046	S08-026047	S08-026048	S08-026049
Description	Ling, Whole fish ID: C356/014, 6.18kg	Blue Ling, ID: C356/17, BLI - S0908S 230, 24/7/08, (106cm, 5500g)	Monk fish - Tails x 2 ID: C356/16, 2.73kg	John Dory,ID: C356/19, 0.49kg	Haddock, ID: C356/20 1008S, 0.50kg	Horse Mackerel, ID: C356/21 1008S, 0.34kg	Hake, ID: C356/22 1008S, 1.24kg	Herring, ID: 356/23 1008S, 0.21kg	Mackerel, ID: C356/24 1008S, 0.34kg	Ling, C356/25 1008S, 1.45kg
ug/kg whole weight	0.66	0.45	0.47	1.59	0.5	2.75	0.77	16.1	25.43	0.39
Dimethyl phthalate	<2	<2	< 72	< 76	< 97	< 85	< 88	< 97	< 93	<175
Diethyl phthalate	<2	<2	< 24	< 80	< 97	< 70	<101	<120	<146	<157
Diisopropyl phthalate	<2	<2	<9	< 58	< 52	< 51	< 51	< 80	< 99	< 68
Diallyl phthalate	<5	<6	< 18	<222	<285	<183	<262	<328	<319	<336
Diisobutyl phthalate	<3	<2	<3	< 66	< 52	< 66	< 55	<105	<107	< 96
Di-n-butyl phthalate	**< 17**	<2	**<7**	< 56	< 46	< 54	< 52	< 91	< 73	< 75
Di-n-pentyl phthalate	<2	<2	<2	< 58	< 58	< 69	< 80	<119	<138	< 72
Di-n-hexyl phthalate	<5	<4	<3	< 58	< 53	< 70	< 79	<117	<143	<765
Benzyl butyl phthalate	< 10	<4	<7	<128	< 96	<172	<181	<220	<253	<153
Dicyclohexyl phthalate	<7	<5	<3	<294	<219	<233	<165	<302	<270	<163
Di-(2-ethylhexyl) phthalate	< 15	**< 20**	<8	<250	<252	<378	<226	<355	<374	<292
Di-n-heptyl phthalate	< 28	< 21	< 19	<327	<667	<616	<504	<640	<359	<653
Di-n-octyl phthalate	<9	<7	<6	< 96	<100	<142	<102	<209	<133	< 87
Diisononyl phthalate	< 152	< 135	< 104	<1757	<2427	<2592	<2902	<4043	<3078	<4233
Diisodecyl phthalate	< 251	< 188	< 105	<3277	<3888	<4088	<3117	<6698	<6986	<5740
Di-n-decyl phthalate	<8	< 11	<7	< 94	<127	<157	<130	<207	<281	<142

i - indicative value

<(bold) - detected, but below the given level of quantitation

Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes

Table 10 (cont'd): Concentrations of Phthalates (µg/kg tissue whole weight)

FERA Sample No.	16559	16560	16561	16763	16764	16765	16766
LIMS No.	S08-026050	S08-026051	S08-026052	S08-031183	S08-031184	S08-031185	S08-031186
Description	Cod, ID: C356/26 1008S, 2.46kg	Spurdog, ID: C356/27 1008S, 2.19kg	Skate, ID: C356/28 1008S, 1.38kg	Torsk, C356/29 S08/226 46E1 510m 23/7/08, 1.64kg, P08-78060, S08-031183	Hake, C356/030, S08/226 46E1,510m 23/7/08, P08-78060, S08-031184	Cuckoo Ray, C356/031, 1008S, 1.18kg S08-031185	Monkfish, C356/032, 1008S, 0.94kg, P08-78060, S08-031186
ug/kg whole weight	0.35	6.42	0.56	0.3	2.23	0.46	0.28
Dimethyl phthalate	<203	<132	<259	< 15	< 27	< 22	< 22
Diethyl phthalate	<149	<167	<226	< 82	<134	< 87	< 90
Diisopropyl phthalate	< 70	< 87	<111	<8	<8	<6	<6
Diallyl phthalate	<331	<419	<509	< 51	< 43	< 31	< 41
Diisobutyl phthalate	< 95	< 86	< 93	< 11	< 11	**< 22**	**< 15**
Di-n-butyl phthalate	< 83	< 70	< 82	**16 i**	**< 29**	**< 17**	**16 i**
Di-n-pentyl phthalate	< 76	< 61	< 55	<7	< 14	<6	<7
Di-n-hexyl phthalate	< 65	< 59	< 62	<8	< 21	<7	<8
Benzyl butyl phthalate	<117	<137	<128	< 19	< 42	< 15	< 16
Dicyclohexyl phthalate	<166	<361	<216	< 12	< 30	< 14	< 12
Di-(2-ethylhexyl) phthalate	<214	<455	<432	**217**	**< 74**	**< 45**	**< 36**
Di-n-heptyl phthalate	<530	ND	<534	< 80	<105	< 84	< 63
Di-n-octyl phthalate	<111	<129	< 90	< 24	< 18	< 19	< 11
Diisononyl phthalate	<3249	<5668	<3068	**2409 i**	< 536	< 393	< 247
Diisodecyl phthalate	<5250	<7465	<4278	< 487	< 697	< 517	<356
Di-n-decyl phthalate	<235	<275	<112	< 18	< 27	< 16	< 15

i - indicative value
<(bold) - detected, but below the given level of quantitation
ND – not determined

Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes

Table 10 (cont'd): Concentrations of Phthalates (µg/kg tissue whole weight)

	Freshwater Fish								
FERA Sample No.	16767	16768	16769	16770	16771	16772	16773	16774	16775
LIMS No.	S08-031187	S08-031188	S08-031189	S08-031190	S08-031191	S08-031192	S08-031193	S08-031194	S08-031195
Description	Roach, Forth & Clyde Canal, C356/033, 1.51kg in 2 bags, P08-78060, S08-031187 (1)	Perch, Firth & Clyde Canal, C356/034, Port Dundas 29.10.08, P08-78060, S08-031188	Pike, Firth & Clyde Canal, C356/035, Port Dundas,P08-78060, S08-031189	Eel, Kirtle Water, C356/037, 26-8-08, 27-8-08, 1.01kg, P08-78060, S08-031190	Trout, Kirtle Water, C356/038, 0.52kg, P08-78060, S08-031191	Eel, Lochar Water, C356/039, 27-8-08, 0.48kg, P08-78060, S08-031192	Trout, Lochhar W, C356/040, 27-08-08, 0.87kg, P08-78060, S08-031193	Eel - R Eden, C356/041, 0.26kg, P08-78060, S08-031194	Trout, R Eden, C356/042, 0.24kg, P08-78060, S08-031195
ug/kg whole weight	2.48	1.16	2.8	18.48	4.24	14.83	1.31	16.45	8.39
Dimethyl phthalate	< 17	< 14	< 38	< 16	<9	< 30	< 27	< 46	< 43
Diethyl phthalate	< 88	< 83	< 57	< 15	< 18	< 55	< 41	< 64	< 92
Diisopropyl phthalate	<8	<7	< 35	< 11	< 14	< 45	< 28	< 51	< 64
Diallyl phthalate	< 36	< 40	<184	< 44	< 52	<165	<118	<166	<186
Diisobutyl phthalate	< 11	<8	< 36	< 25	< 22	< 47	< 27	**<149**	< 68
Di-n-butyl phthalate	**< 27**	<6	< 33	< 20	**< 58**	< 37	< 22	**< 87**	< 42
Di-n-pentyl phthalate	< 10	< 11	< 27	< 24	< 18	< 36	< 37	< 63	< 88
Di-n-hexyl phthalate	< 21	< 15	< 33	< 65	< 38	< 40	< 42	< 81	<110
Benzyl butyl phthalate	< 46	< 37	< 66	<132	< 78	< 94	<115	<195	<244
Dicyclohexyl phthalate	< 25	< 10	< 56	<134	< 97	<181	<121	<192	<301
Di-(2-ethylhexyl) phthalate	< 25	< 31	< 84	<194	<181	<245	<193	<340	<362
Di-n-heptyl phthalate	<113	< 75	<174	<302	<267	<561	<279	<498	<404
Di-n-octyl phthalate	< 15	< 15	< 46	< 85	< 50	<136	< 89	< 88	< 93
Diisononyl phthalate	< 264	< 247	< 842	<2951	<1384	<2865	<1191	<1651	<2366
Diisodecyl phthalate	<609	<410	<2240	<4682	<2915	<4188	<2125	<2742	<6142
Di-n-decyl phthalate	< 17	< 15	< 80	<245	< 91	<225	<119	<125	<179

i - indicative value
<(bold) - detected, but below the given level of quantitation
Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes

Table 10 (cont'd): Concentrations of Phthalates (µg/kg tissue whole weight)

FERA Sample No.	16776	16777	16778	16779	16808	16939	16940
LIMS No.	S08-031196	S08-031197	S08-031198	S08-031199	S08-032253	S09-002037	S09-002038
Description	Trout, W of Girvan, C356/043, 0.68kg, P078060, S08-031196	Pike, L Achray, C356/044, 2.26kg, P08-78060, S08-031197	Eel, R Leven, C356/045, 0.32kg, P08-78060, S08-031198	Trout, Clyde, C356/046, 0.82kg, P08-78060, S08-031199	Trout - White Cart W, C356/036, P08-79260, S08-032253	Roach, Forth & Clyde Canal, C356/033 (2)	Roach, Forth & Clyde Canal, C356/033 (3),
ug/kg whole weight	2.06	1.56	13.08	3.19	7.84	3.65	1.45
Dimethyl phthalate	< 36	< 40	**83 i**	<8	< 36	< 44	< 43
Diethyl phthalate	< 69	**<345**	<155	< 92	< 94	<109	< 84
Diisopropyl phthalate	< 50	< 11	< 13	<9	< 62	< 76	< 57
Diallyl phthalate	<176	< 45	< 41	< 37	<195	<261	<200
Diisobutyl phthalate	< 47	**< 33**	< 14	< 13	< 57	< 75	< 58
Di-n-butyl phthalate	< 38	**< 23**	**< 32**	**< 31**	**<128**	< 64	< 48
Di-n-pentyl phthalate	< 62	< 14	< 13	< 14	ND	< 64	< 67
Di-n-hexyl phthalate	< 61	< 19	< 25	< 24	< 77	< 69	< 66
Benzyl butyl phthalate	<139	< 48	<346	< 63	<208	<161	<132
Dicyclohexyl phthalate	<171	< 25	< 22	< 30	<229	<186	<217
Di-(2-ethylhexyl) phthalate	<217	< 28	**< 91**	**<121**	<170	<268	<427
Di-n-heptyl phthalate	<233	< 95	< 86	<105	<548	<595	<365
Di-n-octyl phthalate	< 88	< 17	< 21	< 15	<174	<115	< 94
Diisononyl phthalate	<1627	< 391	< 511	< 368	<2838	<2025	<1994
Diisodecyl phthalate	<2629	<354	<1042	< 944	<5284	<3444	<2862
Di-n-decyl phthalate	<144	< 16	< 30	< 18	<270	<146	<120

i - indicative value

<(bold) - detected, but below the given level of quantitation

ND – not determined

Note: Diisononyl phthalate and diisodecyl phthalate are isomeric mixes

Table 11: Concentrations of PFCs

FERA sample No.	16277	16283	16288	16384	16763	16767	16770	16776	16777	16779
LIMs No.	S08-016128	S08-016134	S08-016139	S08-019915	S08-031183	S08-031187	S08-031190	S08-031196	S08-031197	S08-031199
Sample Details	1 - Spurdog, ID: C356/001	7 - Hake, ID: C356/007	12 - Black Scabbard Fish, ID: C356/012	Greater Forkbeard, ID: C356/18, S08/226 23/7/08, 46E1, 510M,	Torsk, C356/29 S08/226 46E1 510m, 23/7/08, P08-78060, S08-031183	Roach, Forth & Clyde Canal, C356/033, P08-78060, S08-031187	Eel, Kirtle Water, C356/037, 26-8-08, 27-8-08, P08-78060, S08-031190	Trout, W of Girvan C356/043, P078060, S08-031196	Pike, L Achray, C356/044, P08-78060, S08-031197	Trout, Clyde, C356/046, P08-78060, S08-031199
µg/Kg whole weight	**Marine Fish**					**River Fish**				
PFHxA	<1	<1	<5	<1	<5	<1	<5	<1	<1	<1
PFHpA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFOA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFNA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFDeA	<1	<1	<1	<1	<5	**2**	**1**	<1	<1	<1
PFUnA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFDoA	<1	<1	<1	<1	<1	<1	<5	<1	<1	<1
PFBSH	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFHxSH	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PFOS	**3**	<1	<1	<1	<1	**8**	**6**	**5**	**2**	**3**
PFOSA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Key -
PFHxA (perfluorohexanoic acid), PFHpA (perfluoroheptanoic acid), PFOA (perfluorooctanoic acid) PFNA (perfluorononanoic acid), PFDeA (perfluorodecanoic acid), PFUnA (perfluoroundecanoic acid), PFDoA (perfluorododecanoic acid), PFBSH (perfluorobutane sulphonate), PFHxSH (perfluorohexane sulphonate), PFOS (perfluorooctane sulphonate), PFOSA (perfluorooctanesulphonylamide)

Table 12: Concentrations of polycyclic aromatic hydrocarbons in mussels.

FERA Sample No.	16272		16273		16274		16275		16276	
FERA LIMs No.	S08-015904		S08-015905		S08-015906		S08-015907		S08-015908	
Sample Details:	Mussels - Ardmore 14/5/08		Mussels - Blackness F of F, 18/5/08		Mussels - Inverness Football Ground, 6/6/08		Mussels - Stannergate, 17/6/08		Mussels - Inverness Nigg Bay, 21/6/08	
ug/kg whole weight		%U		%U		%U		%U		%U
acenaphthylene	1.56	33	3.48	24	<0.21	201	<0.26	201	0.72	59
acenaphthene	<0.34	201	<0.35	201	<0.35	201	<0.36	201	0.38	185
fluorene	<0.39	201	<0.4	201	<0.4	201	<0.39	201	<0.4	201
phenanthrene	0.86	116	1.21	85	<0.5	201	<0.49	201	2.58	44
anthracene	1.17	23	2.32	21	0.12	86	0.17	62	1.01	23
fluoranthene	3.37	26	1.63	39	0.58	95	0.52	102	4.99	24
benzo[c]fluorene	0.21	35	0.24	33	<0.07	201	<0.04	201	0.29	29
pyrene	3.01i	30	3.01i	31	0.56	123	0.37	180	4.04i	27
benzo[ghi]fluoranthene	0.97	19	0.61	23	0.19	55	0.14	73	1.00	19
benz (a) anthracene	1.25	17	1.09	17	0.27	27	0.18	37	2.17	16
benzo[b]naphtho[2,1-d]thiophene	0.23	24	<0.25	201	<0.08	201	0.04	101	0.46	18
cyclopenta[c,d]pyrene	0.02	101	0.03	69	0.02	101	<0.01	201	0.04	52
chrysene	1.70i	19	1.38i	21	0.24i	77	0.21i	87	2.23i	18
5-methylchrysene	<0.01	201	<0.01	201	<0.01	201	<0.01	201	<0.01	201
benzo[b]fluoranthene	1.98	18	1.56	19	0.44	32	0.33	35	2.85	17
benzo[j]fluoranthene	0.95	17	0.61	17	0.19	20	0.15	22	1.36	17
benzo[k]fluoranthene	1.05	17	0.70	18	0.18	28	0.13	35	1.18	17
benzo[e]pyrene	3.02	17	2.02	18	0.52	29	0.31	36	2.74	17
benzo[a]pyrene	1.07	18	0.95	19	0.20	43	0.13	64	1.69	18
indeno[1,2,3-cd]pyrene	1.35	17	0.80	19	0.31	30	0.22	40	1.88	16
dibenz[ah]anthracene	0.31	25	0.26	28	<0.08	201	<0.06	201	0.39	22
benzo-[g,h,i]perylene	$2.21i^R$	17	$1.55i^R$	18	$0.49i^R$	33	$0.32i^R$	41	$2.45i^R$	17
anthanthrene	<0.1	201	<0.1	201	<0.1	201	<0.1	201	<0.1	201
dibenzo[a,l]pyrene	0.17	119	<0.1	201	<0.1	201	<0.1	201	0.11	183
dibenzo[a,e]pyrene	0.14	144	<0.1	201	<0.1	201	<0.1	201	0.17	119
dibenzo[a,i]pyrene	0.14	144	0.11	183	<0.1	201	<0.1	201	0.18	112
dibenzo[a,h]pyrene	<0.1	201	<0.1	201	<0.1	201	<0.1	201	<0.1	201
coronene	1.03	25	0.88	28	0.31	66	0.4	52	1.35	22

i=indicative due to interference on confirmatory ion

i^R=indicative due to reference material just out of range

Table 13: Results of reference material analysis. Trace Elements

Units: mg/kg

CRM	RDX	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Cd	Hg	Pb
	Recovery %	128	131	118	100	116	122	105	114	105	107	100
	LoD (0.5 g)	0.1	0.04	0.005	0.1	0.1	0.2	0.08	0.2	0.005	0.01	0.005
DORM 3 Fish protein	Measured	2.5	3.03	0.257	1.7	15.6	50.2	7.09	4.1	0.31	0.42	0.4
	Certified	**1.89**	**~4.6**	**none**	**1.28**	**15.5**	**51.3**	**6.88**	**~3.3**	**0.29**	**0.409**	**0.395**
ERM 278 Mussel tissue	Measured	0.9	7.78	0.36	0.9	9.6	89.8	7.05	2.1	0.36	0.21	1.92
	Certified	**0.78**	**7.69**	**none**	**none**	**9.45**	**83.1**	**6.07**	**1.84**	**0.35**	**0.20**	**2.00**

CRM	RIF	Ag
	Recovery %	100
	LoD (0.5 g)	0.01
DOLT-2 Dogfish liver	Measured	0.46
	Certified	**0.608**
NIST 1566a Oyster tissue	Measured	1.34
	Certified	**1.68**

CRM	RIL	Cr	Mn	Co	Cu	Zn	As	Se	Cd	Hg
	Recovery %	87	91	88	93	113	98	103	109	111
	LoD (0.5 g)	0.1	0.04	0.005	0.1	0.2	0.08	0.2	0.005	0.01
BCR 60 Aquatic plant	Measured	33	1481	4.42	52.0	310	6.88	0.7	2.13	0.39
	Certified	**26**	**1759**	**4.00**	**51.2**	**313**	**8.00**	**0.7**	**2.20**	**0.34**
ERM 278 Mussel tissue	Measured	1.1	8.09	0.35	9.3	86.2	6.67	1.8	0.35	0.23
	Certified	**0.78**	**7.69**	**none**	**9.45**	**83.1**	**6.07**	**1.84**	**0.35**	**0.20**

Methyl –Mercury proficiency testing

FAPAS Round	2008 - 0797	No. of satisfactory participants	2009 - 07115	No. of satisfactory participants
	Canned fish		Canned fish	
Total Hg	150	63	558	60
Methyl-Hg	136	18	487	14
% Me-Hg	91		87	

Table 13 (cont'd): Results of reference material analysis. Phthalates

CSL LIMS sample number	Spike level	Average homogeneity determination	Analysis 1	Analysis 2	Analysis 3	Analysis 4	Analysis 5
Dimethyl phthalate	330	320	366	297	326	351	356
Diethyl phthalate	264	253	292	251	267	278	288
Diisopropyl phthalate	263	248	289	275	235	284	275
Diallyl phthalate	250	237	256	264	235	273	274
Diisobutyl phthalate	292	283	279	261	262	287	338
Di-n-butyl phthalate	241	232	243	219	235	246	279
Di-n-pentyl phthalate	253	272	277	236	238	288	289
Di-n-hexyl phthalate	276	285	284	270	256	302	298
Benzyl butyl phthalate	267	278	277	241	239	239	273
Dicyclohexyl phthalate	256	253	290	281	249	279	285
Di-(2-ethylhexyl) phthalate	272	353	265	246	296	295	243
Di-n-heptyl phthalate	247	268	260	236	229	245	288
Di-n-octyl phthalate	238	318	222	259	226	265	275
Diisononyl phthalate	5037	6308	5790	5062	5288	4808	5874
Diisodecyl phthalate	4987	6050	5166	5208	4881	4720	5503
Di-n-decyl phthalate	270	360	299	278	315	322	256

Table 13 (cont'd): Results of reference material analysis. PAHs and PCBs

CRM458
PAHs in Coconut Oil

Compound	Certified Value(µg/kg)	Uncertainty (µg/kg)	Range (µg/kg)	Batch Reference
				px6953
Pyrene	9.40	1.5	7.9 - 10.9	9.3
Chrysene	4.90	0.4	4.5 - 5.3	4.8
Benzo[k]fluoranthene	1.87	0.18	1.69 - 2.05	1.87
Benzo[a]pyrene	0.93	0.09	0.84 - 1.02	0.93
Indeno[1,2,3-cd]pyrene	1.00	0.07	0.93 - 1.07	0.96
Benzo[ghi]perylene	0.97	0.07	0.90 - 1.04	1.08i^R

i^R=indicative due to reference material just out of range

CRM 350 - PCBs

Certified PCB content of CRM350					**Results of replicate (batch) analysis**				
Concentration, µg/kg oil									
Analyte	**Assigned**	**Uncertainty**	**Range**		**18815**	**18954**	**18979**	**19011**	**18999**
PCB 28	*22.5*	*4*	*18.5-26.5*		*18.5*	*16.4*	*20.1*	*18.2*	*17.8*
PCB 52	62	9	53-71		57	71	69	64	65
PCB 101	164	9	155-173		165	166	173	163	164
PCB 118	142	20	122-162		129	128	133	126	133
PCB 138	*274*	*27*	*247-301*		*324*	*328*	*344*	*317*	*328*
PCB 153	317	20	297-337		320	320	330	312	315
PCB 180	73	13	60-86		62	62	65	60	63

Italics – uncertified values

Table 13 (cont'd): Results of reference material analysis - Dioxins

Certified PCDD/F content of RM534 Concentration, ng/kg powder				
Analyte	**Assigned**	**Uncertainty**	**Acceptable Range**	**Measured Value**
				18966
2,3,7,8-TCDD	0.65	0.13	0.52 - 0.78	0.61
1,2,3,7,8-PeCDD	1.44	0.30	1.14 - 1.74	1.43
1,2,3,4,7,8-HxCDD	0.80	0.16	0.64 - 0.96	0.71
1,2,3,6,7,8-HxCDD	1.92	0.39	1.53 - 2.31	1.89
1,2,3,7,8,9-HxCDD	0.80	0.16	0.64 - 0.96	0.74
1,2,3,4,6,7,8-HpCDD	*0.7*			*0.43*
OCDD	*1.0 to 2.0*			*1.02*
2,3,7,8-TCDF	0.65	0.13	0.52 - 0.78	0.58
1,2,3,7,8-PeCDF	0.15	0.15	0.00 - 0.30	0.08
2,3,4,7,8-PeCDF	3.16	0.64	2.52 - 3.80	3.06
1,2,3,4,7,8-HxCDF	1.75	0.35	1.40 - 2.10	1.68
1,2,3,6,7,8-HxCDF	1.55	0.31	1.24 - 1.86	1.62
1,2,3,7,8,9-HxCDF	*<0.05*			*0.05*
2,3,4,6,7,8-HxCDF	1.90	0.38	1.52 - 2.28	2.11
1,2,3,4,6,7,8-HpCDF	*0.15 to 0.30*			*0.16*
1,2,3,4,7,8,9-HpCDF	*0.02 to 0.05*			*0.02*
OCDF	no value			*0.03*

Indicative values (not certified)

Table 14: Summary of contaminant concentrations (upper bound whole weight basis)

Principal contaminants: Summary of concentrations

Marine Fish	PCDD/F WHO-TEQ	PCB WHO-TEQ	PCDD/F & PCB WHO-TEQ ng/kg	PBDD/F TEQ	Σ PCNs	Σ ICES-6PCBs µg/kg
Min	0.01	0.01	0.02	0.01	0.30	0.08
Median	0.05	0.04	0.10	0.01	1.30	0.45
Mean	0.10	0.24	0.34	0.01	7.64	4.43
Max	0.78	1.88	2.19	0.04	63	44
	Σ PBDEs µg/kg	**Deca-BDE µg/kg**	**As mg/kg**	**Cd mg/kg**	**Hg mg/kg**	**Pb mg/kg**
Min	0.02	0.01	0.48	<0.003	0.03	<0.005
Median	0.08	0.01	9.08	0.004	0.22	0.005
Mean	0.74	0.02	13.60	0.009	0.25	0.005
Max	7.78	0.09	79.18	0.059	0.75	0.009

Freshwater Fish	PCDD/F WHO-TEQ	PCB WHO-TEQ	PCDD/F & PCB WHO-TEQ ng/kg	PBDD/F TEQ	Σ PCNs	Σ ICES-6PCBs µg/kg
Min	0.01	0.06	0.07	0.01	2.49	1.58
Median	0.15	0.54	0.77	0.02	9.22	7.45
Mean	0.20	0.92	1.12	0.03	22.1	14.70
Max	0.59	3.2	3.5	0.06	103	51
	Σ PBDEs µg/kg	**Deca-BDE µg/kg**	**As mg/kg**	**Cd mg/kg**	**Hg mg/kg**	**Pb mg/kg**
Min	0.94	0.01	<0.04	<0.003	0.03	<0.005
Median	2.79	0.04	0.08	0.003	0.07	0.010
Mean	8.78	0.05	0.18	0.009	0.10	0.016
Max	57	0.15	1.25	0.039	0.45	0.084

Shellfish	PCDD/F WHO-TEQ	PCB WHO-TEQ	PCDD/F & PCB WHO-TEQ ng/kg	PBDD/F TEQ	Σ PCNs	B(a)Pyrene µg/kg
Min	0.03	0.02	0.06	0.01	0.84	0.13
Median	0.09	0.06	0.17	0.01	1.62	0.95
Mean	0.08	0.06	0.14	0.013	2.54	0.81
Max	0.12	0.12	0.24	0.02	6.45	1.69
	Σ PBDEs µg/kg	**Deca-BDE µg/kg**	**As mg/kg**	**Cd mg/kg**	**Hg mg/kg**	**Pb mg/kg**
Min	0.12	0.06	1.08	0.10	0.03	0.24
Median	0.27	0.12	1.19	0.12	0.03	0.45
Mean	0.48	0.26	1.78	0.13	0.03	0.63
Max	0.97	0.76	3.53	0.22	0.05	1.55

Regulated Maximum Limits	PCDD/F WHO-TEQ	PCDD/F & PCB WHO-TEQ	B(a)Pyrene	Cd	Hg	Pb
Fish	4.0 ng/kg	8.0 ng/kg	-	0.05 mg/kg	0.5 mg/kg	0.3 mg/kg
Shellfish (mussels)	-	-	10 µg/kg	1.0 mg/kg	-	1.5 mg/kg

Table 15:Ranking of full set of samples by occurrence levels of Organic contaminants.
(Darker shades indicate higher rank/concentrations)

SHELLFISH (mussels)	Mussels - Inverness FG	39
	Mussels- Inverness Nigg Bay	36
	Mussels - Blackness	29
	Mussels-Stannergate,	27
	Mussels- Ardmore	21
MARINE FISH	Lesser Spotted Dogfish,	49
	Haddock	52
	Monkfish,	53
	Greater Forkbeard,	51
	Monk fish	50
	Ling	44
	Cod	48
	Round Nose Grenadier,	46
	Blue Ling,	42
	Skate,	47
	Torsk	41
	Cuckoo Ray,	45
	Ling,	43
	Black-Mouthed Dogfish,	32
	Cuckoo Ray	40
	Torsk,	37
	Smooth Hound,	31
	Spotted Ray,	35
	Starry Smooth Hound,	33
	Skate,	38
	Thornback Ray,	34
	Horse Mackerel,	28
	Hake	26
	John Dory,	23
	Hake,	24
	Mackerel	18
	Hake	22
	Black Scabbard	20
	Spurdog,	7
	Spurdog,	9
	Herring	5
	Spurdog,	2
FRESHWATER FISH	Trout, Lochhar W	30
	Trout, Water of Girvan,	25
	Trout, Clyde,	19
	Trout, Kirtle Water	17
	Eel, Lochar Water	15
	Trout, R Eden,	11
	Pike, Forth-Clyde canal	14
	Pike, L Achray,	16
	Trout - White Cart Water	12
	Roach, Forth-Clyde canal	13
	Perch, Forth-Clyde canal	10
	Eel - R Eden	3
	Eel, Kirtle Water	8
	Roach, Forth-Clyde canal	6
	Eel, R Leven,	1
	Roach, Forth-Clyde canal	4

Annexe 1

Marine Scotland Report

Not to be quoted without prior reference to the authors

Marine Scotland Science Internal Report No 01/10

INVESTIGATION INTO THE LEVELS OF ENVIRONMENTAL CONTAMINANTS IN SCOTTISH MARINE AND FRESHWATER FIN FISH AND SHELLFISH. CONTRACT (S14041) FOR THE FOOD STANDARDS AGENCY SCOTLAND. PHASE I - RISK RANKING AND SAMPLE COLLECTION.

C. D. Robinson

April 2009

Marine Scotland - Science
Marine Laboratory
375 Victoria Road
Aberdeen
AB11 9DB

INVESTIGATION INTO THE LEVELS OF ENVIRONMENTAL CONTAMINANTS IN SCOTTISH MARINE AND FRESHWATER FIN FISH AND SHELLFISH. CONTRACT (S14041) FOR THE FOOD STANDARDS AGENCY SCOTLAND. PHASE I - RISK RANKING AND SAMPLE COLLECTION

Craig D. Robinson

Marine Scotland - Science[1], Marine Laboratory,
375 Victoria Road, Aberdeen, AB11 9DB

INTRODUCTION

Background

This report is for the Food Standards Agency Scotland (FSAS), in partial fulfilment of Phase I of contract S14041. This contract (FRS Project C356) was awarded to Fisheries Research Services (FRS, now part of Marine Scotland[1]) for an investigation into the concentrations of contaminants in Scottish marine and freshwater fish and shellfish. Phase I of the project comprised a risk ranking exercise to identify potential sampling locations and species, and the collection of samples for chemical contaminant determinations by the Food and Environment Research Agency (FERA, formerly the Central Science Laboratory) during Phase II. The risk ranking exercise was applied to both freshwater and marine fin and shell fisheries that may be at highest risk of contaminant exposure, and to identify existing or potential fisheries in those areas (including deep sea and other long-lived or high-trophic level species). After presenting the results of the risk ranking exercise and reaching agreement with FSAS, Marine Scotland/FRS were to supply the agreed samples to FERA for analysis, thereby completing Phase I of the contract. The potential range of contaminants to be studied included chlorinated and brominated dioxins and furans (PCDD/PCDFs & PBDD/PBDFs), chlorinated and brominated biphenyls (CBs & BBs), perfluorinated chemicals (PFCs, e.g. perfluorooctanoic acid (PFOA), perfluorooctane sulphonate (PFOS) and perfluorononanoic acid (PFNA)), polybrominated diphenyl ethers (PBDEs), phthalates, and trace elements. The actual list of contaminants and the numbers of samples to be analysed for each in Phase II was separately negotiated between FSAS and FERA.

Marine and river sediments are recognised sinks for a range of environmental pollutants. Fish and species that live in the sediment or filter particles from the water, used for human food, are susceptible to bio-accumulation of these pollutants. Consequently, marine fish and shellfish have been shown to make a significant contribution to human exposure of some contaminants including dioxins, dioxin-like contaminants (e.g. Dougherty *et al.*, 2000; Domingo and Bocio, 2007; Usydus *et al.*, 2009), brominated flame retardants (Miyake *et al.*, 2008) and metals such as Cd, Pb and Hg, particularly methyl-Hg (e.g. Chen *et al.*, 2008; Usydus *et al.*, 2009). There have been a number of reports of elevated contaminant concentrations in freshwater species including trout, roach, pike, carp and perch (e.g. Giesy *et al.*, 1994; Braune *et al.*, 1999; Kosatsky *et al.*, 2000; Schmitt *et al.*, 2005; Hinck *et al.*, 2006). Within the UK however, it is unclear as to what extent these potential foods contribute to human exposure to persistent organic pollutants (POPs), due to a lack of current knowledge on contaminant concentrations for the various species and the extent to which these species

[1]As of 1st April 2009 Fisheries Research Services (FRS) became part of Marine Scotland, a Directorate within the Scottish Government DG Environment

are consumed by anglers and other members of the public. To help to reduce that uncertainty, the Food Standards Agency UK (FSA) commissioned a report to

identify where unmanaged freshwater fisheries may be occurring at locations in the UK with relatively high pollutant pressure (ADAS, 2007). That report used a Geographical Information Systems (GIS)-based approach to estimate inputs of pollutants from roads, urban areas, agriculture and consented discharges to UK inland waterways and relate that to known species distribution patterns. From this, a number of sites were identified from which to collect fish samples for contaminant analysis in order to address the concerns of the FSA. However, the earlier report did not identify a number of Scottish locations that were anecdotally believed by the FSAS to be under high pollutant pressure and therefore FSAS commissioned the current work. The aim of this project was not to duplicate the existing FSA-funded work (ADAS, 2007), but to build upon it by using environmental monitoring data held by the Scottish Environment Protection Agency (SEPA) that was not available to the authors of the earlier report. SEPA were represented on the project board for this contract and agreed to make such data available for this study. Due to a paucity of recent information on contaminant concentrations in some marine fish and shellfish species, the FSAS research call included a requirement for a risk ranking exercise of such species and the collection of recommended species for contaminant analysis. FSAS indicated that they expected to analyse approximately 100 samples, of which they envisaged approximately 20% being marine fish and 5% shellfish.

Regulatory Environment

In order to protect consumers, the European Commission introduced and amended Regulation (EC) 466/2001 to specify Maximum Permitted Concentrations (MPCs) of environmental contaminants in food (EC, 2001, 2002, 2005a, 2006a). Furthermore, a research recommendation (EC, 2005b) required that the concentrations of a further 15 PAH compounds are determined, in addition to benzo[*a*]pyrene (B[*a*]P). These regulations have since been replaced by Regulation EC/1886/2006 (EC, 2006b) and updated by regulation EC/629/2008 (EC, 2008). Table 1 summarises the maximum permitted concentrations of lead, cadmium, mercury, B[*a*]P, chlorinated dioxins, chlorinated furans and dioxin-like chlorinated biphenyls (CBs), with respect to the edible portions of fish and shellfish.

The Water Framework Directive (2000/60/EC; WFD) is the main driver for the regulation of the environmental quality of groundwaters, inland, transitional, and coastal waters. Under the WFD, SEPA have responsibility for establishing, monitoring and improving the environmental status of the Scotland River Basin District. They also act as the lead agency for the Solway-Tweed River Basin District (in partnership with the Environment Agency of England and Wales). Environmental status is dependant upon several factors, including the quality of components of the faunal and floral communities, contaminant concentrations, abstraction and flow regulation, changes to morphology, the presence of alien species. Over 2300 water bodies are defined within the Scotland river basin district, including >20,000 km of rivers and 309 lochs (SEPA, 2007a); there are 646 water bodies in the Solway-Tweed river basin district, including 21 lochs/lakes (SEPA, 2008a). Since this project started, SEPA have published the environmental status classification of these water bodies (SEPA, 2008b, 2008c).

The OSPAR Convention on the Protection of the North East Atlantic (www.ospar.org) and the European Marine Strategy Framework Directive (2008/56/EC; MSFD) are the main drivers for the regulation and assessment of the quality of the marine environment. The UK

Marine Monitoring and Assessment Strategy (UKMMAS; Defra, 2007) coordinates the UK's monitoring activities in support of these and the Competent Monitoring Authority for offshore Scottish waters is FRS (Marine Scotland since 1st April 2009). Major activities under UKMMAS are to produce a UK State of the Seas report in 2010 that will feed into the OSPAR 2010 Quality Status Reports and the initial assessment required by 2012 under the MSFD. Unlike the WFD, the MSFD and OSPAR both require data on contaminant

concentrations in biota (including fish and shellfish) to be included as part of the assessments of environmental status.

From the above, it can be seen that data from environmental monitoring programs may be useful in helping to identify locations where harvested fish and shellfish may contain the highest concentrations of contaminants, and thus assist in targeting chemical food safety monitoring. In turn, data from food safety monitoring can be used to inform upon the quality of aquatic environments.

MARINE FISH AND SHELLFISH

The FSAS research call indicated a requirement for new contaminant data to be obtained for species including:

"Fin fish and shellfish from marine and fresh water habitats in Scotland where there is a high risk of heavy metal or organic contamination as a result of industrial activities, discharges of sewage or geographical location."

and

"Species of deep sea fish caught from Scottish fishing grounds, which due to their longevity, predatory diet and exposure to historical marine pollution may have bioaccumulated environmental contaminants. These species should not have been included in previous FSA surveys."

In addition to these requirements, FSAS indicated at the project start-up meeting that the study should also consider species, other than those from the deep sea, that may have higher body burdens of POPs due to their longevity, oily flesh and/or high trophic level, and for which little contaminant data were currently available to them.

Marine Fish

The competent monitoring authorities for monitoring environmental concentrations of contaminants in Scottish marine habitats are Marine Scotland and the Scottish Environment Protection Agency (SEPA). Such monitoring is undertaken in order to meet UK obligations under EC Directives (e.g. the Shellfish Growing Waters Directive, the Water Framework Directive) and international agreements such as the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). Data from these monitoring programmes can highlight areas of the marine environment where contaminant concentrations are higher than the expected background, for example due to anthropogenic inputs. The OSPAR Quality Status Report (OSPAR, 2000; QSR2000) indicated that the major source of contaminants to the marine environment is discharge from land-based sources, with the highest contaminant concentrations being found close to industrialised estuaries and river mouths, with lower concentrations offshore. Of relevance to this study was the recognition that in Scotland the areas with highest contaminant concentrations were the firths and estuaries of the Clyde, Forth and Tay. However, as the fish species included in the QSR2000 surveys (dab, plaice, lemon sole) are not of high trophic level or great longevity, these data do not negate the requirement of the current study to examine species from outwith such estuaries and that are predatory and long-lived.

A further potential source of contaminants is the offshore oil and gas industry. The biological effects of contaminants on marine pelagic ecosystems (BECPELAG) associated with the offshore industry were intensively studied by Hylland *et al.* (2006). The findings indicated that concentrations of Cd, Hg, Pb and CBs in caged mussels deployed along a transect were not related to distance from the oilfield, and were 10- to 100-times lower than

the maximums stipulated in the EC food safety Regulations discussed above (except Cd, for which concentrations were 0.49 -1.09 mg/kg and the MPC is 1.0 mg/kg). Similarly, concentrations of Cd, Hg, Pb in caged or feral fish were also 10- to 100-times lower than these limits, and unrelated to distance from the oil field. In mussels, concentrations of PAHs (particularly of the lighter naphthalenes) caged at 500 m from the oil platform were elevated compared to those stationed ≥2 km from the platform. However, the highest concentration of B[*a*]P in mussels was <0.6 μg/kg (compared to the limit in 208/2005/EC of 2 μg/kg in fish and 10 μg/kg in bivalves) and the concentrations of the more toxic, heavier, PAHs were higher in mussels caged in inshore waters of the German Bight than close to the oil platform. Recently, Hylland *et al.* (2008) confirmed that concentrations of organic contaminants in mussels and cod caged near oil fields were "low compared to levels found in many coastal areas", and that contaminants from the studied oil fields "did not cause serious environmental impacts, even though components were detected in mussels and some biological responses were observed". Finally, Webster *et al.* (2003) and Russell *et al.* (2005, 2008) have demonstrated that PAH concentrations in offshore sediments within the UK sector of the North Sea are low in relation to OSPAR BACs and nearshore sediment concentrations. It appears unlikely, therefore, that the offshore oil industry poses a significant health risk to humans through consumption of fish and fishery products, and that fish specifically sourced from such areas are of low priority for this project.

For the purpose of this report "deep sea" fish species are those found below 400 m water depth. In UK waters, this includes an area of the North East Atlantic to the west of Scotland and around Rockall. Fish of the deep sea include bathypelagic and bathydemersal species from the continental slope, demersal species of the shelf edge, and some species which can additionally be found in shallower waters such as the North Sea. From the human dietary point of view, potential deep sea species for this study include blue ling (*Molva dypterygia)*, blue whiting (*Micromesistius poutassou*), halibut (*Hippoglossus hippoglossus)*, Greenland halibut (*Reinhardtius hippoglossoides)*, monk/anglerfish (*Lophius piscatorius*), orange roughy (*Hoplostethus atlanticus)*, roundnose grenadier (*Coryphaenoides rupestris)*, and black scabbard fish (*Aphanopus carbo)*. Additionally, cod (*Gadus morhua*), hake (*Merluccius merluccius*), horse mackerel (*Trachurus trachurus*), mackerel (*Scomber scombrus*), Atlantic salmon (*Salmo salar*), torsk (*Brosme brosme)*, sharks/dogfish, and rays/skates are examples of marine fish which have a high trophic level, and/or have oily flesh, and/or are relatively long lived, and thus come under the expanded remit following the start-up meeting.

These species are of commercial interest to Scottish fisheries, either as target species (e.g. monk/angler fish, cod, blue whiting) or as bycatch from other fisheries. Landings by Scottish vessels of selected fish are listed in Table 2, according to their catch location (ICES sea areas IVa (Northern North Sea), IVb (Central North Sea), VIa (West Scotland) and VIb (Rockall); see Figure 1).

Existing data on contaminants in marine fish

In 2004, the FSA conducted an extensive survey of contaminants (including chlorinated and brominated dioxins and biphenyls, and arsenic) in over 20 fish species available to the British consumer (FSA, 2005, 2006a,b,c,d). Previous surveys of food species have obtained data on Hg (FSA, 2003) and trace metals in fish (MAFF, 1998). The species and analytes included in these surveys are summarised in Table 3.

Marine Scotland holds data on contaminants (trace elements, CBs) from deep sea fish surveys (1998-2001), and historic data (up to 1999) on trace metals in commercial fish species landed in Scotland. More recent Marine Scotland trace element, CB, and PAH data for marine fish is mostly limited to plaice (*Pleuronectes platessa*), dab (*Limanda limanda*) and lemon sole (*Microstomus kitt*), as these are the species used in routine environmental monitoring programmes. However, these species are of relatively low trophic level (<3.5) and these data have not been examined in this project. A research project is in progress at Marine Scotland to determine PAH, CB, and PBDE concentrations in deep sea fish species, but these data were not available at the time this study was being undertaken. The available data are not necessarily from muscle tissue (e.g. the CB and PAH data are for liver tissue), or may not cover the complete suite of compounds now required for food safety testing. Data published by Marine Scotland/FRS includes Brown and Balls (1997), Cronin *et al.* (1998), and Mormede and Davies (2001a,b,c; 2003). As examples, the mean concentrations of Hg in monk/anglerfish flesh from Scottish waters (1980-2001) are shown in Figure 2, and CB concentrations in roundnose grenadier (1998-2001) in Figure 3.

Mean concentrations of As, Cd, Hg, and Pb in fish flesh and of CBs in fish liver held on Marine Scotland databases are shown in Table 4, along with the percentage of samples for each species exceeding the maximum permitted concentrations (MPCs) under Regulation 466/2001/EC (as amended). Only for Hg in halibut and Cd in argentines did the mean contaminant concentration for the species exceed the MPC (as detailed in Table 1). One of only four lesser argentines had a Cd concentration that exceeded the MPC, and this pushed the average concentration over the MPC. For individual fish, Cd values infrequently (<5%) exceeded the MPC (see Table 1) in monk/anglerfish, black scabbard fish, blue whiting, hake, and roundnose grenadier. Hg exceeded the MPC regularly in individual sharks (43%), ling (28%) and dogfish (14%); whilst it infrequently (<5%) exceeded the MPC in monk/anglerfish, blue ling, blue whiting, hake, horse mackerel, mackerel, skate and torsk. The Pb MPC (Table 1) was regularly exceeded in individual blue whiting (36%) and dogfish (25%), occasionally exceeded in orange roughy (9%), and infrequently exceeded in black scabbard fish (4%).

Species selection criteria for marine fish

Marine species to be considered for the ranking exercise were initially chosen based upon habitat (with preference given to deep sea species, even if they did not meet both of the other criteria), trophic level (≥3.9), and potential longevity (≥30 years). Maximum recorded age and trophic level (based upon stomach contents) were obtained from Froese and Pauly (2007). Eighteen species were taken forward for risk ranking (black scabbard fish, blue ling, blue whiting, dogfish spp., greater and lesser argentines, greater forkbeard, Greenland halibut, hake, halibut, horse mackerel, ling, monk/anglerfish, orange roughy, roundnose grenadier, shark spp., rays/skates, torsk and turbot), and seven risk factors identified (potential longevity, trophic level, landings by Scottish vessels, Marine Scotland data on CB concentrations, and the percentage of samples in the Marine Scotland database that exceeded the EC MPC for Cd, Hg, or Pb). The fish species were then ranked (1, 2, 3 …*n*) for each risk factor (i.e. by order of greatest potential longevity, highest trophic level, greatest frequency of exceeding the MPC, and highest CB concentration), and finally according to the number of the risk factors for which they ranked higher (1= highest rank) than the median rank (Table 5).

Marine fish recommended for sampling

Following the risk ranking of the marine species (Table 5), further consideration was given as to whether or not certain species should be included in the study. FSAS already hold recent contaminant data (FSA, 2006 a,b) for hake, halibut, Greenland halibut, mackerel, dogfish and shark, and as there were no Scottish landings of orange roughy and argentines, it was recommended that these species were not sampled, even though they may have ranked highly in terms of the risk assessment. As blue whiting is not eaten fresh, but is processed into fishmeal and oil, this species was not recommended for inclusion in the

contaminant study. Nine remaining species (blue ling, monk/anglerfish, black scabbard fish, ling, roundnose grenadier, rays/skate, torsk, horse mackerel, and greater forkbeard) were recommended for contaminant analysis. Where possible, species should be sourced from two sea areas, although this may not always be possible. The following species descriptions and information were obtained from Froese and Pauly (2007).

- Blue ling (*Molva dypterygia*) - this is a demersal species that inhabits depths from 150 to 1000 m. It has a high trophic level (4.13), and although it has a short maximum life-span (<20 years), historic Marine Scotland data indicates that it can have relatively high organic contaminant concentrations (e.g. CBs) compared to the other species.

- Monk/Anglerfish (*Lophius piscatorius*) – this is a bathydemersal species that inhabits depths to 1000 m, it has a high trophic level (4.55) and a maximum life-span that does not exceed 25 years.

- Black scabbard fish (*Aphanopus carbo*) - this is a benthopelagic species that inhabits depths from 200 to 1700 m; it has a high trophic level (4.48) and a long maximum life-span (>30 years).

- Ling (*Molva molva*) – this is a demersal species that inhabits depths from 100 to 1000 m; it has a high trophic level (4.25) and a maximum life-span that does not exceed 25 years. Historic Marine Scotland data indicates that it can accumulate relatively high Hg concentrations compared to other species.

- Roundnose grenadier (*Coryphaenoides rupestris*) - this is a bathypelagic species that inhabits depths from 180 to 2600 m; it has a relatively low trophic level (3.54), but a long maximum life-span of >50 years. Whilst no recent FSA data is available, historic Marine Scotland data indicates that it may accumulate relatively high organic contaminant concentrations (e.g. CBs in liver) compared to the other species.

- Rays / skate. Landings information is not available for separate species of skates and rays. Species landed and consumed include common skate, Norwegian (or black) skate, thornback ray (roker), spotted ray, starry ray, cuckoo ray and undulate ray. Information presented here is for common skate; potential longevity and trophic level for other species are shown in Table 2.

- Skate (*Dipturus batis*) - this is a demersal species that inhabits depths from 100 to 1000 m; it has a moderate trophic level (3.96) and a long maximum life-span (>50 years).

- Torsk (*Brosme brosme*) - this is a demersal species that inhabits depths to 1000 m; it has a moderate trophic level (4.01) but a short maximum life-span (<20 years).

- Horse mackerel (*Trachurus trachurus*) – this is a pelagic species that inhabits depths to 1050 m; it has a moderate trophic level (3.84), and a long potential maximum life-span (<40 years).

- Greater forkbeard (*Phycis blennoides*) - this is a benthopelagic species that inhabits depths to 1050 m. Although it has a relatively low trophic level (3.66) and a short maximum life-span (<20 years), this fish has been included because it is a “deep sea” species for which FSAS do not hold data.

Sample Collection

Marine Scotland collected samples of several of the selected species from two research cruises to the continental shelf edge area (cruise 1307S, September 2007, Fig. 4a and cruise 09/08, July 2008, Fig 4b) and from one cruise to each of the West of Scotland (cruise 0308S, February 2008; Fig. 4c) and the North Sea (cruise 1008S, August 2008; Fig. 4d).

An excess of material was obtained from these cruises and samples were recommended to FSAS for analysis such that they included all of the required species, and included fish from different geographical locations. Where fish were of disparate sizes, larger fish were selected for analysis, as these would be older and would have had longer to accumulate contaminants. Specimens of a number of species of skate / rays were collected, landings data for skate/ray and the trophic level and maximum recorded age for different species are indicated in Table 2. These species may collectively be marketed as “skate”. On the basis of their trophic level and the size of fish caught, the recommended ray species for analysis were skate (trophic level = 3.96, size = ~1.4 kg), cuckoo ray (trophic level = 3.63, size ~1.3 kg) and thornback ray (also known as roker; trophic level = 4.15, size < 1kg).

Following agreement with FSAS, 23 different species of marine fish were dispatched to FERA for analysis: black scabbard, black-mouthed dogfish, blue ling, cod, cuckoo ray, greater forkbeard, haddock, hake, herring, horse mackerel, John Dory, lesser spotted dogfish, ling, mackerel, monk/anglerfish, roundnose grenadier, skate, smoothhound, spotted ray, spurdog, starry smoothhound, thornback ray (or roker), and torsk. Some of these species were not included in the original risk ranking, but were available from the research cruises. They were dispatched to FERA for analysis with the agreement of FSAS as they are either high trophic level (John Dory, cod), and/or have high landings (haddock, herring, cod) and/or are oily fish (herring). Other species (e.g. hake, mackerel and dogfish) were dispatched for analysis, although they were not recommended above, because of the additional collection location information that would derive from the current study compared to earlier work. The locations the samples were collected are shown in Table 6.

Marine Shellfish

In the tender documents and at project meetings, the FSAS indicated that they wanted approximately 5 shellfish samples to be obtained for contaminant analysis and that these should be mussels from uncontrolled fisheries. That is, they should be from areas where contaminant concentrations were likely to be relatively high and that are not designated as shellfisheries under the EC Shellfish Waters Directive (2006/113/EEC). Selection of sample collection sites was based upon known environmental contaminant distributions (PAHs, CBs, OCPs and trace metals) as these were likely to be the areas also contaminated with the additional substances included in this study; additionally, the individual PAHs and CBs required to be determined for environmental monitoring are not the same as those required under EC/1886/2006.

Existing data for marine shellfish

With respect to environmental contaminants, the QSR2000 (OSPAR, 2000), notes that “In general, blue mussel data show elevated concentrations in the vicinity of industrial and densely populated areas”. Within Scotland, data in the QSR indicated that the estuaries of the Forth, Clyde, and Tay tended to be the areas with highest contaminant concentrations. Compared to background, mussels from the Forth had elevated Cd concentrations, whilst the water had elevated Pb and Cu concentrations, and CB and Hg concentrations were elevated in the sediments. Water concentrations of Cu were elevated in the Clyde, as were concentrations of CBs and DDTs in sediment. In the Tay, mussels were found to have elevated Cd concentrations and Cu concentrations were elevated in the water.

SEPA kindly made available to this study recent (2006) data on contaminants in mussels. These data were collated by site, and data from designated Shellfish Waters were disregarded, as described above. Remaining data were from SEPA’s CSEMP and Mussel Watch monitoring schemes, and some investigative studies. Following initial site ranking according to the organic contaminants data (on a dry weight basis), some sites ranked unexpectedly highly (e.g. Ronas Voe and Ura Firth on Shetland for OCPs), due to a relatively high lipid content compared to mussels from other locations (as they are lipophilic, concentrations of organic contaminants are highly correlated to the lipid content). In order to remove any effects due to spatio-temporal variations in mussel lipid content, the organic contaminants data were normalised to lipid content, even though food safety regulations are based upon wet weight concentrations.

For each contaminant or group (PAH, OCP, CB, Cd, Hg, Pb and As), the sites were ranked by contaminant concentration and sites above the 95th percentile were highlighted (Table 7). Combined rankings were produced for “trace metals” (based upon the summed site rankings for Cd, Hg, Pb and As) and for “organics” (based upon the summed site rankings for PAHs, OCPs and CBs).

As expected, the SEPA data for mussels showed the Firth of Forth and the Firth of Clyde to be the areas with the greatest contamination issues, with the Clyde apparently more affected by organic contaminants and the Forth more so by metals. However, other areas ranked highly for particular contaminants, e.g. Longman Point (Inverness) for OCPs, Stannergate (Dundee) and Nigg Bay (Cromarty) for OCPs and CBs, Arbroath ranked highly for Hg and As, and Loch Etive (Highland) for Cd and Pb.

Recommended marine shellfish sampling sites

It was recommended that the sampling strategy for mussels include areas close to industrialised centres, where mussels were expected and known to have relatively high concentrations of some of the contaminants to be include in the current study (whilst data on other contaminants is not available), and other areas further away from the industrialised centres because of the wide geographical extent of data indicating metal concentrations greater than those permitted under EC food safety Directives. As a result, a shortlist of 7 sites was recommended for sample collection; however, FSAS decided that only the five highest ranked sites should be sampled. The seven recommended sites are listed and described below, and the five sites sampled following agreement with FSAS indicated:

Ardmore (approx. NGR NS320780). This is on the north bank of the Clyde, opposite Port Glasgow; ranked highly for OCPs (5/53), CBs (5/55), PAH (7/32) and Pb (8/87), which exceeded the MPC.

> *Alternative site:* ***Port Gasgow (approx NGR NS330740);*** *ranked #2 for PAH concentrations, and #5 for Pb; CB and OCP data were not available. In the industrialised area of Inverclyde and likely to be more highly contaminated with CBs and OCPs than sites further out along the Firth such as Lunderston Bay (top 10 ranked for each organic contaminant, but 73/78 for metals). The site maybe less accessible and less aesthetically pleasing than Ardmore or Lunderston Bay though.*

Blackness (approx NGR NT050800). On the south bank of the Forth, between Grangemouth and the Forth bridges. This site ranked 4^{th} overall for metals (in the top 10 for Hg, Pb and As), and also ranked highly for CBs (6/55) and OCPs (8/53).

> *Alternative site:* ***Port Edgar (approx NGR NT120780);*** *on the south bank of the Forth, almost under the road bridge. Ranked #1 for metals, and highly for PAHs (9/32) and CBs (10/55); OCP data were not available. Site (next to a harbour/marina) is less aesthetically appealing and therefore it maybe less likely for mussels to be consumed from here.*

Stannergate (approx NGR NO430300). On the north bank of the Firth of Tay, between Dundee and Broughty Ferry. Ranked #1 for CBs and OCPs, and 19/32 for PAH; also highly ranked generally for metals (9/87), although Hg was the highest ranked at 14/87; Cd and Pb concentrations exceeded the MPC.

Longman Point (approx NGR NH670470). On the outskirts of Inverness, close to the former Longman landfill site. The site ranked highly for OCPs (2/53) and CBs (9/55), and at 11/87 for Hg; Pb concentrations exceeded the MPC.

Nigg Bay (approx NGR NH790720). On the Cromarty Firth, close to the Nigg Bay oil terminal and fabrication yard. Ranked highly for OCPs (3/53) and CBs (2/55); Pb concentrations exceeded the MPC.

Seamill, Ayrshire (approx NGR NS210440). This site is included as it is on the outer section of the Firth of Clyde, and thus at a distance from the most contaminated areas of the Clyde; this stretch of coast was designated a shellfish growing water under the 1979 Shellfish Growing Waters Directive, but was not classified by FSAS (SEPA, 2004). In 2006, mussels from here ranked 12/53 for OCPs, 18/32 for PAH, 22/55 for CBs and 28/87 for metals, with Pb and Cd concentrations exceeding the MPC. FSAS decided not to sample from this site.

Ythan estuary (approx NGR NK004255). Small estuary in NE Scotland, known to be nutrient impacted due to agricultural inputs; thus, although no OCP data were available from 2006, concentrations might be expected to be higher than from some other sites. Ranked 24/55 sites for CBs, 21/87 for Hg and 33/87 for Pb; Pb exceeded the MPC. FSAS decided not to sample from this site.

FRESHWATER FISH

Species Selection

The remit for this project was that the FSAS were interested in uncontrolled fisheries of species for which they do not hold any contaminants information, thus farmed and wild salmon, rainbow, brown and sea trout were not required for this study. This remit was of particular relevance to species which may not have been traditionally eaten by the population of Scotland, but that may be eaten by members of recent immigrant populations. Scottish freshwater fish species were checked against the FishBase website (Froese and Pauly, 2007) for evidence that they were at all eaten. Additional anecdotal evidence was provided by Marine Scotland staff of Scottish or of Polish background to confirm the FishBase evidence that certain species were eaten within these communities, and to add species that FishBase did not indicate were eaten. Species which were confirmed as being eaten by either the traditional community or the Polish community were taken forward as potential species for inclusion in the survey (Table 8).

Site Selection

Sampling sites were selected from a preliminary list of candidate sites and geographical areas. Over 90 sites were identified from an internet search to establish where active coarse fisheries are located. The ethos of the coarse fishing sport is catch and release and is often run on stocked waters; waters run by angling organisations or as commercial fisheries were therefore excluded from the list. The list was further reduced by including only sites where at least four of the species of interest were present such that the list comprised 33 sites (Table 9).

Additionally, SEPA kindly provided recent data on the concentrations of organic contaminants (CBs and organochlorine pesticides) in eels caught from 17 sites across Scotland during 2004-2006 (Figure 5), and of phthalates measured in freshwater at 56 locations (2007; Fig. 6). The eel CB and OCP data and the river phthalate concentrations were ranked and sites with greater than the mean and greater than the median concentrations identified (Tables 10 and 11). The five sites with the highest phthalate, highest OCP and highest CB concentrations were added to the list of sites identified above.

Marine Scotland and SEPA have previously worked together to identify sites for a survey of oestrogenic contamination from wastewater treatment works (Robinson *et al.,* 2008). This ranked sewage treatment work discharges to Scottish rivers based upon the dilution factor of sewage effluent into the receiving water (Table 12). This previous work was also used to inform the current study;

Finally, anecdotal evidence suggested four further sites (Kilbirnie Loch in Ayrshire, which is adjacent to a former steelworks; Dreel Burn and Lochgelly Loch/Burn in Fife, and the Spynie canal in Moray) which were all believed to be affected by intensive agriculture.

Sites / Areas Selected for Sampling

Thirty-three coarse fisheries, 10 eel sites, 5 phthalate sites, 6 oestrogenic survey sites, and four sites from anecdotal evidence were identified above. These sites were cross-referenced to produce a list of 54 unique potential sampling sites and an iterative process of reducing this list using available information and expert opinion was then conducted; at the end of this process where several sites were identified within a locality, only one site was included in the final list of sites to be visited.

Many of these sites were small lochs or ponds whose environmental status is not monitored by SEPA, other sites may not support a significant coarse fishery. Sites without evidence for a significant coarse fishery were removed from the list. This information was derived by contacting the local Fisheries Trust, or by reference to NBN species distribution data (Figure 7) and removed two of the oestrogenic sites. Fishing sites not on WFD water bodies monitored by SEPA were removed from the list, unless there was good reason to believe they were under contaminant pressure, such as due to their location in relation to monitored water bodies of unsatisfactory status, or from other available information (e.g. a flooded landfill site, a former clay pit, and a site adjacent to a former steelworks were noted as being fished).

Although the final classification of WFD water body environmental status was not available at that stage of this study, SEPA had produced documents (SEPA 2007a, b) indicating their preliminary assessment of whether WFD water bodies were at risk of failing to meet the WFD classification of “Good Environmental Status”. This categorisation rated water bodies as being “at risk” or “not at risk” of meeting the Directive’s objectives, with subcategories of water bodies “at significant risk (1a)”, “probably at significant risk (1b)”, “probably not at significant risk (2a)”, and “not at significant risk (2b)”. The environmental status of a water body is determined by a number of factors, such as its ecology, whether water abstraction affects its flow, whether its morphology has been altered, and whether alien species are present, as well as its physico-chemical status, e.g. pH, dissolved oxygen, ammonia, and contaminant concentrations. Water bodies not classified as being “at significant risk” were removed from the list.

SEPA were subsequently asked to provide contaminants concentrations for the remaining water bodies. This was made available for a number of sites, and the status of water bodies with respect to whether they failed a WFD standard for contaminants was made available for many of the sites. The information from SEPA was used to further screen the list of candidate locations, by removing any sites that the WFD data did not indicate were contaminated or potentially contaminated. As many sites are not monitored for organic contaminants, and some are not monitored for trace metals, failure for NH_3, or for high P was taken as indicating the site to be at risk of sewage-related contamination, or of agricultural-related contamination respectively.

WFD criteria have not been established to assess the environmental status of artificial water bodies, and therefore it was not known whether any canals or reservoirs failed an environmental standard for contaminant concentrations. Judgement was applied as to the practicality and appropriateness of including these sites. Two sites that were known to support coarse fish but that had been classified by SEPA as “not at risk” of failing the WFD “Good Environmental Status” objective were subsequently discovered to have failed the WFD standard for one or more contaminants and were re-introduced to the list of candidate sites.

At this stage the 39 candidate sites were ranked (high, medium, low hazard) based upon known contaminant pressure and the other available information, and the list compared against the NBN species distributions to assess how many species were present at each site (Table 13). A final list of 25 sites was produced by taking only those “high” ranked sites where at least 3 species were thought to be present, and those “medium” ranked sites were at least 4 species were thought to be present.

Sample Collection

After agreeing the list of potential sampling sites with FSAS, local fisheries trusts and salmon fisheries boards were contacted to establish who the riparian owners were and whether any fisheries were active that could assist with sample collection. Permission was obtained to sample fish from 12 sites including the Water of Girvan, the rivers Almond, Annan, Clyde,

Forth, and Tay, Eglinton Park Loch (Kilwinning), the Lunan Burn/Loch Marlee (nr Blairgowrie), and various sites on the British Waterways canal network. However, riparian owners could not be identified at other sites, did not reply when contacted, or refused permission to sample. Furthermore, it was apparent that significant assistance with sample collection would not be forthcoming from the coarse fishing community, whose members object in principle to killing their quarry. Similarly, the majority of Fisheries Trusts contacted were unable to assist with large-scale sample collection outwith their planned electrofishing programmes. As these were concentrated on headwaters, rather than in the lower parts of catchments, they were generally not suited for obtaining samples for this project. Having identified a difficulty in obtaining sufficient samples of coarse fish, FSAS were approached and it was agreed that the remit of the project would be expanded to include collection of wild brown trout from sites identified in the risk ranking exercise. The rationale was that wild brown trout are known to be eaten in relatively large amounts compared to coarse fish, are abundant, widespread and more frequently fished than coarse fish.

In addition to contacting Fisheries Trusts and angling organisations, scientists within SEPA and Marine Scotland were contacted in order to arrange opportunities for mutual assistance in sampling or provision of samples for this project. As a result of these contacts, SEPA agreed to make available a number of samples from their electrofishing programme and Marine Scotland Fish Health Inspectorate assisted with collecting coarse fish from the Forth and Clyde canal. During the sample collection phase of this study (summer/autumn 2009), bad weather and high river levels severely restricted fishing opportunities. Consequently, we were unable to obtain fish from all of the identified sites. Brown trout were eventually obtained from 6 sites, eels from 4 sites, pike from two sites, and perch and roach from one site. Although permission was obtained to obtain fish from the River Annan and the Annan DSFB were able to assist with fish sampling, no samples were obtained from the River Annan due to it running dangerously high when the Annan DSFB were attempting to obtain fish. However, trout and eels were obtained from two neighbouring rivers that the Annan DSFB suggested as alternatives. These rivers (the Kirtle Water and the Lochar Water) were classified by SEPA (SEPA, 2007b) as being “at risk” of failing to meet the WFD classification of “Good Environmental Status” and as “not likely to achieve good status” by 2015. A large (2.3 kg) adult pike, gifted by SEPA, was accepted for analysis due to its age and predatory nature, although it was obtained from a water body that was classified as “not at risk” of failing the WFD Good Environmental Status assessment. Table 14 lists the freshwater fish samples that were obtained and dispatched to FERA, together with relevant sampling information.

ACKNOWLEDGEMENTS

Marine Scotland would like to thank the Scottish Environment Protection Agency (SEPA) for advice, access to environmental data, and provision of freshwater fish samples; particular thanks go to Danny Frew, Brian Miller, Judy Dobson, Ian Ridgeway, Alistair Duguid, Kenneth MacGregor, and Rebecca Fitton.

Annan District Salmon Fishery Board, British Waterways, Roddy Finnie (bailiff for the Busby (White Cart Improvement) Angling Association) and Carrick Angling Club (Water of Girvan) provided permission and assistance with collection of fish for the freshwater component of the study.

The following Marine Scotland staff also assisted with aspects of the report: Dave Tulett with GIS assistance; Melanie Harding with obtaining marine fish landings data; Barbara Zarod and Lukasz Nowik with advice on Polish fish consumption habits; Ross Gardener and Hilary

Anderson with advice in relation to freshwater fisheries; Francis Neat, Finlay Burns and their colleagues with collecting marine fish species during their *RV Scotia* cruises; Matt Gubbins and Ian Davies with advice on how to approach the project and for checking the report.

REFERENCES

ADAS. 2007. *Environmental contaminants in fish and shellfish from unmanaged inland UK waterways – Identification of high pollutant pressure sites.* Final Report to the Food Standards Agency. June 2007. 32pp.

Braune, B., Muir, D., DeMarch, B., Gamberg, M., Poole, K., Currie, R., Dodd, M., Duschenko, W., Eamer, J., Elkin, B., Evans, M., Grundy, S., Hebert, C., Johnstone, R., Kidd, K., Koenig, B., Lockhart, L., Marshall, H., Reimer, K., Sanderson, J., Shutt, L. 1999. Spatial and temporal trends of contaminants in Canadian Arctic freshwater and terrestrial ecosystems: a review. *Science of the Total Environment*, **230**, 145-207.

Brown, F. M. J., and Balls, P. W. 1997. *Trace metals in fish and shellfish from Scottish waters*. Scottish Office Agriculture, Environment and Fisheries Department, Scottish Fisheries Research Report No. 60/97. 36pp.

Chen, C. Y., Serrell, N., Evers, D. C., Fleishman, B. J., Lambert, K. F., Weiss, J., Mason, R. P., Bank, M. S. 2008. Meeting report: Methylmercury in marine ecosystems--from sources to seafood consumers. *Environmental Health Perspectives*, **116**, 1706-12.

Cronin, M., Davies, I. M., Newton, A., Pirie, J. M., Topping, G., Swan, S. 1998 . Trace metal concentrations in deep sea fish from the North Atlantic. *Marine Environmental Research,* **45**, 225-238.

Domingo, J.L. and Bocio, A. 2007. Levels of PCDD/PCDFs and PCBs in edible marine species and human intake: A literature review. *Environment International,* **33,** 397-405.

Dougherty, C.P., Henricks Holtz, S., Reinert, J.C., Panyacosit, L., Axelrad, D.A., Woodruff, T.J. 2000. Dietary exposures to food contaminants across the United States. *Environmental Research*, **84**, 170-85.

EC. 2001. *COMMISSION DIRECTIVE 2001/22/EC of 8 March 2001laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs.* Official Journal of the European Communities, L 77/14.

EC. 2002. *COMMISSION REGULATION (EC) No 221/2002 of 6 February 2002 amending Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs.* Official Journal of the European Communities, L 37/4.

EC. 2005a. *COMMISSION REGULATION (EC) No 208/2005 of 4 February 2005 amending Regulation (EC) No 466/2001 as regards polycyclic aromatic hydrocarbons.* Official Journal of the European Communities, L 34/3.

EC. 2005b. *COMMISSION RECOMMENDATION of 4 February 2005 on the further investigation into the levels of polycyclic aromatic hydrocarbons in certain foods.* Official Journal of the European Communities, L 34/43.

EC. 2006a. *COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs.* Official Journal of the European Communities, L 364/5.

EC. 2006b. *COMMISSION REGULATION (EC) No 199/2006 of 3 February 2006 amending Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs as regards dioxins and dioxin-like CBs.* Official Journal of the European Communities, L 32/34.

EC. 2008. *COMMISSION REGULATION (EC) No 629/2008 of 2 July 2008 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs.* Official Journal of the European Communities, L 173/6.

FSA. 2003. *Mercury in Imported Fish and Shellfish, UK Farmed Fish and Their Products.* Food Standards Agency Food Survey Information Sheet 40/03. 18pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis40_2003.pdf

FSA. 2005. *Arsenic in Fish and Shellfish.* Food Standards Agency Food Survey Information Sheet 82/05. October 2005. 44pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis8205.pdf

FSA. 2006a. *Dioxins and Dioxin-like CBs in Farmed and Wild Fish and Shellfish.* Food Standards Agency Food Survey Information Sheet 03/06. February 2006. 44pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis0306.pdf

FSA. 2006b. *Brominated Chemicals in Farmed and Wild Fish and Shellfish and Fish Oil Dietary Supplements.* Food Standards Agency Food Survey Information Sheet 04/06. February 2006. 32pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis0406.pdf

FSA. 2006c. *Dioxins and Dioxin-like CBs in Processed Fish and Fish Products.* Food Standards Agency Food Survey Information Sheet 07/06. February 2006. 33pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis0706.pdf

FSA. 2006d. *Survey of Metals and other Elements in Processed Fish and Shellfish.* Food Standards Agency Food Survey Information Sheet 08/06. May 2006. 30pp. Available from http://www.food.gov.uk/multimedia/pdfs/fsis0806.pdf

Froese, R. and Pauly, D. 2007. *FishBase.* World Wide Web electronic publication. www.FishBase.org, version (12/2007).

Marine Scotland, unpublished. *Contaminants database.* Marine Scotland, internal database on contaminant concentrations.

Giesy, J. P., Verbrugge, D. A., Othout, R. A., Bowerman, W. W., Mora, M. A., Jones, P. D., Newsted, J. L., Vandervoort, C., Heaton, S. N., Aulerich, R. J., Bursian, S. J., Ludwig, J. P., Ludwig, M., Dawson, G. A., Tillitt, D. E. 1994. Contaminants in fishes from Great Lakes-influenced sections and above dams of three Michigan rivers. 1: Concentrations of organochlorine insecticides, polychlorinated biphenyls, dioxin equivalents, and mercury. *Archives of Environmental Contamination and Toxicology,* **27,** 202-212.

Hinck, J. O. E., Schmitt C.J., Blazer V.S., Denslow N.D., Bartish T.M., Anderson P.J., Coyle J.J., Dethloff G.M., Tillitt, D.E. 2006. Environmental contaminants and biomarker responses in fish from the Columbia River and its tributaries: Spatial and temporal trends. *Science of the Total Environment,* **366,** 549-578.

Hylland, K., Lang, T., Vethaak, A.D. (Eds.). 2006. *Biological effects of contaminants in marine pelagic ecosystems.* Society of Environmental Toxicology and Chemistry (SETAC): Pensacola, FL (USA). ISBN 1-880611-84-8. xxix, 474 pp.

Hylland, K., Tollefsen, K. E., Ruus, A., Jonsson, G., Sundt, R. C., Sanni, S., Roe Utvik, T. I., Johnsen, S., Nilssen, I., Pinturier, L., Balk, L., Barsiene, J., Marigomez, I., Feist, S. W., Borseth, J. F. 2008. Water column monitoring near oil installations in the North Sea 2001-2004. *Marine Pollution Bulletin,* **56,** 414-429.

Kosatsky, T., Przybysz, R., Armstrong, B. 2000. Mercury exposure in Montrealers who eat St. Lawrence River sportfish. *Environmental Research,* **84,** 36-43.

MAFF (1998). *Concentrations of Metals and Other Elements in Marine Fish and Shellfish*. Food Surveillance Information Sheet 151/98. May 1998. On-line citation, February 2008. Available from http://archive.food.gov.uk/maff/archive/food/infsheet/1998/no151/151fish.htm

MCS. 2008. *Fish to Avoid. 26. Skates and Rays (except mature cuckoo, spotted and starry rays).* Marine Conservation Society. Online citation, April 2008. Available from http://www.fishonline.org/advice/avoid/?item=26

Miyake, Y., Jiang, Q., Yuan, W., Hanari, N., Okazawa, T., Wyrzykowska, B., So, M.K., Lam, P.K.S., Yamashita, N. 2008. Preliminary health risk assessment for polybrominated diphenyl ethers and polybrominated dibenzo-p-dioxins/furans in seafood from Guangzhou and Zhoushan, China. *Marine Pollution Bulletin,* **57,** 357-364.

Mormede, S. and Davies, I.M. 2001a. Heavy metal concentrations in commercial deep-sea fish from the Rockall Trough. *Continental Shelf Research,* **21**, 899-916.

Mormede, S. and Davies, I.M. 2001b. Polychlorobiphenyl and pesticide residues in monkfish Lophius piscatorius and black scabbard Aphanopus carbo from the Rockall Trough. *ICES Journal of Marine Science,* **58**, 725-736.

Mormede, S. and Davies, I.M. 2001c. Trace elements in deep-water fish species from the Rockall Trough. *Fisheries Research,* **51**, 197-206.

Mormede, S. and Davies, I.M. 2003. Horizontal and vertical distribution of organic contaminants in deep-sea fish species. *Chemosphere,* **50**, 563-574.

OSPAR. 2000. *Quality Status Report 2000 for the North-East Atlantic.* Available from www.ospar.org

Robinson, C.D., Robinson, N., Redshaw, J., Davies, I.M. 2008. *Assessment of oestrogenic endocrine disruption in wild Scottish salmon and trout.* Fisheries Research Services Collaborative Report No. 01/08. 20pp.

Russell, M., Webster, L., Walsham, P., Packer, G., Dalgarno, E.J., McIntosh, A.D., Moffat, C.F. 2005. The effects of oil exploration and production in the Fladen Ground: Composition and concentration of hydrocarbons in sediment samples collected during 2001 and their comparison with sediment samples collected in 1989. *Marine Pollution Bulletin,* **50,** 638-651.

Russell, M., Webster, L., Walsham, P., Packer, G., Dalgarno, E.J., McIntosh, A.D., Fryer, R.J., Moffat, C.F. 2008. Composition and concentration of hydrocarbons in sediment samples from the oil producing area of the East Shetland Basin, Scotland. *Journal of Environmental Monitoring,* **10,** 559-569.

Schmitt C.J, Hinck, J. O. E., Blazer V.S., Denslow N.D., Dethloff G.M., Bartish T.M., Coyle J.J., Tillitt, D.E. 2005. Environmental contaminants and biomarker responses in fish from the Rio Grande and its U.S. tributaries: Spatial and temporal trends. *Science of the Total Environment,* **350,** 161-193.

SEPA. 2004. *Designated Shellfish Waters in Scotland Site Data. Area 7: Ayrshire Coast.* Scottish Environment Protection Agency. 4pp. On-line citation, April 2008. Available from http://www.sepa.org.uk/pdf/data/shellfish/7.pdf

SEPA. 2007a. *Significant water management issues in the Scotland river basin district.* Scottish Environment Protection Agency. 159pp. On-line citation, February 2008. Available from http://www.sepa.org.uk/pdf/consultation/current/swmi/swmi_scotland_main.pdf

SEPA. 2007b. *A summary of significant water management issues in the SolwayTweed river basin district.* Scottish Environment Protection Agency / Environment Agency. 159pp. On-line citation, February 2008. Available from: http://www.sepa.org.uk/pdf/consultation/current/swmi/swmi_solway_tweed_main.pdf

SEPA. 2008a. *Draft river basin management plan for the Solway Tweed river basin district.* Scottish Environment Protection Agency / Environment Agency. 66pp. On-line citation, March 2009. Available from: http://www.sepa.org.uk/water/river_basin_planning.aspx

SEPA. 2008b. *Draft river basin management plan for the Solway Tweed river basin district. Annex 2 – Classification.* Scottish Environment Protection Agency / Environment Agency. 18pp. On-line citation, March 2009. Available from: http://www.sepa.org.uk/water/river_basin_planning.aspx

SEPA. 2008c. *Draft river basin management plan for the Scotland river basin district. Annex 2 – Classification.* Scottish Environment Protection Agency / Environment Agency. 19pp. On-line citation, March 2009. Available from: http://www.sepa.org.uk/water/river_basin_planning.aspx

Usydus, Z., Szlinder-Richert, J., Polak-Juszczak, L., Komar, K., Adamczyk, M., Malesa-Ciecwierz, M., Ruczynska, W. 2009. Fish products available in Polish market - assessment of the nutritive value and human exposure to dioxins and other contaminants. *Chemosphere*, **74**, 1420-8.

Van den Berg, M., Birnbaum, L., Bosveld, A. T., Brunstrom, B., Cook, P., Feeley, M., Giesy, J. P., Hanberg, A., Hasegawa, R., Kennedy, S. W., Kubiak, T., Larsen, J. C., van Leeuwen, F. X., Liem, A. K., Nolt, C., Peterson, R. E., Poellinger, L., Safe, S., Schrenk, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F., Zacharewski, T. 1998. Toxic Equivalency Factors (TEFs) for CBs, PCDDs, PCDFs for Humans and for Wildlife. *Environmental Health Perspectives,* **106,** 775-792.

Webster, L., Twigg, M., Megginson, C., Walsham, P., Packer, G., Moffat, C. 2003. Aliphatic Hydrocarbons and Polycyclic Aromatic Hydrocarbons (PAHs) in Sediments Collected From the 110 Mile Hole and Along a Transect From 58 Degrees 58.32 ' N 1 Degrees 10.38 ' W to the Inner Moray Firth, Scotland. *Journal of Environmental Monitoring,* **5,** 395-403.

TABLE 1

European Commission limits on the maximum permitted concentrations of certain environmental contaminants in edible portions of fish and shellfish (whole fish if appropriate) as defined in EC/1881/2006 (this Regulation repeals EC/266/2001, as amended). TEQ = Toxic Equivalent Concentration (summed concentrations of certain planar organic compounds based upon their relative toxicity; see van den Berg *et al.*, 1998).

Compound or element	Maximum permitted concentration (wet weight)	Species to which the limit applies
Pb	0.3 mg/kg	Muscle meat of fish
Pb	0.5 mg/kg	Crustacea (excluding crab brown meat & head / thorax of lobster and similar spp)
Pb	1.0 mg/kg	Cephalopods (without viscera)
Pb	1.5 mg/kg	Bivalve molluscs
Cd	0.05 mg/kg	Muscle meat of fish, with the exceptions indicated below:
Cd	0.1 mg/kg	Anchovy, bonito, common two-banded seabream, eel, grey mullet, horse mackerel or scad (*Trachurus sp.*), louvar or luvar, sardine, sardinops, tuna, wedge sole.
Cd	0.3 mg/kg	Swordfish
Cd	0.5 mg/kg	Crustacea (excluding crab brown meat & head / thorax of lobster and similar spp)
Cd	1.0 mg/kg	Cephalopods (without viscera), bivalve molluscs
Hg	0.5 mg/kg	Muscle meat of fish (with the exceptions indicated below), fishery products, crustacea (excluding crab brown meat & head / thorax of lobster and similar spp)
Hg	1.0 mg/kg	Anglerfish, atlantic catfish, bonito, eel, emperor, orange roughy, rosy soldierfish, grenadier, halibut, marlin, megrim, mullet, pike, plain bonito, poor cod, portuguese dogfish, rays, redfish, sail fish, scabbard fish, seabream, pandora, shark (all species), snake mackerel or butterfish, sturgeon, swordfish, tuna.
B[*a*]P	2.0 µg/kg	Muscle meat of fish (other than smoked fish).
B[*a*]P	5.0 µg/kg	Crustacea and cephalopods (without viscera), other than smoked. Excludes crab brown meat, and head / thorax of lobster and similar spp
B[*a*]P	10.0 µg/kg	Bivalve molluscs
Dioxins & furans	4.0 pg TEQ / g	Muscle meat of fish, crustacea, fishery products, excluding crab brown meat and head / thorax meat of lobster (and similar spp.)
Dioxins, furans & CBs	8.0 pg TEQ / g	Muscle meat of fish (excluding eel), crustacea, fishery products, excluding crab brown meat and head / thorax meat of lobster (and similar spp.)
Dioxins, furans & CBs	12.0 pg TEQ / g	Eel
Dioxins & furans	2.0 pg TEQ / g fat	Marine oils (fish body oil, fish liver oil and oils of other marine organisms intended for human consumption)
Dioxins, furans & CBs	10.0 pg TEQ / g fat	

TABLE 2

Potential longevity, trophic level and 2006 Scottish fishing vessel landings (tonnes) of marine finfish species identified as potentially suitable for inclusion in the contaminant survey. Longevity and trophic level for other species are also indicated for comparison purposes. Landings were from ICES sea areas IVa (Northern North Sea), IVb (Central North Sea), VIa (West of Scotland) and VIb (Rockall). See Figure 1 for a map of the different ICES sea areas. Source: Marine Scotland Fisheries Management database. Maximum age and trophic level from Froese and Pauly (2007). ND = no available data.

Fish Species	Maximum age (yrs)	Trophic level	Landings by ICES SEA AREA (tonnes)				
			IVa	IVb	VIa	VIb	TOTAL
Mackerel	17	3.73	23,765	31.0	119,331	0	143,127.6
Blue whiting	20	3.70	5.5	0	51956	0	51,961.5
Monk/Anglerfish	24	4.55	5589.8	119.8	2215.6	422.3	8,347.5
Ling	25	4.25	1156.2	9.85	1983.8	173.8	3,323.7
Hake	20	4.30	558.9	58.2	2109.6	4.4	2,731.2
Dogfish spp.†	36	3.77	86.1	11.8	608.8	0.7	1,292.1
Blue ling	20	4.13	1.1	0	1130.2	11.3	1,142.6
Skate††	51	3.96	278.6	4.4	809.6	29.9	1,122.5
Torsk	20	4.01	96.2	0.2	275.3	30	401.7
Greater forkbeard	20	3.66	2	0	275.5	11.3	288.8
Halibut	50	4.34	145.2	33.8	30.5	2.8	212.3
Greenland halibut	30	4.09	5.2	0	206.2	0.2	211.6
Horse mackerel	11	3.84	61.4	0	127.9	0	189.4
Black scabbard fish	32	4.48	0	0.8	177.5	0	178.2
Roundnose grenadier	54	3.54	0	0	45.5	0	45.5
Turbot	25	3.96	21.9	3.7	11.1	0	36.7
Orange roughy	149	4.05	0	0	0	0	0
Lesser argentine	16	3.62	ND	ND	ND	ND	ND
Shark spp.†††	43	4.33	ND	ND	ND	ND	ND
Atlantic salmon (wild)	13	3.76					
Dab	12	3.39					
Herring	11	3.29					
Plaice	50	3.23					
Thornback ray / roker	16	4.15					
Spotted ray	14	3.97					
Cuckoo ray	28	3.63					
John Dory	12	4.24					

†Data for "Dogfish spp." = **smooth hound** (no landings data), **spurdog** and **lesser spotted dogfish** (longevity and max. age are averaged)
††Landings data are for skate and rays combined (longevity and max. age data are for skate)
†††Data for "Shark spp." = tope and porbeagle (longevity and max. age are averaged)

TABLE 3

Species and analytes previously included in Food Standards Agency/Ministry of Agriculture Fisheries and Food surveys of contaminants in marine fish. Chlorinated compounds = dibenzo-*p*-dioxins, dibenzofurans and biphenyls; brominated compounds = dioxins, furans, biphenyls, diphenyl ethers, hexabromo-cyclododecanes and tetrabromobisphenol-A; trace metals = aluminium, antimony, arsenic (As), barium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, germanium, gold, iron, lead, lithium, manganese, mercury (Hg), molybdenum, nickel, selenium, strontium, thallium, tin and zinc.

	Chlorinated compounds	Brominated compounds	As	Hg	Trace metals
Wild fish					
Atlantic salmon	Y	Y	Y	Y	
Cod	Y	Y	Y		Y
Coley/saithe	Y	Y	Y		
Dogfish	Y	Y	Y		
Greenland halibut	Y	Y	Y		
Haddock	Y	Y	Y		Y
Hake	Y	Y	Y		
Halibut	Y	Y	Y	Y	
Herring	Y	Y	Y		Y
Lemon sole	Y	Y	Y		
Mackerel	Y	Y	Y		Y
Plaice	Y	Y	Y		Y
Sardines/pilchards	Y	Y	Y		
Sea bass	Y	Y	Y		
Shark	Y	Y	Y		
Sprat	Y	Y	Y		
Swordfish	Y	Y	Y		
Turbot	Y	Y	Y		
Whitebait	Y	Y	Y		
Whiting	Y	Y	Y		Y
Farmed fish					
Atlantic salmon	Y	Y	Y	Y	
Halibut	Y	Y	Y	Y	
Organic salmon	Y	Y	Y		
Sea bass	Y	Y	Y	Y	
Sea bream	Y	Y	Y	Y	
Sea trout	Y	Y	Y		
Turbot	Y	Y	Y		
Year of survey:	2004	2004	2004	1999-2002	1995-1997
Source:	FSA, 2006a	FSA, 2006b	FSA, 2005	FSA, 2003	MAFF, 1998

TABLE 4

Mean As, Cd, Hg, and Pb concentrations (Marine Scotland data; 1980-2000; mg/kg wet weight) in flesh and CB concentrations (1998-2000; µg/kg wet weight) in liver tissue of various fish species from Scottish waters. ANG = monk/anglerfish; BLI = blue ling; BSC = black scabbard fish; BWH = blue whiting; Dogfish spp = smooth hound, spurdog, lesser spotted dog; GAR/LAR = greater & lesser argentines; HAK = hake; HAL = halibut; HMA = horse mackerel; LIN = ling; MAC = mackerel; ORO = orange roughy; RNG = roundnose grenadier; Shark spp = tope, porbeagle; SKA = skate; TOR = torsk; TUR = turbot. *n* = no. of observations; >MPC = percentage of concentrations that exceeded the maximum permitted concentration (466/2001/EC; as amended; see Table 1). ICES-7 CBs = sum of CBs 28, 52, 101, 118, 138, 153 and 180.

Species	As		Cd			Hg			Pb			ICES-7 CBs	
	n	Mean±sd	*n*	Mean±sd	>MPC (%)	*n*	Mean±sd	>MPC (%)	*n*	Mean±sd	>MPC (%)	*n*	Mean±sd
ANG	0		102	0.012±0.008	1.0	844	0.101±0.255	0.2	102	0.025±0.016	0.0	31	124±112
BLI	0		31	0.014±0.002	0.0	55	0.507±0.188	3.6	32	0.048±0.036	0.0	7	461±124
BSC	0		145	0.016±0.011	0.7	91	0.301±0.147	0.0	145	0.033±0.071	4.1	33	57±48
BWH	0		41	0.046±0.181	2.4	53	0.114±0.099	1.9	42	0.109±0.109	36	12	90±112
Dogfish spp	31	15±5.4	57	0.005±0.004	0.0	354	0.281±0.241	14.1	57	0.13±0.136	24.6	0	
GAR / LAR	0		4	0.083±0.093	25.0	81	0.175±0.087	0.0	4	0.063±0.025	0.0	0	
HAK	69	1.3±0.6	86	0.009±0.011	2.3	433	0.052±0.05	0.2	91	0.049±0.039	0.0	0	
HAL	30	5.2±5.1	1	0.09	100.0	199	2.346±0.766	96.5	0			0	
HMA	0		0			136	0.289±0.226	1.5	0			0	
LIN	14	4.9±2.7	20	0.007±0.008	0.0	138	0.339±0.25	27.5	25	0.029±0.021	0.0	0	
MAC	26	3.9±6	25	0.007±0.005	0.0	221	0.087±0.07	0.5	25	0.043±0.015	0.0	0	
ORO	0		32	0.012±0.005	0.0	32	0.27±0.172	0.0	32	0.062±0.13	9.4	7	169±54
RNG	0		142	0.01±0.011	0.7	142	0.062±0.056	0.0	137	0.021±0.011	0.0	44	361±205
Shark spp	20	10.6±3.4	0			51	0.728±0.666	43.1	0			0	
SKA	2	12.5±0.4	29	0.006±0.002	0.0	98	0.215±1.307	1.0	29	0.036±0.017	0.0	0	
TOR	5	9.3±0.6	5	0.005±0	0.0	39	0.192±0.119	2.6	5	0.05±0	0.0	0	
TUR	6	4.9±3.9	6	0.005±0	0.0	34	0.098±0.071	0.0	6	0.043±0.016	0.0	0	

TABLE 5

Risk ranking (1 = highest ranked species) of marine fish species according to each of six risk factors (maximum age, trophic level, landings, and concentrations of Cd, Hg, Pb in flesh tissue, CB in liver), and by frequency of being ranked higher than the median rank for each risk factor (see text). ANG = monk/anglerfish; BLI = blue ling; BSC = black scabbard fish; BWH = blue whiting; Dogfish spp = smooth hound, spurdog, lesser spotted dog; GAR/LAR = greater & lesser argentines; HAK = hake; HAL = halibut; HMA = horse mackerel; LIN = ling; MAC = mackerel; ORO = orange roughy; RNG = roundnose grenadier; Shark spp = tope, porbeagle; SKA = skate; TOR = torsk; TUR = turbot.

Species	Species Ranking by Risk Factor							Frequency of ranking in top 50% of species	Overall Risk Rank
	Max age	Trophic level	Landings	Cd	Hg	Pb	CB		
BLI	14	7	7	8	5	6	1	5	1
ANG	11	1	3	5	11	5	4	4	2
BSC	7	2	14	7	13	4	6	4	2
BWH	12	16	2	3	7	1	5	4	2
DOG	6	14	6	9	4	2		4	2
HAK	4	3	5	4	12	8		4	2
LIN	9	6	4	10	3	9		4	2
ORO	1	9	17	12	15	3	3	4	2
RNG	2	19	15	6	16	11	2	3	3
Shark spp	5	4			2			3	3
GAR / LAR	16	17		2	14	7		2	4
GFO	8	8	10					2	4
HAL	19	13	11	1	1			2	4
SKA / rays	3	11	8	13	9	12		2	4
GHA	13	5	12					1	5
HMA	18	18	13		8			1	5
MAC	17	15	1	11	10	10		1	5
TOR	15	10	9	14	6	13		1	5
TUR	10	12	16	15	17	14		0	6
Median rank	10	10	9	8	9	7.5	3.5		

TABLE 6

Approximate locations from where marine fish species were obtained.

Species	Risk ranking	Location(s) caught (ICES stat square and depth, if known)	Sample ID: C356 /
Blackscabbard fish	2	NE Atlantic (435; 1000 m)	012
Black-mouthed dogfish	2	NE Atlantic (451, 452; 150-200 m)	010
Blue Ling	1	NE Atlantic (432; 130 m)	017
Cod	*	North Sea	026
Cuckoo ray	4	NE Atlantic (430, 463, 471; 115-150 m) North Sea	009 031
Greater forkbeard	4	NE Atlantic (421; 510 m)	018
Haddock	*	North Sea	020
Hake	2	NE Atlantic (470; 400 m) NE Atlantic (421; 510 m) North Sea	007 030 022
Herring	*	North Sea	023
Horse mackerel	5	North Sea	021
John Dory	*	NE Atlantic and North Sea	019
Lesser spotted dogfish	2	NE Atlantic (458, 465; 115-135 m)	011
Ling	2	NE Atlantic (470; 400 m) North Sea	014 025
Mackerel	5	North Sea	024
Monk/angerfish	2	NE Atlantic (435; 580 m) North Sea	016 032
Round nose grenadier	3	NE Atlantic (435; 1000 m)	015
Skate	4	NE Atlantic (452, 472; 95-150 m) North Sea	006 028
Smoothhound	2	NE Atlantic (456; 180 m)	003
Spotted ray	4	NE Atlantic (432, 457, 471; 115-160 m)	008
Spurdog	2	NE Atlantic (416; 125 m) NE Atlantic (450, 470; 160-400 m) North Sea	001 002 027
Starry smoothhound	2	NE Atlantic (456; 180 m)	004
Thornback ray	4	NE Atlantic (458, 471; 115-135 m)	005
Torsk	5	NE Atlantic (470; 400 m) NE Atlantic (421; 510 m)	013 029

*These species were not included in the original risk ranking, but were available from the research cruises. They were dispatched to FERA for analysis, with the agreement of FSAS, as they are either high trophic level (John Dory, cod), and/or have high landings (haddock, herring, cod) and/or are oily fish (herring).

TABLE 7

SEPA shellfish monitoring sites from where sampled mussels contained contaminant concentrations (2006) greater than the 95th percentile of all sites examined (the number of sites sampled is italicised), and the ten highest ranked sites for overall metal (Cd, Hg, Pb and As) or organic contamination. The organics data were first normalised to the lipid content of the samples. Data courtesy of SEPA.

PAH (*n=31*)	**OCP** (*n=53*)	**CB** (*n*=55)	**Cd** (*n=78*)	**Hg** (*n=78*)	**Pb** (*n=78*)	**Organics** (overall ranking)	**Metals** (overall ranking)
Dunoon E, F. of Clyde	Stannergate, Dundee	Stannergate, Dundee	Loch Etive (Ardchattan)	Port Edgar F. of Forth	Loch Long (Ardgartan)	Lunderston Bay, Firth of Clyde	Port Edgar Firth of Forth
Port Glasgow, F. of Clyde	Longman Point, Inverness	Nigg Bay, Cromarty	Dornoch Firth	Arbroath	Loch Etive (Achnacloich)	Ardmore, Firth of Clyde	Culross Firth of Forth
Woodhall, F. of Clyde	Nigg Bay, Cromarty	Lunderston Bay, F. of Clyde	Fairlie, F. of Clyde	Culross F. of Forth	Dunoon West, F. of Clyde	Stannergate, Dundee	Limekilns Firth of Forth
			Loch Etive (Achnacloich)	Tynemouth Dunbar	Port Edgar, F. of Forth	South Bay, Saltcoats Firth of Clyde	Blackness Firth of Forth
			Skinflats, F. of Forth	Limekilns F. of Forth	Port Glasgow, F. of Clyde	Joppa, Firth of Forth	Skinflats Firth of Forth
						Nigg Bay, Cromarty	Fairlie Firth of Clyde
						Kilchattan bay, Bute, Firth of Clyde	Avonmouth Firth of Forth
						Longman Point, Inverness	Ferryden, Montrose
						Camas Nathais, Lynn of Lorn	Stannergate, Dundee
						Dunoon E / Blackness	Loch Etive (Achnacloich)

TABLE 8

Species of freshwater fish for identified as potentially suitable for sampling, comment on whether they are thought to be eaten according to the FishBase website (Froese and Pauly, 2007), or according to Scottish or Polish custom (various Marine Scotland staff), and which species were recommended as suitable for inclusion in the contaminants survey.

	FishBase	Scotland	Poland	Recommended?
Arctic charr	Yes	Some eaten		YES
Bream	Yes	Rarely eaten, if at all	Yes	YES
Carp	Yes	Rarely eaten, if at all	Yes (at Xmas)	YES
Eel	Yes	Some eaten		YES
Grayling	*Not indicated*	Eaten, but less so than in the past		YES
Perch	Yes	Some eaten	Yes	YES
Pike	Yes	Some eaten	Yes	YES
Roach	Yes	A few eaten	Yes	YES
Tench	Yes	Rarely eaten, if at all	Yes	YES
Chubb	Mediocre flesh quality	Rarely eaten, if at all		NO
Dace	*Not indicated*	Rarely eaten, if at all		NO
Gudgeon	*Not indicated*	Rarely eaten, if at all		NO
Ide	Flesh not tasty	Rarely eaten, if at all		NO
Lamprey, brook	Rarely fished, poor flesh	Rarely eaten, if at all		NO
Lamprey, river	Yes	Rarely eaten, if at all		NO
Rudd	Yes	Rarely eaten, if at all		NO

TABLE 9

List of coarse fishing sites identified by internet search. Environmental status as classified by SEPA is indicated: 1a = "at significant risk", 1b = "probably at significant risk", 2a = "probably not at significant risk", and 2b = "not at significant risk", of failing the WFD objective of Good Environmental Status.

Site name	Area	Grid Reference	Fish caught	Information Source	Comment	SEPA WFD Waterbody ID	WFD status
Aboyne Loch	Aberdeenshire	NJ534000	Perch, pike, eels, roach, bream, carp	CSCAC; fishbritain	stocked in 2002 and 2003 with roach, bream, and a few carp; 01339 886244		1a
Auchenreoch Loch	Newton Stewart	NX819715	Bream, Perch, Pike, Roach	spinfish; fishBritain	01556 690281; info@lochviewmotel.co.uk		
Auchinstarry Quarry,	Kilsyth	NS719770	Rudd, roach, pike and tench	CSCAC; fishBritain	The rudd and roach are mainly small; no permit required		
Bookers pit	Irvine, N Ayrshire	KA11 5AU	Roach, perch, pike, eel	CSCAC	Flooded landfill site		
Broadwood Loch	Cumbernauld	NS720736	Pike, roach, bream and some carp	CSCAC	no permit required	10144 (Broadwood Burn)	1a
Byres Loch	Galashiels		Carp, roach, tench, perch	fishBritain; Scotts CAC	01896 751620		
Castle Loch	Lochmaben, Dumfriesshire	NY089811	Bream, roach, perch, eels, tench and carp	CSCAC; fishBritain		100332	1a

Castle Semple Loch	Lochwinnoch	NS363591	Roach, perch, eels and pike	CSCAC; fishBritain	Contact: 01505 842882	100294	1a
Eglinton Park Loch	Kilwinning, North Ayrshire	NS327422	Bream, carp, roach, perch	CSCAC; spinfish	former brick pit; contact: 01294 551776 georgeclark@north-ayrshire.gov.uk		
Eliburn Reservoir	Livingston, W. Lothian	NT029678	Carp, tench, roach, and perch.	CSCAC			
Forestburn Reservoir	Shotts	NS867647	Roach, perch, pike and eels	CSCAC; spinfish	no permit		
Forth and Clyde Canal	Bowling to Grangemouth	Various	Tench, bream, roach, perch, pike	CSCAC; spinfish; fishBritain; course-fishing.freeuk.com	there is also a project for stocking of the canal.; Firhill Basin in Glasgow is noted for serious carp, Lowland Canal Angling Partnership, 01324 671217	various	various
Hogganfield Loch,	Cumbernauld Rd Glasgow	NS642670	Carp, pike, roach, perch and bream.	CSCAC; spinfish; fishBritain	dodgy! No permit; Free but permit required, call 0141 287 5167		1a
Kelhead Quarry	Annan	NY145694	Pike, carp, roach, bream, perch, tench, eel	fishBritain	01461 700344		
Kilbirnie Loch,	Kilbirnie, N Ayrshire	NS331546	Roach, perch, pike	CSCAC; fishBritain	01505 682191; close to former steelworks		1a
Lanark Loch	Lanark	NS903430	Carp, tench, roach, perch, pike	CSCAC; spinfish; fishBritain	Scottish carp group; no permit; 0131 477 1804/01698 424101		
Loch Heron /	Kirkcowan,	NX266646	Pike,	fishBritain;	Two adjoining lochs; 01988 402390		

Loch Ronald	Newton Stewart		bream, roach, carp, perch	visitScotland			
Loch Ken	New Galloway	NX714684	Roach, pike, perch, bream	CSCAC; fishbritain	01556 504100		1a
Loch Libo	Uplawmoor, Ayrshire	NS432554	Tench, carp, roach, perch, pike	Scottish Carp Group	collasped mine; Reserved for SCG, members must return fish alive; Contact: 0141 776 7922	10383	1a
Loch Lomond		various	Roach, perch, eels, bream	CSCAC	coarse fish are more often to be found in the Southern half; Drumkinnon Bay at Balloch used to be good		
Lochgelly Loch	Fife	NT200924	Pike, roach, perch, eel	Spinfish; Fife TB	no permit	100277	1a
Lochrutton	Dumfries	NX898730	Bream, pike, roach, perch	CSCAC; spinfish	no permit required		2b
Monkland Canal,	Drumpellier Park, Coatbridge	NS713654	Carp, bream, roach, tench	CSCAC / MCAC	The carp are now huge and very difficult to catch, but the bream can still be caught near the basin.	10752	1a
Pumpherston Pond	Uphall, W. Lothian	NT071693	Pike, perch, roach, carp, tench and bream	CSCAC	"went course fishing to day - caught 17 perch ranging from 2 inches to 3 inches"		
River Clyde,	Glasgow	NS595644	Roach, bream, perch and eels	CSCAC; spinfish; fishBritain	upstream of the tidal weir (at Albert Bridge, A8) at Glasgow Green, Richmond Park, Swanston Street and Dalmarnock Road; Fishing is free within the city limits	10040	1b
River Endrick	Stirlingshire	NS447884	Roach, perch, eels	CSCAC; visitScotland	Mains Farm, details of this being available from the JB Angling Centre in Kirkintilloch;	10152	1a

			and bream		Spittal Farm, By Drymen Contact: 01360 660264		
River Forth	near Stirling	NS769960	Roach, perch and eels.	CSCAC; spinfish	Permits from D. Crocketts, Stirling, Contact: 01786 465517.	4700	2a
River Isla / R Ericht	Near Cupar Angus	NO201446	Grayling, roach, perch and pike	Visit Scotland		6535	1a
River Tay	Perth	NO119216	Grayling, pike, perch and roach	CSCAC; Spinfish; Fishingnet.com	All trout angling clubs on the River Tay are obliged by law to sell permits for other species. see Perth & District AA or Stormont AC 01738 552308	6489	2a
River Tweed	Norham	NT898477	Grayling, roach, eel and perch	visit Scotland	Ladykirk and Norham AA: contact Jim: 01289382481; jili.cameron@virgin.net	5200	1a
Spectacle Lochs	Newton Stewart	NX350688	Pike, Perch, Roach, Tench	fishBritain; Spinfish	Forest Enterprise: 01671 402420; lucy.hadley@forestry.gsi.gov.uk		
Stroan Loch	Newton Stewart	NX644703	Pike, Perch, Roach, Tench	fishBritain	Forest Enterprise: 01671 402420; lucy.hadley@forestry.gsi.gov.uk		
Strathclyde Park,	Motherwell	NS730572	Roach, perch, bream, carp , pike and tench	CSCAC; fishBritain	01698 266155		1a
Union Canal	Falkirk to Edinburgh	e.g. NT174703 NT077723	Roach, perch, pike, tench, carp and eels	CSCAC Waterscape.com South Queensferry CAC	the fish population is not as varied or as large as the Forth and Clyde; Linlithgow CAC; 01324 671217	8	1a

TABLE 10

Mean (±SD) concentrations (µg/kg; *n*=5) of total organochlorine pesticides (OCPs) and total ICES-7 chlorinated biphenyls (sum of CBs 28, 52, 101, 118, 138, 153 and 180) in eels 2004-2006. Sites highlighted in **bold** on grey had concentrations greater than the overall mean concentration; those in **bold** on white had concentrations greater than the overall median concentration. Data courtesy of SEPA.

Site	Total OCPs		Site	Total CBs
Lunan Burn	**872±963**		**River Clyde @ Tidal Weir**	**3203±4159**
Whiteadder	**496±149**		**River Don**	**592±643**
River Don	**371±36**		**White Cart @ Hammils**	**199±44**
River Eden	**352±50**		**River Almond**	**188±46**
Monikie Burn, Angus	**230±68**		**River Garnock**	**103±28**
White Cart @ Hammils	**176±37**		**River Irvine**	**91±42**
River Tweed	**142±43**		**Annick Water**	**87±59**
Annick Water	**127±47**		**White Cart @ Pollock House**	**78±21**
River Garnock	**122±48**		D/S River Devon	40±9
U/S River Devon	107±63		Whiteadder	37±16
D/S River Devon	99±29		River Eden	29±3
White Cart @ Pollock House	89±32		Monikie Burn, Angus	26±7
River Almond	75±21		U/S River Devon	22±13
River Irvine	73±28		River Tweed	17±4
River Clyde @ Tidal Weir	67±71		Ness (H'land)	15±3
River Dee	36±19		River Dee	12±5
Ness (H'land)	22±8		Lunan Burn	9±4

TABLE 11

Concentrations (ng/l) of total phthalates (sum of benzyl butyl phthalate, di-(*n*-butyl) phthalate, di-(2-ethyl hexyl) phthalate, and di-(*n*-octyl) phthalate) in Scottish freshwaters sampled in Jan-Nov 2007. Sites highlighted in **bold** on grey had concentrations greater than the overall mean concentration; those in **bold** on white had concentrations greater than the overall median concentration. Data courtesy of SEPA.

Site	Mean	SD	*n*=	Site	Mean	SD	*n*=
Water of Girvan @ Abstraction Weir	**61272**	**85892**	**2**	**R. Leven @ Renton Footbridge**	**268**	**129**	**4**
R. Annan @ Brydekirk G.S.	**23422**	**67742**	**9**	**R. Eden @ Kemback G.S.**	**243**	**178**	**10**
R. Garnock @ Kilwinning	**7651**	**10552**	**2**	**R. Stinchar @ Ballantrae**	**242**	**209**	**8**
R. Clyde @ Tidal Weir	**2409**	**3788**	**8**	**R. Kelvin @ Partick Bridge**	**238**	**160**	**3**
Lugton Water @ Old A737 Road	**802**	**234**	**2**	**R. Lossie - Arthurs Bridge**	**229**	**127**	**3**
R. Avon @ Jinkaboot Bridge	**621**	**231**	**3**	**R. Ewe @ A832 Roadcrossing**	**222**	**97**	**2**
R. Ayr @ Victoria Bridge	**583**	**860**	**7**	**R. Ness @ Infirmary Bridge Inverness**	**217**	**439**	**10**
R. Leven D/S National Steel Foundry	**546**	**393**	**4**	**Dighty Water @ Balmossie Mill**	**212**	**164**	**4**
Black Cart Water @ Blackstoun Farm	**516**	**105**	**3**	R. Tweed @ Norham G.S.	204	108	4
R. Spey - U/S Fochabers Stw (Hm/Ecn)	**497**	**931**	**11**	R. Allan @ Bridge Of Allan	191	164	4
Whiteadder Water @ Chesterfield	**415**	**156**	**2**	R. Don @ Grandholm Bridge (Hm)	183	117	4
R. North Esk @ Marykirk	**405**	**265**	**11**	R. Esk @ Musselburgh G.S.	168	31	3
R. Ugie - Inverugie (Hm)	**392**	**379**	**4**	Urr Water @ Dalbeattie G.S.	162	131	4
R. Cree @ Newton Stewart G.S. (Chemistry)	**392**	**347**	**2**	R. Dee @ Glenlochar G.S.	156	200	3
R. Bladnoch @ Torhouse Mill	**383**	**-**	**1**	R. Nevis @ Nevis Bridge	155	236	10
Annick Water @ A71 Road Bridge	**373**	**159**	**8**	R. Esk @ Canonbie G.S.	153	79	7
R. South Esk @ Kinnairds Mill	**371**	**221**	**11**	R. Deveron @ Bridge Of Alvah (Hm)	108	108	3
R. Ythan - Ellon Car Park D/S Sws (Hm)	**370**	**634**	**4**	Bervie Water @ Inverbervie G.S.	104	106	4
R. Carron @ Carron Ironworks Bridge	**367**	**49**	**3**	R. Tyne @ East Linton	100	63	8
R Devon @ Cambus New Bridge	**364**	**364**	**4**	R. Doon @ Doon Foot	89	-	1
R. Irvine @ Dreghorn	**353**	**252**	**7**	R. Elchaig @ Faddoch	72	102	2
R.Almond @ Craigiehall	**336**	**255**	**9**	Leven R. Below B.A. Kinlochleven	54	88	4
R. Earn @ Forteviot Rd. Bridge	**330**	**243**	**4**	R. Dee @ Milltimber (Hm)	54	77	4
R. Tay @ Queens Br.Perth	**322**	**272**	**10**	R. Nairn @ Jubilee Bridge Nairn	48	48	3
White Cart Water @ Hawkhead (Chemistry)	**317**	**-**	**1**	R. Conon @ Roadcrossing Conon Bridge	47	26	4
R. Forth @ Craigforth (G.S.)	**289**	**253**	**10**	R. Findhorn @ A96 Roadcrossing	42	45	2
Eye Water @ G.S.	**285**	**136**	**3**	R. Beauly @ Lovat Bridge	5	7	2
Water Of Leith @ Anderson Place	**273**	**197**	**3**	R. Shin @ Inveran.	4	5	3
				Overall Mean	*1617*	*14434*	*271*
				Overall Median	*207*		*271*

TABLE 12

Risk ranking of sewage effluent treatment works, based upon dilution of effluent discharge into the receiving water (from Robinson *et al.,* 2008). The dilution was estimated from the effluent discharge rate and the discharge of the receiving water exceeded 95% of the time (Q95). WWTW = wastewater treatment work; PE = population equivalent; SEC AS = secondary activated sludge treatment; SEC BF = secondary biological filtration treatment; DWF = dry weather flow.

Site	Locality	Discharge NGR	PE	Treatment	Receiving water	DWF dilution
Philipshill WWTW	Lanarkshire	NS 6008 5599	51,960	SEC AS	Kittoch Water → White Cart Water	1.1
Dunswood WWTW	Central	NS 7819 7731	25,000	SEC AS	Red Burn → Bonny Water→ R. Carron	3.3
Stewarton WWTW	Ayrshire	NS 4087 4483	7,000	SEC BF	Annick Water	3.6
Cumnock WWTW	Ayrshire	NS 5567 2054	16,000	SEC AS	Lugar Water	5.9
Denny WWTW	Central	NS 8226 8289	13,000	Primary	R. Carron, nr estuary	7.3
Bridge of Earn WWTW	Central				River Earn	

TABLE 13

List of possible freshwater sites. Sites were identified as described in the text and ranked based upon knowledge of contaminant pressures and other factors. It is proposed to collect fish samples from sites in bold font. Presence of fish as indicated by angling websites (e.g. the Central Scotland Coarse Angling Club, CSCAC), the National Biodiversity Network (NBN) or Ayrshire Rivers Trust (ART). D&G = Dumfries and Galloway. *Risk of failing the WFD objective of Good Environmental Status, as classified by SEPA: 1a = "at significant risk", 1b = "probably at significant risk", 2a = "probably not at significant risk", and 2b = "not at significant risk". PAH = Polycyclic Aromatic hydrocarbons; CB = polychlorinated biphenyls; OCP = organochlorines pesticides; DEHP = diethyl hexyl phthalate; SP = specific pollutants; DO = dissolved oxygen; TM = trace metals. *Italicised* WFD information refers to the nearest monitored waterbody, rather than to the site listed.

Site	**NGR**	**At risk rating***	**SEPA WFD information**	**other info**	**Fish spp. present**	**No spp.**	**Ranking assigned**
River Almond, Barnton, Edinburgh	NT165752	1a	Fails for PAH, OCP;	high CBs in eel	Eel, carp, tench, roach, pike, perch (NBN)	6	1
River Tay, Perth	NO119216	2a	Fails for PAH		Grayling, pike, perch, roach (fishTay), also eel, tench (NBN)	6	1
Forth and Clyde Canal (Glasgow branch)	NS582678	1a	no data available		Tench, bream, roach, perch, pike	5	1
Forth and Clyde Canal (Rough castle to Grahamston), Falkirk	NS868800	1a	no data available		Tench, bream, roach, perch, pike	5	1
River Annan, Annan, D&G	NY190704	1a	Fails for overall chemistry, PAH, DEHP;	phthalates high	Grayling, pike, eel, roach, perch	5	1
River Garnock, Kilwinning, N. Ayrshire	NS306426	1a	passes chemistry;	phthalates high; high CBs in eel	Eel (ART); also perch, carp, roach, pike (NBN)	5	1
White Cart Water, Pollock CP, Glasgow	NS548617	1a	Fails for NH3, SP	high CBs and OCPs in eel; sewage influenced	Eel, carp, roach, pike, perch (NBN)	5	1
Kittoch water, East Kilbride	NS601560	1a	Fails for NH3, SP	sewage influenced	Eel, roach, pike, perch (NBN)	4	1
Lugton W / Eglinton Park Loch, Kilwinning, N Ayrshire	NS317420 / NS327422	1a	River Fails for Fe	phthalates high in river / loch is former clay pit	Eel, roach (ART); also bream, carp, perch (CSCAC)	4	1
River Clyde, Glasgow	NS595644	1a	Fails for PAH	high CBs in eel;	Roach, bream, perch and eels	4	1
Water of Girvan, S. Ayrshire	NX196991	1a	Fails for PAH, OCP, SP	phthalates high old mine workings u/s at Dailly	Perch, pike, tench, eel (NBN); grey mullet in tidal reaches (ART)	4 (5)	1
Lochgelly Burn / Loch, Fife	NT196924	1a / 1a	Fails for NH3, SP / ecology, P, no chem data	sewage/agric influenced	Pike, roach, perch, eel	4	1
Lunan Burn, near Blairgowrie, Perthshire	NO133445	1b	passes NH3, DO; no TM or organics data	high OCPs in eel	Perch, eel, roach, pike (NBN)	4	1

River Earn, Bridge of Earn, Perth	NO131186	1b	Fails for PAH, OCP	sewage influenced	Grayling, eel, roach, pike (NBN)	4	1
Red Burn, Castlecary, Cumbernauld	NS785784	1a	Fails for NH3, SP	sewage influenced	Perch, pike, carp (NBN)	3	1
River Carron, Stenhousemuir	NS882824	1a	Fails for PAH, Fe	sewage influenced	Perch, pike, eel (NBN)	3	1
Whiteadder Water, nr Berwick	NT939536	1a	Fails for PAH, OCP	high OCPs in eel	Roach, eel, perch	3	1
River Forth u/s Stirling	NS776954	2a	Fails for PAH		Roach, perch and eels.	3	1
Annick Water, Irvine / Stewarton, N Ayrshire	NS328381 / NS394441	1a	Fails for PAH, OCP, Fe	sewage influenced	Eel, pike (NBN)	2	1
River Don, Aberdeen	NJ924092	1a	Fails for NH3, PAH, SP	high CBs and OCPs in eel	Eel, pike (NBN)	2	1
River Eden, Fife	NO415158	1a	Fails for PAH, OCP	high OCPs in eel	Pike, eel (NBN)	2	1
Monikie Burn, Angus	NO579353	1a	passes NH3, DO; no TM or organics data	high OCPs in eel	Eel (NBN)	1	1
Forth and Clyde Canal (Kirkintilloch to Kelvinhead), Bishopbriggs	NS605716	1a	no data available		Tench, bream, roach, perch, pike	5	2
Forth and Clyde Canal (Wyndford to Rough castle), Bonnybridge	NS805791	1a	no data available		Tench, bream, roach, perch, pike	5	2
Strathclyde Park, Motherwell	NS730572	1a	no data requested from SEPA		Roach, perch, bream, carp and tench	5	2
Bookers pit, Irvine, N. Ayrshire	NS333361		*R. Irvine (1a) Fails for PAH, OCP, Fe*	former landfill site	Roach, rudd, perch and pike	4	2
Kilbirnie Loch, Lochwhinnock, Renfrewshire	NS331546	1a	no data requested from SEPA	Adjacent to former steelworks	Roach, perch (fishScotland), also pike, perch (NBN)	4	2
Monkland Canal, Coatbridge	NS713654	1a	no data available		Carp, bream, roach, tench	4	2
Union Canal, Broxburn, Edinburgh	NT178705	1a	no data available		Pike, roach, perch, carp	4	2
Spynie canal, Elgin	NJ226664	1a	no data available	historically had high OCPs in eel (Davies, pers. comm)	Pike, perch, eel (NBN)	3	2
Kelhead Quarry, Annan, D&G	NY145694		*Pow water (1a) - no data requested from SEPA*		Pike, carp, roach, bream, perch, tench, eel	7	3
Pumpherston Pond, Livingston	NT071693		*R. Almond (1a) fails for PAH, OCP*	golf course water hazard	Pike, perch, roach, carp, tench and bream	6	3
Eliburn Reservoir, Livingston	NT029678		*R. Almond (1a) fails for PAH, OCP*		Carp, tench, roach, and perch.	4	3
Forestburn Reservoir, Shotts	NS867647		*Forestburn Water (1a) - no data requested from SEPA*		Roach, perch, pike and eels	4	3

Hogganfield Loch, Glasgow	NS642670		*Molendinar Burn - no data requested from SEPA*		Carp, perch, pike, roach	4	3
Loch Ken, Castle Douglas, D&G	NX714684	1a	no data requested from SEPA		Roach, pike, perch, bream	4	3
Loch Lomond South, Balloch, W Dumbarton	NS382825	1a	no data requested from SEPA		Roach, perch, eels, bream	4	3
Spectacle Lochs, Newton Stewart, D&G	NX350688		*R. Bladnoch (1a) - no data requested from SEPA*	forested upland catchment	Pike, perch, roach, tench	4	3
Stroan Loch, Newton Stewart, D&G	NX644703		*Blackwater of Dee (1a) - no data requested from SEPA*	forested upland catchment	Pike, perch, roach, tench	4	3

TABLE 14

List of freshwater fish obtained and dispatched to FERA for analysis.

Waterbody	Location	Species	No. obtained	Total weight (g)	Method of collection	Provider
Forth & Clyde canal	Port Dundas, Glasgow	Pike	3	135	Electrofishing	Marine Scotland
Forth & Clyde canal	Port Dundas, Glasgow	Perch	14	685	Electrofishing	Marine Scotland
Forth & Clyde canal	Port Dundas, Glasgow	Roach	12	1440	Electrofishing	Marine Scotland
Kirtle Water	Kirkpatrick Fleming to tidal limit	Eel	?		Electrofishing	Annan DSFB / Marine Scotland
Kirtle Water	Kirkpatrick Fleming to tidal limit	Trout	2		Electrofishing	Annan DSFB / Marine Scotland
Lochar Water	A75 bridge	Eel	7	460	Electrofishing	Annan DSFB / Marine Scotland
Lochar Water	A75 bridge	Trout	5		Electrofishing	Annan DSFB / Marine Scotland
River Eden, Fife	Kenback Gauging Station	Eel	8	240	Electrofishing	SEPA
River Eden, Fife	Kenback Gauging Station	Trout	3	240	Electrofishing	SEPA
Water of Girvan		Trout	3	665	Angling	Carrick Angling Club
Loch Achray, The Trossachs		Pike	1	2300	Angling	SEPA
River Leven, Fife	Milton of Balgonie	Eel	4	300	Electrofishing	SEPA
White Cart Water		Trout	2	420	Angling	Busby (White Cart Improvement) Angling Association (via Roddy Finnie, bailiff)

FIGURES

Figure 1: International Council for the Exploration of the Sea (ICES) sea areas and stat squares around the UK. Landings data in this report are from sub-areas IVa (Northern North Sea), IVb (Central North Sea), VIa (West of Scotland) and VIb (Rockall).

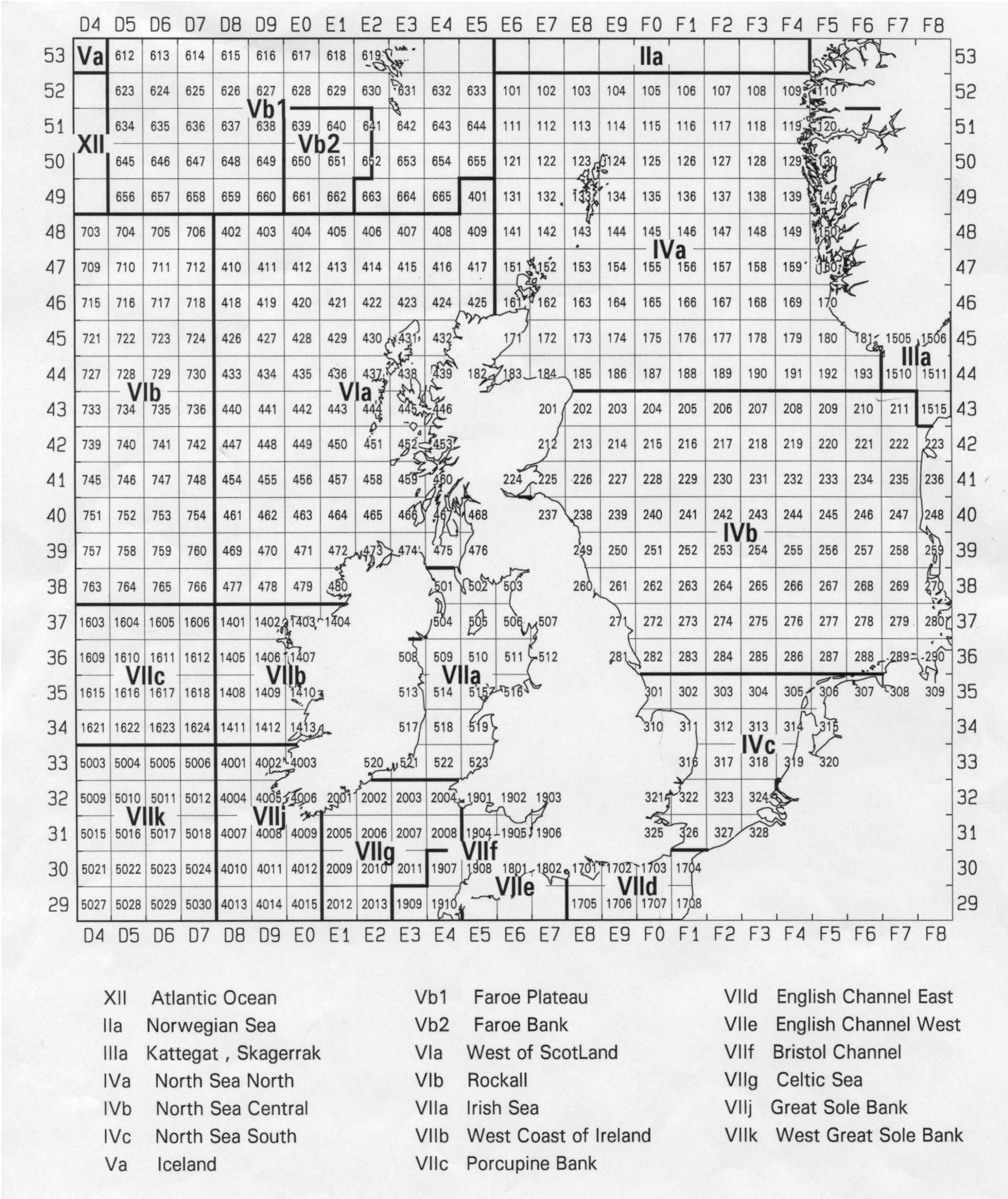


Figure 2: Mean mercury concentrations (µg/kg wet weight) in flesh tissue of monk/anglerfish (*Lophius piscatorius*) caught between 1980 and 2001. Concentrations symbolised on the centre of ICES statistical squares. The maximum permitted Hg concentration under Regulation 78/2005/EC is 1000 µg/kg. Data source: Marine Scotland contaminants database.

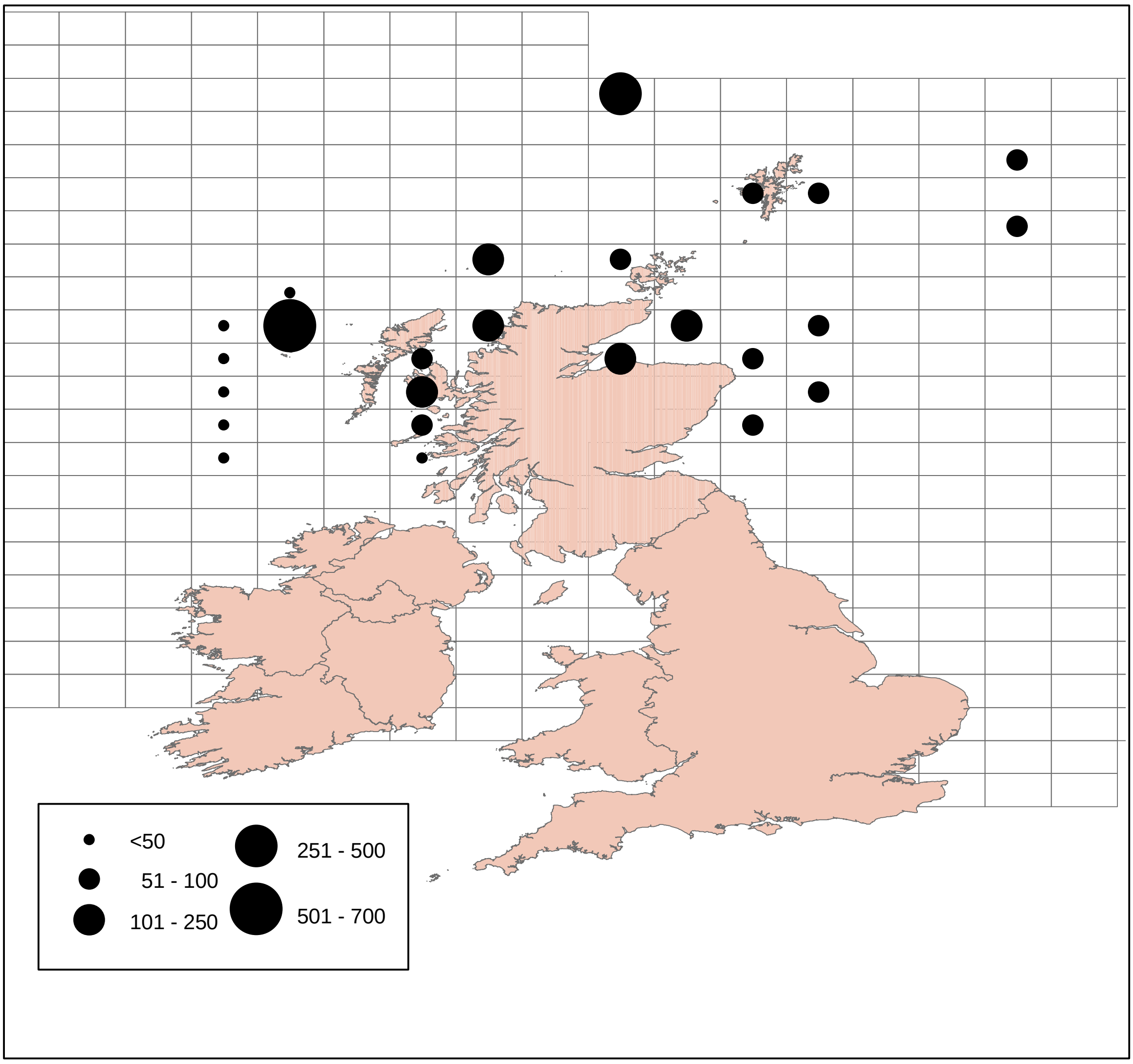


Figure 3: Mean total ICES-7 CB concentrations (µg/kg wet weight) in liver of roundnose grenadier (*Coryphaenoides rupestris*) caught between 1998 and 2001. Total ICES-7 CBs = sum of IUPAC CB congeners 28, 52, 101, 118, 138, 153 and 180. Concentrations symbolised on the centre of ICES statistical squares. Data source: Marine Scotland contaminants database.

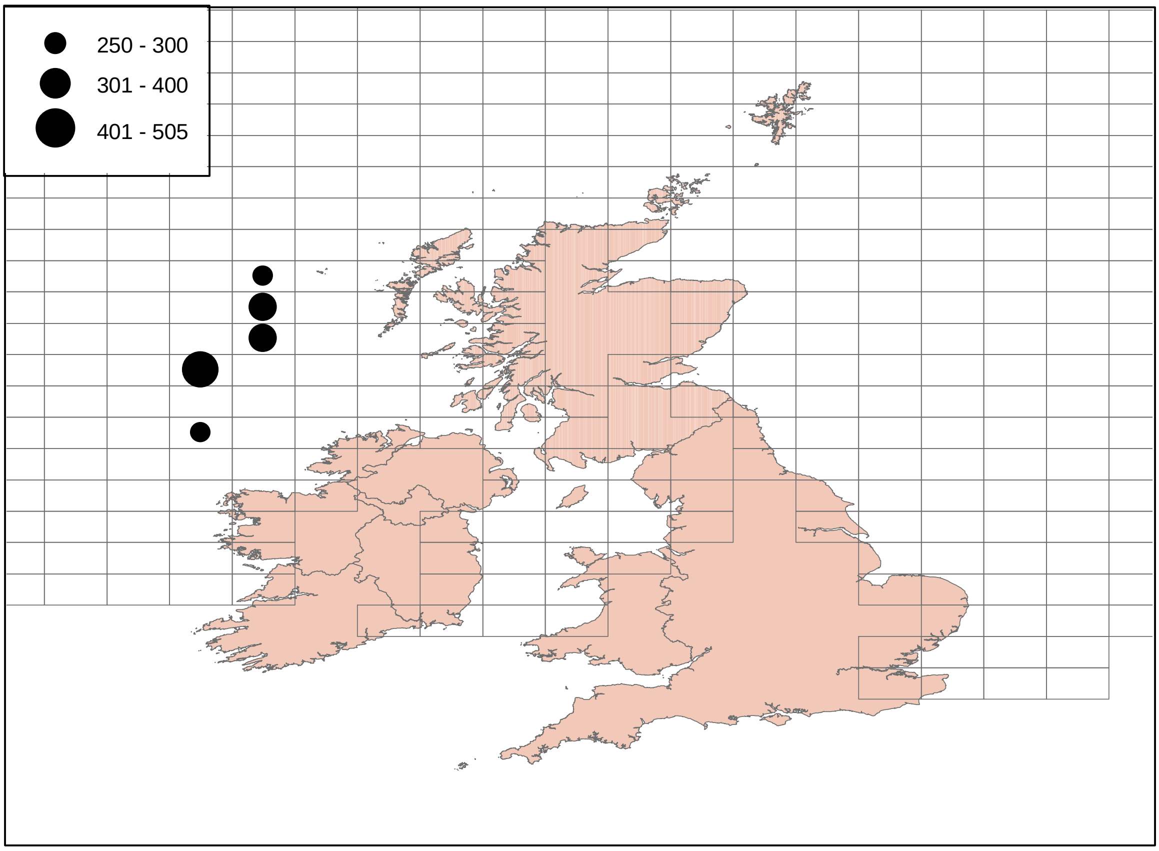


Figure 4. Locations from which marine fish were obtained during Marine Scotland research cruises: (a) "Deep water" trawling stations to the west of Northern Ireland and the Scottish Western Isles from cruise 1307S, September 2007 (red crosses at depths of 500 m, 1000 m, 1500 m and 1800 m); (b) "Deep water" trawling stations to the west of the Scottish Western Isles from cruise 0908S in July 2008 (red dots at depths of 500, 1000, 1500 m, and at depths between 1650-1800 m); (c) west of Scotland trawling stations from cruise 0308S February 2008 (numerals indicate haul number); and (d) North Sea trawling stations (black crosses) from Marine Scotland cruise 1008S August 2008.

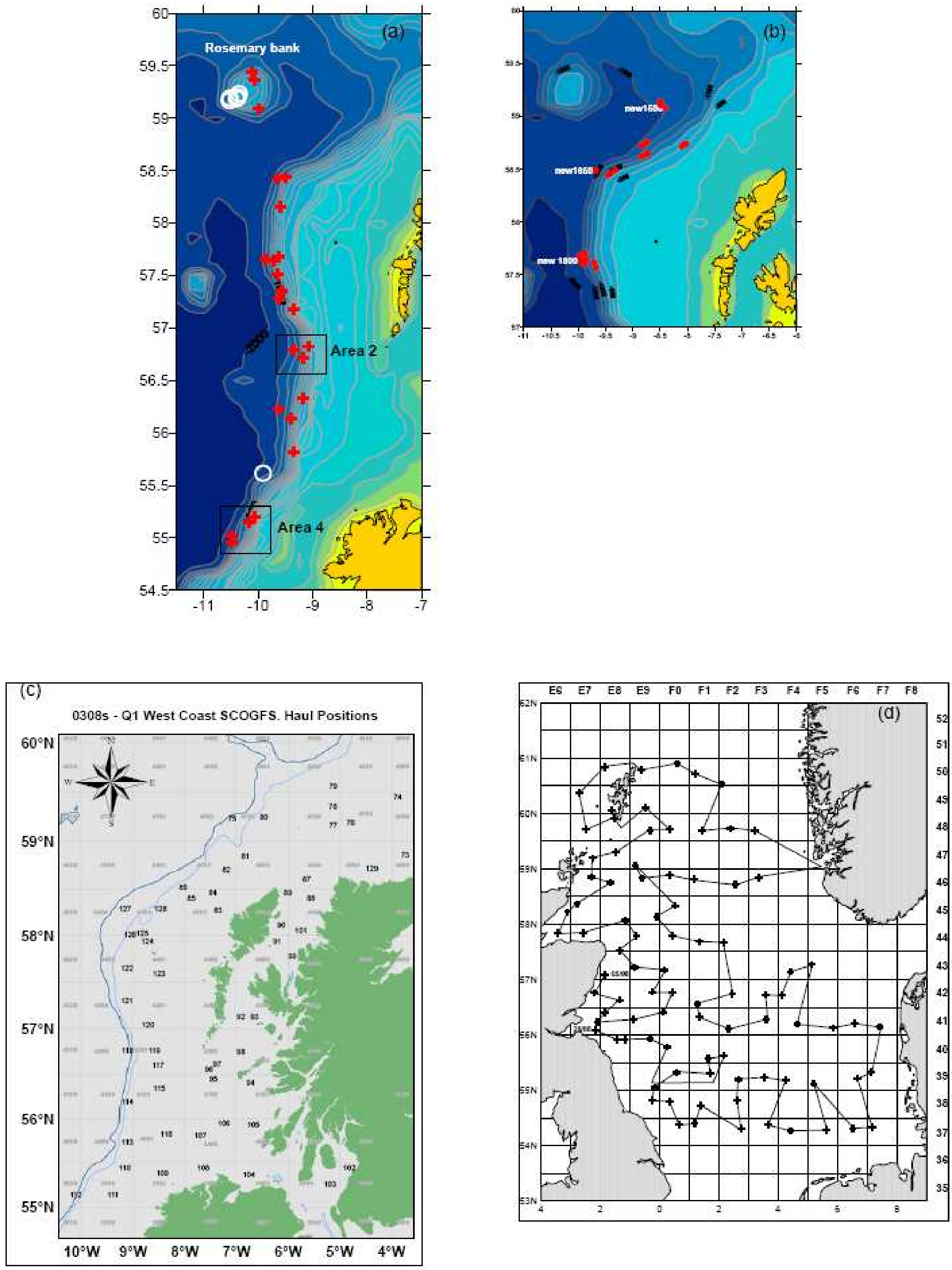


Figure 5: Mean concentrations of organic pollutants (µg/kg wet weight) in eels caught between 2004 and 2006. a) organochlorine pesticides (OCPs); b) ICES-7 polychlorinated biphenyls (CBs; sum of CBs 28, 52, 101, 118, 138, 153 and 180). Data source: SEPA.

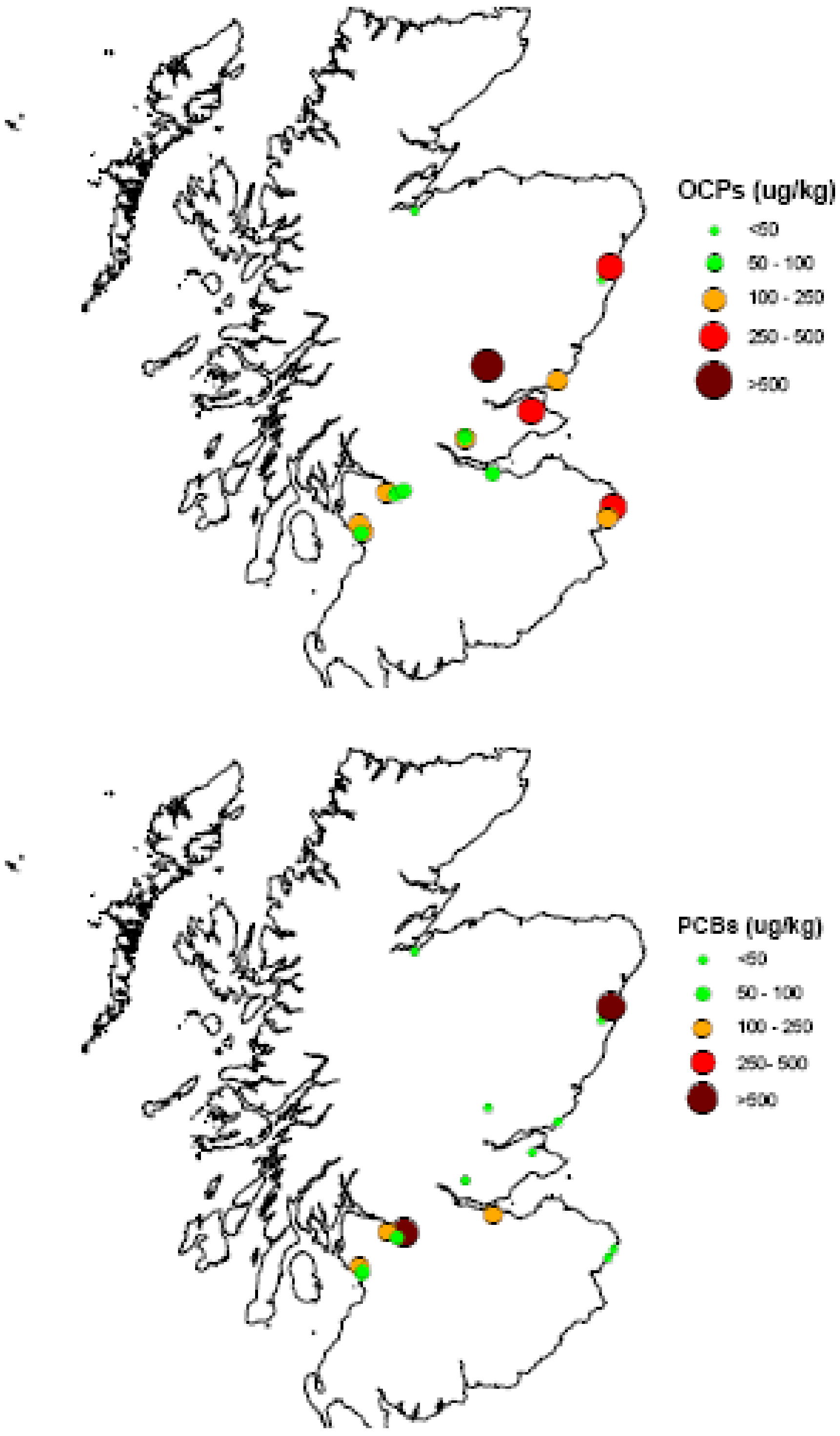


Figure 6: Mean concentrations of phthalates (ng/l) in Scottish rivers during 2007. Phthalates = sum of benzyl butyl phthalate (BBP), di-(*n*-butyl) phthalate (DBP), di-(2-ethyl hexyl) phthalate (DEHP) and di(*n*-octyl) phthalate (DNOP). Data source: SEPA.

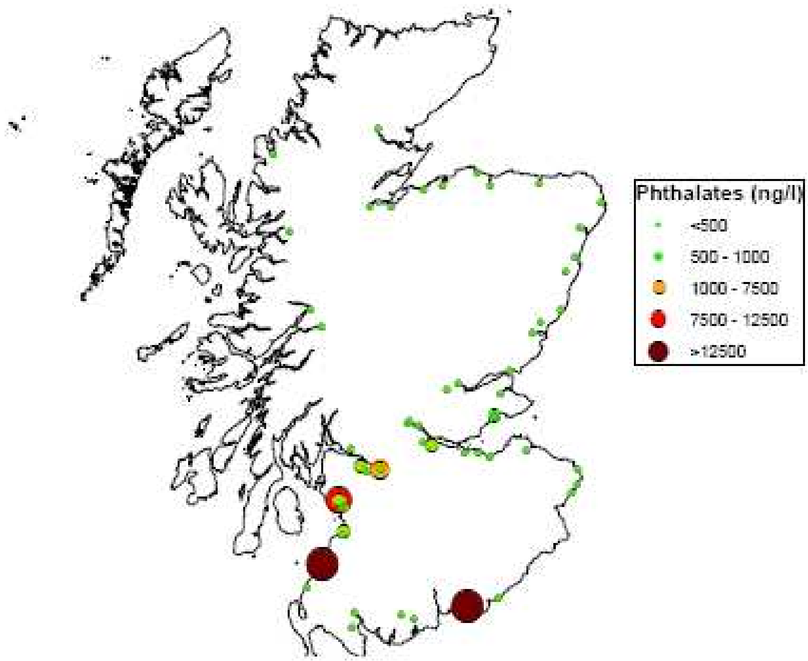


Figure 7. Freshwater fish species distribution maps. a) Number of selected fish species (see text) present in each 10 km grid square, and location of SEPA environmental monitoring sites under the Water Framework Directive (black dots); (b) example species distribution for pike (*Esox lucius*) in Scotland; (c) Distributions of selected fish species (by 10 km grid square) in central Scotland. (Data: www.NBN.org.uk and SEPA).

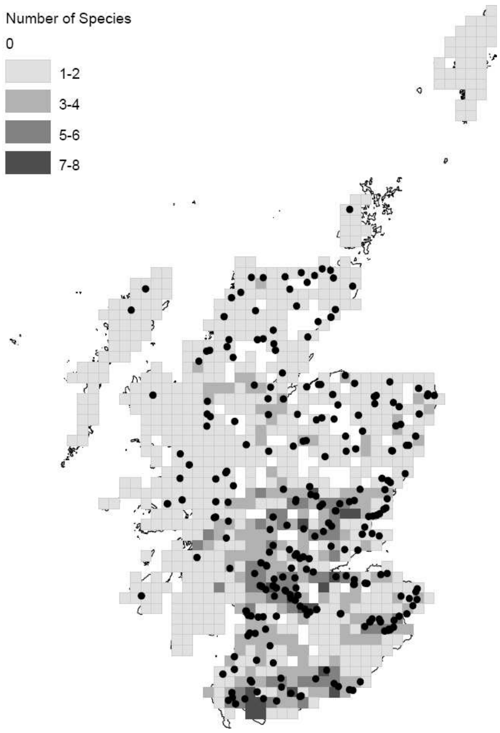


Fig. 7a)

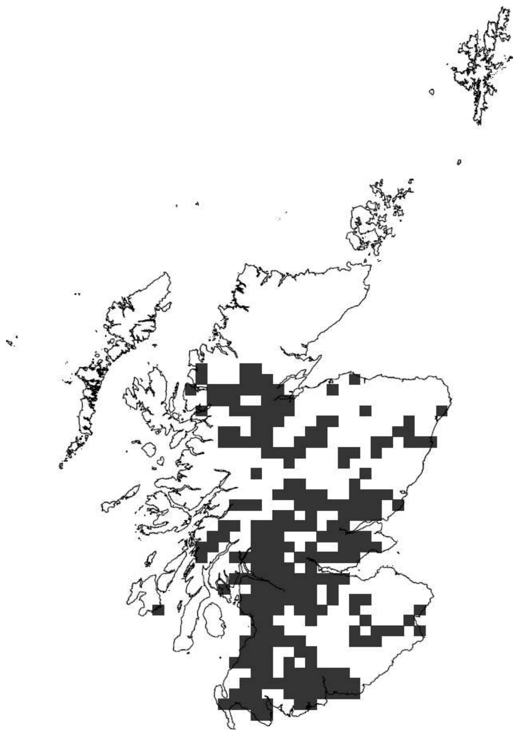


Fig. 7b)

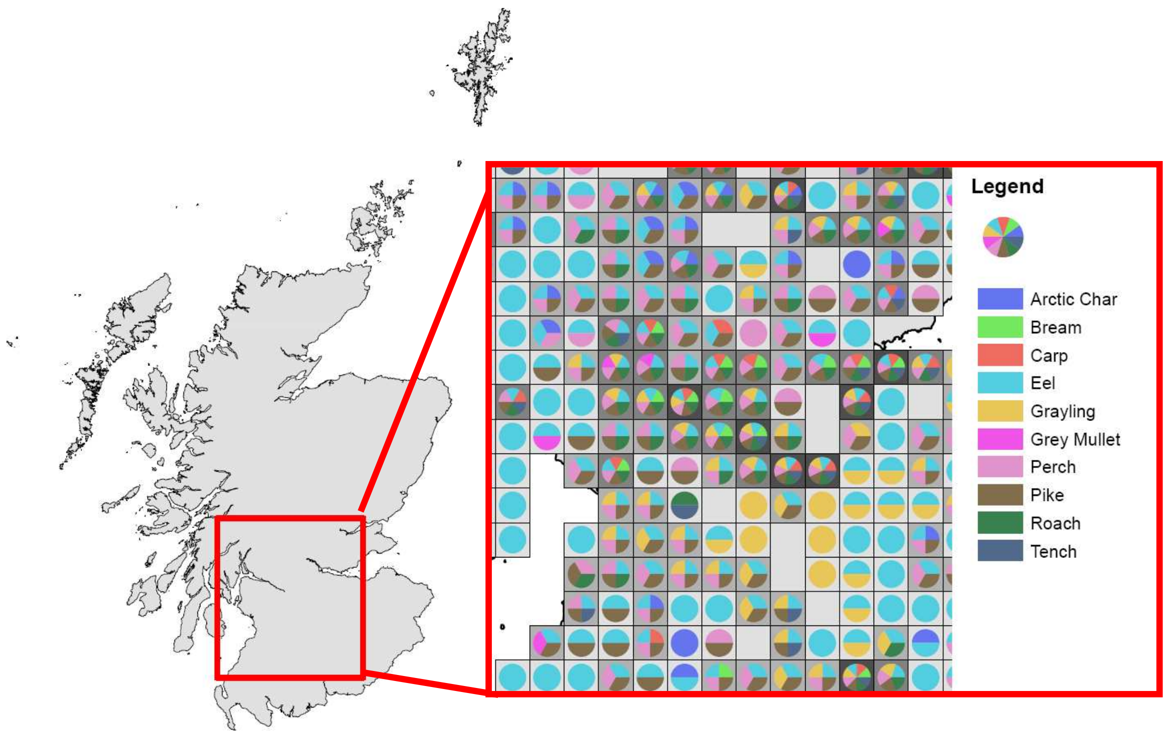


Fig. 7c)