Chemical Contaminant Sampling and Analysis of Shellfish from Classified Harvesting Areas (2017)

Report to Food Standards Scotland

June 2017




Contract reference FSA199 – FSS2017005/C5669 – C7481

Chemical Contaminant Sampling and Analysis of Shellfish from Classified Harvesting Areas (2017)

Authors: R.G. Petch, S. Panton, M. Baxter, F.Smith, A. Fernandes,

Date: June 2017

Customer: Food Standards Scotland
Food Protection Science and Surveillance
4th Floor, Pilgrim House
Old Ford Road
Aberdeen
AB11 5RL

Principal Workers: L. Greene, Z. Turford, R.G. Petch, S. Panton, M. Holland, J. Holland, F. Smith, T. Neal, M. Walls, M. Baxter, N. Brereton,

Head of Programme: E Bradley

Document prepared by:	R.G. Petch, Fera	
Document checked by:	C5669/C7481 Project Manager - M. Algoet, 07/06/17 F.Smith,– Fera, 27/05/16	Review Date: N/A
Document approved by:	M. Algoet, **/07/06/17	Classification: Not classified

Quality statement: All results were quality checked and approved prior to release to FSS. Information relating to the origin of the samples (place and date of collection) is as provided by sampling staff and has not undergone verification checks by Fera/Cefas.

Contents

Glossary of Main Terms

Term or Acronym	General Meaning Of Term
EU	European Union
EC	European Commission
FSS	Food Standards Scotland
FSA	Food Standards Agency
WHO	World Health Organisation
PAHs	Polycyclic aromatic hydrocarbons
PAH 4	Sum of 4 PAHs (benzo[*a*]pyrene; (BaP), benz[a]anthracene; (BaA) , benzo[b]fluoranthene; (BbF), chrysene; (Chr))
PCB	Polychlorinated biphenyl
Ortho-PCB	Ortho-substituted PCB (non planar)
Non-ortho-PCB	Non-ortho-substituted PCB (co-planar)
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/ polychlorinated dibenzofuran (dioxins)
TEF	Toxic Equivalency Factor – toxicity expressed for each dioxin-like compound as a fraction of 2,3,7,8-TCDD (2,3,7,8-TCDD = 1).
TEQ	Toxic Equivalence – product of the congener concentration and the TEF
Total TEQ	Total of the Sum of all the Toxic Equivalences (TEQs) for each group of compounds
Sum of ICES 6	Sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180
fat weight	Values relevant to the assessed fat content of the sample
whole weight	Values based on the sample as received 'whole' or wet
WHO-TEQ 2005	World Health Organisation - TEQ based on values as set in 2005
LOD	Limit of Detection
LOQ	Limit of Quantification
Lower bound	assumes values at less than the limit of detection are zero (e.g.<0.01=0)
Upper bound	assumes values at less than the limit of detection are equal to the limit of detection (e.g. <0.07=0.07)
Trace Element	An element in a sample that has an average concentration of less than 100 parts per million (less than 100 mg/kg)
Heavy Metals	A loosely defined subset of elements that exhibit metallic properties (some are toxic, some are a nutritional requirement in small amounts), (This survey includes, Cr, Mn, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Hg & Pb, (Chromium, manganese, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, mercury and lead)
ng/kg	Nanogram per kilogram ($x10^{-9}$/ part per trillion)
µg/kg	Microgram per kilogram ($x\ 10^{-6}$/ part per billion)
mg/kg	Milligram per kilogram ($x\ 10^{-3}$/ part per million)
ICP-MS	Inductively coupled plasma-mass spectrometry
HRGC-HRMS	High resolution gas chromatography - high resolution mass spectrometry
HRGC-LRMS	High resolution gas chromatography – unit resolution mass spectrometry
LIMS	Laboratory Information Management System

Executive Summary

This study on chemical contaminants in shellfish from Scottish classified shellfish production areas, fulfils part of the requirements of EU member states (EU Regulations (EC) No.1881/2006 and (EC) No. 854/2004) to adopt appropriate monitoring measures and carry out compliance checks on shellfish produced for human consumption. In comparison to earlier years, the scope of this study was widened to include production areas that had not been tested before. Marine shellfish bio-accumulate environmental contaminants because of their inability to metabolise these during feeding. The study determines concentrations of regulated environmental contaminants in the flesh of edible species with a view to determine current levels of occurrence and to allow estimation of consumer exposure.

The study analysed eighteen composite samples of shellfish including Common mussels, Pacific oysters, Common cockles, Surf clams, Carpet clams and Razor clams for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, dioxins), polychlorinated biphenyls (PCBs) and heavy metals. There were twenty two samples tested for polycyclic aromatic hydrocarbons (PAHs) that included the aforementioned species. The methodologies used for the analyses were UKAS accredited to the ISO 17025 standard and follow EU commission regulations for data quality criteria.

The highest individual levels of the currently regulated PAHs were observed in three separate samples showing concentrations of benzo[b]fluoranthene at 6.79 µg/kg in one, chrysene at 3.79µg/kg in another, benz(a)anthracene at 3.36µg/kg and benzo(a)pyrene (BaP) at 1.90µg/kg in a third sample, which also had the highest PAH4 Sum at 11.24 µg/kg, all fall below the maximum permitted level (MPL) of 5 µg/kg (for BaP) and 30 µg/kg for PAH4 (Regulation (EC) No. 1881/2006 as amended). These concentrations were lower than the highest levels reported in the 2016 study. In the case of PCDD/Fs and PCBs in particular, contaminant concentrations were all below the regulatory maximum levels (Regulation (EC) No. 1881/2006 as amended). Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits (Regulation (EC) No. 1881/2006 as amended). Contaminant profiles from the current study are similar to the previous year's data.

1. Background to Study

Marine shellfish are an excellent source of protein, are high in essential minerals, and low in calories and fat. In many parts of the UK and in Scotland in particular, the shellfish industry makes a significant contribution to the local economy. Shellfish have a recognised potential for bio-accumulating contaminants and some bivalve species such as mussels, are commonly used as early indicators of local pollution. Bivalves feed by filtering plankton from the surrounding water that washes through their habitat. This feeding mechanism leads to the bio-accumulation of pollutants of biogenic and anthropogenic origin such as polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), heavy metals (trace elements) and polycyclic aromatic hydrocarbons (PAHs), from the surrounding waters. The bio-accumulation potential of the shellfish species used for food is particularly relevant in the case of environmental contaminants with long half-lives such as chlorinated PCDD/Fs and PCBs. These contaminants have been the subject of a number of studies (Garraud et al 2007, Lee et al 2007, Fernandes et al 2009, Fernandes et al 2012) relating to the occurrence and bio-accumulation in marine species and the resulting potential for human exposure arising from the consumption of the edible species.

In recognising the requirements of food safety the EU has, for a number of years, defined limits for the control of these contaminants in a range of foods including shellfish. (Commission Regulation (EC) No 1881/2006, as amended). EU member states are required to adopt appropriate monitoring measures and carry out compliance checks with regard to the occurrence of these contaminants in shellfish produced for human consumption.

PCDD/Fs 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) (e.g.FSA 2003, FSA 2012 -FD 12/04) carried out over the last two decades; fish (including shellfish) has consistently been one of the highest dioxin and PCB containing food groups. 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.

Although metabolised in many fish species, PAHs persist in shellfish as filter feeding species appear unable to affect bio-transformation of these contaminants. Other than this bio-accumulation

pathway, PAHs can also arise in fish and shellfish through some food preparation and processing methods – e.g. 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 2002, Commission Regulation (EC) No. 208/2005). However, more recent evaluation by EFSA's CONTAM panel, concluded that a set of 4 compounds, namely benzo[a]pyrene (BaP), chrysene, benz[a]anthracene and benzo[b]fluoranthene (collectively referred to as PAH4) were more suitable indicators of PAH toxicity in food (EFSA, 2008). These four compounds were subsequently included in the updated Commission Regulation (EC) No. 835/2011, which came into force from September 2012. In a 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). In comparison to a study carried out about a decade earlier, reported levels were significantly lower and no sample showed levels above the 5 µg/kg EU limit for BaP in shellfish.

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. Metals and other elements may enter marine and aquatic environments and bio-accumulate in species at any point during growth and harvesting. Some potentially toxic elements occur naturally as part of the local geology, but others may also be found in the location of certain industries, as a result of unauthorised discharge, or as a result of other anthropogenic activity.

As part of its monitoring requirements in support of EU regulations, Food Standards Scotland (FSS) has overseen the collection of shellfish each year, from classified shellfish production areas within relevant local authority areas. The production areas are required to monitor shellfish samples, with the edible tissues analysed for the contaminants described above, and specified for dioxins, dioxin-like PCBs and non-dioxin-like PCBs for certain foodstuffs in Commission Regulation (EU) No 589/2014. Sampling officers from Scotland were required to obtain suitable shellfish samples from designated sampling points within classified shellfish production areas, as defined by the FSS. The collection of shellfish and transport logistics were co-ordinated by Cefas. Samples were taken and live shellfish sent to Fera, with the edible tissues analysed for the contaminants described above. The analysis is carried out at Fera in York.

Fera has generated environmental contaminant data on shellfish collected from new and existing shellfish production areas in Scotland since 2007. This report collates the results of the individual

analyses for dioxins, PAHs and heavy metals in samples of shellfish collected from Scottish production areas in the first quarter of 2017.

2. Method

2.1 Sample Collection and Preparation

Twenty-two samples of shellfish, including species such as common mussels, Pacific oysters, common cockles, surf clams, carpet clams, and razor clams were collected during January to March 2017. The sampling period was timed to coincide with the period of optimal contaminant concentrations in the shellfish.

Details on the locations, with descriptions of the samples and identification are given in Table 1.

On receipt at the laboratory each sample was given a unique laboratory reference number and the sample details were logged into a database using LIMS. The samples were stored frozen prior to analysis. Sample preparation consisted of shelling followed by thorough homogenisation and aliquots taken for PAH and heavy metal analysis, prior to freeze-drying. Freeze-dried sample powders were re-homogenised and aliquots used for dioxin and PCB analysis.

2.2 Contaminants measured – Specific Analytes

The following analytes were determined: Regulated contaminants are highlighted in **bold.**

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

Dioxin-like PCBs - IUPAC no. 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169 and 189.

Non Dioxin-like PCBs - IUPAC numbers 18, **28**, 31, 47, 49, 51, **52**, 99, **101**, 128, **138**, **153** and **180**.

PAHs -

acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, benzo[c]fluorene, pyrene, benzo[e]pyrene, benzo[b]naptho[2,1-d]thiophene, anthanthrene, coronene, benzo[ghi]fluoranthene, **benz[a]anthracene**, **chrysene**, **benzo[b]fluoranthene**, benzo[j]fluoranthene, benzo[k]fluoranthene, **benzo[a]pyrene**, cyclopenta[c,d]pyrene, indeno[123cd]pyrene, dibenzo[ah]anthracene, benzo[ghi]perylene, dibenzo[al]pyrene, dibenzo[ae]pyrene, dibenzo[ai]pyrene, dibenzo[ah]pyrene and the substituted PAH, 5-methylchrysene.

Heavy Metals – Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Silver (Ag), **Cadmium** (**Cd), Mercury (Hg), Lead (Pb)**

2.3 PCDD/F and PCB - Analytical Methodology

(FERA (UK NRL) SOPs FSG 401-414)

The method used for the preparation, extraction and analysis of samples has been reported previously (Fernandes et al 2004) and is part of the CEN EN16215:2012 standard. In brief, samples were fortified with ^{13}C-labelled analogues of target compounds and exhaustively extracted using mixed organic solvents. Ortho substituted PCBs were separated from non-ortho substituted PCBs and PCDD/Fs by fractionation on activated carbon. The two fractions were further purified using adsorption chromatography on alumina. Analytical measurement was carried out using high resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS) for the seventeen, 2,3,7,8-Cl substituted PCDD/F congeners and non-ortho substituted PCBs. HRGC-unit resolution mass spectrometry (HRGC-LRMS) was used for the measurement of the ortho substituted PCBs.

All analyses were UKAS accredited to ISO 17025 standards, with the inclusion of reference material and method blanks which were evaluated prior to reporting. Further quality assurance measures included the successful participation in international inter-comparison exercises such as Dioxins in Food-2013 and Dioxins in Food-2014, on dioxins and dioxin-like PCBs. Quality control evaluation for the accompanying data follows the criteria specified for chlorinated dioxins and PCBs (Commission Regulation (EU) No 589/2014. In addition, as NRL for chemical contaminants, FERA participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL, and achieves consistently good results.

2.4 Polycyclic Aromatic Hydrocarbons (PAH) - Analytical Methodology

(FERA (UK NRL) SOP FSG 410)

The analytical methodology for the PAHs has been reported before (Rose et al, 2007) and is based on internal standardisation with GC-MS measurement. An aliquot of the homogenised sample was fortified with ^{13}C-labelled analogues of target compounds and saponified with methanolic potassium hydroxide. The extracted PAH solutions were purified in two stages with a DMF/cyclohexane partition followed by adsorption chromatography on activated silica. Purified extracts were sensitivity standardised and measured using high resolution gas chromatography-unit resolution mass spectrometry.

The analytical procedure for PAHs is UKAS accredited to the ISO 17025 standard and includes the assessment of method blanks and reference materials, (e.g. T0658, PAHs in cocoa butter) for

compliance with the accreditation criteria. The methodology also meets the criteria required for evaluating data against the maximum permitted limits for benzo[a]pyrene as specified in EU Commission Regulations. FERA regularly participates in FAPAS PT exercises for PAHs in food. In addition, as NRL for chemical contaminants, FERA participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL and achieves consistently good results.

2.5 Trace Elements - Analytical Methodology

(Fera (UK NRL) SOP FSG 461 and 457)

Aliquots of the homogenised sample were weighed into allotted digestion vessels and a mixture (4:1) of nitric acid and hydrochloric acid added. The vessels were capped and the contents digested using a high pressure microwave digestion system. Reagent blanks, certified reference materials and a spiked sample 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. The digest solutions together with a set of standards covering the expected concentration range, were internally standardised with indium or rhodium in dilute nitric acid (1 %v/v). Measurements were made using an Agilent 7700x ICP-MS with collision cell.

In common with the other two sets of analyses, the analytical procedure is accredited to the ISO 17025 standard. The criteria used to assess data included checks on instrument drift, spike recovery, replicate agreement, limits of detection and certified reference material values. Regular, successful participation in FAPAS inter-comparison exercises provides further confidence in the data. In addition, as NRL for chemical contaminants, Fera participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL and achieves consistently good results.

3. Results

Analyte concentrations are presented in Tables 2.1 to 2.6. Concentration units reflect current convention as required by regulation, and data were rounded to two decimal places or as appropriate. The reporting limits (quoted as "<") for dioxins, PCBs and PAHs are estimated as a dynamic parameter and therefore represent the limits of determination that prevail during the course of the measurement. For PCDD/Fs, PCBs, metals and PAHs, the reporting limits are consistent with the requirements of EU regulations. Data on the reference materials that were analysed concurrently with the samples, were within established acceptable limits, and are available if required. Measurement uncertainty (MU) was calculated and applied to data following guidelines and principals set out in Measurement Uncertainty For Persistent Organic Pollutants By Isotope-Dilution Mass Spectrometry (Epp, et al 2014). MU and reference material data can be made available if required.

In addition to the concentration of individual congeners, the dioxin-like toxicity of the samples arising from PCDD/Fs and dioxin-like PCBs has also been reported as a toxic equivalent (WHO-TEQ), which is calculated by multiplying the concentration of each congener of interest by its toxicity equivalency factor (WHO-TEF). The TEQs are presented in terms of the 2005 TEFs (van den Berg et al 2006). Additionally as per the requirements of Regulation 1259/2011, the sum of the ICES-6 PCBs is also provided. The regulations for shellfish are based on whole weight concentrations; however in keeping with previous reports to Food Standards Scotland, the results for PCDD/Fs and PCBs have also been reported on a fat weight basis.

PCDD/Fs and PCBs were detected in all samples at levels well within the regulatory limits. The combined PCDD/F + PCB TEQ (whole weight) ranged from 0.05 pg TEQ/g to 0.21 pg TEQ/g. In all samples, PCDD/Fs contributed at least half of the total TEQ.

The concentration of ICES-6 PCB ranged from 0.06 µg/kg to 1.06 µg/kg, with the highest levels found in a Pacific oysters sample (S17-002927) from Loch Fyne: Stonefield Oysters.

PAHs were detected in all 22 samples analysed. Higher molecular weight PAHs such as anthanthrene and the dibenzopyrenes were either not found above the LOQ or found at relatively low levels in all of the samples. benzo[a]pyrene concentrations ranged from <0.05 µg/kg to 1.90 µg/kg and PAH4 concentrations ranged from 0.35 µg/kg to 11.24 µg/kg. The single highest concentration for the regulated compounds was found in a sample of common mussels (S17-001741) collected from Loch Leven Upper (benzo[b]fluoranthene). The sample with the next two highest concentrations for the regulated compounds was observed in a sample of razors (S17-

001078) collected from Gullane Point North (benzo[a]pyrene, & benz (a) anthracene). All samples showed levels below MPL for BaP (set at 5 µg/kg) and PAH4 (set at 30 µg/kg).

Heavy metals were detected in all samples. The three most abundant heavy metals were zinc (Zn), manganese (Mn) and copper (Cu), with Zn present at the highest concentration. Concentrations of the regulated heavy metals mercury (Hg), cadmium (Cd) and lead (Pb) were all below the regulatory limit (Commission Regulation EC 1881/2006, as amended). Two samples had 3 or more of the highest element values in the range. Pacific oysters (S17-002927) collected from Loch Fyne: Stonefield; Mn, Cu & Cd, and carpet clams (S17-002928) collected from Eriska Shoal Carpet Clams; Ni, As, Se & Ag. All highest individual element levels detected this year were lower than those highest values from the last study in 2016.

In general, the patterns and levels of the three contaminant classes were consistent with those recorded last year.

4. References

1. European Commission (2004) Commission Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. *Official Journal of the European Union*, L226/83, 25.6.2004
2. European Commission (2005). 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 Union*, L34/3, 8.2.2005
3. European Commission (2006) Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. *Official Journal of the European Union*, L364, 20/12/2006, 0005-0024.
4. European Commission (2008).Commission Regulation (EC) No 629/2008 of 3 July 2008 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs *Official Journal of the European Union*, L173/6, 3.7.2008
5. European Commission (2007) Commission Regulation (EC) No 333/2007 of 28 March 2007 laying down the methods of sampling and analysis for the official control of the levels of lead, cadmium, mercury, inorganic tin, 3-MCPD and benzo(a)pyrene in foodstuffs *Official Journal of the European Union*, L88/29, 29.3.2007
6. European Commission (2011).Commission Regulation (EU) No 835/2011 of 19 August 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for polycyclic aromatic hydrocarbons in food stuffs.
7. European Commission (2011).Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs.
8. European Commission (2012). Commission Regulation (EU) No 252/2012 of 21 March 2012 laying down methods of sampling and analysis for the official control of levels of dioxins, dioxin- like PCBs and non-dioxin-like PCBs in certain foodstuffs and repealing Regulation (EC) No 1883/2006 *Official Journal of the European Union*, L84/1, 23.3.2012
9. European Food Safety Authority (EFSA), (2008) Polycyclic Aromatic Hydrocarbons in Food: Scientific Opinion of the Panel on Contaminants in the Food Chain. (Question N° EFSA-Q-2007-136) *The EFSA Journal* (2008) 724

10. FAPAS Proficiency Test 0658 Report, Environmental Contaminants, PAHs in Cocoa butter April – June 2013. (Consensus value data from participating laboratories used for establishing acceptance criteria for use as an in-house reference material.)
11. Fernandes A, Holland J, Brereton N and Rose M (2012). Chemical contaminant sampling and analysis of shellfish from classified harvesting areas - 2012. Report to the Food Standards Agency, Scotland. Fera Report No. FD 12/03.
12. Fernandes A, White S, D'Silva K and Rose M (2004), Simultaneous Determination of PCDDs, PCDFs, PCBs and PBDEs in Food, *Talanta*, 63, 1147-1155. 2.
13. Fernandes, A., Mortimer, D., Dicks, P., Gem, M., Smith, F., Rose, M., (2009). Brominated dioxins (PBDD/Fs), PBBs and PBDEs in Marine Shellfish in the UK. Food Add. Contam. 26(6), 918-927.
14. Food Standards Agency, 2003. Dioxins and dioxin-like PCBs in the UK diet: 2001 total diet study samples, Food Surveillance Information Sheet No. 38/2003, FSA, London.
15. Food Standards Agency, 2005. Survey of polycyclic aromatic hydrocarbons in shellfish. Food Survey Information Sheet 83/05, FSA London, October 2005
16. Food Standards Agency (2009) Survey on measurement of the concentrations of metals and other elements from the 2006 UK total diet study. FSIS No. 01/2009, FSA, London
17. 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
18. "Interlaboratory Comparison on dioxins and PBDEs in food (2013) – Fourteenth round of an International Study" Norwegian Institute of Public Health, Oslo, Norway, Available at: www.fhi.no/ilc
19. "Interlaboratory Comparison on dioxins and PBDEs in food (2012) – Thirteenth round of an International Study" Norwegian Institute of Public Health, Oslo, Norway, Available at: http://www.fhi.no/ilc
20. Lee K, Lee J H , Lee J S , Park K, Kim S, Shim W, Hong S, Im U, Giesy J. , and Oh J (2007) Human Exposure to Dioxin-Like Compounds in Fish and Shellfish Consumed in South Korea. Human and Ecological Risk Assessment, 13, 223–235.

21. Rose M, White S, MaCarthur R, Petch R, Holland J, & Damant A.(2007). Single -laboratory validation of a GC/MS Method for the determination of 27 polycyclic aromatic hydrocarbons in oils and fats. *Food Additives & Contaminants Vol 24 Number 6 June 2007*, 635-651

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

23. 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.

24. Gauthier Eppe, Gianfranco Diletti, Alwyn Fernandes, Johannes Haedrich, Jerry Hart, Helge Hove, Anna Laura Iamiceli, Alexander Kotz, Rainer Malisch, Philippe Marchand, Wolfgang Moche, Georges Scholl, Giampiero Scortichini, Thorsten Bernsmann, Yves Tondeur, Wim Traag (2014). Measurement Uncertainty For Persistent Organic Pollutants By Isotope-Dilution Mass Spectrometry.

Table 1: Overview of Samples

Local Authority	Production Area	Site name	Sample type	GR or *NGR for sample	SIN Number	Date of Collection	Date Received at Fera	Fera LIMS no.
Argyll and Bute	Seil Sound North	Balvicar North	Pacific Oysters	NM 77596 17263	AB-247-735-13	23/01/2017	24/01/2017	S17-001409
Argyll and Bute	Peniver Razors	Peniver Razors	Razors	NR 85569 22631	AB-766-1962-16	23/01/2017	25/01/2017	S17-001505
Argyll and Bute	Loch Craigish Cockles	Ardfern	Common Cockles	NM 82031 05314	AB-786-2028-04	30/01/2017	31/01/2017	S17-002249
Argyll and Bute	Kerrera West	Oitir Mhor	Common Cockles	NM 82399 29998	AB-697-1514-04	31/01/2017	01/02/2017	S17-002254
Argyll and Bute	Kerrera East	Ardantrive	Common Cockles	NM 84061 29943	AB-697-1513-04	31/01/2017	01/02/2017	S17-002255
Argyll and Bute	Loch Fyne: Stonefield Oysters	North Bay Oysters	Pacific Oysters	NR 86495 72268	AB-435-840-13	18/01/2017	14/02/2017	S17-002927
Argyll and Bute	Eriska Shoal Carpet Clams	Eriska Shoal Clams	Carpet Clams	NM 88939 42116	AB-547-1006-02	18/01/2017	14/02/2017	S17-002928
Dumfries & Galloway	Wigtown Bay	Islands of Fleet	Razors	NX 5330 5172	DG-305-182-16	17/01/2017	19/01/2017	S17-001166
East Lothian	Gullane Point North	Gullane North	Razors	NT 4593 8511	EL-601-1087-16	17/01/2017	18/01/2017	S17-001078
Highland Council: Lochaber	Loch Leven Upper	Upper	Common Mussels	NN 14778 61678	HL-171-223-08	25/01/2017	27/01/2017	S17-001741
Highland Council: Lochaber	Loch Leven Lower	Lower	Common Mussels	NN07106 59051	HL-170-222-08	25/01/2017	27/01/2017	S17-001742
Highland Council: Sutherland	Kyle of Durness	Keodale	Pacific Oysters	NC 3778 6613	Not Listed on sample sheet (Should be according to plan: HS-773-1984-13)	13/02/2017	15/02/2017	S17-003001
Fife	Forth Estuary Surf Clams	Shell Bay	Surf Clams	NO 4494 0123	FF-772-1975-19	16/01/2017	18/01/2017	S17-001077
Fife	Fife Ness Surf Clams	Kingsbarn	Surf Clams	NO 6267 1251	FF-771-1974-19	16/01/2017	18/01/2017	S17-001079
Lewis and Harris	Tong Sands	Tong Sands Cockles	Common Cockles	NB 4429 3429	LH-605-110-04	14/02/2017	16/02/2017	S17-003027
Shetland Islands	Wadbister Voe	Wadbister Voe	Common Mussels	HU 4348 5047	SI-294-466-08	06/02/2017	08/02/2017	S17-002683
Shetland Islands	Eshaness Mussels	Eshaness Mussels	Common Mussels	HU 2382 8020	SI-785-2013-08	21/02/2017	22/02/2017	S17-003529
South Ayrshire	North Bay	Barassie	Razors	NS 3183 3386	SA-33771916	16/01/2017	19/01/2017	S17-001165

Local Authority	Production Area	Site name*	Sample type	GR or *NGR for sample	SIN Number*	Date of Collection*	Date Received at Fera	Fera LIMS no.
South Ayrshire	Girvan South Razors	Girvan South Razors	Razors	NX 1775 9732	SA-778-1997-16	27/03/2017	28/03/2017	S17-009723
South Ayrshire	Ballantrae Razors	Ballantrae Razors	Razors	NX 0771 824	SA-780-1999-16	27/03/2017	28/03/2017	S17-009724
South Ayrshire	Lendalfoot Razors	Lendalfoot Razors	Razors	NX 1278 8981	SA-776-1995-16	27/03/2017	28/03/2017	S17-009725
Comhairle nan Eilean Siar: Uist & Barra	Traigh Cille Razors	Traigh Cille Razors	Razors	NF 7160 0728	UB-711-1574-16	20/02/2017	21/02/2017	S17-003384

**Quality statement: Information relating to the origin of the samples (place, date of collection and GR/NGR details) is as provided by sampling staff and has not undergone verification checks by Fera/Cefas.*

Table 2.1: PCDD/Fs (dioxins) concentrations - Whole weight

Note: results maked with an “i” are indicative

Fera LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Whole weight pg/g							
2,3,7,8-TCDD	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
1,2,3,7,8-PeCDD	0.04	0.01	<0.01	<0.01	<0.01	0.04	<0.01
1,2,3,4,7,8-HxCDD	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
1,2,3,6,7,8-HxCDD	0.02	0.01	<0.01	<0.01	<0.01	0.03	<0.01
1,2,3,7,8,9-HxCDD	0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
1,2,3,4,6,7,8-HpCDD	0.03	0.09	0.03	0.03	0.05	0.06	0.02
OCDD	0.09	0.42	0.16	0.20	0.27	0.32	0.06
2,3,7,8-TCDF	0.21	0.20	<0.01	0.01	0.02	0.33	0.04
1,2,3,7,8-PeCDF	0.02	0.01	<0.01	<0.01	<0.01	0.03	<0.01
2,3,4,7,8-PeCDF	0.07	0.05	<0.01	<0.01	0.01	0.12	0.01
1,2,3,4,7,8-HxCDF	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,2,3,6,7,8-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	0.02	0.01	<0.01	<0.01	<0.01	0.03	<0.01
1,2,3,4,6,7,8-HpCDF	<0.01	0.03	<0.01	0.01	0.02	<0.01	<0.01
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
OCDF	<0.01	0.03	<0.01	0.01	0.02	0.02	0.01
WHO-TEQ 2005 (pg/g) lower	**0.10**	**0.05**	**<0.01**	**<0.01**	**0.01**	**0.13**	**0.01**
WHO-TEQ 2005 (pg/g) upper	**0.10**	**0.06**	**0.03**	**0.03**	**0.03**	**0.13**	**0.03**

Fera LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample Type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Whole weight							
pg/g							
2,3,7,8-TCDD	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,2,3,7,8-PeCDD	0.01	0.02	<0.01	0.01i	<0.01	0.02	0.01
1,2,3,4,7,8-HxCDD	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,2,3,6,7,8-HxCDD	0.02	0.02	0.02	0.03	<0.01	0.02	0.01
1,2,3,7,8,9-HxCDD	0.01	0.01	0.02	0.01	<0.01	<0.01	<0.01
1,2,3,4,6,7,8-HpCDD	0.10	0.05	0.28	0.28	0.03	0.08	0.06
OCDD	0.60	0.21	1.05	1.10	0.16	0.17	0.17
2,3,7,8-TCDF	0.29	0.12	0.03	0.04	0.01	0.12	0.07
1,2,3,7,8-PeCDF	0.01	0.02	<0.01	<0.01	<0.01	0.02	0.01
2,3,4,7,8-PeCDF	0.07	0.06	0.03	0.02	<0.01	0.06	0.03
1,2,3,4,7,8-HxCDF	0.02	<0.01	0.02	0.02	<0.01	0.01	<0.01
1,2,3,6,7,8-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	0.01	0.02	0.01	0.01	<0.01	0.02	0.01
1,2,3,4,6,7,8-HpCDF	0.05	<0.01	0.07	0.08	0.01	0.03	0.02
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
OCDF	0.05	<0.01	0.08	0.08	<0.01	0.02	0.02
WHO-TEQ 2005 (pg/g) lower	**0.08**	**0.06**	**0.02**	**0.03**	**<0.01**	**0.06**	**0.03**
WHO-TEQ 2005 (pg/g) upper	**0.08**	**0.07**	**0.05**	**0.04**	**0.03**	**0.07**	**0.04**

Fera LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Whole weight				
pg/g				
2,3,7,8-TCDD	<0.01	<0.01	<0.01	<0.01
1,2,3,7,8-PeCDD	<0.01	<0.01	<0.01	<0.01
1,2,3,4,7,8-HxCDD	<0.01	<0.01	<0.01	<0.01
1,2,3,6,7,8-HxCDD	<0.01	<0.01	<0.01	0.01
1,2,3,7,8,9-HxCDD	<0.01	<0.01	<0.01	<0.01
1,2,3,4,6,7,8-HpCDD	0.09	0.11	0.09	0.06
OCDD	0.43	0.54	0.41	0.20
2,3,7,8-TCDF	0.08	0.14	0.10	0.09
1,2,3,7,8-PeCDF	0.01	0.01	0.01	<0.01
2,3,4,7,8-PeCDF	0.02i	0.03i	0.02	0.03
1,2,3,4,7,8-HxCDF	0.02i	0.02	0.02	<0.01
1,2,3,6,7,8-HxCDF	<0.01	0.01	<0.01	<0.01
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	0.01	0.01	<0.01	0.01
1,2,3,4,6,7,8-HpCDF	0.04i	0.04	0.04	0.02
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01
OCDF	0.04	0.03	0.04	0.01
WHO-TEQ 2005 (pg/g) lower	**0.02**	**0.03**	**0.02**	**0.02**
WHO-TEQ 2005 (pg/g) upper	**0.04**	**0.05**	**0.05**	**0.05**

Table 2.1: PCDD/Fs (dioxins) concentrations - Lipid weight

Fera LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Lipid weight pg/g							
2,3,7,8-TCDD	1.17	0.44	0.75	0.97	0.66	1.51	0.42
1,2,3,7,8-PeCDD	3.90	0.66	2.01	2.06	1.70	4.56	0.77
1,2,3,4,7,8-HxCDD	0.92	0.36	1.07	2.19	1.15	1.39	0.16
1,2,3,6,7,8-HxCDD	2.11	0.80	2.20	3.67	2.57	3.96	0.54
1,2,3,7,8,9-HxCDD	1.44	0.40	1.51	3.54	2.36	2.24	0.33
1,2,3,4,6,7,8-HpCDD	2.92	5.13	17.85	27.57	20.65	7.38	2.04
OCDD	8.09	24.12	105.31	167.02	107.97	38.95	7.04
2,3,7,8-TCDF	18.25	11.37	6.10	8.50	8.44	39.77	4.86
1,2,3,7,8-PeCDF	2.09	0.70	2.58	3.35	3.18	4.17	0.68
2,3,4,7,8-PeCDF	5.86	3.12	3.14	5.35	4.82	14.42	1.35
1,2,3,4,7,8-HxCDF	<0.1	0.63	2.07	4.19	3.18	0.15	0.56
1,2,3,6,7,8-HxCDF	0.71	0.29	1.63	2.83	2.47	1.51	0.42
1,2,3,7,8,9-HxCDF	<0.05	<0.03	0.63	1.16	0.71	<0.1	0.09
2,3,4,6,7,8-HxCDF	1.63	0.69	1.82	3.54	3.56	3.44	0.54
1,2,3,4,6,7,8-HpCDF	0.34	1.56	5.78	10.69	8.71	1.15	1.12
1,2,3,4,7,8,9-HpCDF	<0.1	0.14	0.63	1.55	0.71	0.07	0.16
OCDF	0.29	1.48	4.40	11.01	8.00	2.03	1.32
WHO-TEQ 2005 (pg/g) lower	**9.43**	**3.59**	**5.76**	**8.15**	**6.68**	**15.87**	**2.40**
WHO-TEQ 2005 (pg/g) upper	**9.45**	**3.59**	**5.76**	**8.15**	**6.68**	**15.88**	**2.40**

Fera LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample Type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Lipid weight							
pg/g							
2,3,7,8-TCDD	1.08	1.33	0.89	1.09	0.54	0.81	0.82
1,2,3,7,8-PeCDD	1.06	4.84	1.85	2.01i	2.33	2.46	1.77
1,2,3,4,7,8-HxCDD	0.42	2.25	1.49	1.38	1.68	0.68	0.76
1,2,3,6,7,8-HxCDD	1.42	3.60	5.00	5.43	2.81	2.43	1.84
1,2,3,7,8,9-HxCDD	0.85	2.65	3.01	2.67	2.63	1.00	1.04
1,2,3,4,6,7,8-HpCDD	8.66	10.36	55.90	55.17	24.00	9.63	9.21
OCDD	49.72	40.80	211.10	212.86	110.41	20.72	27.86
2,3,7,8-TCDF	23.85	24.10	6.56	8.20	7.96	14.91	11.39
1,2,3,7,8-PeCDF	1.06	3.82	1.66	1.48	3.59	2.59	2.29
2,3,4,7,8-PeCDF	5.92	11.13	5.33	4.74	4.97	7.31	5.69
1,2,3,4,7,8-HxCDF	1.40	<0.22	3.21	3.36	2.99	1.30	0.95
1,2,3,6,7,8-HxCDF	0.62	1.63	1.16	1.32i	1.68	1.18	1.12
1,2,3,7,8,9-HxCDF	<0.1	<0.18	<0.3	<0.43	<0.48	0.47	<0.32
2,3,4,6,7,8-HxCDF	1.15	3.42	2.68	2.90	2.75	2.39	2.10
1,2,3,4,6,7,8-HpCDF	4.06	1.39	13.78	14.75	7.66	3.46	2.94
1,2,3,4,7,8,9-HpCDF	0.19	0.18	0.96	0.92	0.84	0.32	0.35
OCDF	4.02	1.55	16.86	15.60	6.58	2.93	2.46
WHO-TEQ 2005 (pg/g) lower	**7.06**	**13.52**	**7.47**	**7.87**	**7.08**	**8.12**	**6.42**
WHO-TEQ 2005 (pg/g) upper	**7.07**	**13.56**	**7.50**	**7.91**	**7.13**	**8.12**	**6.45**

Fera LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Lipid weight pg/g				
2,3,7,8-TCDD	0.46i	0.44i	0.66i	0.52
1,2,3,7,8-PeCDD	0.41i	<0.37	0.82	0.92
1,2,3,4,7,8-HxCDD	0.49i	<0.29	0.62	0.52
1,2,3,6,7,8-HxCDD	0.37i	<0.44	0.78	1.25
1,2,3,7,8,9-HxCDD	0.24	0.74	0.80	0.83
1,2,3,4,6,7,8-HpCDD	12.59	12.46	11.67	6.18
OCDD	59.92	61.44	54.33	21.93
2,3,7,8-TCDF	10.81	15.67	12.72	10.40
1,2,3,7,8-PeCDF	1.63	1.37	1.35	0.90
2,3,4,7,8-PeCDF	2.66i	3.75i	2.42	3.54
1,2,3,4,7,8-HxCDF	2.54i	1.84	2.01	1.08
1,2,3,6,7,8-HxCDF	1.02i	1.15	0.73	0.71
1,2,3,7,8,9-HxCDF	<0.29	<0.17	<0.37	<0.19
2,3,4,6,7,8-HxCDF	1.56i	1.23	1.28	1.32
1,2,3,4,6,7,8-HpCDF	5.90i	4.71	5.67	2.59
1,2,3,4,7,8,9-HpCDF	<0.1	<0.15	0.23	<0.11
OCDF	4.93	3.85	4.76	1.51
WHO-TEQ 2005 (pg/g) lower	**3.62**	**3.86**	**4.33**	**4.23**
WHO-TEQ 2005 (pg/g) upper	**3.65**	**4.32**	**4.37**	**4.25**

Table 2.2: Non-*ortho* PCB concentrations

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Whole Weight							
pg/g							
PCB77	2.32	6.90	0.23	0.42	0.80	7.67	0.46
PCB81	0.13	0.30	0.01	0.02	0.04	0.33	0.03
PCB126	0.43	0.48	0.04	0.09	0.17	0.65	0.06
PCB169	0.10	0.08	0.02	0.06	0.09	0.11	0.02
WHO-TEQ 2005 (pg/g) lower	**0.05**	**0.05**	**<0.01**	**0.01**	**0.02**	**0.07**	**0.01**
WHO-TEQ 2005 (pg/g) upper	**0.05**	**0.05**	**<0.01**	**0.01**	**0.02**	**0.07**	**0.01**
Lipid Weight							
pg/g							
PCB77	205.01	396.38	148.43	351.05	326.98	929.29	53.01
PCB81	11.51	17.37	7.29	16.88	16.38	40.12	3.34
PCB126	38.22	27.59	26.72	71.37	69.24	78.37	6.50
PCB169	9.26	4.69	15.03	46.51	38.46	13.61	2.33
WHO-TEQ 2005 (pg/g) lower	**4.12**	**2.94**	**3.14**	**8.57**	**8.12**	**8.35**	**0.73**
WHO-TEQ 2005 (pg/g) upper	**4.12**	**2.94**	**3.14**	**8.57**	**8.12**	**8.35**	**0.73**

FERA LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample Type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Whole Weight							
pg/g							
PCB77	5.96	0.78	1.74	2.20	0.22	2.01	0.45
PCB81	0.28	0.05	0.14	0.19	0.01	0.12	0.03
PCB126	0.63	0.18	0.22	0.26	0.05	0.39	0.15
PCB169	0.13	0.05	0.06	0.06	0.03	0.12	0.05
WHO-TEQ 2005 (pg/g) lower	**0.07**	**0.02**	**0.02**	**0.03**	**0.01**	**0.04**	**0.02**
WHO-TEQ 2005 (pg/g) upper	**0.07**	**0.02**	**0.02**	**0.03**	**0.01**	**0.04**	**0.02**
Lipid Weight							
pg/g							
PCB77	493.26	150.15	348.23	426.98	157.39	242.45	74.30
PCB81	22.95	9.03	29.01	37.36	9.16	14.33	4.43
PCB126	51.78	35.59	43.18	50.82	38.42	46.61	24.17
PCB169	11.08	10.40	11.69	12.41	19.69	14.52	8.28
WHO-TEQ 2005 (pg/g) lower	**5.57**	**3.89**	**4.71**	**5.51**	**4.45**	**5.13**	**2.67**
WHO-TEQ 2005 (pg/g) upper	**5.57**	**3.89**	**4.71**	**5.51**	**4.45**	**5.13**	**2.67**

FERA LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors

Whole Weight

pg/g				
PCB77	3.07	5.96	3.97	1.07
PCB81	0.15	0.23	0.18	0.06
PCB126	0.17	0.29	0.22	0.17
PCB169	0.03	0.04	0.03	0.04
WHO-TEQ 2005 (pg/g) lower	**0.02**	**0.03**	**0.02**	**0.02**
WHO-TEQ 2005 (pg/g) upper	**0.02**	**0.03**	**0.02**	**0.02**

Lipid Weight

pg/g				
PCB77	424.46	679.47	524.01	119.43
PCB81	20.81	26.12	24.13	6.44
PCB126	22.91	33.04	28.85	18.93
PCB169	3.46	4.91	4.14	4.39
WHO-TEQ 2005 (pg/g) lower	**2.44**	**3.53**	**3.07**	**2.04**
WHO-TEQ 2005 (pg/g) upper	**2.44**	**3.53**	**3.07**	**2.04**

Table 2.3: *Ortho* PCB concentrations – Whole weight

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Whole weight µg/kg							
PCB18	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB28	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01
PCB31	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB47	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01
PCB49	<0.01	0.03	<0.01	<0.01	<0.01	0.03	<0.01
PCB51	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB52	0.01	0.04	<0.01	<0.01	<0.01	0.04	<0.01
PCB99	0.03	0.06	<0.01	<0.01	<0.01	0.10	<0.01
PCB101	0.05	0.12	<0.01	<0.01	<0.01	0.14	<0.01
PCB105	0.01	0.04	<0.01	<0.01	<0.01	0.04	<0.01
PCB114	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB118	0.06	0.10	<0.01	<0.01	<0.01	0.13	<0.01
PCB123	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB128	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01
PCB138	0.09	0.19	<0.01	<0.01	0.02	0.31	0.02
PCB153	0.15	0.23	<0.01	<0.01	0.02	0.51	0.02
PCB156	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB157	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB167	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
PCB180	0.01	<0.01	<0.01	<0.01	0.01	0.04	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	**0.31**	**0.60**	**<0.01**	**<0.01**	**0.05**	**1.06**	**0.04**
SUM of ICES 6(µg/kg) upper	**0.32**	**0.61**	**0.06**	**0.06**	**0.08**	**1.06**	**0.08**
WHO-TEQ 2005 (pg/g) lower	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**<0.01**
WHO-TEQ 2005 (pg/g) upper	**<0.01**	**0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**<0.01**

FERA LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Surf Clams Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Whole weight µg/kg							
PCB18	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB28	0.02	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
PCB31	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB47	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB49	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB51	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB52	0.02	<0.01	<0.01	0.01	<0.01	0.01	<0.01
PCB99	0.05	<0.01	0.02	0.02	<0.01	0.02	<0.01
PCB101	0.09	0.01	0.04	0.05	<0.01	0.03	0.01
PCB105	0.03	<0.01	0.01	0.01	<0.01	0.01	<0.01
PCB114	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB118	0.09	0.02	0.04	0.04	<0.01	0.04	0.01
PCB123	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB128	0.03	<0.01	0.01	0.02	<0.01	<0.01	<0.01
PCB138	0.17	0.03	0.12	0.13	<0.01	0.08	0.03
PCB153	0.21	0.05	0.13	0.14	<0.01	0.12	0.05
PCB156	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB157	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB167	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB180	<0.01	<0.01	0.04	0.04	<0.01	<0.01	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	**0.51**	**0.09**	**0.33**	**0.37**	**<0.01**	**0.25**	**0.09**
SUM of ICES 6(µg/kg) upper	**0.52**	**0.12**	**0.35**	**0.38**	**0.06**	**0.26**	**0.12**
WHO-TEQ 2005 (pg/g) lower	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**
WHO-TEQ 2005 (pg/g) upper	**0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**

FERA LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Whole weight µg/kg				
PCB18	<0.01	<0.01	<0.01	<0.01
PCB28	<0.01	0.01	<0.01	<0.01
PCB31	<0.01	0.01	<0.01	<0.01
PCB47	<0.01	0.02	0.01	<0.01
PCB49	0.01	0.02	0.02	<0.01
PCB51	<0.01	<0.01	<0.01	<0.01
PCB52	0.02	0.03	0.02	<0.01
PCB99	0.04	0.06	0.05	<0.01
PCB101	0.09	0.13	0.10	0.02
PCB105	0.02	0.04	0.03	<0.01
PCB114	<0.01	<0.01	<0.01	<0.01
PCB118	0.07	0.12	0.08	0.02
PCB123	<0.01	<0.01	<0.01	<0.01
PCB128	0.02	0.03	0.02	<0.01
PCB138	0.14	0.21	0.16	0.03
PCB153	0.17	0.25	0.19	0.04
PCB156	<0.01	<0.01	<0.01	<0.01
PCB157	<0.01	<0.01	<0.01	<0.01
PCB167	<0.01	<0.01	<0.01	<0.01
PCB180	<0.01	<0.01	<0.01	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	**0.42**	**0.63**	**0.47**	**0.09**
SUM of ICES 6(µg/kg) upper	**0.44**	**0.64**	**0.49**	**0.12**
WHO-TEQ 2005 (pg/g) lower	**<0.01**	**0.01**	**<0.01**	**<0.01**
WHO-TEQ 2005 (pg/g) upper	**0.01**	**0.01**	**0.01**	**<0.01**

Table 2.3: *Ortho* PCB concentrations – Lipid weight

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Lipid weight							
µg/kg							
PCB18	0.14	0.22	0.18	<0.26	0.22	0.27	0.13
PCB28	0.54	1.05	0.52	0.64	0.48	1.97	0.32
PCB31	0.36	0.74	0.33	0.50	0.39	1.09	0.42
PCB47	0.47	0.98	0.35	0.40	0.43	2.79	0.25
PCB49	0.62	1.49	0.34	0.34	0.38	3.40	0.35
PCB51	0.06	0.13	<0.13	0.08	<0.11	0.29	0.04
PCB52	1.13	2.41	0.71	0.58	0.70	4.89	0.41
PCB99	2.73	3.70	1.03	0.87	1.34	11.70	0.54
PCB101	4.41	6.79	1.49	1.37	2.16	17.23	0.94
PCB105	1.31	2.01	0.60	0.68	1.02	5.23	0.23
PCB114	0.06	0.05	0.06	<0.03	0.05	0.23	0.02
PCB118	4.86	5.90	2.02	2.34	3.51	16.25	0.72
PCB123	0.08	0.20	0.06	0.03	0.08	0.63	0.02
PCB128	0.71	1.34	0.44	0.59	0.82	2.90	0.23
PCB138	7.89	10.66	3.90	4.28	6.85	37.43	2.26
PCB153	13.03	13.14	4.63	5.11	7.20	61.41	2.87
PCB156	0.23	0.25	0.23	0.29	0.45	0.72	0.12
PCB157	0.16	0.11	0.11	0.14	0.24	0.64i	0.04
PCB167	0.36	0.23	0.19	0.32	0.41	1.26	0.06
PCB180	0.90	0.16i	1.16	2.50	4.42	5.21	1.05
PCB189	<0.01	<0.01	<0.05	<0.07	0.13	0.07	0.03
SUM of ICES 6(µg/kg) lower	**27.90**	**34.21**	**12.41**	**14.48**	**21.81**	**128.14**	**7.85**
SUM of ICES 6(µg/kg) upper	**27.90**	**34.21**	**12.41**	**14.48**	**21.81**	**128.14**	**7.85**
WHO-TEQ 2005 (pg/g) lower	**0.21**	**0.26**	**0.10**	**0.11**	**0.18**	**0.75**	**0.04**
WHO-TEQ 2005 (pg/g) upper	**0.21**	**0.26**	**0.10**	**0.12**	**0.18**	**0.75**	**0.04**

FERA LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Lipid weight							
µg/kg							
PCB18	0.21	0.13	0.32	0.36	0.17	0.30	0.10
PCB28	1.29	0.46	1.32	1.54	0.43	1.30	0.33
PCB31	0.83	0.36	0.89	1.01	0.28	0.84	0.26
PCB47	0.79	0.46	0.87	1.10	0.57	0.73	0.41
PCB49	1.23	0.50	1.32	1.54	0.27	0.99	0.30
PCB51	0.06	0.06	0.10	0.12	0.08	<0.04	0.03
PCB52	1.92	0.91	2.00	2.39	0.50	1.55	0.66
PCB99	4.01	1.62	4.17	4.70	0.67	2.47	1.18
PCB101	7.48	2.85	9.00	10.15	1.20	4.21	2.30
PCB105	2.33	0.87	2.49	2.74	0.62	1.41	0.76
PCB114	0.08	<0.04	0.14	0.16	<0.1	0.07	0.04
PCB118	7.64	2.91	7.48	8.50	1.81	4.53	2.45
PCB123	0.16	0.07	0.28	0.39	<0.07	0.11	0.05
PCB128	2.07	0.57	2.71	3.01	0.37	1.07	0.60
PCB138	14.09	6.59	23.76	25.13	3.17	9.75	5.66
PCB153	17.06	10.02	25.86	27.55	3.14	13.98	8.02
PCB156	0.41	0.23	0.46	0.58	0.24	0.39	0.25
PCB157	0.21	0.13	0.52	0.62	0.08	0.19	0.10
PCB167	0.37	0.28	0.96	0.99	0.20	0.39	0.20
PCB180	0.06	1.40	7.16	7.61	0.70	0.96	0.46
PCB189	0.03	<0.09	0.12	0.12	<0.08	0.06	0.07
SUM of ICES 6(µg/kg) lower	**41.90**	**22.23**	**69.10**	**74.37**	**9.14**	**31.75**	**17.43**
SUM of ICES 6(µg/kg) upper	**41.90**	**22.23**	**69.10**	**74.37**	**9.14**	**31.75**	**17.43**
WHO-TEQ 2005 (pg/g) lower	**0.34**	**0.14**	**0.37**	**0.42**	**0.09**	**0.22**	**0.12**
WHO-TEQ 2005 (pg/g) upper	**0.34**	**0.14**	**0.37**	**0.42**	**0.10**	**0.22**	**0.12**

FERA LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Lipid weight				
µg/kg				
PCB18	0.27	0.31	0.27	0.09
PCB28	1.08	1.47	1.28	0.32
PCB31	0.83	1.16	0.97	0.26
PCB47	1.14	1.76	1.46	0.37
PCB49	1.74	2.47	2.00	0.31
PCB51	0.11	0.15	0.13	0.04
PCB52	2.90	3.88	3.11	0.55
PCB99	5.67	7.35	6.25	0.86
PCB101	11.91	14.89	13.01	1.58
PCB105	3.32	4.60	3.89	0.51
PCB114	0.13	0.17	0.13	<0.04
PCB118	9.92	13.44	11.19	1.72
PCB123	0.27	0.38	0.24	0.03
PCB128	2.36	3.00	2.62	0.41
PCB138	19.31	23.61	20.84	3.19
PCB153	22.90	28.07	25.59	4.14
PCB156	0.68	0.82	0.75	0.10
PCB157	0.27	0.27	0.28	0.04
PCB167	0.42	0.51	0.45	0.08
PCB180	<0.96	0.85	0.86	0.11
PCB189	<0.23	0.07	<0.04	<0.02
SUM of ICES 6(µg/kg) lower	**58.10**	**72.77**	**64.69**	**9.89**
SUM of ICES 6(µg/kg) upper	**59.06**	**72.77**	**64.69**	**9.89**
WHO-TEQ 2005 (pg/g) lower	**0.45**	**0.61**	**0.51**	**0.07**
WHO-TEQ 2005 (pg/g) upper	**0.46**	**0.61**	**0.51**	**0.08**

Table 2.4: Summary of PCDD/F and PCB WHO-TEQ, and ICES-6 concentrations

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams
Fat content (% whole)	1.13	1.74	0.15	0.12	0.25	0.82	0.86
WHO TEQ 2005 pg/g whole							
Dioxin	0.10	0.06	0.03	0.03	0.03	0.13	0.03
non ortho-PCB	0.05	0.05	<0.01	0.01	0.02	0.07	0.01
ortho-PCB	<0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01
Sum of WHO TEQs (upper)	**0.16**	**0.12**	**0.05**	**0.05**	**0.06**	**0.21**	**0.05**
WHO TEQ 2005 pg/g Fat							
Dioxin	9.45	3.59	5.76	8.15	6.68	15.88	2.40
non ortho-PCB	4.12	2.94	3.14	8.57	8.12	8.35	0.73
ortho-PCB	0.21	0.26	0.10	0.12	0.18	0.75	0.04
Sum of WHO TEQs (upper)	**13.78**	**6.79**	**9.00**	**16.84**	**14.98**	**24.98**	**3.17**
SUM of ICES 6 µg/kg whole (upper)	**0.32**	**0.61**	**0.06**	**0.06**	**0.08**	**1.06**	**0.08**
SUM of ICES 6 µg/kg fat (upper)	**27.90**	**34.21**	**12.41**	**14.48**	**21.81**	**128.14**	**7.85**

FERA LIMS Sample No.	S17-001166	S17-003001	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529
Sample Type	Razors	Pacific Oysters	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels
Production area	Wigtown Bay	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels
Site name	Islands of Fleet	Keodale	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels
Fat content (% whole)	1.21	0.52	0.50	0.52	0.14	0.83	0.61
WHO TEQ 2005 pg/g whole							
Dioxin	0.08	0.07	0.05	0.04	0.03	0.07	0.04
non ortho-PCB	0.07	0.02	0.02	0.03	0.01	0.04	0.02
ortho-PCB	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sum of WHO TEQs (upper)	**0.16**	**0.10**	**0.08**	**0.08**	**0.05**	**0.12**	**0.07**
WHO TEQ 2005 pg/g Fat							
Dioxin	7.07	13.56	7.50	7.91	7.13	8.12	6.45
non ortho-PCB	5.57	3.89	4.71	5.51	4.45	5.13	2.67
ortho-PCB	0.34	0.14	0.37	0.42	0.10	0.22	0.12
Sum of WHO TEQs (upper)	**12.98**	**17.59**	**12.58**	**13.84**	**11.68**	**13.47**	**9.24**
SUM of ICES 6 µg/kg whole (upper)	**0.52**	**0.12**	**0.35**	**0.38**	**0.06**	**0.26**	**0.12**
SUM of ICES 6 µg/kg fat (upper)	**41.90**	**22.23**	**69.10**	**74.37**	**9.14**	**31.75**	**17.43**

FERA LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Fat content (% whole)	0.72	0.88	0.76	0.89
WHO TEQ 2005 pg/g whole				
Dioxin	0.04	0.05	0.05	0.05
non ortho-PCB	0.02	0.03	0.02	0.02
ortho-PCB	0.01	0.01	0.01	<0.01
Sum of WHO TEQs (upper)	**0.07**	**0.09**	**0.08**	**0.08**
WHO TEQ 2005 pg/g Fat				
Dioxin	3.65	4.32	4.37	4.25
non ortho-PCB	2.44	3.53	3.07	2.04
ortho-PCB	0.46	0.61	0.51	0.08
Sum of WHO TEQs (upper)	**6.55**	**8.46**	**7.95**	**6.37**
SUM of ICES 6 µg/kg whole (upper)	**0.44**	**0.64**	**0.49**	**0.12**
SUM of ICES 6 µg/kg fat (upper)	**59.06**	**72.77**	**64.69**	**9.89**

Table 2.5: PAH concentrations (µg/kg whole weight)

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive
µg/kg whole weight					
acenaphthylene	<0.16	0.57	<0.17	<0.05	<0.05
acenaphthene	<0.39	<0.37	<0.39	<0.38	<0.38
fluorene	<0.4	0.66	<0.4	<0.43	<0.43
phenanthrene	1.35	2.16	<0.51	<0.5	<0.5
anthracene	0.09	0.22	0.01	0.01	<0.03
fluoranthene	2.52i	4.53	0.53	0.31	0.44
benzo[c]fluorene	0.13	0.25	0.03	0.01	0.03
pyrene	1.49	3.37i	<0.28	0.27i	0.43i
benzo[ghi]fluoranthene	1.01	1.67	0.22	0.13	0.20
benz (a) anthracene	**0.52**	**1.54**	**0.16**	**0.12**	**0.19**
benzo[b]naphtho[2,1-d]thiophene	0.16	0.22	0.05	0.03	0.07
cyclopenta[c,d]pyrene	0.08	0.06	0.02	<0.01	0.02
chrysene	**0.92**	**1.62**	**0.33**	**0.21**	**0.35**
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	**1.54**	**2.46**	**0.42**	**0.33**	**0.39**
benzo[j]fluoranthene	0.37	1.05	0.20	0.15	0.19
benzo[k]fluoranthene	0.53	1.10	0.20	0.16	0.22
benzo[e]pyrene	1.69	3.39	0.49	0.43	0.49
benzo[a]pyrene	**0.22**	**0.96**	**0.15**	**0.12**	**0.18**
indeno[1,2,3-cd]pyrene	0.22	0.67	0.28	0.27	0.28
dibenz[ah]anthracene	0.05i	0.10i	<0.04	<0.05	0.04i
benzo-[g,h,i]perylene	0.29	0.74	0.25	0.28	0.30
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	0.10	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	**3.20**	**6.58**	**1.06**	**0.78**	**1.11**
PAH 4 Sum Upper µg/kg	**3.20**	**6.58**	**1.06**	**0.78**	**1.11**

FERA LIMS Sample No.	S17-002927	S17-002928	S17-001166	S17-001078	S17-001741
Sample Type	Pacific Oysters	Carpet Clams	Razors	Razors	Common Mussels
Production area	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams	Wigtown Bay	Gullane Point North	Loch Leven Upper
Site name	North Bay Oysters	Eriska Shoal Clams	Islands of Fleet	Gullane North	Upper
µg/kg whole weight					
acenaphthylene	0.10	<0.05	<0.16	0.25i	<0.17
acenaphthene	<0.38	<0.38	<0.39	<0.38	<0.39
fluorene	<0.43	<0.43	0.45	0.51	<0.4
phenanthrene	0.74	1.18	2.02	1.84	<0.51
anthracene	0.10	0.09	0.17	0.37	0.08
fluoranthene	2.24	1.12	4.77	6.10i	1.12
benzo[c]fluorene	0.11	0.08	0.25	0.45	0.11
pyrene	2.32i	0.85i	2.89i	5.97i	1.22
benzo[ghi]fluoranthene	1.29	0.31	2.05	2.41	0.79
benz (a) anthracene	**0.84**	**1.14**	**2.12**	**3.36**	**0.71**
benzo[b]naphtho[2,1-d]thiophene	0.14	0.10	0.32	0.36	0.19
cyclopenta[c,d]pyrene	0.06	0.03	0.03	0.06	0.05
chrysene	**0.86**	**1.13**	**2.02**	**2.82**	**1.28**
5-methylchrysene	0.05i	<0.01	0.01	0.03	<0.01
benzo[b]fluoranthene	**3.21**	**0.78**	**2.95**	**3.16**	**6.79**
benzo[j]fluoranthene	0.86	0.19	1.13	1.40	1.73
benzo[k]fluoranthene	1.37	0.14	1.32	1.51	2.45
benzo[e]pyrene	3.95	0.47	4.02	4.47	5.98
benzo[a]pyrene	**0.62**	**0.09**	**1.11**	**1.90**	**1.79**
indeno[1,2,3-cd]pyrene	0.63	0.15	0.69	0.93	1.89
dibenz[ah]anthracene	0.14i	<0.04	0.13i	0.18i	0.41
benzo-[g,h,i]perylene	0.98	0.20	0.72	1.21	2.76
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	0.12	<0.1	0.12	0.19	0.24
PAH 4 Sum Lower µg/kg	**5.53**	**3.14**	**8.20**	**11.24**	**10.57**
PAH 4 Sum Upper µg/kg	**5.53**	**3.14**	**8.20**	**11.24**	**10.57**

FERA LIMS Sample No.	S17-001742	S17-003001	S17-001077	S17-001079
Sample Type	Common Mussels	Pacific Oysters	Surf Clams	Surf Clams
Production area	Loch Leven Lower	Kyle of Durness	Forth Estuary Surf Clams	Fife Ness Surf Clams
Site name	Lower	Keodale	Shell Bay	Kingsbarn
µg/kg whole weight				
acenaphthylene	<0.17	<0.05	<0.17	<0.17
acenaphthene	<0.39	<0.38	<0.39	<0.39
fluorene	<0.4	<0.43	0.43	0.44
phenanthrene	0.53	<0.5	1.60	1.52
anthracene	0.07	0.02	0.24	0.24
fluoranthene	0.95	0.84	2.18	2.52
benzo[c]fluorene	0.08	0.03	0.14	0.18
pyrene	0.83	0.48i	1.96i	2.15i
benzo[ghi]fluoranthene	0.61	0.32	0.69	0.79
benz (a) anthracene	**0.53**	**0.13**	**0.95**	**1.18**
benzo[b]naphtho[2,1-d]thiophene	0.13	0.04	0.13	0.13
cyclopenta[c,d]pyrene	0.06	<0.01	0.04	0.05
chrysene	**0.89**	**0.27**	**0.97**	**1.19**
5-methylchrysene	0.03	<0.01	<0.01	<0.01
benzo[b]fluoranthene	**3.57**	**0.68**	**1.09**	**1.26**
benzo[j]fluoranthene	0.98	0.15	0.51	0.60
benzo[k]fluoranthene	1.27	0.25	0.53	0.64
benzo[e]pyrene	3.26	0.77	1.52	1.60
benzo[a]pyrene	**0.64**	**0.06**	**0.78**	**0.91**
indeno[1,2,3-cd]pyrene	1.03	0.14	0.76	0.80
dibenz[ah]anthracene	0.18i	<0.04	0.12i	0.12i
benzo-[g,h,i]perylene	1.66	0.19	0.98	1.06
anthanthrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	0.11
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1
coronene	0.17	<0.1	0.25	0.26
PAH 4 Sum Lower µg/kg	**5.63**	**1.14**	**3.79**	**4.54**
PAH 4 Sum Upper µg/kg	**5.63**	**1.14**	**3.79**	**4.54**

FERA LIMS Sample No.	S17-003027	S17-002683	S17-003529	S17-001165
Sample Type	Common Cockles	Common Mussels	Common Mussels	Razors
Production area	Tong Sands	Wadbister Voe	Eshaness Mussels	North Bay
Site name	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels	Barassie
µg/kg whole weight				
acenaphthylene	<0.05	0.06	<0.05	<0.17
acenaphthene	<0.38	<0.38	<0.38	<0.39
fluorene	<0.43	0.44	<0.43	0.81
phenanthrene	<0.5	0.94	<0.5	3.54
anthracene	0.02	0.06	0.02	0.19
fluoranthene	0.26	0.84	0.48	6.72i
benzo[c]fluorene	<0.01	0.04	0.02	0.38
pyrene	0.23i	0.85	0.33i	3.51i
benzo[ghi]fluoranthene	0.07	0.35	0.17	2.27
benz (a) anthracene	**0.06**	**0.23**	**0.09**	**2.28**
benzo[b]naphtho[2,1-d]thiophene	0.02	0.09	0.04	0.41
cyclopenta[c,d]pyrene	<0.01	0.03	0.01	0.07
chrysene	**0.13**	**0.45**	**0.26**	**2.56**
5-methylchrysene	<0.01	<0.01	<0.01	0.02
benzo[b]fluoranthene	**0.11**	**0.79**	**0.32**	**3.62**
benzo[j]fluoranthene	0.04	0.28	0.11	1.43
benzo[k]fluoranthene	0.05	0.28	0.10	1.54
benzo[e]pyrene	0.12	0.91	0.32	4.98
benzo[a]pyrene	**<0.05**	**0.15**	**0.06**	**1.28**
indeno[1,2,3-cd]pyrene	0.09i	0.36	0.12i	0.84
dibenz[ah]anthracene	<0.04	<0.04	<0.04	0.14i
benzo-[g,h,i]perylene	0.08	0.48	0.16	0.91
anthanthrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	0.14	<0.1	0.15
PAH 4 Sum Lower µg/kg	**0.30**	**1.62**	**0.73**	**9.74**
PAH 4 Sum Upper µg/kg	**0.35**	**1.62**	**0.73**	**9.74**

FERA LIMS Sample No.	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Razors	Razors	Razors	Razors
Production area	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
µg/kg whole weight				
acenaphthylene	0.10	<0.06	<0.07	<0.05
acenaphthene	<0.38	<0.31	<0.31	<0.38
fluorene	<0.43	<0.39	<0.39	0.51
phenanthrene	1.52	1.69	1.57	1.37
anthracene	0.18	0.18	0.17	0.05
fluoranthene	4.46	5.35i	4.53i	1.20
benzo[c]fluorene	0.23	0.30	0.24	0.06
pyrene	3.19i	3.77i	2.78i	0.72
benzo[ghi]fluoranthene	1.60	1.96	1.70	0.41
benz (a) anthracene	**2.20**	**2.82**	**2.41**	**0.26**
benzo[b]naphtho[2,1-d]thiophene	0.50	0.59	0.51	0.08
cyclopenta[c,d]pyrene	0.05	0.07	0.05	0.02
chrysene	**2.98**	**3.79**	**3.13**	**0.56**
5-methylchrysene	0.07i	0.09	0.07	0.01
benzo[b]fluoranthene	**2.07**	**2.41**	**2.02**	**0.85**
benzo[j]fluoranthene	0.94	1.07	0.93	0.32
benzo[k]fluoranthene	1.19	1.34i	1.20i	0.35
benzo[e]pyrene	2.89	3.46	2.91	0.89
benzo[a]pyrene	**1.23**	**1.44**	**1.17**	**0.15**
indeno[1,2,3-cd]pyrene	0.85	0.93	0.77	0.27
dibenz[ah]anthracene	0.12i	0.17i	0.16i	<0.04
benzo-[g,h,i]perylene	0.96	1.00	0.86	0.26
anthanthrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1
coronene	0.23	0.22	0.21	<0.1
PAH 4 Sum Lower µg/kg	**8.48**	**10.46**	**8.73**	**1.82**
PAH 4 Sum Upper µg/kg	**8.48**	**10.46**	**8.73**	**1.82**

.

Table 2.6: Heavy Metal Concentrations (mg/kg whole weight)

FERA LIMS Sample No.	S17-001409	S17-001505	S17-002249	S17-002254	S17-002255	S17-002927	S17-002928	S17-001166	S17-003001
Sample Type	Pacific Oysters	Razors	Common Cockles	Common Cockles	Common Cockles	Pacific Oysters	Carpet Clams	Razors	Pacific Oysters
Production area	Seil Sound North	Peniver Razors	Loch Craigish Cockles	Kerrera West	Kerrera East	Loch Fyne: Stonefield Oysters	Eriska Shoal Carpet Clams	Wigtown bay	Kyle of Durness
Site name	Balvicar North	Peniver Razors	Ardfern	Oitir Mhor	Ardantrive	North Bay Oysters	Eriska Shoal Clams	Islands of Fleet	Keodale
Cr	~0.05	0.3	0.14	0.18	0.19	~0.05	0.13	0.17	~0.04
Mn	2.93	1.67	1.9	1.67	1.16	5.73	0.7	3.04	2.8
Co	0.02	0.101	0.149	0.144	0.089	0.021	0.185	0.086	0.021
Ni	~0.04	0.14	1.5	2.31	1.79	~0.06	1.17	~0.09	~0.05
Cu	7.56	1.15	0.32	0.22	0.24	9.32	0.84	1.26	3.18
Zn	132	16.7	4.96	3.73	3.14	97.6	7.23	15.5	65.4
As	1.73	1.73	0.8	1.09	1.03	1.69	4.8	1.45	1.07
Se	0.195	0.341	0.161	0.152	0.123	0.231	0.494	0.331	0.18
Ag	0.297	0.451	~0.005	~0.004	~0.005	0.526	1.77	0.177	0.214
Cd	0.091	0.044	0.032	0.021	0.024	0.318	0.092	0.034	0.11
Hg	0.014	0.019	0.008	0.008	0.007	~0.007	0.015	0.022	~0.007
Pb	0.038	0.056	0.037	0.055	0.062	0.036	0.04	0.124	0.024

' ~ ' indicates the measured value was above LoD but below LoQ

FERA LIMS Sample No.	S17-001077	S17-001079	S17-003027	S17-002683	S17-003529	S17-009723	S17-009724	S17-009725	S17-003384
Sample Type	Surf Clams	Surf Clams	Common Cockles	Common Mussels	Common Mussels	Razors	Razors	Razors	Razors
Production area	Forth Estuary Surf Clams	Fife Ness Surf Clams	Tong Sands	Wadbister Voe	Eshaness Mussels	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Site name	Shell Bay	Kingsbarn	Tong Sands Cockles	Wadbister Voe	Eshaness Mussels	Girvan South Razors	Ballantrae Razors	Lendalfoot Razors	Traigh Cille Razors
Cr	0.2	0.16	0.16	~0.1	~0.06	0.11	0.17	0.11	0.13
Mn	3.07	2.08	1	1.03	1.41	1.94	2.63	2.03	0.82
Co	0.139	0.136	0.071	0.017	0.016	0.055	0.069	0.058	0.036
Ni	0.29	0.27	1.63	0.13	~0.09	0.1	0.12	0.1	~0.06
Cu	1.09	1.1	0.24	0.78	0.58	1.1	1.38	1.22	0.8
Zn	7.16	7.54	3.25	12.5	10.4	14.7	17.7	14.9	12.7
As	1.51	1.52	0.9	1.26	1.16	1.33	1.56	1.3	1.33
Se	0.397	0.407	0.093	0.254	0.249	0.203	0.255	0.213	0.201
Ag	0.208	0.181	~0.006	~0.006	~0.005	0.068	0.07	0.068	0.067
Cd	0.064	0.067	0.033	0.072	0.063	0.02	0.023	0.02	0.033
Hg	0.014	0.015	~0.004	~0.005	~0.005	0.009	0.01	0.009	0.011
Pb	0.114	0.1	0.03	0.085	0.05	0.069	0.081	0.067	0.031

' ~ ' indicates the measured value was above LoD but below LoQ

Fera hereby excludes all liability for any claim, loss, demands or damages of any kind whatsoever (whether such claims, loss, demands or damages were foreseeable, known or otherwise) arising out of or in connection with the preparation of any technical or scientific report , including without limitation, indirect or consequential loss or damage; loss of actual or anticipated profits (including loss of profits on contracts); loss of revenue; loss of business; loss of opportunity; loss of anticipated savings; loss of goodwill; loss of reputation; loss of damage to or corruption of data; loss of use of money or otherwise, and whether or not advised of the possibility of such claim, loss demand or damages and whether arising in tort (including negligence), contract or otherwise. This statement does not affect your statutory rights.

Nothing in this disclaimer excludes or limits Fera liability for: (a) death or personal injury caused by Fera negligence (or that of its employees, agents or directors); or (b) the tort of deceit; [or (c) any breach of the obligations implied by Sale of Goods Act 1979 or Supply of Goods and Services Act 1982 (including those relating to the title, fitness for purpose and satisfactory quality of goods);] or (d) any liability which may not be limited or excluded by law (e) fraud or fraudulent misrepresentation.

The parties agree that any matters are governed by English law and irrevocably submit to the non-exclusive jurisdiction of the English courts.