

Chemical Contaminant Sampling and Analysis of Shellfish from Classified Harvesting Areas (2014)

Report to the Food Standards Agency in Scotland

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Glossary of Main Terms

Term or Acronym	General Meaning Of Term
EU	European Union
EC	European Commission
FSAS	Food Standards Agency in Scotland
WHO	World Health Organisation
PAHs	Polycyclic aromatic hydrocarbons
PAH 4 Sum	Sum of 4 PAHs (benzo[a]pyrene, benz[a]anthracene, benzo[b]fluoranthene, chrysene)
PCB	Polychlorinated biphenyl
<i>Ortho</i> -PCB	Ortho-substituted PCB (non planar)
<i>Non-ortho</i> -PCB	Non-ortho-substituted PCB (co-planar)
Dioxins	Collective name for chlorinated Dioxins & Furans
PCDD/F	Polychlorinated dibenzo- <i>p</i> -dioxin/ polychlorinated dibenzofuran
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. <math><0.01=0</math>)
Upper bound	assumes values at less than the limit of detection are equal to the limit of detection (e.g. <math><0.07=0.07</math>)
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

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 nine composite samples of shellfish including mussels, Pacific oysters, cockles, native oysters, queen scallop, razor clams, wedge clams and surf clams for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, dioxins), polychlorinated biphenyls (PCBs) and thirty-six samples for polycyclic aromatic hydrocarbons (PAHs) and heavy metals. 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 observed levels of the currently regulated PAHs were benzo[a]pyrene at 5.93 µg/kg, and PAH 4 at 29.94 µg/kg compare to the maximum permitted level (MPL) of 5 µg/kg and 30 µg/kg respectively (Regulation (EC) No. 835/2011). Four samples exceeded the MPL for benzo[a]pyrene. In the case of PCDD/Fs and PCBs in particular, contaminant concentrations were all below the regulatory maximum levels (Regulation (EU) No. 1259/2011), and this level of occurrence is unlikely to pose a risk to public health. Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits except for one sample, which contained cadmium at 3.98 mg/kg (MPL 1.0 mg/kg - Commission Regulation (EC) No. 1881/2006 as amended). Contaminant profiles from the current study are similar to the previous year's data. The data contained in this report will be issued as individual test reports for each of the relevant shellfish producing area local authorities.

Following the exceedence of MPLs for benzo[a]pyrene and cadmium, the areas in question were re-sampled and tests carried out for PAHs and metals respectively. The results for the re-sampled areas all showed levels to be below MPLs.

1. Study Background

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 dioxins 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 regulation for the control of these contaminants in a range of foods including shellfish. (Commission Regulation (EC) No 1259/2011, Commission Regulation (EU) No 835/2011, Commission Regulation (EC) No 333/2007). Some of the regulations specify new requirements on the controls expected by the competent authority (Food Standards Agency) with respect to classified shellfish production areas. 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) (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. 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 effect 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, 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). However 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 B[a]P 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, the FSA in Scotland has overseen the collection of shellfish each year, from classified shellfish production sites within relevant local authority areas in Scotland. In comparison to previous years, the present study has been extended to sites that were not included in earlier chemical contaminant testing. The production sites are required to monitor shellfish samples, with the edible tissues analysed for the contaminants described above, as specified in Commission Regulation (EU) No. 252/2012. The analysis is carried out at the Food and Environment Research Agency (FERA) in York.

FERA is an executive agency of the UK Government's Department for Environment, Food and Rural affairs (DEFRA). In the current context, FERA has generated environmental contaminant data to FSA Scotland, on shellfish collected from new and existing shellfish sites since 2007. This report collates the results of the individual analyses for dioxins, PAHs and heavy metals in samples

of shellfish collected from Scottish sites in the first quarter of 2014 and samples collected in June 2014 from five harvesting areas where exceedance of MPLs was observed in earlier samples.

2. Methodology

2.1 Sample Collection and Preparation

Thirty six samples (individual sub-samples from each site were composited) of shellfish, including species such as common mussels, Pacific oysters, common cockles, surf clams, king scallops, queen scallop, native oysters and razor clams were collected during January to February 2014. The sampling period was timed to coincide with the period of optimal contaminant concentrations in the shellfish. In June 2014, five further samples were collected from areas where the initial samples exceeded MPLs - three razor clam samples and a queen scallop sample for benzo[a]pyrene and a king scallop sample for cadmium.

Details on the locations, with descriptions of the samples and identification are given in Table 1. The broad geographical distribution of Scottish shellfish production areas is given in Figure 1.

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 prior to analysis. Sample preparation consisted of shelling followed by compositing of individual sub-samples. The composites were thoroughly homogenised 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.

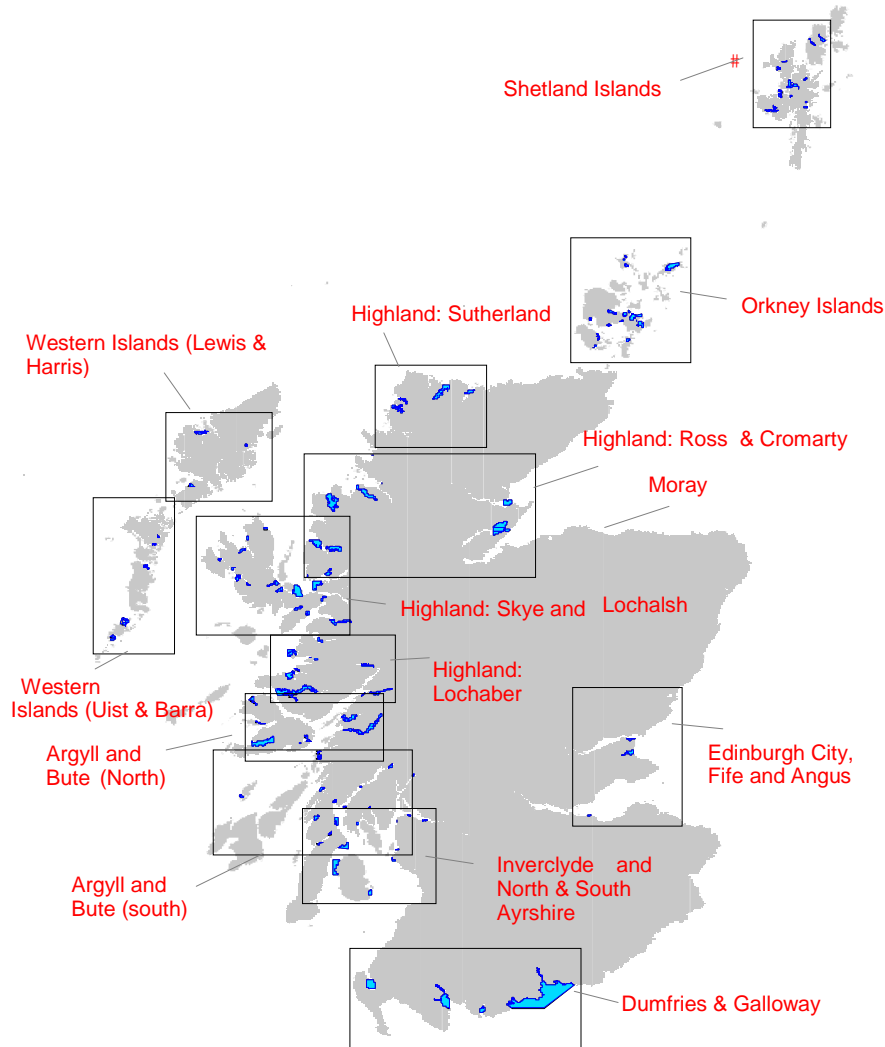
Non Dioxin-like PCBs - IUPAC numbers 18, **28**, 31, 47, 49, 51, **52**, 99, **101**, 128, **138**, **153** and **180**.

PAHs -

acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, benzo[c]fluorene, pyrene, benzo[e]pyrene, benzo[b]naphtho[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)**

Figure 1: Shellfish Production Areas that have been monitored since 2006



2.3 PCDD/F and PCB - Analytical Methodology

(FERA (UK NRL) SOPs FSG 453-460)

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 ¹³C-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-2011 and Dioxins in Food-2012, 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 252/2012). In addition, as NRL for chemical contaminants, FERA participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL.

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 ¹³C-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. T0651, PAHs in palm oil) 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.

2.5 Trace Elements - Analytical Methodology

(FERA (UK NRL) SOP FSG 454 and 457)

Aliquots of the homogenised sample were weighed into allotted quartz digestion vessels and a mixture (4:1) of nitric acid and hydrochloric acid added. The vessels were sealed and the contents digested using a high pressure microwave digestion system. 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. 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 7500ce ICP-MS with collision cell.

In common with the other two sets of analyses, 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. 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.

Table 1: Overview of samples

Local Authority	Production Area	Site name	Collection period	Sample type	GR or *NGR for sample	OEC Sample No.
Argyll and Bute	Ardcastle Bay Mussels	Ardcastle Mussels	18/02/2014	Common Mussels	NR 95497 91887	22546
	Ardcastle Bay Oysters	Ardcastle Oysters	18/02/2014	Pacific Oyster	NR 95497 91887	22549
	Loch Fyne Otter Ferry	Ballimore	21/01/2014	Pacific Oysters	NR 92174 83505	22289
	Loch Fyne Stonefield	North Bay	16/01/2014	Queen Scallops	NR 86486 72257	22262
	Loch Fyne Stonefield (Re-sample)	North Bay	16/06/2014	Queen Scallops	NR86494 72258	22833
	Loch Spelve	Croggan Pier	14/01/2014	Pacific Oysters	NM 70779 27339	22259
	West Jura	Jura	14/01/2014	Razors	Unverified	22261
Dumfries and Galloway	Loch Ryan	Loch Ryan	13/01/2014	Native oysters	NX0675 6624	22254
	Luce Bay	Luce Sand	17/02/2014	Razors	NX 1208 5204	22550
	Luce Bay (Re-sample)	Luce Sand	24/06/2014	Razors	NX1300 5200	22840
Fife	Forth Estuary Anstruther	Anstruther	14/01/2014	Surf Clams	56' 13.86N 002' 39.40W	22256
	Forth Estuary Largo Bay	Largo Bay	19/02/2014	Razors	NO 4429 0134	22588
	Forth Estuary Pittenweem	Pittenweem Surfs	14/01/2014	Surf Clams	56' 12.40N 002' 43.01W	22255
Highland: Ross and Cromarty	Loch Ewe & Loch Thurnaig Scallops	Loch Ewe	03/02/2014	King Scallops	NG 85832 88632	22432
	Loch Ewe & Loch Thurnaig Scallops (Re-sample)	Loch Ewe	17/06/2014	King Scallops	NG 8585888513	22834
Highland:Lochaber	Loch Leven Lower	Lower	10/02/2014	Common Mussels	NN0716 5905	22453
	Loch Leven Upper	Upper	10/02/2014	Common Mussels	NN1480 6168	22452
	Loch Sunart	Liddesdale	28/01/14	Common Mussels	NM78325 60112	22419
Highland:Sutherland	Dornoch Firth	Dornoch Firth	20/01/2014	Common Mussels	NH 7751 8484	22285
	Kyle of Tongue	Kyle of Tongue	19/02/2014	Pacific Oyster	NC 5932 5902	22589
	Loch Glencoul	Kylesku	18/02/2014	Common Mussels	NC 2407 3406	22593
	Loch Inchard	Loch Inchard Site 4	20/01/2014	Common Mussels	NL 2350 5536	22267

Local Authority	Production Area	Site name	Collection period	Sample type	GR or *NGR for sample	OEC Sample No.
Lewis and Harris	East Loch Tarbert	Sound of Scalpey	21/01/2014	Common Mussels	NG 2221 9762	22288
	Loch Leurbost	Eilean Miavaig	28/1/14	Common Mussels	NB 3764 2453	22420
	Loch Roag: Barraglom	Barraglom	17/02/2014	Common Mussels	NB 1667 3417	22548
North Ayrshire	Fairlie	Southannan Sands	21/01/2014	Pacific Oysters	NS 1942 5435	22287
	Stevenston Sands	Stevenston Sands	11/02/2014	Razors	NS 3035 3781	22456
	Stevenston Sands (Re-sample)	Stevenston Sands	16/06/2014	Razors	NS2904 3878	22838
Orkney	Ferness Bay	Ferness Razors	12/01/2014	Razors	Unverified	22258
Shetland Islands	Baltasound Mussels	Baltasound Harbour	18/02/2014	Common Mussels	HP 6448 0885	22547
	Clift Sound Booth	Booth	05/02/2014	Common Mussels	HU 4019 3778	22434
	Clift Sound Houss	Houss	05/02/2014	Common Mussels	HU 3854 3193	22433
	Mid Yell Voe	Camb	14/01/2014	Common Mussels	HU 5117 9191	22257
	Olna Firth Inner	Inner	10/02/2014	Common Mussels	HU 3968 6361	22451
	Stromness Voe	Burra Holm	17/02/2014	Common Mussels	HU 3857 4556	22537
	Vaila Sound: East of Linga and Galtaskerry	Whitesness	15/01/2014	Common Mussels	HU 2439 4760	22260
South Ayrshire	Meikle Craigs	Silver Sands	11/02/2014	Razors	NS 3430 2637	22457
	Meikle Craigs (Re-sample)	Silver Sands	16/06/2014	Razors	N/A	22839
	North Bay	Barassie	20/01/2014	Razors	NS 3183 3386	22286
Uist and Barra	North Ford	Ortir Mhor	29/01/14	Common Cockles	NF 8405 5786	22418
	Traigh Mhor	Traigh Mhor	21/01/2014	Common Cockles	NF 7036 0497	22353

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.

3. Results

Analyte concentrations are presented in Tables 3.1 to 3.6. 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.

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, 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 ranged from 0.06 pg TEQ/g to 0.46 pg TEQ/g which is comparable to data from 2013. The highest value was found in Pacific oysters, as was the case in 2012 and 2013. For most of the samples PCDD/Fs contributed roughly two-thirds to the total TEQ. The exceptions were a common mussel sample from Shetlands and a razor clam from the Forth Estuary, where PCDD/Fs only contributed approximately half the total TEQ.

The concentration of ICES-6 PCB ranged from 0.09 µg/kg to 2.42 µg/kg, with the highest levels found in Pacific oysters.

PAHs were detected in all 36 samples analysed. Higher molecular weight PAHs such as anthanthrene and the dibenzopyrenes were not found above the LOQ in any samples. Residues of PAH4 ranged from 0.51 µg/kg to 29.94 µg/kg, compared with 0.49 µg/kg to 23.3 µg/kg in 2013. The highest levels were found in razor clams. Three of the seven razor clam samples and a queen scallops sample contained benzo[a]pyrene above the regulatory limit of 5 µg/kg (Commission Regulation (EC) No. 835/2011). These were samples collected from Stevenston Sands, Meikle Craigs, Luce Bay and Loch Fyne Stonefield with benzo[a]pyrene concentrations of 5.50 (± 0.94),

5.93 (\pm 1.01), 5.82 (\pm 0.99) & 5.45 (\pm 0.94) $\mu\text{g}/\text{kg}$ respectively. One razor clam collected from Meikle Criags was on the borderline of exceeding the limit for PAH4 set at 30 $\mu\text{g}/\text{kg}$ with a concentration of 29.94 (\pm 2.48) $\mu\text{g}/\text{kg}$. Lowest levels were found in common cockles.

Heavy metals were detected in all samples. The four 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 by 629/2008) except for a king scallop collected from Loch Ewe which exceeded MPL of 1 mg/kg for Cd (level detected in sample 3.92 (\pm 0.71) mg/kg). The Cd result was based on the analysis of the whole animal. As only the adductor muscle and the gonad are usually consumed, recent changes in regulations (488/2014) have been modified with regard to the requirement of king scallop testing to reflect this.

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

Following the exceedance of MPLs for benzo[a]pyrene and Cd, the areas in question were re-sampled and tests were carried out for PAHs and metals respectively. The results for the re-sampled areas all showed levels to be below MPLs. The three razor clam samples each gave a benzo[a]pyrene concentration of 0.20 $\mu\text{g}/\text{kg}$ and the queen scallop sample gave a benzo[a]pyrene concentration of 0.34 $\mu\text{g}/\text{kg}$. The king scallop gave a Cd concentration of 0.52 mg/kg. The follow up sample details are below the original details in table 1 and the follow up results are included alongside the original sample data in the results tables 3.5 & 3.6.

4. Conclusions

In general terms the results of the 2014 monitoring for PCDD/Fs, PCBs, PAHs and heavy metals are similar to the 2013 data, with a slight elevation of concentrations observed. In particular, there were three razor clam samples and one queen scallop sample which exceeded the maximum permitted limit (MPL) for benzo[a]pyrene. There was also one king scallop sample which exceeded the MPL for cadmium. No firm conclusion can be drawn from the data due to the low number of samples for a given species and location. Following the exceedance of MPLs, the areas in question were re-sampled and tests carried out for PAHs and metals. The results for the re-sampled areas all showed levels to be below MPLs.

Further analysis of the data in conjunction with details such as sampling locations and times would yield information on spatial distribution of contaminants, and may allow further conclusions to be drawn, but this is outside the scope of the current project.

Table 3.1 PCDD/Fs (dioxins) concentrations - Whole weight

Note: results marked with an “i” are indicative

OEC Reference No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
Fera LIMS Sample No.	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Sample type	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Production area	Dornoch Firth	Fairlie	Loch Sunar	Clift Sound Houss	Loch Leven Lower	Meikle Craigs	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Site name	Dornoch Firth	Southannan Sands	Liddesdale	Clift Sound Houss	Lower	Silver Sands	Bay Mussels	Bay Oysters	Largo Bay
Whole weight pg/g									
2,3,7,8-TCDD	<0.01	0.03 i	<0.01	<0.01	0.01 i	0.02	<0.01	0.02	<0.01
1,2,3,7,8-PeCDD	<0.01	0.06	0.03	0.02	0.03	0.02	0.04	0.08	0.02
1,2,3,4,7,8-HxCDD	<0.01	0.02	0.02	0.01	0.02	0.02	0.03	0.03	<0.01
1,2,3,6,7,8-HxCDD	<0.01	0.04	0.03	0.03	0.03	0.03	0.06	0.07	0.04
1,2,3,7,8,9-HxCDD	<0.01	0.03	0.02	0.02	0.02	0.01	0.04	0.04	0.02
1,2,3,4,6,7,8-HpCDD	0.03	0.1	0.12	0.12	0.22	0.15	0.29	0.14	0.29
OCDD	0.15	0.29	0.3	0.29	0.75	0.54	0.69	0.31	1.13
2,3,7,8-TCDF	0.03	0.9	0.11	0.21	0.14	0.65	0.16	0.57	0.13
1,2,3,7,8-PeCDF	<0.01	0.06	0.03	0.03	0.07	0.02	0.04	0.07	0.04 i
2,3,4,7,8-PeCDF	0.02	0.39	0.07 i	0.09	0.1	0.28	0.2	0.3	0.04 i
1,2,3,4,7,8-HxCDF	<0.01	<0.01	0.01	0.02	0.02	0.03	0.04	0.01	0.02
1,2,3,6,7,8-HxCDF	<0.01	0.02	0.01	0.01	0.02	0.02	0.03	0.04	0.02
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	<0.01	0.04	0.03	0.03	0.03	0.02	0.07	0.08	0.01
1,2,3,4,6,7,8-HpCDF	<0.01	<0.01	0.02	0.04	0.04	0.05	0.06	0.03	0.07
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
OCDF	0.01	0.02	0.02	0.05	0.05	0.06	0.07	0.03	0.07
WHO-TEQ 2005 (pg/g) lower	0.01	0.31	0.08	0.08	0.10	0.20	0.15	0.28	0.06
WHO-TEQ 2005 (pg/g) upper	0.04	0.32	0.09	0.09	0.10	0.21	0.16	0.28	0.07

Table 3.1 PCDD/Fs (dioxins) concentrations - Lipid weight

OEC Reference No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
Fera LIMS Sample No.	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Sample Type	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Production area	Dornoch Firth	Fairlie	Loch Sunar	Clift Sound Houss	Loch Leven Lower	Meikle Craigs	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Site name	Dornoch Firth	Southannan Sands	Liddesdale	Clift Sound Houss	Lower	Silver Sands	Bay Mussels	Bay Oysters	Largo Bay
Lipid weight pg/g									
2,3,7,8-TCDD	0.63	2.42 i	1.02	0.65 i	1.88 i	1.57	0.73	0.02	0.61
1,2,3,7,8-PeCDD	1.52	4.76	2.87	2.16	4.05	1.69	5.17	0.08	1.32
1,2,3,4,7,8-HxCDD	1.73	1.4	1.84	1.07	3.47	1.38	3.87	0.03	0.59
1,2,3,6,7,8-HxCDD	1.18	3.68	3.02	2.63	4.84	1.99	7.01	0.07	2.78
1,2,3,7,8,9-HxCDD	0.6 i	2.35	2.16	1.56	3.22	0.99	4.62	0.04	1.28
1,2,3,4,6,7,8-HpCDD	9.43	8.09	13.74	12.14	32.94	10.98	34.89	0.14	22.66
OCDD	44.37	24.45	33.36	28.74	111.01	38.93	83.57	0.31	87.62
2,3,7,8-TCDF	7.75	75.77	12.92	21.1	20.51	46.38	19.12	0.57	10.28
1,2,3,7,8-PeCDF	2.05	5.23	3.13	2.9	10.04	1.76	4.88	0.07	3.39 i
2,3,4,7,8-PeCDF	6.04	33.04	7.84 i	9.39	14.63	19.9	23.62	0.3	3.37 i
1,2,3,4,7,8-HxCDF	0.92	0.13	1.21	1.62	3.68	1.98	4.6	0.01	1.25
1,2,3,6,7,8-HxCDF	0.81	1.83	1.34	1.47	2.75	1.16	3.84	0.04	1.25
1,2,3,7,8,9-HxCDF	<0.24	0.18	0.18 i	<0.1	0.55	0.41	0.9	<0.01	<0.1
2,3,4,6,7,8-HxCDF	1.08	3.23	2.87	3.01	5.16	1.74	8.52	0.08	0.99
1,2,3,4,6,7,8-HpCDF	1.89	0.84	2.05	3.6	6.54	3.76	7.63	0.03	5.73
1,2,3,4,7,8,9-HpCDF	<0.21	0.13	0.3	0.59	1.05	0.31	2.73	<0.01	<0.21
OCDF	3.44	1.45	2.49	5.49	7.52	4.09	8.17	0.03	5.43
WHO-TEQ 2005 (pg/g) lower	5.56	26.20	9.06	9.13	15.48	15.05	18.86	0.28	5.20
WHO-TEQ 2005 (pg/g) upper	5.58	26.20	9.06	9.14	15.48	15.05	18.86	0.28	5.21

Table 3.2 Non-ortho PCB concentrations

OEC Reference No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
FERA LIMS Sample No.	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Sample type	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Production area	Dornoch Firth	Fairlie	Loch Sunar	Clift Sound Houss	Loch Leven Lower	Meikle Craigs	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Site name	Dornoch Firth	Southannan Sands	Liddesdale	Clift Sound Houss	Lower	Silver Sands	Bay Mussels	Bay Oysters	Largo Bay
Whole Weight pg/g									
PCB77	1.28	19.45	1.94	4.94	1.26	28.35	2.77	9.77	6.76
PCB81	0.03	0.81	0.07	0.12	0.07	1.07	0.03	0.49	0.63
PCB126	0.09	1.17	0.25	0.72	0.23	1.09	0.34	0.82	0.54
PCB169	0.02	0.16	0.09	0.11	0.10	0.11	0.09	0.16	0.12
WHO-TEQ 2005 (pg/g) lower	0.01	0.12	0.03	0.08	0.03	0.12	0.04	0.09	0.06
WHO-TEQ 2005 (pg/g) upper	0.01	0.12	0.03	0.08	0.03	0.12	0.04	0.09	0.06
Lipid Weight pg/g									
PCB77	381.21	1644.67	218.60	495.91	187.49	2027.31	335.88	943.87	525.45
PCB81	9.53	68.33	8.41	11.74	9.81	76.16	3.55	47.72	49.31
PCB126	25.60	99.03	28.66	72.31	34.67	78.04	40.92	79.15	41.75
PCB169	7.17	13.62	10.38	11.00	15.20	7.94	10.47	15.73	8.96
WHO-TEQ 2005 (pg/g) lower	2.82	10.50	3.20	7.61	3.94	8.27	4.44	8.50	4.51
WHO-TEQ 2005 (pg/g) upper	2.82	10.50	3.20	7.61	3.94	8.27	4.44	8.50	4.51

Table 3.3 *Ortho* PCB concentrations - Whole weight

OEC Reference No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
FERA LIMS Sample No.	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Sample type	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Production area	Dornoch Firth	Fairlie Southannan Sands	Loch Sunar	Clift Sound Houss	Loch Leven Lower	Meikle Craigs	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Site name	Dornoch Firth	Fairlie Southannan Sands	Liddesdale	Clift Sound Houss	Lower	Silver Sands	Bay Mussels	Bay Oysters	Largo Bay
Whole weight µg/kg									
PCB18	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02
PCB28	<0.01	0.06	<0.01	0.01	<0.01	0.11	<0.01	0.02	0.05
PCB31	<0.01	0.04	<0.01	<0.01	<0.01	0.08	<0.01	0.02	0.04
PCB47	<0.01	0.06	<0.01	<0.01	<0.01	0.11	<0.01	0.03	0.03
PCB49	<0.01	0.10	<0.01	0.02	<0.01	0.17	0.01	0.04	0.05
PCB51	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
PCB52	<0.01	0.16	<0.01	0.03	0.01	0.25	0.02	0.06	0.08
PCB99	<0.01	0.23	0.02	0.06	0.02	0.27	0.03	0.11	0.08
PCB101	0.01	0.41	0.03	0.15	0.03	0.48	0.07	0.18	0.17
PCB105	<0.01	0.10	<0.01	0.04	<0.01	0.12	0.02	0.05	0.04
PCB114	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB118	0.01	0.33	0.03	0.13	0.02	0.37	0.05	0.15	0.11
PCB123	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB128	<0.01	0.06	<0.01	0.03	<0.01	0.09	0.02	0.03	0.03
PCB138	0.02	0.68	0.07	0.20	0.07	0.71	0.16	0.33	0.24
PCB153	0.03	1.01	0.09	0.21	0.09	0.84	0.19	0.49	0.26
PCB156	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
PCB157	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB167	<0.01	0.02	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01
PCB180	<0.01	0.10	<0.01	<0.01	<0.01	0.01	0.02	0.04	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	0.06	2.42	0.19	0.60	0.20	2.40	0.46	1.12	0.80
SUM of ICES 6(µg/kg) upper	0.09	2.42	0.22	0.61	0.22	2.40	0.47	1.12	0.81
WHO-TEQ 2005 (pg/g) lower	<0.01	0.01	<0.01	0.01	<0.01	0.02	<0.01	0.01	<0.01
WHO-TEQ 2005 (pg/g) upper	<0.01	0.02	<0.01	0.01	<0.01	0.02	<0.01	0.01	0.01

Table 3.3 *Ortho* PCB concentrations - Lipid weight

OEC Reference No. FERA LIMS Sample No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
Sample type	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Production area	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Site name	Dornoch Firth	Fairlie Southannan Sands	Loch Sunar Liddesdale	Clift Sound Houss	Loch Leven Lower	Meikle Craigs Silver Sands	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Lipid weight µg/kg									
PCB18	0.92	0.81	0.17	0.32	0.40	1.41	0.30	0.45	1.25
PCB28	1.80	4.84	0.52	1.00	0.99	7.75	1.13	2.40	3.61
PCB31	1.43	3.72	0.36	0.70	0.79	5.96	0.76	1.66	2.88
PCB47	1.03	5.24	0.49	0.92	0.69	7.57	1.13	2.94	1.95
PCB49	1.70	8.57	0.67	1.60	1.01	12.22	1.51	4.04	3.56
PCB51	0.14	0.54	0.03	0.06	0.09	0.73	0.07	0.30	0.24
PCB52	2.90	13.50	1.07	3.36	1.71	17.53	2.54	6.04	5.89
PCB99	1.86	19.66	2.00	6.24	2.29	19.07	4.24	10.86	5.95
PCB101	4.20	34.34	3.61	14.86	4.03	34.13	8.06	17.13	13.27
PCB105	1.02	8.49	0.88	3.55	1.00	8.83	1.97	4.62	2.95
PCB114	0.06	0.42	0.05	0.10	0.05	0.34	0.11	0.22	0.19
PCB118	3.04	27.52	2.88	13.40	3.32	26.12	6.18	14.27	8.34
PCB123	0.06	1.09	0.07	0.19	0.11	0.67	0.26	0.40	0.19
PCB128	0.64	4.91	0.88	3.48	1.13	6.60	2.10	2.75	2.65
PCB138	6.00	57.75	7.67	20.53	10.25	51.00	19.66	32.13	18.81
PCB153	7.47	85.37	10.13	21.41	13.47	59.74	23.55	47.42	20.58
PCB156	0.26	1.37	0.27	0.94	0.39	1.41	0.76	0.62	0.55
PCB157	0.09	0.94	0.12	0.37	0.18	0.45	0.27	0.45	0.26
PCB167	0.22	1.92	0.24	0.79	0.31	0.93	0.59	1.02	0.57
PCB180	0.35	8.54	0.56	0.66	1.04	0.87	2.03	4.13	0.36
PCB189	0.04	<0.07	<0.04	0.09	0.06	0.12	<0.07	<0.04	<0.02
SUM of ICES 6(µg/kg) lower	22.72	204.34	23.56	61.82	31.49	171.02	56.97	109.25	62.52
SUM of ICES 6(µg/kg) upper	22.72	204.34	23.56	61.82	31.49	171.02	56.97	109.25	62.52
WHO-TEQ 2005 (pg/g) lower	0.14	1.25	0.14	0.58	0.16	1.17	0.30	0.65	0.39
WHO-TEQ 2005 (pg/g) upper	0.14	1.25	0.14	0.58	0.16	1.17	0.31	0.65	0.39

Table 3.4 Summary of PCDD/F and PCB WHO-TEQ, and ICES-6 concentrations

OEC Reference No.	22285	22287	22419	22433	22453	22457	22546	22549	22588
FERA LIMS Sample No.	S14-009687	S14-009689	S14-010001	S14-010267	S14-010540	S14-010830	S14-011294	S14-011297	S14-011395
Sample type	Common Mussels	Pacific Oysters	Common Mussels	Common Mussels	Common Mussels	Razors	Common Mussels	Pacific Oysters	Razors
Production area	Dornoch Firth	Fairlie	Loch Sunar	Clift Sound Houss	Loch Leven Lower	Meikle Craigs	Ardcastle Bay Mussels	Ardcastle Bay Oysters	Forth Estuary - Largo Bay
Site name	Dornoch Firth	Southannan Sands	Liddesdale	Clift Sound Houss	Lower	Silver Sands	Bay Mussels	Bay Oysters	Largo Bay
Fat content (% whole)	0.34	1.18	0.89	1.00	0.67	1.40	0.83	1.04	1.29
WHO TEQ 2005 pg/g whole									
Dioxin	0.04	0.32	0.09	0.09	0.1	0.21	0.16	0.28	0.07
non ortho-PCB	0.01	0.12	0.03	0.08	0.03	0.12	0.04	0.09	0.06
ortho-PCB	<0.01	0.02	<0.01	0.01	<0.01	0.02	<0.01	0.01	0.01
Sum of WHO TEQs (upper)	0.06	0.46	0.16	0.18	0.14	0.35	0.21	0.38	0.14
WHO TEQ 2005 pg/g Lipid									
Dioxin	5.58	26.2	9.06	9.14	15.48	15.05	18.86	26.44	5.21
non ortho-PCB	2.82	10.50	3.20	7.61	3.94	8.27	4.44	8.50	4.51
ortho-PCB	0.14	1.25	0.14	0.58	0.16	1.17	0.31	0.65	0.39
Sum of WHO TEQs (upper)	8.54	37.95	12.40	17.33	19.58	24.49	23.61	35.59	10.11
SUM of ICES 6 µg/kg whole (upper)	0.09	2.42	0.22	0.61	0.22	2.40	0.47	1.12	0.81
SUM of ICES 6 µg/kg fat (upper)	22.72	204.34	23.56	61.82	31.49	171.02	56.97	109.25	62.52

Table 3.5 PAH concentrations ($\mu\text{g}/\text{kg}$ whole weight)

Note: results marked with an “i” are indicative

OEC Reference No.	22254	22255	22256	22257	22258	22259
Fera LIMS Sample No.	S14-008357	S14-008358	S14-008359	S14-008360	S14-008361	S14-008362
Sample type	Native Oysters	Surf Clams	Surf Clams	Common Mussels	Razors	Pacific Oysters
Production area	Loch Ryan	Forth Estuary - Pittenwee	Forth Estuary - Anstruther	Mid Yell Voe	Ferness bay	Loch Spelve - Croggan Pier
Site name	Loch Ryan	Pittenweem Surfs,	Anstruther	Camb	Ferness Razors	Croggan Pier
$\mu\text{g}/\text{kg}$ whole weight						
acenaphthylene	0.37	0.43	0.20	0.51	0.33	0.10
acenaphthene	<0.61	<0.61	<0.61	<0.58	<0.47	<0.61
fluorene	<0.68	<0.68	<0.68	<0.65	<0.48	<0.68
phenanthrene	3.35	1.36	<1.12	<1.00	<0.7	<1.12
anthracene	0.27	0.38	0.30	0.09	<0.04	<0.08
fluoranthene	5.73i	2.05i	1.68	0.58	0.94	2.16i
benzo[c]fluorene	0.29	0.14	0.13	0.03	0.05	0.14
pyrene	3.56i	2.03i	1.78i	0.81	0.62	1.59i
benzo[ghi]fluoranthene	1.36	0.42	0.38	0.21	0.31	1.08
benz (a) anthracene	1.72	0.92	0.84	0.21	0.22	0.76
benzo[b]naphtho[2,1-d]thiophene	0.40	0.11	0.09	0.05	0.06	0.14
cyclopenta[c,d]pyrene	0.05	0.03	0.02	0.02	<0.01	0.14
chrysene	1.85	0.88	0.78	0.25	0.36	1.16
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	3.69	0.91	0.82	0.46	0.60	2.95
benzo[j]fluoranthene	1.38	0.45	0.40	0.19	0.22	0.79
benzo[k]fluoranthene	4.07	0.49	0.42	0.18	0.24	1.11
benzo[e]pyrene	2.77	1.23	1.13	0.58	0.58	2.65
benzo[a]pyrene	0.95	0.75	0.67	0.16	0.13	0.45
indeno[1,2,3-cd]pyrene	1.21	0.67	0.62	0.18	0.18	0.50
dibenz[ah]anthracene	0.26	<0.13	<0.12	<0.05	<0.04	<0.14
benzo-[g,h,i]perylene	1.20	0.94	0.89	0.27	0.18	0.59
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	0.10i	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	0.11i	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower $\mu\text{g}/\text{kg}$	8.21	3.46	3.11	1.08	1.31	5.32
PAH 4 Sum Upper $\mu\text{g}/\text{kg}$	8.21	3.46	3.11	1.08	1.31	5.32

OEC Reference No.	22260	22261	22262	22833	22267	22285
Fera LIMS Sample No.	S14-009098	S14-009099	S14-009165	S14-029692	S14-009647	S14-009687
Sample type	Common Mussels	Razors	Queen Scallops	Queen Scallops (Re-sample)	Common Mussels	Common Mussels
Production area	Vaila Sound: East of Linga and Galtaskerr	West Jura	Loch Fyne Stonefield	Loch Fyne Stonefield	Loch Inchard	Dornoch Firth
Site name	Whitesness	Jura	North Bay	North Bay	Loch Inchard	Dornoch Firth
µg/kg whole weight						
acenaphthylene	0.10	0.16	1.92	0.57	<0.19	0.39
acenaphthene	<0.61	<0.57	<0.72	<0.45	<0.58	<0.48
fluorene	<0.68	<0.64	<0.8	<0.48	1.16	<0.49
phenanthrene	<1.12	<1.00	2.89	1.77	7.12	<0.71
anthracene	<0.08	<0.06	0.60	0.20	0.24	<0.04
fluoranthene	<0.41	1.75	9.36	1.78	1.77i	0.50
benzo[c]fluorene	0.02	0.09	0.61	0.08	0.32	0.04
pyrene	0.36i	0.98	9.70i	1.02	2.75i	0.51
benzo[ghi]fluoranthene	0.12	0.52	4.72	1.14	0.44	0.16
benz (a) anthracene	0.10	0.46	4.54	0.39	0.41	0.13
benzo[b]naphtho[2,1-d]thiophene	0.03	0.11	0.70	0.12	0.25	<0.03
cyclopenta[c,d]pyrene	<0.01	0.01	0.36	0.39	0.02	<0.01
chrysene	0.14	0.73	5.11	0.63	0.95	0.20
5-methylchrysene	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01
benzo[b]fluoranthene	0.35	1.38	10.70	1.32	0.43	0.26
benzo[j]fluoranthene	0.13	0.50	5.40	0.64	0.16	0.11
benzo[k]fluoranthene	0.10	0.60	5.62	0.72	0.16	0.09
benzo[e]pyrene	0.35	1.36	10.50	1.38	0.71	0.23
benzo[a]pyrene	0.07	0.32	5.45	0.34	0.07	0.07
indeno[1,2,3-cd]pyrene	0.15	0.42	3.87	0.39	0.12	0.12
dibenz[ah]anthracene	<0.03	<0.08	0.97	<0.08	<0.03	<0.03
benzo-[g,h,i]perylene	0.22	0.42	3.63	0.30	0.18	0.15
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	0.14i	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	0.28i	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	0.17i	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	0.66	2.89	25.80	2.68	1.86	0.66
PAH 4 Sum Upper µg/kg	0.66	2.89	25.80	2.68	1.86	0.66

OEC Reference No.	22286	22287	22288	22289	22353	22418
Fera LIMS Sample No.	S14-009688	S14-009689	S14-009690	S14-009691	S14-009765	S14-010000
Sample type	Razors	Pacific Oysters	Common Mussels	Pacific Oysters	Common cockles	Common cockles
Production area	North Bay	Fairlie	East Loch Tarbert	Loch Fyne Otter Ferry Balliemore	Traigh Mhar	North Ford
Site name	Barassie	Southann an Sands	Sound of Scalpey		Traigh Mhar	Ortir Mher
µg/kg whole weight						
acenaphthylene	0.19	0.55	0.37	0.19	<0.05	<0.05
acenaphthene	<0.58	<0.48	<0.58	<0.58	<0.58	<0.57
fluorene	<0.65	<0.49	<0.65	<0.65	<0.65	<0.64
phenanthrene	1.39	2.75	<1.00	<1.00	<1.00	<1.00
anthracene	0.17	0.50	0.10	0.12	<0.06	<0.06
fluoranthene	4.47	11.26i	1.24	3.26i	<0.42	0.60
benzo[c]fluorene	0.27	0.68	0.05	0.21	0.02	0.03
pyrene	3.53	10.56i	0.78	3.10i	<0.33	0.40i
benzo[ghi]fluoranthene	1.14	3.56	0.42	1.23	0.10	0.15
benz (a) anthracene	1.58	4.05	0.24	1.05	0.08	0.15
benzo[b]naphtho[2,1-d]thiophene	0.28	0.75	0.07	0.22	0.02	0.04
cyclopenta[c,d]pyrene	0.03	0.17	0.02	0.08	<0.01	<0.01
chrysene	1.72	4.68	0.32	1.55	0.18	0.32
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	2.22	7.17	0.65	2.53	0.19	0.27
benzo[j]fluoranthene	0.99	2.35	0.24	0.79	0.11	0.15
benzo[k]fluoranthene	1.13	3.48	0.24	1.03	0.11	0.15
benzo[e]pyrene	2.54	7.49	1.20	2.68	0.22	0.24
benzo[a]pyrene	1.02	2.34	0.13	0.52	0.06	0.12
indeno[1,2,3-cd]pyrene	0.62	1.24	0.25	0.44	0.14	0.19
dibenz[ah]anthracene	<0.12	0.37	<0.05	<0.12	<0.04	<0.05
benzo-[g,h,i]perylene	0.68	1.77	0.43	0.56	0.10	0.14
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	6.54	18.24	1.34	5.65	0.51	0.86
PAH 4 Sum Upper µg/kg	6.54	18.24	1.34	5.65	0.51	0.86

OEC Reference No.	22419	22420	22432	22433	22434	22451
Fera LIMS Sample No.	S14-010001	S14-010002	S14-010197	S14-010267	S14-010268	S14-010538
Sample type	Common Mussels	Common Mussels	King Scallops	Common Mussels	Common Mussels	Common Mussels
Production area	Loch Sunar	Loch Leurbost	Loch Ewe & Loch Thurnaig	Clift Sound Houss	Clift Sound: Booth	Olna Firth Inner
Site name	Liddesdale	Eilean Miavaig	Loch Ewe	Clift Sound Houss	Booth	Inner
µg/kg whole weight						
acenaphthylene	0.68	0.63	0.39	0.15	0.85	<0.2
acenaphthene	<0.47	<0.58	<0.47	<0.48	<0.58	<0.45
fluorene	<0.48	<0.65	<0.48	<0.49	<0.65	<0.5
phenanthrene	<0.7	<1.00	0.71	1.56	2.26	1.08
anthracene	0.05	0.06	<0.04	0.06	0.16	0.06
fluoranthene	1.21	1.06	1.57	2.03	3.92	1.80
benzo[c]fluorene	0.11	0.06	0.04	0.11	0.24	0.10
pyrene	1.17	0.90	0.88	1.45	2.91	1.66i
benzo[ghi]fluoranthene	0.85	0.39	1.12	0.99	1.66	1.05
benz (a) anthracene	0.61	0.27	0.59	0.65	1.22	0.97
benzo[b]naphtho[2,1-d]thiophene	0.13	0.06	0.11	0.11	0.22	0.15
cyclopenta[c,d]pyrene	0.12	<0.01	0.05	0.17	<0.18	0.11
chrysene	1.15	0.37	0.74	1.42	2.39	1.92
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.06	<0.01
benzo[b]fluoranthene	1.54	0.74	2.16	1.70	2.83	2.36
benzo[j]fluoranthene	0.65	0.31	0.79	0.67	1.18	1.05
benzo[k]fluoranthene	0.55	0.28	0.99	0.55	0.96	0.85
benzo[e]pyrene	1.63	1.11	1.15	1.57	3.29	2.20
benzo[a]pyrene	0.41	0.16	0.45	0.29	0.60	0.57
indeno[1,2,3-cd]pyrene	0.44	0.33	0.47	0.57	0.96	0.77
dibenz[ah]anthracene	<0.09	<0.07	<0.09	<0.08	<0.14	0.11
benzo-[g,h,i]perylene	0.66	0.55	0.36	0.73	1.10	0.78
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	3.71	1.54	3.94	4.06	7.04	5.82
PAH 4 Sum Upper µg/kg	3.71	1.54	3.94	4.06	7.04	5.82

OEC Reference No.	22452	22453	22456	22838	22457	22839
Fera LIMS Sample No.	S14-010539	S14-010540	S14-010829	S14-029693	S14-010830	S14-029852
Sample type	Common Mussels	Common Mussels	Razors	Razors (Re-sample)	Razors	Razors (Re-sample)
Production area	Loch Leven Upper	Loch Leven Lower	Stevenston Sands	Stevenson sands	Meikle Craigs	Meikle Craigs
Site name	Upper	Lower	Stevenston Sands 3	Stevenson sands 3	Silver Sands	Silver Sands
µg/kg whole weight						
acenaphthylene	0.20	<0.13	0.56	0.15	1.12	0.16
acenaphthene	<0.45	<0.48	<0.48	<0.46	<0.61	<0.45
fluorene	<0.49	<0.49	<0.49	<0.48	<0.68	<0.48
phenanthrene	1.04	0.75	2.96	0.94	3.67	1.00
anthracene	0.21	0.10	0.57	0.10	1.04	0.09
fluoranthene	2.20	1.67	12.94	1.43	14.40i	1.51
benzo[c]fluorene	0.21	0.14	1.02	0.09	0.81	0.08
pyrene	2.81i	1.66i	12.37	0.73	14.85i	0.73
benzo[ghi]fluoranthene	1.30	1.10	3.56	0.35	3.98	0.35
benz (a) anthracene	1.51	1.09	6.87	0.41	7.52	0.41
benzo[b]naphtho[2,1-d]thiophene	0.41	0.27	0.87	0.11	0.97	0.11
cyclopenta[c,d]pyrene	0.08	0.10	0.15	0.41	0.15	0.42
chrysene	2.51	1.78	6.72	0.55	7.77	0.58
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	14.54	6.41	8.11	0.51	8.72	0.48
benzo[j]fluoranthene	3.80	1.89	4.04	0.22	4.38	0.22
benzo[k]fluoranthene	5.59	2.42	4.34	0.25	4.36	0.23
benzo[e]pyrene	16.54	6.04	9.28	0.65	11.02	0.63
benzo[a]pyrene	4.88	1.60	5.50	0.20	5.93	0.20
indeno[1,2,3-cd]pyrene	4.50	1.94	1.98	0.21	2.25	0.22
dibenz[ah]anthracene	0.92	0.39	0.44	<0.05	0.50	<0.05
benzo-[g,h,i]perylene	6.51	2.79	2.45	0.22	2.79	0.22
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	0.17i	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	0.69i	<0.1	<0.1	<0.1	0.22i	<0.1
dibenzo[a,i]pyrene	0.27i	<0.1	<0.1	<0.1	0.14i	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	23.44	10.88	27.20	1.67	29.94	1.67
PAH 4 Sum Upper µg/kg	23.44	10.88	27.20	1.67	29.94	1.67

OEC Reference No.	22537	22546	22547	22548	22549
Fera LIMS Sample No.	S14-011220	S14-011294	S14-011295	S14-011296	S14-011297
Sample type	Common Mussels	Common Mussels	Common Mussels	Common Mussels	Pacific Oysters
Production area	Stromness Voe	Ardcastle Bay Mussels	Baltasound Mussels	Loch Roag Barraglow	Ardcastle Bay Oysters
Site name	Burra Holm	Bay Mussels	Baltasound Harbour	Loch Roag Barraglow	Bay Oysters
µg/kg whole weight					
acenaphthylene	0.22	0.56	0.26	<0.06	0.47
acenaphthene	<0.45	<0.48	<0.45	<0.61	<0.61
fluorene	<0.49	<0.49	<0.5	<0.68	<0.68
phenanthrene	3.39	1.57	1.46	<1.11	1.72
anthracene	0.18	0.21	0.11	<0.08	0.25
fluoranthene	3.96	3.69i	1.75	0.63	6.05i
benzo[c]fluorene	0.22	0.29	0.09	0.04	0.38
pyrene	3.32i	3.47i	1.26	0.47i	5.56i
benzo[ghi]fluoranthene	1.89	1.64	0.91	0.22	2.67
benz (a) anthracene	1.51	1.86	0.54	0.14	2.50
benzo[b]naphtho[2,1-d]thiophene	0.19	0.40	0.08	0.04	0.50
cyclopenta[c,d]pyrene	0.14	0.23	0.11	0.02	0.29
chrysene	3.04	3.56	1.13	0.31	4.08
5-methylchrysene	<0.01	0.02	<0.01	<0.01	<0.01
benzo[b]fluoranthene	2.65	3.51	1.05	0.45	6.14
benzo[j]fluoranthene	1.03	1.79	0.45	0.17	2.03
benzo[k]fluoranthene	0.95	1.46	0.36	0.15	2.70
benzo[e]pyrene	2.48	3.53	1.45	0.50	5.76
benzo[a]pyrene	0.58	0.86	0.17	0.07	1.46
indeno[1,2,3-cd]pyrene	0.73	0.91	0.35	0.19	1.05
dibenz[ah]anthracene	0.12	0.18	<0.06	<0.04	0.30
benzo-[g,h,i]perylene	0.73	1.33	0.46	0.26	1.26
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	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	7.78	9.79	2.89	0.97	14.18
PAH 4 Sum Upper µg/kg	7.78	9.79	2.89	0.97	14.18

OEC Reference No.	22550	22840	22588	22589	22593
Fera LIMS Sample No.	S14-011298	S14-029990	S14-011395	S14-011396	S14-011424
Sample type	Razors	Razors (Re-sample)	Razors	Pacific Oysters	Common Mussels
Production area	Luce Bay	Luce Bay	Forth Estuary - Largo Bay	Kyle of Tongue	Kylesku
Site name	Luce Sand Razors	Luce Sand Razors	Largo Bay	Tongue	Loch Glencowl
µg/kg whole weight					
acenaphthylene	1.43	0.22	0.34	<0.07	0.13
acenaphthene	<0.45	<0.45	<0.61	<0.43	<0.61
fluorene	0.59	<0.48	0.74	<0.48	1.55
phenanthrene	3.13	0.79	3.14	0.96	9.72
anthracene	0.89	0.11	0.67	<0.05	0.41
fluoranthene	14.55i	1.56	6.30	1.57	2.01i
benzo[c]fluorene	0.84	0.09	0.56	0.05	0.25
pyrene	13.52i	0.47	5.64i	0.82	2.03i
benzo[ghi]fluoranthene	4.20	0.57	1.34	0.36	0.62
benz (a) anthracene	7.04	0.55	2.66	0.17	0.47
benzo[b]naphtho[2,1-d]thiophene	1.00	0.13	0.39	0.04	0.81
cyclopenta[c,d]pyrene	0.11	0.56	0.06	<0.01	0.07
chrysene	7.72	0.70	2.49	0.34	1.00
5-methylchrysene	<0.01	<0.01	0.01	<0.01	<0.01
benzo[b]fluoranthene	8.76	0.77	2.31	0.51	0.96
benzo[j]fluoranthene	4.10	0.33	1.10	0.12	0.37
benzo[k]fluoranthene	4.67	0.39	1.09	0.16	0.36
benzo[e]pyrene	13.46	1.06	2.72	0.53	1.26
benzo[a]pyrene	5.82	0.20	1.83	<0.05	0.22
indeno[1,2,3-cd]pyrene	2.06	0.22	0.90	0.09	0.38
dibenz[ah]anthracene	0.46	<0.03	0.18	<0.03	<0.09
benzo-[g,h,i]perylene	2.61	0.22	1.37	0.13	0.85
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	0.34i	<0.1	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	0.12i	<0.1	0.13i	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	29.34	2.22	9.29	1.02	2.65
PAH 4 Sum Upper µg/kg	29.34	2.22	9.29	1.07	2.65

Table 3.6 Heavy metal concentrations (mg/kg whole weight)

OEC Reference No.	22254	22255	22256	22257	22258	22259	22260	22261	22262	22267
Fera LIMS Sample No.	S14-008357	S14-008358	S14-008359	S14-008360	S14-008361	S14-008362	S14-009098	S14-009099	S14-009165	S14-009647
Sample type	Native Oysters	Surf Clams	Surf Clams	Common Mussels	Razors	Pacific Oysters	Common Mussels	Razors	Queen Scallops	Common Mussels
Production area	Loch Ryan	Forth Estuary: Pittenweem	Forth Estuary - Anstruther	Mid Yell Voe	Ferness bay	Loch Spelve - Croggan Pier	Vaila Sound:East of Linga and Galtaskerry	West Jura	Loch Fyne Stonefield	Loch Inchard
Site name	Loch Ryan	Pittenweem Surfs	Anstruther	Camb	Ferness Razors	Croggan Pier	Whitesness	Jura	North Bay	Loch Inchard Site 4
Cr	0.16	0.21	0.28	~0.08	~0.08	~0.05	~0.07	0.17	~0.08	~0.08
Mn	3.83	2.06	5.56	0.99	0.61	2.92	1.66	1.20	28.9	0.65
Co	0.045	0.136	0.151	0.020	0.028	0.023	0.019	0.072	0.054	0.018
Ni	0.14	0.25	0.28	~0.10	~0.04	~0.05	~0.08	~0.05	~0.09	~0.07
Cu	10.87	1.28	1.50	0.71	0.82	8.09	0.57	1.16	2.67	0.61
Zn	293	7.21	7.34	10.5	12.6	398	14.3	14.9	41.3	9.35
As	1.17	1.44	1.42	1.10	1.22	1.50	0.88	1.55	1.48	1.14
Se	0.402	0.365	0.417	0.218	0.230	0.220	0.202	0.271	0.480	0.260
Ag	1.435	0.213	0.340	<0.003	0.039	0.462	<0.003	0.273	1.279	~0.008
Cd	0.400	0.065	0.070	0.061	0.039	0.224	0.113	0.023	0.399	0.105
Hg	0.016	0.017	0.015	~0.005	0.008	0.011	~0.005	0.014	0.015	0.008
Pb	0.067	0.101	0.147	0.073	0.037	0.050	0.121	0.051	0.167	0.054

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

OEK Reference No.	22285	22286	22287	22288	22289	22353	22418	22419	22420
Fera LIMS Sample No.	S14-009687	S14-009688	S14-009689	S14-009690	S14-009691	S14-009765	S14-010000	S14-010001	S14-010002
Sample type	Common Mussels	Razors	Pacific Oysters	Common Mussels	Pacific Oysters	Common Cockles	Common Cockles	Common Mussels	Common Mussels
Production area	Dornoch Firth	North Bay	Fairlie	East Loch Tarbert	Loch Fyne Otter Ferry	Traigh Mhor	North Ford	Loch Sunart	Loch Leurbost
Site name	Dornoch Firth	Barassie	Southannan Sands	Sound of Scalpey	Balliemore	Traigh Mhor	Ortir Mhor	Liddesdale	Eilean Mhiabhaing
Cr	0.15	0.29	~0.08	~0.10	~0.06	0.15	0.21	~0.08	0.13
Mn	6.10	1.67	4.41	0.78	3.03	0.76	0.89	2.74	1.43
Co	0.033	0.062	0.031	0.025	0.024	0.064	0.088	0.024	0.029
Ni	0.12	0.11	~0.08	~0.09	~0.06	1.10	1.89	~0.08	0.13
Cu	0.51	0.91	12.31	0.71	6.41	0.38	0.62	0.78	0.77
Zn	4.34	14.3	157	8.79	83.7	4.19	6.89	9.14	9.17
As	0.93	1.34	1.81	1.18	1.31	0.88	1.56	1.18	1.17
Se	0.171	0.213	0.274	0.256	0.179	0.128	0.187	0.317	0.289
Ag	<0.003	0.085	0.670	<0.003	0.430	0.015	0.045	~0.010	~0.007
Cd	0.071	0.023	0.153	0.056	0.176	0.050	0.031	0.057	0.046
Hg	0.012	0.009	0.013	~0.006	0.009	~0.004	0.011	0.009	~0.006
Pb	0.057	0.061	0.081	0.113	0.037	0.019	0.054	0.987	0.082

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

OEK Reference No.	22432	22834	22433	22434	22451	22452	22453	22456	22457	22537
Fera LIMS Sample No.	S14-010197	S14-029694	S14-010267	S14-010268	S14-010538	S14-010539	S14-010540	S14-010829	S14-010830	S14-011220
Sample type	King Scallops	King Scallops (Re-sample)	Common Mussels	Common Mussels	Common Mussels	Common Mussels	Common Mussels	Razors	Razors	Common Mussels
Production area	Loch Ewe and Loch Thurnaig	Loch Ewe & Loch Thurnaig	Cliff Sound Houss	Cliff Sound: Booth	Olna Firth Inner	Loch Leven Upper	Loch Leven Lower	Stevenston Sands	Meikle Craigs	Stromness Voe
Site name	Loch Ewe Scallops	Loch Ewe Scallops	Cliff Sound Houss	Booth	Inner	Upper	Lower	Stevenston Sands	Silver Sands	Burra Holm
Cr	0.14	0.097	~0.08	0.12	~0.09	~0.09	0.14	0.20	0.19	~0.05
Mn	25.5	16.21	0.79	0.69	0.50	3.66	4.62	0.65	0.88	4.06
Co	0.037	0.018	0.021	0.025	0.018	0.027	0.032	0.054	0.051	0.031
Ni	0.10	0.068	0.11	~0.10	~0.09	~0.08	0.13	~0.03	~0.03	~0.07
Cu	0.70	0.543	0.83	0.97	0.59	0.62	0.96	0.88	0.94	0.56
Zn	31.2	31.65	11.4	13.6	13.7	6.54	6.28	18.0	16.8	12.9
As	1.81	1.457	1.02	1.12	1.10	1.15	1.10	1.29	1.22	0.98
Se	0.482	0.304	0.252	0.239	0.275	0.299	0.323	0.232	0.230	0.224
Ag	0.058	0.019	<0.003	<0.003	<0.003	~0.006	~0.006	0.127	0.107	~0.004
Cd	3.92	0.522	0.072	0.051	0.089	0.047	0.045	0.029	0.028	0.071
Hg	0.013	0.016	~0.004	0.008	~0.006	0.009	0.011	0.011	0.012	~0.006
Pb	0.085	0.125	0.080	0.128	0.124	0.083	0.097	0.053	0.060	0.058

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

OEC Reference No.	22546	22547	22548	22549	22550	22588	22589	22593
Fera LIMS Sample No.	S14-011294	S14-011295	S14-011296	S14-011297	S14-011298	S14-011395	S14-011396	S14-011424
Sample type	Common Mussels	Common Mussels	Common Mussels	Pacific Oysters	Razors	Razors	Pacific Oysters	Common Mussels
Production area	Ardcastle Bay Mussels	Baltasound Mussels	Loch Roag: Barraglom	Ardcastle Bay Oysters	Luce Bay	Forth Estuary - Largo Bay	Kyle of Tongue	Loch Glencoul
Site name	Ardcastle Mussels	Baltasound Harbour	Loch Barraglom	Ardcastle Oysters	Luce Sand Razors	Largo Bay	Kyle of Tongue	Kylesku
Cr	~0.09	0.33	~0.08	~0.04	0.13	0.13	~0.08	0.58
Mn	5.37	0.68	0.52	4.48	1.24	1.69	2.06	1.58
Co	0.045	0.060	0.021	0.025	0.036	0.070	0.018	0.044
Ni	0.12	0.54	~0.08	~0.07	<0.02	~0.08	~0.04	0.32
Cu	0.75	0.69	0.61	11.07	0.95	1.42	3.61	0.84
Zn	7.38	11.1	8.47	115	16.2	14.3	93.2	12.8
As	1.44	1.15	1.10	1.74	1.20	1.13	1.28	1.55
Se	0.418	0.245	0.314	0.322	0.221	0.215	0.169	0.503
Ag	~0.004	~0.003	<0.003	0.747	0.124	0.039	0.186	0.013
Cd	0.075	0.103	0.058	0.263	0.025	0.017	0.217	0.096
Hg	0.012	~0.005	~0.007	0.010	0.009	0.008	0.009	0.013
Pb	0.061	0.086	0.069	0.032	0.075	0.106	0.035	0.105

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

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