Provision of Statutory Shellfish Monitoring Services for Scotland- Chemical Contaminant Analysis of Shellfish from Classified Harvesting Areas (2019)

Report to Food Standards Scotland

May 2019




Contract reference FSS0008/271184341/C7714

Chemical Contaminant Analysis of Shellfish from Classified Harvesting Areas (2019)

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Document checked by CEFAS:	V1: Cefas principal investigator / J. Barber – 12/04/2019 Project Manager/ Jane Heywood - 29/04/2019 V2: Project Manager/ Jane Heywood -24/05/2019	Review Date: N/A
Document Checked by Fera	F. Smith, M. Baxter – Fera, 10/05/2019	
Document approved by:	J. Heywood, 24/05/2019	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
µg/kg	Microgram per kilogram (part per billion)
EC	European Commission
EU	European Union
FAPAS	Food Analysis Proficiency Assurance Scheme
fat weight	Values based on the assessed fat content of the sample
FSA	Food Standards Agency
FSS	Food Standards Scotland
GC-HRMS	Gas chromatography - high resolution mass spectrometry
GC-LRMS	Gas chromatography – low (unit) resolution mass spectrometry
Heavy Metals	A loosely defined subset of naturally occurring metallic elements than have a high atomic weight and a density of 5g/mL or more.
ICP-MS	Inductively coupled plasma-mass spectrometry
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantification
Lower bound	assumes values at less than the limit of detection is zero (e.g.<0.07 = 0)
mg/kg	Milligram per kilogram (part per million)
ng/kg	Nanogram per kilogram (part per trillion)
Non-ortho-PCB	Non-ortho-substituted PCB (co-planar)
Ortho-PCB	Ortho-substituted PCB (non planar)
PAH 4	Sum of 4 PAHs (benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene, chrysene)
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/ polychlorinated dibenzofuran (dioxins)
Sum of ICES 6	Sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180
TEF	Toxic Equivalency Factor – toxicity expressed for each dioxin-like compound relative to 2,3,7,8-TCDD (TEF = 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
Trace Element	An element in a sample that has an average concentration of less than 100 parts per million (< 100 mg/kg)
Upper bound	assumes values at less than the limit of detection is equal to the limit of detection (e.g. <0.07 = 0.07)
wet weight	Values based on the sample as received (whole weight)
WHO	World Health Organisation
WHO-TEQ 2005	World Health Organisation TEQ based on TEF values as set in 2005

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. Marine shellfish bio-accumulate environmental contaminants because of their inability to metabolise them to easily excreted compounds. 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 28 samples of shellfish including Common mussels, Pacific oysters, Common cockles, and Razor clams for polycyclic aromatic hydrocarbons (PAHs), and trace elements. One of the samples was also analysed for polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs). 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 levels for both benzo[a]pyrene and for the sum of PAH4 all fall below the maximum permitted levels (MPL), of 5 µg/kg and 30 µg/kg respectively (Regulation (EC) No. 1881/2006 as amended) [3].
PCDD/Fs and PCBs in the one sample tested were below the maximum regulatory levels [3] Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits [3]. Contaminant profiles from the 2019 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 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. 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) collectively referred to as dioxins, polychlorinated biphenyls (PCBs), 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 PCDD/Fs and PCBs. These contaminants have been the subject of several 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 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 regarding 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 PCDD/F 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 (BaP) 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 the European Food Safety Authority (EFSA) CONTAM panel, concluded that a set of 4 compounds; benzo[a]pyrene, chrysene, benzo[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.

Some trace elements e.g. cadmium, mercury and lead, are established toxic contaminants. Others, such as copper, chromium, selenium and zinc are essential to health but may be toxic at high levels of exposure. These elements may enter marine and aquatic environments and bio-accumulate in some species. 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. Shellfish from classified production areas are monitored, 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 was carried out at Fera Science Limited 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 classified Scottish production areas in the first quarter of 2019.

2. Methods

2.1 Sample Collection and Preparation

Twenty-eight samples of shellfish, including species of common mussels (13 samples), Pacific oysters (3), native oysters (1), common cockles (3), surf clams (1), and razor clams (7) were collected during January and February 2019. The sampling period was timed to coincide with the period of optimal contaminant concentrations in the shellfish which relates to the period before annual spawning.

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 Nautilus LIMS database. The samples were stored frozen prior to analysis. Sample preparation consisted of shelling followed by thorough homogenisation. Aliquots were then taken for PAH, trace element and dioxin analysis as appropriate. Dioxin sample aliquots underwent additional freeze-drying and were re-homogenised prior to analysis.

2.2 Contaminants measured – Specific Analytes

The following analytes were determined: Regulated contaminants are highlighted in **bold,** and summarised regulation limts are listed below:

Maximum regulatory levels (MRL) relevant for live bivalve molluscs

	Maximum levels (wet weight)	Maximum levels (wet weight)	Maximum levels (fat)
Lead	1.5 mg/kg		
Cadmium	1.0 mg/kg		
Mercury	0.50 mg/kg		
Dioxins and PCBs	Sum of dioxins (WHO PCDD/F-TEQ)	Sum of dioxins and dioxin-like PCBs (WHO PCDD/F-PCB-TEQ)	Sum of PCB28, PCB52, PCB101, PCB138 and PCB180 (ICES 6 Indicator PCBs)
	3.5 pg/g	6.5 pg/g	75 ng/g
PAHs	Benzo[a]pyrene	Sum of Benzo[a]pyrene, Benzo[a]anthracene, Benzo[b]fluoranthene and Chrysene)	
	5.0 µg/kg	30 µg/kg	

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, **benzo[a]anthracene**, **chrysene**, **benzo[b]fluoranthene**, benzo[j]fluoranthene, benzo[k]fluoranthene, **benzo[a]pyrene**, cyclopenta[cd]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[ghi]perylene, dibenzo[a,l]pyrene, dibenzo[a,e]pyrene, dibenzo[a,i]pyrene, dibenzo[a,h]pyrene and the alkylated PAH, 5-methylchrysene.

Trace elements – 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 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 GC-HRMS for the seventeen, 2,3,7,8-Cl substituted PCDD/F congeners and non-ortho substituted PCBs. GC-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 (in-house reference material, LIMS No. s11-018695 crude cod liver oil) and method blanks which were evaluated prior to reporting. Further quality assurance measures included the successful participation in international inter-comparison exercises such as the Norwegian Institute of Public Health's "Dioxins in Food" on an annual basis. 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 the National Reference Laboratory (NRL) for dioxins and halogenated contaminants, Fera participates in proficiency testing (PT) exercises and other inter-laboratory exercises as organised by the European Union Reference Laboratory (EU-RL) and achieves consistently good results.

2.4 Polycyclic Aromatic Hydrocarbons (PAH) - Analytical Methodology

(Fera 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 GC-LRMS.

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 PAHs, 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 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 and 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 (e.g. CE 278K mussel tissue) values. Regular, successful participation in FAPAS inter-comparison exercises provides further confidence in the data. In addition, as NRL for trace elements, Fera participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL and achieves consistently good results.

2.6 Fat analysis

For samples requiring dioxin and PCB analysis, total fat was determined by the Werner-Schmidt method under UKAS accreditation by West Yorkshire Analytical Services.

3. Results

Analyte concentrations are presented in Tables 3 to 5. 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 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 wet 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.

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

Only one sample (S19-011909 Mussels, AithVoe Sletta, Slyde) was tested for PCDD/Fs and PCBs. Levels found were well within the regulatory limits. The combined PCDD/F + PCB TEQ (wet weight, upper bound) was 0.08 pg TEQ/g. PCDD/Fs contributed at least half of the total TEQ.

The concentration of ICES-6 PCB on an upper bound wet weight basis was 0.15 µg/kg. Table 3 shows both wet and lipid weight data for this sample.

PAHs were detected in all 28 samples analysed. All samples showed levels below MRL for BaP (5 µg/kg) and PAH4 (30 µg/kg). Benzo[a]pyrene concentrations ranged from 0.05 µg/kg to 2.38 µg/kg and the sum of PAH4 concentrations ranged from 0.62 µg/kg to 14.94 µg/kg. The single highest concentration for the regulated compounds was benzo[b]fluoranthene at 4.96 µg/kg in a sample of native oysters (S19-011908) collected from Loch Ryan.

The sample with the highest concentration of benzo[a]anthracene at 3.92 µg/kg was a sample of razors (S19-012600) collected from Stevenston Sands. It also had the highest benzo[a]pyrene (2.38 µg/kg), chrysene (4.67 µg/kg) and sum of PAH 4 concentrations (14.94 µg/kg). This is higher than observed in razors sampled from the same site last year. Table 4 shows PAH data in µg/kg wet weight.

Heavy metals were detected in all samples. Concentrations of the regulated heavy metals (Cd, Hg, Pb) were all below the regulatory limit (Commission Regulation EC 1881/2006, as amended). The concentration ranges for Hg, Cd and Pb were 0.017mg/kg to 0.268 mg/kg, <0.004 mg/kg to 0.021 mg/kg and 0.023 mg/kg to 0.741 mg/kg respectively. The highest concentrations of Hg were found in razor clams. The three most abundant heavy metals were zinc, manganese and copper, with zinc present at the highest concentration.

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Table 1: Overview of all Samples*

Local Authority	Production Area	Sample Site Name	Site Identification No	Grid Reference	Species	Date Sample Taken	Date Received at Fera	FERA LIMS No.
Argyll & Bute	Kerrera West	Oitir mhor	AB-697-1514-04	NM8238130008	Cockles	22/01/2019	23/01/2019	S19-001116
Argyll & Bute	Loch Creran Cockles	Loch Creran Cockles	AB-729-1685-04	NM9169740625	Cockles	20/01/2019	23/01/2019	S19-001117
Argyll & Bute	Loch Fyne: Ardkinglas Oysters	The Shore	AB-147-036-13	NN1635009884	Pacific Oysters	28/01/2019	29/01/2019	S19-009963
Argyll & Bute	Loch Fyne: Otter Point	Otter Point	AB-714-1659-04	NR9239084215	Cockles	14/01/2019	15/01/2019	S19-000790
Argyll & Bute	Sound of Gigha	Sound of Gigha 2 Razors	AB-515-1250-16	NR69005200	Razor Clams	21/01/2019	22/01/2019	S19-001118
Comhairle nan Eilean Siar: Lewis & Harris	East Loch Tarbert	Sound of Scalpay	LH-057-106-08	NG22219762	Mussels	09/01/2019	12/01/2019	S19-000759
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Ceabhagh	Keava	LH-381-772-08	NB19993445	Mussels	15/01/2019	16/01/2019	S19-000861
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Drovinish	Loch Drovinish	LH-186-121-08	NB13973242	Mussels	15/01/2019	16/01/2019	S19-000862
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Linngeam	Linngeam	LH-187-122-08	NB14913348	Mussels	15/01/2019	16/01/2019	S19-000863
Dumfries & Galloway	Fleet Bay Razors	Fleet Bay Razors	DG-752-1880-16	NX57534862	Razor Clams	11/02/2019	13/02/2019	S19-011444
Dumfries & Galloway	Loch Ryan	Leffnoll Point	DG-191-174-12	NX07106571	Native Oysters	19/02/2019	20/02/2019	S19-011908
Dumfries & Galloway	Wigtown Bay: Islands of Fleet	Wigtown Bay	DG-305-182-16	NX51935055	Razor Clams	11/02/2019	13/02/2019	S19-011443
East Lothian	Gullane Point North	Gullane North	EL-601-1087-16	NT43948180	Razor Clams	11/02/2019	13/02/2019	S19-011441
Fife	Firth of Forth: North	Anstruther	FF-068-184-19	NO5958804909	Surf Clams	19/02/2019	20/02/2019	S19-011907
Highland - Lochaber	Loch Eil	Duisky	HL-134-216-08	NN0052077530	Mussels	23/01/2019	24/01/2019	S19-001265
Highland - Lochaber	Loch Leven: Upper	Upper	HL-171-223-08	NN1480061680	Mussels	15/01/2019	16/01/2019	S19-000860
Highland - Lochaber	Loch Sunart	Liddesdale	HL-206-1237-08	NM78366016	Mussels	29/01/2019	30/01/2019	S19-009991

Local Authority	Production Area	Sample Site Name	Site Identification No	Grid Reference	Species	Date Sample Taken	Date Received at Fera	FERA LIMS No.
Highland - Ross & Cromarty	Inner Loch Torridon	Dubh Aird	RC-090-1616-08	NG87475496	Mussels	22/01/2019	23/01/2019	S19-001088
Highland - Ross & Cromarty	Little Loch Broom Pacific Oysters	Little Loch Broom Pacific Oysters	RC-805-2122-13	NH08238878	Pacific Oysters	22/01/2019	23/01/2019	S19-001119
Highland - Sutherland	Loch Laxford	Weavers Bay	HS-167-320-08	NC21344858	Mussels	12/02/2019	13/02/2019	S19-011442
North Ayrshire	Fairlie	Southannan Sands	NA-065-332-13	NS19845430	Pacific Oysters	07/02/2019	12/02/2019	S19-011387
North Ayrshire	Stevenston Sands Razors	Stevenston Sands Razors	NA-825-2169-16	NS24804021	Razor Clams	26/02/2019	28/02/2019	S19-012600
Shetland	Aith Voe Sletta	Slyde	SI-326-733-08	HU34805860	Mussels	18/02/2019	20/02/2019	S19-011909
Shetland	Catfirth	Catfirth	SI-032-412-08	HU4431353497	Mussels	20/02/2019	21/02/2019	S19-012059
Shetland	South of Houss Holm	South of Houss Holm	SI-261-444-08	HU37343083	Mussels	16/01/2019	17/01/2019	S19-000898
Shetland	Weisdale Voe Upper	Olligarth	SI-378-1521-08	HU38304794	Mussels	09/01/2019	10/01/2019	S19-000632
South Ayrshire	Croy Bay	Culzean Bay	SA-681-1482-16	NS19380591	Razor Clams	26/02/2019	28/02/2019	S19-012599
South Ayrshire	North Bay	Barassie	SA-337-719-16	NS31833386	Razor Clams	22/01/2019	24/01/2019	S19-001264

**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: Samples: Chemical contaminant testing

Local Authority	Production Area	Sample Site Name	Site Identification No	Species	PAHs	Trace Elemenets	DXN/PCBs	FERA LIMS No.
Argyll & Bute	Kerrera West	Oitir mhor	AB-697-1514-04	Cockles	•	•		S19-001116
Argyll & Bute	Loch Creran Cockles	Loch Creran Cockles	AB-729-1685-04	Cockles	•	•		S19-001117
Argyll & Bute	Loch Fyne: Ardkinglas Oysters	The Shore	AB-147-036-13	Pacific Oysters	•	•		S19-009963
Argyll & Bute	Loch Fyne: Otter Point	Otter Point	AB-714-1659-04	Cockles	•	•		S19-000790
Argyll & Bute	Sound of Gigha	Sound of Gigha 2 Razors	AB-515-1250-16	Razor Clams	•	•		S19-001118
Comhairle nan Eilean Siar: Lewis & Harris	East Loch Tarbert	Sound of Scalpay	LH-057-106-08	Mussels	•	•		S19-000759
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Ceabhagh	Keava	LH-381-772-08	Mussels	•	•		S19-000861
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Drovinish	Loch Drovinish	LH-186-121-08	Mussels	•	•		S19-000862
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag: Linngeam	Linngeam	LH-187-122-08	Mussels	•	•		S19-000863
Dumfries & Galloway	Fleet Bay Razors	Fleet Bay Razors	DG-752-1880-16	Razor Clams	•	•		S19-011444
Dumfries & Galloway	Loch Ryan	Leffnoll Point	DG-191-174-12	Native Oysters	•	•		S19-011908
Dumfries & Galloway	Wigtown Bay: Islands of Fleet	Wigtown Bay	DG-305-182-16	Razor Clams	•	•		S19-011443
East Lothian	Gullane Point North	Gullane North	EL-601-1087-16	Razor Clams	•	•		S19-011441
Fife	Firth of Forth: North	Anstruther	FF-068-184-19	Surf Clams	•	•		S19-011907
Highland - Lochaber	Loch Eil	Duisky	HL-134-216-08	Mussels	•	•		S19-001265
Highland - Lochaber	Loch Leven: Upper	Upper	HL-171-223-08	Mussels	•	•		S19-000860
Highland - Lochaber	Loch Sunart	Liddesdale	HL-206-1237-08	Mussels	•	•		S19-009991
Highland - Ross & Cromarty	Inner Loch Torridon	Dubh Aird	RC-090-1616-08	Mussels	•	•		S19-001088

Local Authority	Production Area	Sample Site Name	Site Identification No	Species	PAHs	Trace Elemenets	DXN/PCBs	FERA LIMS No.
Highland - Ross & Cromarty	Little Loch Broom Pacific Oysters	Little Loch Broom Pacific Oysters	RC-805-2122-13	Pacific Oysters	•	•		S19-001119
Highland - Sutherland	Loch Laxford	Weavers Bay	HS-167-320-08	Mussels	•	•		S19-011442
North Ayrshire	Fairlie	Southannan Sands	NA-065-332-13	Pacific Oysters	•	•		S19-011387
North Ayrshire	Stevenston Sands Razors	Stevenston Sands Razors	NA-825-2169-16	Razor Clams	•	•		S19-012600
Shetland	Aith Voe Sletta	Slyde	SI-326-733-08	Mussels	•	•	•	S19-011909
Shetland	Catfirth	Catfirth	SI-032-412-08	Mussels	•	•		S19-012059
Shetland	South of Houss Holm	South of Houss Holm	SI-261-444-08	Mussels	•	•		S19-000898
Shetland	Weisdale Voe Upper	Olligarth	SI-378-1521-08	Mussels	•	•		S19-000632
South Ayrshire	Croy Bay	Culzean Bay	SA-681-1482-16	Razor Clams	•	•		S19-012599
South Ayrshire	North Bay	Barassie	SA-337-719-16	Razor Clams	•	•		S19-001264

Table 3: PCDD/Fs and PCB concentrations

FERA LIMS No.	S19-011909
Species	Mussels
Production Area	Aith Voe Sletta
Site Name	Slyde
% lipid (wet weight)	0.6

	PCDD/Fs	
	Wet weight	**Lipid weight**
pg/g		
2,3,7,8-TCDD	<0.01	<0.67
1,2,3,7,8-PeCDD	<0.02	<3.53
1,2,3,4,7,8-HxCDD	<0.01	0.52
1,2,3,6,7,8-HxCDD	0.01	2.02
1,2,3,7,8,9-HxCDD	<0.01	0.77
1,2,3,4,6,7,8-HpCDD	0.05	8.17
OCDD	0.12	20.22
2,3,7,8-TCDF	0.06	9.88
1,2,3,7,8-PeCDF	0.01	1.96
2,3,4,7,8-PeCDF	0.03	5.22
1,2,3,4,7,8-HxCDF	<0.02	<3.57
1,2,3,6,7,8-HxCDF	<0.01	0.71
1,2,3,7,8,9-HxCDF	<0.01	<0.32
2,3,4,6,7,8-HxCDF	0.01	2.2
1,2,3,4,6,7,8-HpCDF	0.02	3.33
1,2,3,4,7,8,9-HpCDF	<0.01	<0.49
OCDF	<0.03	<4.22
WHO TEQ (ng/kg) lower	**0.02**	**3.36**
WHO TEQ (ng/kg) upper	**0.05**	**7.95**

	PCBs	
	Wet weight	**Lipid weight**
ng/g		
PCB 18	<0.01	0.71
PCB 28	<0.01	0.83
PCB 31	<0.01	<0.78
PCB 47	<0.01	0.41
PCB 49	<0.01	<0.54
PCB 51	<0.01	<0.15
PCB 52	<0.01	1.03
PCB 99	<0.01	1.64
PCB 101	0.02	3.01
PCB 105	<0.01	0.76
PCB 114	<0.01	<0.12
PCB 118	0.02	2.89
PCB 123	<0.01	<0.07
PCB 128	<0.01	0.87
PCB 138	0.04	6.38
PCB 153	0.06	9.32
PCB 156	<0.01	0.24
PCB 157	<0.01	0.12
PCB 167	<0.01	0.27
PCB 180	<0.01	0.38
PCB 189	<0.01	<0.29
pg/g		
PCB77	0.49	82.23
PCB 81	0.03	5.22
PCB 126	0.15i	24.44i
PCB 169	0.05	8.49
WHO TEQ (ng/kg) lower	**0.02**	**2.84**
WHO TEQ (ng/kg) upper	**0.03**	**2.85**
Sum ICES 6 (µg/kg) lower	**0.12**	**20.95**
Sum ICES 6 (µg/kg) upper	**0.15**	**20.95**

	Sum TEQ (PCDD/Fs + PCBs)	
Total WHO TEQ (ng/kg) lower	**0.04**	**6.2**
Total WHO TEQ (ng/kg) upper	**0.08**	**10.8**

Note: results maked with an “i” are indicative

Table 4: PAH concentrations (µg/kg wet weight)

FERA LIMS No.	S19-001116	S19-001117	S19-009963	S19-000790	S19-001118
Species	Cockles	Cockles	Pacific Oysters	Cockles	Razor Clams
Production Area	Kerrera West	Loch Creran Cockles	Loch Fyne: Ardkinglas Oysters	Loch Fyne: Otter Point	Sound of Gigha
Sample Site Name	Oitir mhor	Loch Creran Cockles	The Shore	Otter Point	Sound of Gigha 2 Razors
acenaphthylene	<0.31	<0.31	0.32	<0.36	<0.31
acenaphthene	<0.58	<0.57	<0.4	<0.68	<0.57
fluorene	<0.78	<0.78	<0.59	<0.97	<0.78
phenanthrene	<1	<0.99	1.24	<1.34	1.48
anthracene	<0.07	<0.07	0.32	<0.28	0.21
fluoranthene	<0.47	<0.47	3.52	0.71	2.37
benzo[c]fluorene	<0.03	<0.03	0.2	0.04	0.13
pyrene	<0.47	<0.47	2.05	0.54	0.75
benzo[ghi]fluoranthene	0.17	0.18	2.14	0.45	0.94
Benzo[a]anthracene	0.14	0.14	1.21	0.35	0.68
benzo[b]naphtho[2,1-d]thiophene	0.06	0.07	0.37	0.09	0.23
cyclopenta[cd]pyrene	<0.01	<0.01	0.11	0.02	0.03
chrysene	0.25	0.27	1.78	0.49	1.13
5-methylchrysene	<0.01	<0.01	<0.1	0.02	0.04
benzo[b]fluoranthene	0.42	0.39	4.51	0.71	1.72
benzo[j]fluoranthene	0.18	0.18	1.33	0.39	0.66
benzo[k]fluoranthene	0.23	0.22	2.01	0.45	0.8
benzo[e]pyrene	0.61	0.59	6.3	1.32	2.73
benzo[a]pyrene	0.19	0.19	0.94	0.36	0.58
indeno[1,2,3-cd]pyrene	0.32	0.28	0.79	0.44	0.56
dibenz[a,h]anthracene	0.06	0.06	0.22	0.1	0.1
benzo[ghi]perylene	0.28	0.25	1.01	0.43	0.55
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.13	<0.13	<0.11	<0.1	<0.14
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	0.11	<0.1	0.12	<0.1	0.19
PAH 4 Sum Lower µg/kg	**1**	**0.99**	**8.44**	**1.91**	**4.11**
PAH 4 Sum Upper µg/kg	**1**	**0.99**	**8.44**	**1.91**	**4.11**

Where shown i= indicative

FERA LIMS No.	S19-000759	S19-000861	S19-000862	S19-000863	S19-011444
Species	Mussels	Mussels	Mussels	Mussels	Razor Clams
Production Area	East Loch Tarbert	Loch Roag: Ceabhagh	Loch Roag: Drovinish	Loch Roag: Linngeam	Fleet Bay Razors
Sample Site Name	Sound of Scalpay	Keava	Loch Drovinish	Linngeam	Fleet Bay Razors
acenaphthylene	<0.36	<0.31	<0.31	<0.3	0.3
acenaphthene	<0.68	<0.58	<0.58	<0.56	<0.39
fluorene	<0.97	<0.78	<0.79	<0.76	<0.58
phenanthrene	<1.34	<1	<1.01	<0.97	1.46
anthracene	<0.28	<0.07	<0.07	<0.07	0.35
fluoranthene	0.98	<0.47	<0.47	<0.46	3.04
benzo[c]fluorene	0.07	<0.03	<0.03	<0.03	0.18
pyrene	0.55	<0.47	<0.47	<0.46	1.51
benzo[ghi]fluoranthene	0.59	0.11	0.11	0.14	1.24
Benzo[a]anthracene	0.32	0.06	0.07	0.07	1.3
benzo[b]naphtho[2,1-d]thiophene	0.09	<0.03	<0.03	0.03	0.26
cyclopenta[cd]pyrene	0.06	<0.01	<0.01	0.01	0.02
chrysene	0.55	0.13	0.15	0.16	1.35
5-methylchrysene	0.01	<0.01	<0.01	<0.01	0.05
benzo[b]fluoranthene	1.06	0.33	0.32	0.31	2.04
benzo[j]fluoranthene	0.39	0.11	0.11	0.11	0.85
benzo[k]fluoranthene	0.4	0.12	0.13	0.12	1.03
benzo[e]pyrene	1.65	0.34	0.34	0.41	3.23
benzo[a]pyrene	0.25	0.1	0.1	0.11	0.94
indeno[1,2,3-cd]pyrene	0.31	0.16	0.18	0.17	0.7
dibenzo[ah]anthracene	0.07	<0.05	<0.05	<0.03	0.14
benzo[ghi]perylene	0.65	0.19	0.21	0.2	0.72
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.13	<0.13	<0.12	<0.19
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	0.17	<0.1	<0.1	<0.1	0.19
PAH 4 Sum Lower µg/kg	**2.18**	**0.62**	**0.64**	**0.65**	**5.63**
PAH 4 Sum Upper µg/kg	**2.18**	**0.62**	**0.64**	**0.65**	**5.63**

FERA LIMS No.	S19-011908	S19-011443	S19-011441	S19-011907	S19-001265
Species	Native Oysters	Razor Clams	Razor Clams	Surf Clams	Mussels
Production Area	Loch Ryan	Wigtown Bay: Islands of Fleet	Gullane Point North	Firth of Forth: North	Loch Eil
Sample Site Name	Leffnoll Point	Wigtown Bay	Gullane North	Anstruther	Duisky
acenaphthylene	0.55	0.47	0.69	0.32	0.15
acenaphthene	<0.39	<0.4	<0.39	<0.4	<0.39
fluorene	0.7	<0.56	0.73	<0.59	<0.54
phenanthrene	4.24	1.93	3.31	2.57	1.2
anthracene	0.59	0.42	0.86	0.54	0.22
fluoranthene	8.07	3.75	5.72	2.55	1.54
benzo[c]fluorene	0.5	0.2	0.36	0.2	0.12
pyrene	2.65	1.7	3.43	1.78	1.2
benzo[ghi]fluoranthene	2.42	1.17	1.72	0.82	0.86
Benzo[a]anthracene	2.42	1.3	2.1	1.26	0.64
benzo[b]naphtho[2,1-d]thiophene	0.62	0.28	0.36	0.19	0.22
cyclopenta[cd]pyrene	0.1	0.03	0.06	0.02	0.07
chrysene	2.73	1.34	1.87	1.26	0.85
5-methylchrysene	0.11	0.07	0.08	0.05	0.03
benzo[b]fluoranthene	4.96	2.16	2.21	1.44	1.64
benzo[j]fluoranthene	2.04	0.86	0.96	0.59	0.61
benzo[k]fluoranthene	4.61	1.11	1.18	0.72	0.77
benzo[e]pyrene	5.42	3.08	3.37	2.47	2.69
benzo[a]pyrene	1.39	1.11	1.53	1.05	0.37
indeno[1,2,3-cd]pyrene	1.37	0.72	0.78	0.93	0.38
dibenzo[ah]anthracene	0.38	0.14	0.17	0.19	0.08
benzo[ghi]perylene	1.53	0.76	1.08	1.4	0.56
anthanthrene	<0.1	<0.1	<0.1	0.1	<0.1
dibenzo[a,l]pyrene	<0.15	<0.13	<0.15	<0.21	<0.11
dibenzo[a,e]pyrene	<0.1	<0.13	<0.12	<0.13	<0.12
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	0.3	0.18	0.36	0.6	0.1
PAH 4 Sum Lower µg/kg	**11.5**	**5.91**	**7.71**	**5.01**	**3.5**
PAH 4 Sum Upper µg/kg	**11.5**	**5.91**	**7.71**	**5.01**	**3.5**

FERA LIMS No.	S19-000860	S19-009991	S19-001088	S19-001119	S19-011442
Species	Mussels	Mussels	Mussels	Pacific Oysters	Mussels
Production Area	Loch Leven: Upper	Loch Sunart	Inner Loch Torridon	Little Loch Broom Pacific Oysters	Loch Laxford
Sample Site Name	Upper	Liddesdale	Dubh Aird	Little Loch Broom Pacific Oysters	Weavers Bay
acenaphthylene	<0.31	0.09	<0.31	<0.31	0.24
acenaphthene	<0.58	<0.4	<0.58	<0.57	<0.4
fluorene	<0.79	<0.55	<0.79	<0.78	<0.56
phenanthrene	<1.01	0.83	<1.01	<0.99	1.42
anthracene	0.34	0.09	<0.07	0.14	0.16
fluoranthene	1.58	0.82	<0.47	1.63	1.11
benzo[c]fluorene	0.13	0.05	<0.03	0.06	0.07
pyrene	0.62	0.42	<0.47	0.6	0.46
benzo[ghi]fluoranthene	0.83	0.42	0.23	0.7	0.49
Benzo[a]anthracene	0.67	0.27	0.09	0.25	0.22
benzo[b]naphtho[2,1-d]thiophene	0.22	0.14	0.05	0.07	0.1
cyclopenta[cd]pyrene	0.06	0.04	0.01	0.02	0.03
chrysene	1.13	0.46	0.2	0.41	0.33
5-methylchrysene	0.04	<0.02	<0.01	0.01	0.01
benzo[b]fluoranthene	4.14	0.68	0.31	1.06	0.76
benzo[j]fluoranthene	1.2	0.29	0.1	0.21	0.25
benzo[k]fluoranthene	1.75	0.26	0.1	0.41	0.27
benzo[e]pyrene	5.86	0.87	0.49	1.42	1.2
benzo[a]pyrene	1.07	0.16	0.1	0.14	0.19
indeno[1,2,3-cd]pyrene	1.1	0.24	0.11	0.14	0.33
dibenzo[ah]anthracene	0.24	<0.05	<0.03	<0.05	<0.07
benzo[ghi]perylene	1.91	0.34	0.17	0.19	0.47
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.14	<0.12	<0.13	<0.13	<0.12
dibenzo[a,e]pyrene	<0.16	<0.13	<0.1	<0.1	<0.13
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	0.22	<0.1	<0.1	<0.1	0.16
PAH 4 Sum Lower µg/kg	**7.01**	**1.57**	**0.7**	**1.86**	**1.5**
PAH 4 Sum Upper µg/kg	**7.01**	**1.57**	**0.7**	**1.86**	**1.5**

FERA LIMS No.	S19-011387	S19-012600	S19-011909	S19-012059	S19-000898
Species	Pacific Oysters	Razor Clams	Mussels	Mussels	Mussels
Production Area	Fairlie	Stevenston Sands Razors	Aith Voe Sletta	Catfirth	South of Houss Holm
Sample Site Name	Southannan Sands	Stevenston Sands Razors	Slyde	Catfirth	South of Houss Holm
acenaphthylene	0.81	0.77	<0.07	<0.11	<0.31
acenaphthene	<0.4	0.55	<0.39	<0.4	<0.58
fluorene	<0.55	1.51	<0.55	<0.59	<0.79
phenanthrene	1.96	5.78	<0.78	<0.94	<1
anthracene	1.09	1.04	<0.05	<0.06	<0.07
fluoranthene	5.21	11.07	0.42	<0.45	<0.47
benzo[c]fluorene	0.31	0.54	0.03	<0.04	<0.03
pyrene	4.2	6.59	<0.34	<0.45	<0.47
benzo[ghi]fluoranthene	2.4	3.01	0.23	0.13	0.25
Benzo[a]anthracene	2.01	3.92	0.15	0.09	0.15
benzo[b]naphtho[2,1-d]thiophene	0.55	0.78	0.06	<0.04	<0.03
cyclopenta[cd]pyrene	0.11	0.08	0.02	<0.02	0.02
chrysene	2.57	4.67	0.22	0.16	0.21
5-methylchrysene	0.12	<0.16	<0.01	<0.01	<0.01
benzo[b]fluoranthene	4.8	3.97	0.64	0.32	0.42
benzo[j]fluoranthene	1.49	1.76	0.22	<0.12	0.16
benzo[k]fluoranthene	2.41	2.02	0.24	0.13	0.17
benzo[e]pyrene	6.65	6.46	0.84	0.39	0.55
benzo[a]pyrene	1.44	2.38	0.17	0.05	0.17
indeno[1,2,3-cd]pyrene	0.84	0.66	0.31	0.17	0.19
dibenzo[ah]anthracene	0.26	0.16	<0.05	<0.05	<0.05
benzo[ghi]perylene	1.14	0.72	0.37	0.18	0.3
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.12	<0.11	<0.12	<0.11	<0.13
dibenzo[a,e]pyrene	<0.13	<0.1	<0.12	<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	0.14	0.11	<0.1	<0.1	<0.1
PAH 4 Sum Lower µg/kg	**10.82**	**14.94**	**1.18**	**0.62**	**0.95**
PAH 4 Sum Upper µg/kg	**10.82**	**14.94**	**1.18**	**0.62**	**0.95**

FERA LIMS No.	S19-000632	S19-012599	S19-001264
Species	Mussels	Razor Clams	Razor Clams
Production Area	Weisdale Voe Upper	Croy Bay	North Bay
Sample Site Name	Olligarth	Culzean Bay	Barassie
acenaphthylene	<0.35	0.29	0.39
acenaphthene	<0.67	<0.4	<0.39
fluorene	<0.95	<0.59	<0.58
phenanthrene	<1.31	1.9	2.47
anthracene	<0.28	0.27	0.46
fluoranthene	<0.47	4.29	5.21
benzo[c]fluorene	0.02	0.27	0.22
pyrene	<0.45	1.63	2.46
benzo[ghi]fluoranthene	0.15	1.52	1.49
Benzo[a]anthracene	0.13	1.03	1.66
benzo[b]naphtho[2,1-d]thiophene	0.03	0.33	0.32
cyclopenta[cd]pyrene	0.01	0.03	0.03
chrysene	0.2	1.54	1.84
5-methylchrysene	<0.01	0.03	0.05
benzo[b]fluoranthene	0.49	1.28	2.15
benzo[j]fluoranthene	0.17	0.5	0.9
benzo[k]fluoranthene	0.22	0.55	1.08
benzo[e]pyrene	0.5	2.58	3.73
benzo[a]pyrene	0.16	0.4	1.09
indeno[1,2,3-cd]pyrene	0.31	0.28	0.47
dibenzo[ah]anthracene	0.06	<0.06	0.11
benzo[ghi]perylene	0.34	0.31	0.57
anthanthrene	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.11	<0.14
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1
coronene	0.11	<0.1	<0.1
PAH 4 Sum Lower µg/kg	**0.98**	**4.25**	**6.74**
PAH 4 Sum Upper µg/kg	**0.98**	**4.25**	**6.74**

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Table 5: Trace Element Concentrations (mg/kg wet weight)

FERA LIMS No.	S19-001116	S19-001117	S19-009963	S19-000790	S19-001118
Species	Cockles	Cockles	Pacific Oysters	Cockles	Razor Clams
Production Area	Kerrera West	Loch Creran Cockles	Loch Fyne: Ardkinglas Oysters	Loch Fyne: Otter Point	Sound of Gigha
Sample Site Name	Oitir mhor	Loch Creran Cockles	The Shore	Otter Point	Sound of Gigha 2 Razors
Chromium	0.15	0.1	~0.03	~0.09	0.11
Manganese	1.95	1.53	3.17	1.61	1.33
Cobalt	0.118	0.094	0.022	0.137	0.064
Nickel	1.55	1.53	~0.06	1.34	~0.09
Copper	0.29	0.36	7.22	0.29	0.80
Zinc	4.07	4.35	101	4.75	15.5
Arsenic	0.87	0.74	1.12	0.88	1.48
Selenium	0.162	0.163	0.219	0.201	0.34
Silver	<0.003	~0.007	0.339	~0.004	0.163
Cadmium	0.019	0.021	0.187	0.027	0.022
Mercury	~0.005	~0.006	0.009	~0.005	0.021
Lead	0.045	0.21	0.029	0.038	0.058

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

FERA LIMS No.	S19-000759	S19-000861	S19-000862	S19-000863	S19-011444
Species	Mussels	Mussels	Mussels	Mussels	Razor Clams
Production Area	East Loch Tarbert	Loch Roag: Ceabhagh	Loch Roag: Drovinish	Loch Roag: Linngeam	Fleet Bay Razors
Sample Site Name	Sound of Scalpay	Keava	Loch Drovinish	Linngeam	Fleet Bay Razors
Chromium	~0.08	~0.07	~0.07	~0.08	0.15
Manganese	1.12	0.48	0.47	0.56	2.19
Cobalt	0.024	0.014	0.014	0.016	0.083
Nickel	~0.09	~0.08	~0.07	~0.07	~0.09
Copper	0.82	0.44	0.48	0.42	1.40
Zinc	11.8	8.00	8.55	8.49	12.0
Arsenic	1.78	1.00	1.02	0.93	1.11
Selenium	0.413	0.245	0.267	0.248	0.289
Silver	~0.006	~0.004	~0.004	~0.004	0.307
Cadmium	0.073	0.052	0.054	0.057	0.031
Mercury	0.007	~0.006	~0.006	~0.006	0.021
Lead	0.1	0.068	0.07	0.077	0.114

FERA LIMS No.	S19-011908	S19-011443	S19-011441	S19-011907	S19-001265
Species	Native Oysters	Razor Clams	Razor Clams	Surf Clams	Mussels
Production Area	Loch Ryan	Wigtown Bay: Islands of Fleet	Gullane Point North	Firth of Forth: North	Loch Eil
Sample Site Name	Leffnoll Point	Wigtown Bay	Gullane North	Anstruther	Duisky
Chromium	0.29	0.22	0.14	0.2	~0.06
Manganese	6.10	2.19	2.29	3.48	3.60
Cobalt	0.057	0.081	0.077	0.129	0.021
Nickel	0.19	~0.09	~0.08	0.29	~0.07
Copper	16.4	1.32	1.63	1.44	0.56
Zinc	187	12.8	14.1	8.12	7.03
Arsenic	1.33	1.17	1.25	1.34	0.85
Selenium	0.433	0.289	0.261	0.337	0.258
Silver	1.17	0.232	0.113	0.159	~0.007
Cadmium	0.282	0.029	0.017	0.070	0.047
Mercury	0.013	0.018	0.011	0.010	0.010
Lead	0.114	0.113	0.102	0.125	0.030

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

FERA LIMS No.	S19-000860	S19-009991	S19-001088	S19-001119	S19-011442
Species	Mussels	Mussels	Mussels	Pacific Oysters	Mussels
Production Area	Loch Leven: Upper	Loch Sunart	Inner Loch Torridon	Little Loch Broom Pacific Oysters	Loch Laxford
Sample Site Name	Upper	Liddesdale	Dubh Aird	Little Loch Broom Pacific Oysters	Weavers Bay
Chromium	~0.06	~0.07	0.1	~0.03	0.24
Manganese	1.71	2.86	0.98	2.71	2.20
Cobalt	0.017	0.021	0.020	0.020	0.034
Nickel	~0.06	~0.08	~0.07	~0.04	0.23
Copper	0.63	0.50	0.44	3.46	0.97
Zinc	6.48	6.41	4.77	117	10.5
Arsenic	0.93	0.88	1.48	1.81	1.87
Selenium	0.285	0.262	0.252	0.269	0.413
Silver	~0.007	~0.007	~0.004	0.243	0.011
Cadmium	0.05	0.052	0.084	0.286	0.055
Mercury	0.011	0.010	0.011	0.009	0.007
Lead	0.041	0.741	0.085	0.023	0.118

FERA LIMS No.	S19-011387	S19-012600	S19-011909	S19-012059	S19-000898
Species	Pacific Oysters	Razor Clams	Mussels	Mussels	Mussels
Production Area	Fairlie	Stevenston Sands Razors	Aith Voe Sletta	Catfirth	South of Houss Holm
Sample Site Name	Southannan Sands	Stevenston Sands Razors	Slyde	Catfirth	South of Houss Holm
Chromium	~0.08	0.16	0.10	~0.08	~0.09
Manganese	2.88	1.40	0.79	1.31	0.81
Cobalt	0.026	0.063	0.019	0.018	0.020
Nickel	~0.08	~0.09	0.10	~0.09	~0.09
Copper	10.7	1.01	0.58	0.57	0.56
Zinc	157	14.2	13.4	14.4	14.3
Arsenic	1.64	1.08	1.25	1.00	1.18
Selenium	0.231	0.224	0.284	0.199	0.217
Silver	0.558	0.101	~0.004	<0.003	<0.003
Cadmium	0.119	0.026	0.139	0.077	0.135
Mercury	0.016	0.010	~0.005	~0.005	~0.006
Lead	0.088	0.083	0.107	0.149	0.128

FERA LIMS No.	S19-000632	S19-012599	S19-001264
Species	Mussels	Razor Clams	Razor Clams
Production Area	Weisdale Voe Upper	Croy Bay	North Bay
Sample Site Name	Olligarth	Culzean Bay	Barassie
Chromium	0.10	0.16	0.17
Manganese	1.98	1.52	0.71
Cobalt	0.02	0.10	0.083
Nickel	0.12	0.30	0.10
Copper	0.34	0.84	0.89
Zinc	10.2	15.4	12.7
Arsenic	0.82	1.19	1.40
Selenium	0.18	0.292	0.251
Silver	~0.004	0.070	0.329
Cadmium	0.121	0.022	0.024
Mercury	~0.004	0.010	0.017
Lead	0.107	0.044	0.047

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