Centre for Environment Fisheries & Aquaculture Science

Cefas

The Shellfish official control monitoring programmes for Scotland

Summary report for 2020

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July 2021

This publication is available at www.gov.uk/government/publications

www.cefas.co.uk

Cefas Document Control

Submitted to:	Graham Ewen, Food Standards Scotland (FSS)
Date submitted:	15 July 2021
Project Manager:	Karen Litster
Report compiled by:	Myriam Algoet, based on input from Lewis Coates, Sarah Swan, Lesley Bickerstaff, Charlotte Ford and Sean Panton
Quality control by:	Michelle Price-Hayward, 09 July 2021
Approved by and date:	Karen Litster, 15 July 2021
Version:	Final V1
Classification:	Official
Recommended citation for this report:	Algoet, M., Coates L., Swan. S, Bickerstaff L., Ford C., Panton S. (2021). The Shellfish official control monitoring programmes for Scotland. Summary report for 2020. Cefas Project Report for FSS (Contract C7711/C7712/C7713/C7714/C7715), 38 pp.

Version control history

Version	Author	Date	Comment
Draft V1	M. Algoet, L. Coates, S. Swan, L. Bickerstaff, C. Ford, S. Panton	24/06/2021	Submitted for accessibility check by Cefas Communications team and to GM for QC
Draft V2	M. Price-Hayward	09/07/2021	Quality controlled
Draft V3	M. Algoet	09/07/2021	Final amendment and submitted to PM for internal approval
Draft V4	K. Litster	12/07/2021	Submitted to FSS for review and customer approval
Final V1	K Litster	15/07/2021	Final Report submitted to FSS

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This report describes the results of the Scottish Official Control Monitoring Programmes delivered by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) and partners for the period 1st January to 31st December 2020. The programmes were delivered on behalf of Food Standards Scotland (FSS), the national competent authority for food safety and were aimed at delivering the testing required for the statutory monitoring of biotoxins, *E.coli* and chemical contaminants in shellfish and for the identification and enumeration of potentially harmful algal species in selected shellfish harvesting areas, as described in European Commission (EC) regulations 2017/625 and 2074/2005.

The co-ordination of the programme, its logistics, toxin analyses and the majority of *E. coli* analyses were conducted by Cefas, whilst phytoplankton analyses were performed by SAMS Research Services Ltd. (SRSL) in Oban, chemical contaminants analyses by Fera Science Ltd (Fera) in York and *E. coli* analyses for Shetland only by SSQC Ltd in Scalloway. These laboratories were contracted by Cefas under the scope of the 'Shellfish Partnership'.

A summary of these programmes and their results are presented in the following sections of this report:

- Section 1: Toxin and phytoplankton monitoring programme
- Section 2: *E. coli* monitoring programme
- Section 3: Chemical contaminants monitoring programme

A full report on the methodology used for the above programme and their results in 2020 has been provided to FSS.

A total of 3,989 shellfish samples and 1,318 water samples were collected for the purpose of the 2020 Scottish official control monitoring programmes. Since the 1st of April 2018, sampling officers from Hall Mark Meat Hygiene (HMMH) have collected or arranged collection for all samples from all geographic locations, under a new contract arrangement with Cefas. For the purpose of this report and in line with FSS protocol, a 'verified' shellfish sample is defined as a sample collected from the agreed monitoring point by an authorised sampling officer. Samples 'verified from shore' are defined as samples collected by harvesters under the supervision of the authorised sampling officer. Such arrangements are implemented when sampling officers are unable to accompany the harvester to the location of the monitoring point at the time of collection. The harvester can be witnessed from shore by the sampling officer. Where collection from the shellfish bed cannot be witnessed from the shore by the sampling officer (due to the remoteness of the shellfish bed or the lack of suitable and accessible vantage point), the samples are recorded as 'unverified'.

The delivery of the 2020 monitoring programme continued throughout the Covid-19 pandemic with service maintained and delivered in a COVID secure manner. During

lockdown restrictions a few harvesting areas voluntarily ceased harvesting which led to fewer samples being collected and tests delivered.

Only <0.3% of the biotoxin samples and 3.1% of *E. coli* samples were rejected as unsuitable for analysis on arrival at the laboratories. Two water samples were rejected as they were collected in error. All chemical contaminants samples were suitable.

All analyses followed the approved methods laid out in EC legislation and specified by FSS for the purpose of this programme. All methods were accredited to ISO17025:2017 standards at the testing laboratories. Amnesic shellfish poisoning toxins (ASP) were monitored in 958 samples, lipophilic toxins (LT) in 2,043 samples and paralytic shellfish poisoning toxins (PSP) in 1,267 samples. 1,862 samples were tested for *E. coli*, 16 for heavy metals (lead, cadmium and mercury), 18 for PAHs and 5 for dioxins and PCBs.

All results were reported to FSS' specifications and met the required FSS turnaround times. Specifically:

- 97.7% of all toxin results were reported within 1 working day of sample receipt, 99.9% within 2 working days, 100% withing 3 working days;
- 100% of phytoplankton results were reported within 3 days of sample receipt;
- 99% of *E. coli* actionable results ('outwith') were reported within 3 working days of onset of analysis;
- 100% *of E. coli* non-actionable results were reported within 5 working days of onset of analysis;
- Draft chemical contaminant report produced by end May 2020.

The results of the monitoring programme are presented in each section of this report. In summary:

- 161 samples breached the maximum permitted limits (MPL) for lipophilic toxins (OA/DTX/PTX group only), 11 samples breached the MPL for PSP toxins and 1 sample breached the MPL for ASP toxins (see section 1);
- Outwith *E. coli* results were reported in 5.9% of the analyses undertaken in 2020 (see section 2);
- All chemical contaminants results were below the regulatory maximum limits (see section 3).

1. Toxin and Phytoplankton summary

This section provides a summary of the toxin and phytoplankton monitoring undertaken in Scottish shellfish under the FSS programme in 2020. The full results of the FSS toxin and phytoplankton monitoring programmes are available on the FSS website. For results for individual RMPs (Representative Monitoring Points), please visit the Scotland's Aquaculture website at the following links:

- Biotoxin monitoring
- Phytoplankton monitoring

A total of 2,105 bivalve shellfish samples from 91 inshore sampling locations (Figure 1) were submitted to Cefas for toxin analyses in 2020. They comprised of; common mussels (1,375), Pacific oysters (472), razors (67), common cockles (123), surf clams (55) and native oysters (13). Six of these samples (representing less than 0.3% of those received) were rejected on arrival at the laboratory – two of these had perished in transit, the other samples were not collected according to the sampling schedule. Four samples of processed scallops (3 king & 1 queen scallops - all adductor and roe) were also collected from commercial establishments in the Dumfries and Galloway region under the scope of the FSS official control verification programme and were submitted for toxin analysis in 2020.

A total of 1,318 seawater samples from 49 inshore sampling locations (Figure 2) were submitted to SRSL for the identification and enumeration of potentially harmful algal species in 2020. Two of these samples were rejected as they were not on the sampling schedule for that week.

All results were compared to the maximum permitted levels (MPL) (Table 1) stipulated in retained EC regulation 853/2004. Toxin test results must not exceed these limits in either whole body or any edible part separately. Please note that for ease of reading, in the text of this report, toxin concentrations are shown as mg/kg or µg/kg, without reference to the toxin parent.

Table 1: Maximum permitted limits of toxins in shellfish flesh.

Toxin groups	Maximum permitted limits (MPL)
Amnesic shellfish poisoning (ASP) toxins	20 mg of Domoic/epi-domoic acid per kg of shellfish flesh
Lipophilic toxins (LTs)	For Diarrhetic shellfish poisoning toxins (DSP) and pectenotoxins (PTX) together: 160 µg of okadaic acid (OA) equivalents per kg of shellfish flesh OR For Yessotoxins (YTX): 3.75 mg of YTX equivalents per kg of shellfish flesh OR For Azaspiracids (AZA): 160 µg of AZA equivalents per kg of shellfish flesh
Paralytical shellfish poisoning (PSP) toxins	800 µg of saxitoxin (STX) equivalents per kg of shellfish flesh

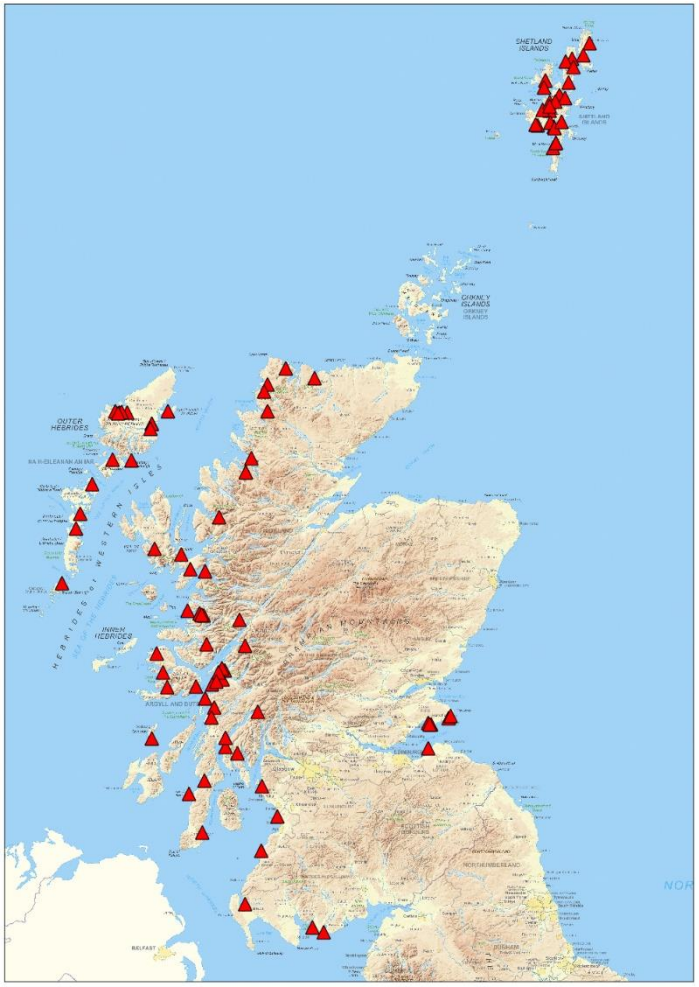

Figure 1. Scottish inshore shellfish sampling locations – Food Standards Scotland biotoxin monitoring programme in 2020

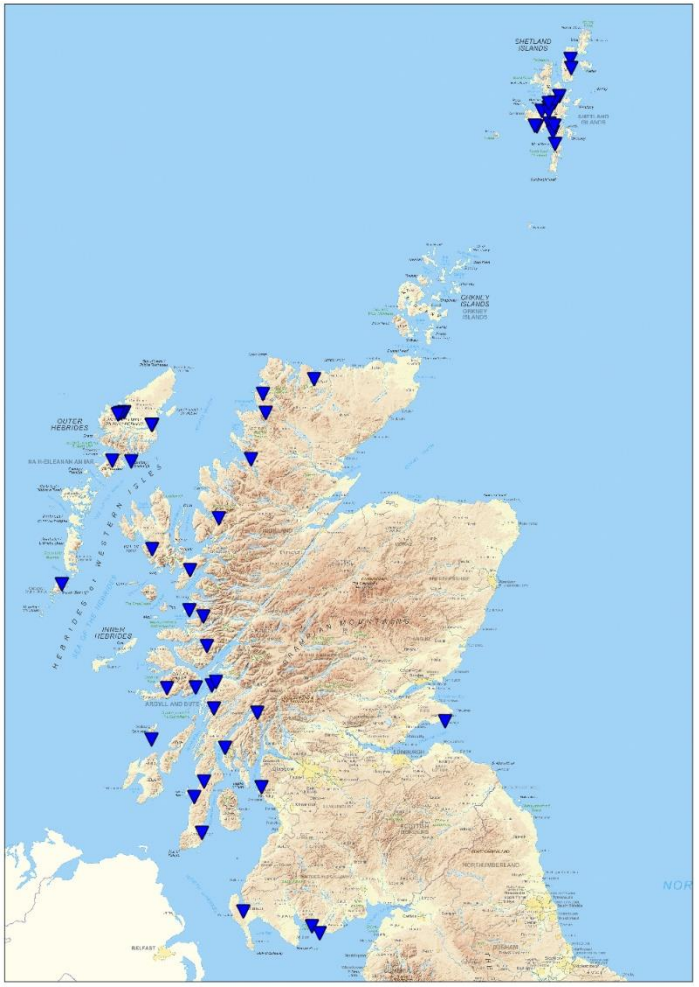

Figure 2. Scottish water sampling locations – Food Standards Scotland phytoplankton monitoring programme in 2020

1.1. lipophilic toxins

In total, lipophilic toxins (LTs) analyses were performed on 2039 inshore samples and 4 verification samples. Monitoring for LTs was conducted using an ISO17025 accredited liquid chromatography with tandem mass spectrometry (LC-MS/MS) method and results are summarised below.

161 inshore samples breached the MPL for lipophilic toxins (Table 1). As highlighted in previous annual reports, where the MPL for lipophilic toxins had been exceeded and sampling had occurred in the previous two to three weeks, the LC-MS/MS method provided an early warning, detecting low toxin levels prior to closure in the majority of cases. This indicates the methods performance and advantage as an early warning mechanism, when applied to risk management practices such as the FSS "traffic light" guidance.

1.1.1. OA/DTX/PTX group

- OA/DTX/PTX group toxins were detected in 792 inshore samples, comprising of mussels (716 samples), surf clams (47), Pacific oysters (15), common cockles (10) and razors (4).
- 161 samples comprising of mussels (153 samples), surf clams (4), Pacific oysters (3) and razors (1) from 35 sites (Figure 3) recorded results above the MPL in 2020. These results were recorded between June and October 2020.
- The highest level recorded during 2020 was 2072µg OA eq./kg, almost 13 times the regulatory limit, in a sample from Loch Laxford (Highland Council: Sutherland) in late July 2020. Levels of OA/DTX/PTX group toxins at this site had started to rise in late May and increased to exceed the regulatory limit in early June. The site recorded its second consecutive result below the MPL in early September.
- Elsewhere, OA/DTX/PTX group toxins were detected below the MPL in a further 631 samples from 58 sites (Figure 4), between January and December 2020.
- No OA/DTX/PTX group toxins were detected in the Scallop verification samples received in 2020.

1.1.2. AZA group

AZAs were not detected in 2020.

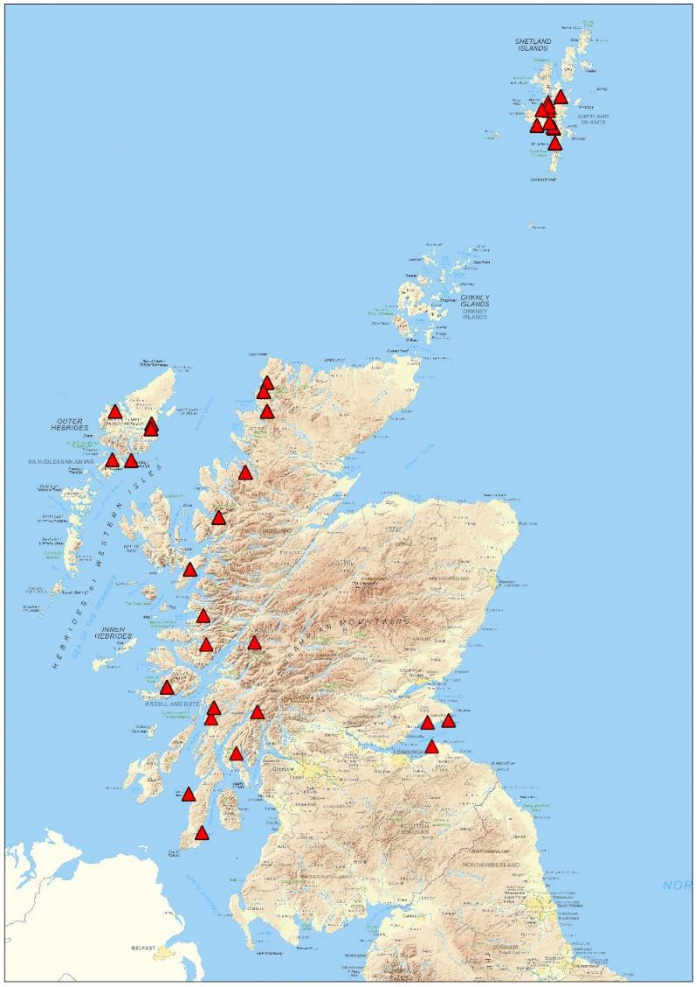

Figure 3. Inshore locations recording OA/DTX/PTX group results above the maximum permitted limit (>160µg OA eq./kg) in 2020

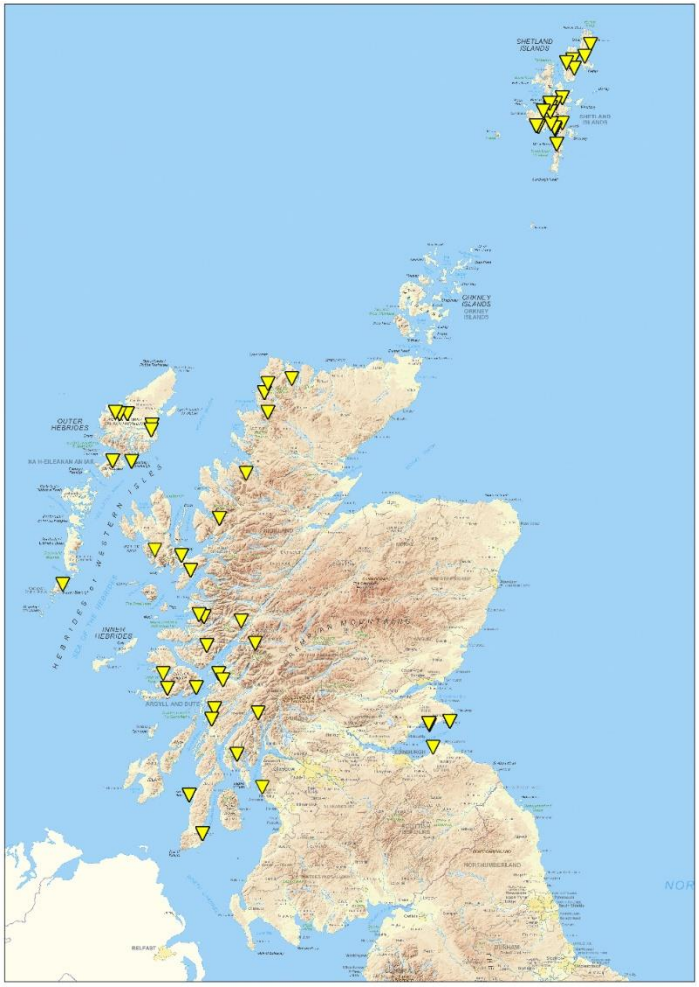

Figure 4. Inshore locations where toxins of OA/DTX/PTX group were detected below the maximum permitted limit (≤160µg OA eq./kg) in 2020

1.1.3. YTX group

YTXs were detected in 26 inshore samples from six sites (see Figure 5) between June and September. All results were below the MPL (Table 1). The highest level recorded was 1.1 mg YTXeq/kg from Pod 18 – Campbeltown Loch in samples taken on the 15th and 29th of June 2020.

Figure 5. Inshore locations where YTX group toxins were detected in 2020 (all below the maximum permitted limit (3.75 mg YTX eq./kg))

1.1.4. Phytoplankton associated with the production of lipophilic toxins

- *Dinophysis* species were present in 549 (41.7%) of the 1,316 samples analysed during 2020 and were detected between March and October. They were observed at or above trigger level (set at 100 cells/L) in 257 samples (19.5%) between May and October. The majority of *Dinophysis* blooms occurred around the Scottish coast from June to August, with 52.3% of the samples collected in July exceeding threshold counts. (Please note that in this report, references to *Dinophysis* species also include *Phalacroma rotundatum* (synonym *Dinophysis rotundata*) and that blooms are denoted as cell counts at or exceeding trigger level, where appropriate for individual species/genera).
- The earliest blooms breaching trigger level were recorded in Fairlie (North Ayrshire), Campbeltown Loch (Argyll & Bute), Loch Torridon (Highland: Ross & Cromarty), and East Loch Tarbert (Lewis & Harris), all in the first week of May 2020. As in every year since 2016, dense blooms of *Dinophysis* were observed at Loch Fyne: Ardkinglas (Argyll & Bute) during the summer of 2020, with the highest cell density reaching 81,300 cells/L on 22nd July. These dense blooms appeared to be confined to upper Loch Fyne, with samples obtained from lower Loch Fyne: Otter Ferry during the same time period containing *Dinophysis* at lower concentrations. Elsewhere in Argyll & Bute, blooms were observed on the west coast of the Isle of Mull at Kilfinichen Bay, with 9,820 cells/L recorded on 16th June and 7,420 cells/L on 30th June.
- *Dinophysis* blooms were widespread around most of the Highland region between June and July, with a cell count of 9,600 cells/L reported from Loch Torridon (Highland: Ross & Cromarty) on 1st July. On 7th July, counts of 16,540 cells/L and 6,220 cells/L were recorded in Highland: Sutherland at Kyle of Tongue and Loch Laxford, respectively. *Dinophysis* was frequently observed around Lewis & Harris in June and July, and around the Shetland Islands in July and August.
- The total percentage of *Dinophysis* at or exceeding trigger level during the 2020 reporting period (19.5%) was higher than in 2019 (15.8%).
- The benthic dinoflagellate *Prorocentrum* was present in 267 samples (20.3%) analysed during 2020. It was recorded from March to October and was most abundant between May and September. *Prorocentrum lima* was reported at or above the trigger level (set at 100 cells/L) in 50 samples (3.8%), collected between April and October. This species is generally detected more often in the sandy sediments of shallow bays where oyster cultivation takes place, although it can also grow epiphytically on substrates such as seaweed.
- The densest bloom of *Prorocentrum lima* in 2020 was observed in the Shetland Islands, with 8,580 cells/L recorded in Basta Voe Cove on 28th July. Similar to 2018 and 2019, *Prorocentrum lima* was frequently observed at this site, with counts exceeding trigger level for 15 continuous weeks between June and September. It was also regularly detected in Mid Yell Voe (Shetland Islands).

- Elsewhere in Scotland, *Prorocentrum lima* blooms were noted at several sites in Argyll & Bute, with a maximum density of 380 cells/L recorded in Campbeltown Loch and in the Sound of Gigha on 29th June and 7th September, respectively. It was also present in 62.5% of the Colonsay samples and 56.5% of the Ganavan samples.
- The dinoflagellate *Protoceratium reticulatum* was detected in 43 samples (3.3%) between March and August and was most abundant in May and June. It was observed in all regions except Fife and Dumfries & Galloway. Some unusually dense blooms were detected in 2020, notably in Loch Torridon (Highland: Ross & Cromarty) where a concentration of 87,607 cells/L was recorded on 27th May. Cell counts of 5,120 cells/L and 1,440 cells/L were observed in East Loch Tarbert (Lewis & Harris) and Loch Fyne: Otter Ferry (Argyll & Bute) on 5th May and 15th June, respectively. No trigger level has been set for *Protoceratium reticulatum*.
- The dinoflagellate *Lingulodinium polyedra* is rarely abundant in Scottish coastal waters. In 2020 it was found on only one occasion (0.1 % of samples), in Brighouse Bay (Dumfries & Galloway), at a concentration of 40 cells/L on 27th August. Samples were not collected from Loch Creran in 2020, so it is not known whether this species was present at this site, as has been the case in previous years. No trigger level has been set for *Lingulodinium polyedra*.

1.2. PSP toxins

A total of 1,263 inshore samples and 4 scallop verification samples were tested for paralytic shellfish poisoning (PSP) toxins in 2020. All samples were tested by an ISO17025 accredited high-performance liquid chromatography (HPLC) method and results are summarised below.

- Eleven samples from seven monitoring sites (Figure 6) were found to contain PSP toxins above the MPL of 800µg STX eq./kg shellfish flesh in early June. These comprised mussels (7 samples), Pacific oysters (2) and cockles (2). The results were recorded from late May and through till the end of June and were all detected in the north-west of mainland Scotland and one occurrence on this Isle of Barra.
- The highest level recorded was 16,200 µg/kg recorded in Pod 48 – Loch Laxford in early June.
- PSP toxins above reporting levels, but below the MPL were detected in a further 22 samples comprising mussels (15 samples), cockles (3), Pacific oysters (3) and surf clams (1) from 13 separate pods (Figure 7). All occurrences were recorded between mid-April and early July 2020.

- A range of PSP toxins were quantified during 2020. Eleven samples were quantified and recorded toxin results above the reporting limit (160µg STXeq/kg). A further 46 samples (31 mussels, six cockles, six Pacific oysters and three surf clams) were subjected to full quantitative analysis but returned results below the reporting limit for the test. The profiles predominantly consisted of the toxins Saxitoxin (STX), Gonyautoxins (GTX) 2&3, GTX1&4, Neosaxitoxin (NEO) and C toxins 1&2 (data not shown). Lower concentrations of GTX5 and dcSTX were also detected in some shellfish samples. Proportions of each toxin varied considerably, but the profiles were consistent with previous years, and similar to those expected from shellfish contaminated with *Alexandrium* as documented in Turner et al, 2014., with profiles dominated by GTX1&4, GTX2&3, NEO and STX.
- No quantifiable levels of PSP toxins were detected in the scallop verification samples.

Phytoplankton associated with the production of PSP toxins:

- Dinoflagellates belonging to the genus *Alexandrium* were observed between March and October and were detected in 371 (28.2%) of the 1,316 samples analysed during 2020. They were reported at or above the trigger level (set at 40 cells/L) in 258 samples (19.6%). Blooms were most frequently recorded between May and August, and 41.1% of the samples analysed in May breached the *Alexandrium* trigger level.
- The earliest *Alexandrium* bloom of 2020 was observed on 11th March at Loch Fyne: Otter Ferry (Argyll & Bute). *Alexandrium* was frequently detected at many sites in the Shetland Islands between May and August. It was also recorded around the Western Isles between May and September, with toxin-producing *Alexandrium* present at 120 cells/L in Loch Leurbost (Lewis & Harris) on 12th May, and at 100 cells/L in Traigh Mhor (Uist & Barra) on 25th May.
- *Alexandrium* was frequently observed throughout the Highland region between April and June. The densest bloom of 2020 occurred in Loch Torridon (Highland: Ross & Cromarty) on 27th May where a concentration of 9,740 cells/L was recorded, one week before PSP toxins exceeded the regulatory limit in mussels. Similarly, a bloom of 1,340 cells/L occurring in Loch Laxford (Highland: Sutherland) on 26th May resulted in PSP toxicity in mussels the following week. PSP toxins at more than half the regulatory limit in shellfish were associated with *Alexandrium* counts exceeding trigger level at two other Highland: Sutherland sites; at Loch Glencoul with 620 cells/L on 2nd June, and at Kyle of Tongue with 240 cells/L on 9th June.
- The percentage of samples with *Alexandrium* counts at or above trigger level in 2020 (19.6%) was higher than in 2019 (15.6%).

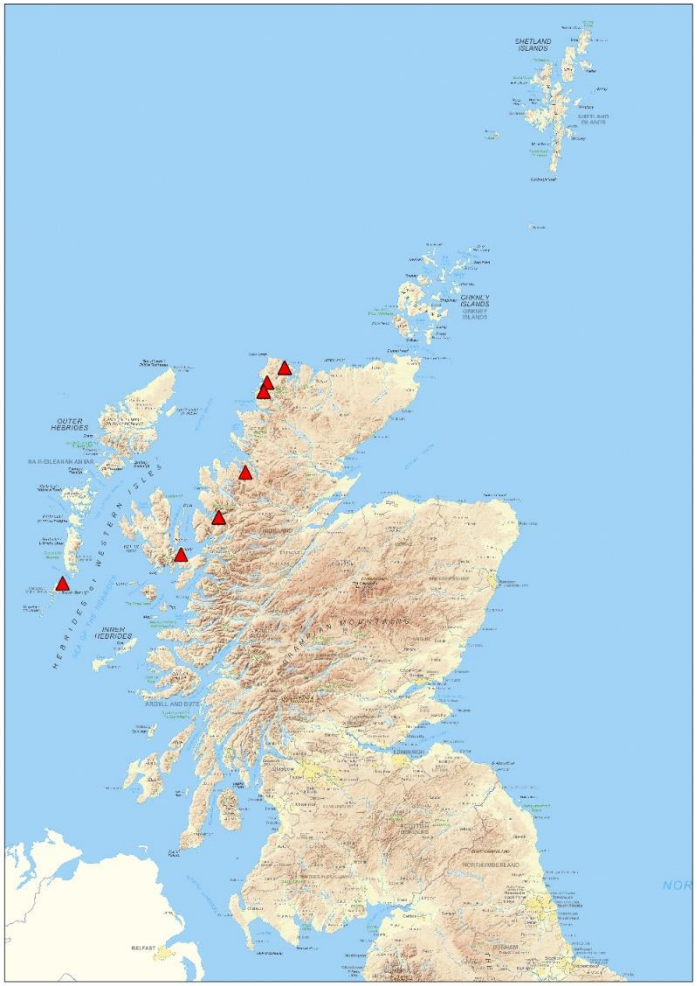

Figure 6. Inshore locations recording PSP toxin results above the maximum permitted limit (>800µg STX eq./kg) in 2020

Figure 7. Inshore locations recording PSP toxin results below the maximum permitted limit (≤800µg STX eq./kg) in 2020

1.3. ASP toxins

Analyses for amnesic shellfish poisoning (ASP) toxin were conducted on 954 inshore samples and 4 scallop verification samples. All samples were analysed by an ISO17025 accredited HPLC method. Results are summarised below.

- ASP was detected in 77 inshore samples comprising of: common mussels (21 samples), Pacific oysters (31), common cockles (9), surf clams (13) and razors (3) (Figure 9). One sample of cockles collected in early June from Pod 77 Traigh Mhor (Figure 8), exceeded the MPL (Table 1) with a result of 20.3 mg/kg.
- Low concentrations (between 1 and 5 mg/kg) were recorded throughout 2020. The peak period occurred between May & September, during which time ASP was detected in 56 samples.
- No ASP was detected in the scallop verification samples received in 2020.

Phytoplankton associated with the production of ASP toxins

Diatoms belonging to the genus *Pseudo-nitzschia* were detected during every month in 2020 and were present in 1,193 (90.7%) of the 1,316 samples analysed. Blooms (here referred to as cell densities exceeding the trigger level of 50,000 cells/L) were detected between March and October and were most frequently observed between June and September. Blooms were widespread in April, but only one bloom was recorded in May. *Pseudo-nitzschia* counts at or above the trigger level were detected in 129 samples (9.8%), with 16.7% of the samples analysed in July exceeding this level.

- The earliest bloom of 2020 occurred in Loch Kanaird (Highland: Ross & Cromarty) on 16th March, with an abundance of 59,947 cells/L. Also in spring, a bloom of density 819,421 cells/L was recorded at Loch Torridon (Highland: Ross & Cromarty) on 23rd March. *Pseudo-nitzschia* was abundant at all the monitoring sites in Highland: Ross & Cromarty and Highland: Sutherland in the last week of June. The latest bloom of 2020 occurred at another site in this region, Loch Harport (Highland: Skye & Lochalsh), with a cell count of 50,160 cells/L reported on 19th October. The densest *Pseudo-nitzschia* bloom of 2020 was recorded in Dales Voe (Shetland Islands) on 30th June, where cell counts reached 1,161,329 cells/L.
- Elsewhere around the coast, *Pseudo-nitzschia* blooms were rarely observed in south-west Scotland (Dumfries & Galloway, North Ayrshire, Argyll & Bute), or around the Western Isles (Lewis & Harris, Uist & Barra) or Fife. In contrast, *Pseudo-nitzschia* was abundant around the Shetland Islands between July and September, with some associated ASP toxicity in mussels.

- The percentage of samples with *Pseudo-nitzschia* counts at or above trigger level in 2020 (9.8%) was higher than in 2019 (5.3%).

1.4. Other potentially harmful phytoplankton

The dinoflagellate *Prorocentrum cordatum* was detected in 642 samples (48.8%) analysed in 2020. It was observed in January and from March through to October, typically at densities below 1,000 cells/L. It was most frequently recorded between April and September and was present in 77.4% of the June samples. *Prorocentrum cordatum* was widespread around the Scottish coast and found in all regions, but the densest blooms occurred around the Shetland Islands in May and June, with concentrations of 391,561 cells/L recorded in Busta Voe on 25th May, 397,541 cells/L in Vaila Sound on 22nd June, and 324,253 cells/L in Clift Sound on 23rd June. No trigger level has been set for this species.

The potentially problematic dinoflagellate *Karenia mikimotoi* was found in 126 (9.6%) of the samples analysed. It was present between March and October, but most frequently observed between May and August, being detected in 22.6% of the samples collected in May. This species is not an issue in terms of shellfish harvesting, as it does not produce biotoxins that are harmful to human health, although it may negatively impact aquaculture. It produces ichthyotoxins that can kill finfish, and dense blooms of the order of several million cells/L may result in both fish and invertebrate mortality due to hypoxia. Cell counts were much lower than in 2019, with a maximum density of 800 cells/L recorded from East Loch Tarbert (Lewis & Harris) on 5th May.

Figure 8. Inshore locations where ASP toxins were detected above the maximum permitted limit (>20mg/kg) in 2020

Figure 9. Inshore locations where ASP toxins were detected below the maximum permitted limit (>20mg/kg) in 2020

1.5. Programme review & recommendations

1.5.1. Toxin monitoring

Sampling and testing frequencies for toxin and phytoplankton monitoring are defined by FSS, as the competent authority, based on the results of risk assessments which FSS commissioned in 2004 (Holtrop & Horgan), 2008 (Holtrop) and 2016 (Holtrop et al.). The recommendations of the 2016 risk assessment led to testing frequencies been defined and implemented for each site separately. The aim of the review conducted for this report was to look at toxin occurrence over the last couple of years (based on the results of the FSS official monitoring alone as industry data was not available) and identify sites where the set testing frequency may need adjustment, as a result of a recent change to toxin incidence and levels at these sites.

During 2020, the detection rates of toxins had risen to similar levels detected prior to 2019. Areas listed below are recommended for review:

Pod 1: Loch na Keal West: Trigger levels exceeded for LTs in June/July

Pod 31: Loch Leven: LT MPL exceeded in July

Pod 51: Kyle of Tongue: Trigger levels for PSP exceeded in June

Pod 77: Taigh Mhor: PSP MPL exceeded in May & ASP MPL exceeded in June

Pod 90: Gullane Point North: LT MPL exceeded in June

1.5.2. Phytoplankton monitoring

The phytoplankton monitoring points used in 2020 were reviewed and suggested changes are outlined in Table 2 below, alongside FSS decision.

Table 2. Recommended changes to phytoplankton monitoring RMPs

2020 phytoplankton RMP	Recommended phytoplankton RMP for 2021	FSS decision (notes)
Pod 40: Loch Harport Inner - Carbost	Pod 42: Kyles of Scalpay	Not implemented (Kyles of Scalpay is only classified for part of the year)
Pod 144: Loch Kanaird	Pod 39: Little Loch Broom	To be implemented
Pod 63: Weisdale Voe: North Flotta	Pod 157: Bay of Skaill: Westray	To be implemented (sampling to be from Pierowall due to access)

2. *E. coli* summary

This section provides a summary of the microbiological monitoring undertaken in Scottish shellfish under the FSS programme in 2020. All data generated under the Scottish shellfish harvesting classification programme is available on the Cefas website. *E.coli* results are also available on the Scotland's Aquaculture website and on the FSS' website.

2.1. Sample collections and analyses

A total of 1,862 bivalve shellfish samples from 186 RMPs were submitted for microbiological analyses in 2020. 10.3% of the samples received were of unverified origin. The sampling locations covered classified production areas within 10 Local Authority regions (14 regional offices). The samples comprised of the species identified in Table 3.

Table 1. Number of samples collected for the FSS microbiological monitoring programme, by bivalve species in 2020

Common name	Latin name	No. samples received in 2020	% of total
Common mussels	*Mytilus* spp	891	47.9
Pacific oysters	*Crassostrea gigas* (*Magallana gigas*)	393	21.1
Common cockles	*Cerastoderma edule*	324	17.4
Razor clams	*Ensis* spp	184	9.9
Surf clams	*Spisula solida*	33	1.8
Native oysters	*Ostrea edulis*	13	0.7
Pullet carpet shell	*Venerupis corrugata*	12	0.6
Carpet clams	*Venerupis pullastra*	11	0.6
Sand gapers	*Mya arenaria*	1	0.1

The majority of samples (98.5%) arrived at the laboratory within 48h of sample collection. When delays occurred, these were generally attributed to the time at which the samples were collected, thus missing the routine post office collection deadline, or to other events outside of the laboratory or sampling officers' control, such as inclement weather or transport network problems.

3.1% (*n*=58) of the samples received at the laboratories were rejected on arrival. The majority of rejections (n=45) were due to exceedance of the time/temperature criteria set out in FSS protocols.

All analyses were initiated within 48h of sample collection. Samples were analysed using the FSS specified method for enumeration of *E. coli* in shellfish (ISO 16649-3:2015 (ISO 2015)). Initial preparation of shellfish samples followed ISO 6887-3 (ISO 2003) and derivation of MPN results ISO 7218 (ISO 2007). Methods are accredited to ISO 17025:2017 standard. A total of 1804 tests were undertaken in 2020.

All results were compared to the classification categories are set out in Table 4.

Table 4. Criteria for the classification of bivalve shellfish harvesting areas

Classification category	Microbiological standard[1]
Class A	Samples of live bivalve molluscs from these areas must not exceed, in 80% of samples collected during the review period, 230 *E. coli* per 100 g of flesh and intra-valvular liquid The remaining 20% of samples must not exceed 700 *E. coli* per 100 g of flesh and intra-valvular liquid[2]
Class B	Live bivalve molluscs from these areas must not exceed, in 90% of the samples, 4 600 MPN *E. coli* per 100 g of flesh and intra-valvular liquid. In the remaining 10% of samples, live bivalve molluscs must not exceed 46 000 MPN *E. coli* per 100 g of flesh and intra-valvular liquid[3]
Class C	Live bivalve molluscs from these areas must not exceed 46 000 *E. coli* MPN per 100 g of flesh and intra-valvular liquid[4]

2.2. Results by local authority region

Summaries of samples received, rejected and providing results outwith of their classification are shown in Tables 5 to 17 for each classified production area in each local authority region.

[1] The reference method for analysis of *E. coli* is the detection and Most Probably Number (MPN) technique specified in EN/ISO 16649-3. Alternative methods may be used if they are validated against this reference method in accordance with the criteria in EN/ISO 16140 (Regulation (EC) 854/2004 as amended by Regulation (EC) 2285/2015).
[2] Regulation (EC) 854/2004 as amended by Regulation (EC) 2285/2015.
[3] Regulation (EC) 854/2004 as amended by Regulation (EC) 1021/2008
[4] Regulation (EC) 854/2004

2.2.1. Argyll & Bute

Table 5. *E. coli* samples received from Argyll & Bute Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Ardencaple	Ardencaple cockles	AB 818 2146 04	Common cockles	15	6	1
Campbeltown Loch	Kildalloig Bay	AB 029 008 04	Common cockles	13	0	2
Castle Stalker	Port Appin	AB 492 909 04	Common cockles	12	1	0
Colonsay	The Strand (East)	AB 041 1199 13	Pacific oysters	15	1	4
Colonsay East of the Strand	Islands of Colonsay and Oransay	AB 774 1987 16	Razors	1	0	0
Dunstaffnage Cockles	Dunstaffnage Bay	AB 696 1511 04	Common cockles	13	2	1
East Tarbert Bay	Isle of Gigha	AB 541 972 13	Pacific oysters	3	0	0
Eilean an Atha	Eilean an Atha	AB 877 2390 13	Pacific Oyster	1	0	0
Eilean Gainimh	Eilean Gainimh	AB 870 2379 24	Pullet Carpet Shell	12	0	0
Eriska Shoal	Eriska Shoal Cockles	AB 490 907 04	Common cockles	12	1	0
Eriska Shoal Carpet Clams	Eriska Shoal Carpet Clams	AB 547 1006 02	Carpet Clams	11	0	0
Gallochoille Old Pier	Gallochoille Old Pier	AB 699 1519 13	Pacific oysters	1	0	0
Ganavan Cockles	Ganavan	AB 697 1512 04	Common cockles	13	0	2
Islay	Loch Gruinart Craigens	AB 094 011 13	Pacific oysters	13	0	3
Kerrera East	Ardantrive	AB 697 1513 04	Common cockles	12	1	0
Kerrera West	Oitir Mhor	AB 697 1514 04	Common cockles	13	2	0

Kilbrannan Sound	Kilbrannan Sound Gapers	AB 849 2287 18	Sand Gapers	1	0	0
Kilfinichen Bay	Kilfinichen Bay	AB 695 1507 04	Common cockles	12	3	0
Loch A Chumhainn: Inner Deep Site	Inner Deep Site	AB 112 017 13	Pacific oysters	12	0	0
Loch A Chumhainn: Outer	Outer	AB 113 018 13	Pacific oysters	13	1	0
Loch Craignish Cockles	Ardfern	AB 786 2028 04	Common cockles	12	0	1
Loch Creran Cockles	Loch Creran Cockles	AB 729 1685 04	Common cockles	14	2	1
Loch Creran Upper Oysters	East - Barrington	AB 129 021 13	Pacific oysters	12	4	0
Loch Creran: Rubha Mor	Rubha Mor	AB 130 022 13	Pacific oysters	13	3	0
Loch Fyne: Ardkinglas Oysters	The Shore	AB 147 036 13	Pacific oysters	13	1	0
Loch Fyne: Otter Ferry	Balliemore	AB 151 039 13	Pacific oysters	12	3	0
Loch Fyne: Otter Point	Otter Point	AB 714 1659 04	Common cockles	13	1	0
Loch Fyne: Stonefield Oysters	North Bay Oysters	AB 435 840 13	Pacific oysters	11	0	1
Loch Gair	Loch Gair Common Cockles	AB 863 2347 04	Common cockles	13	0	1
Loch Linnhe	Loch Linnhe	AB 172 047 13	Pacific oysters	13	0	1
Loch na Cille	Loch na Cille Cockles	AB 617 1204 04	Common cockles	13	2	2
Loch Na Keal	Eilean Liath	AB 284 080 13	Pacific oysters	12	0	0
Loch Na Keal West	Eilean Casach	AB 286 082 13	Pacific oysters	12	0	0
Loch Riddon Cockles	Loch Riddon Cockles	AB 656 1409 04	Common cockles	13	1	0
Loch Spelve Cockles	North West Spelve	AB 767 1963 04	Common cockles	12	1	0

Loch Spelve Croggan Pier	Croggan Pier	AB 199 055 13	Pacific oysters	12	0	0
Loch Spelve North	Ardura	AB 200 1915 08	Common mussels	12	1	0
Lynn of Lorn Sgeir Liath	Sgeir Liath	AB 318 068 13	Pacific oysters	12	0	0
North Connel Cockles	Ledaig Point Cockles	AB 758 1909 04	Common cockles	16	2	1
Oitir Mhor Bay	Oitir Mhor	AB 308 701 13	Pacific oysters	12	2	0
Porte Na Coite	Porte Na Coite	AB 876 2389 13	Pacific oysters	3	0	0
Seil Point	Poll a' Bhrochain (Cyster)	AB 245 070 13	Pacific oysters	12	0	0
Seil Sound East	East of Balvicar	AB 247 703 08	Common mussels	10	1	0
Seil Sound North	Balvicar North	AB 247 735 13	Pacific oysters	10	1	0
Seil Sound: Balvicar	Rubha nan Ron South	AB 247 728 13	Pacific oysters	3	0	0
Sound of Gigha	Sound Of Gigha Razors 2	AB 515 1250 16	Razors	6	0	0
Sound of Gigha Leim	Leim	AB 856 2309 16	Razors	2	0	0
Sound of Gigha Muasdale	Sound of Gigha Muasdale	AB 854 2305 16	Razors	1	0	0
Sound of Gigha North	North	AB 855 2307 16	Razors	1	0	0
Traigh Bhan	Traigh Bhan Oysters	AB 859 2315 13	Pacific oysters	1	0	0
West Jura Razors	Jura	AB 482 805 16	Razors	10	1	0
West Loch Tarbert	Loup Bay	AB 299 084 13	Pacific oysters	13	1	1

2.2.2. Comhairle Nan Eilean Siar - Lewis & Harris

Table 6. *E. coli* samples received from Comhairle Nan Eilean Siar - Lewis & Harris

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Broad Bay Aiginish	Aiginish	LH 743 1740 16	Razors	9	0	0
East Loch Tarbert	Sound of Scalpay	LH 057 106 08	Common mussels	13	0	1
Loch Erisort: Garbh Eilean	Garbh Eilean	LH 357 747 08	Common mussels	12	2	0
Loch Erisort: Gob Glas	Gob Glas	LH 357 711 08	Common mussels	12	0	0
Loch Leurbost	Eilean Mhiabhaig	LH 168 732 08	Common mussels	11	0	1
Loch Leurbost	Loch Leurbost	LH 168 114 08	Common mussels	2	0	0
Loch Leurbost: Crosbost	Site 1 Crosbost	LH 339 795 13	Pacific oysters	12	0	0
Loch Roag - Gob Sgrithir	Gob Sgrithir	LH 829 2215 08	Common mussels	12	1	0
Loch Roag: Barraglom	Loch Barraglom	LH 185 120 08	Common mussels	10	0	0
Loch Roag: Ceabhagh	Keava	LH 381 772 08	Common mussels	10	1	0
Loch Roag: Drovinish	Loch Drovinish	LH 186 121 08	Common mussels	10	1	0
Loch Roag: Eilean Chearstaigh	Eilean Scarastaigh	LH 344 697 08	Common mussels	10	0	0
Loch Roag: Eilean Teinish	Eilean Teinish	LH 338 720 08	Common mussels	10	0	0
Loch Roag: Linngeam	Linngeam	LH 187 122 08	Common mussels	12	2	0
Loch Roag: Miavaig	Miavaig	LH 188 123 08	Common mussels	10	2	0
Loch Roag: Torranish	Loch Torranish	LH 189 124 08	Common mussels	10	2	0

Loch Seaforth	Loch Seaforth	LH 193 126 08	Common mussels	12	0	0
Seilebost	Seilebost	LH 249 129 04	Common cockles	12	1	0
Tong Sands	Tong Sands Cockles	LH 605 1100 04	Common cockles	4	0	0

2.2.3. Comhairle Nan Eilean Siar - Uist & Barra

Table 6. *E. coli* samples received from Comhairle Nan Eilean Siar - Uist & Barra

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Ardmhor	Ardmhor	UB 874 2385 13	Pacific oysters	7	0	0
Caolas Bhearnaraigh	Caolas Bhearnaraigh	UB 735 1706 16	Razors	1	0	0
Cidhe Eolaigearraidh	Sound Of Barra: Pacific Oysters	UB 427 830 13	Pacific oysters	15	1	4
Garbh Lingeigh	Garbh Lingeigh	UB 713 1622 13	Pacific oysters	13	1	1
North Ford	Oitir Mhor	UB 493 852 04	Common cockles	12	0	0
South Ford	South Ford	UB 259 162 04	Common cockles	12	1	0
Traigh Cille Bharra Cockles	Traigh Cille Bharra Cockles	UB 392 790 04	Common cockles	15	4	4
Traigh Mhor	Traigh Mhor	UB 282 165 04	Common cockles	16	2	4

2.2.4. Dumfries & Galloway

Table 7. *E. coli* samples received from Dumfries & Galloway Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Fleet Bay Razors	Fleet Bay Razors	DG 752 1880 16	Razors	2	0	0

Kirkcudbright Bay Razors	Kirkcudbright Bay Razors	DG 809 2132 16	Razors	8	0	0
Loch Ryan	Leffnoll Point	DG 191 174 12	Native oysters	13	1	0
Wigtown Bay: Islands of Fleet	Wigtown Bay	DG 305 182 16	Razors	8	0	0

2.2.5. East Lothian

Table 8. *E. coli* samples received from East Lothian Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Gullane Point North	Gullane North	EL 601 1087 16	Razors	14	3	1
Gullane Point South	Gullane South	EL 703 1525 16	Razors	14	2	1
North Berwick Razors	North Berwick Razors	EL 736 1707 16	Razors	7	0	0

2.2.6. Fife

Table 9. *E. coli* samples received from Fife Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Elie Razors	Elie Razors	FF 868 2365 16	Razors	12	0	0
Fife Ness Surf Clams	Kingsbarns	FF 771 1974 19	Surf Clams	11	0	2
Firth of Forth: North	Anstruther	FF 068 184 19	Surf Clams	12	0	0
Forth Estuary Surf Clams	Shell Bay	FF 772 1975 19	Surf Clams	10	0	0
Forth Estuary: Largo Bay	Largo Bay	FF 072 188 16	Razors	10	1	0

2.2.7. Highland - Lochaber

Table 10. *E. coli* samples received from Highland Council: Lochaber area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Arisaig	Sgeirean Buidhe	HL 004 202 13	Pacific oysters	12	0	0
Camas a Chuilinn: Loch Linnhe	Camas a Chuilinn: Loch Linnhe	HL 875 2386 08	Common mussels	6	0	0
Loch Ailort	Eilean Dubh	HL 114 937 08	Common mussels	11	0	0
Loch Ailort 1	Loch Ailort 1	HL 114 214 08	Common mussels	11	0	0
Loch Ailort 3	Camus Driseach	HL 114 207 13	Pacific oysters	12	1	0
Loch Beag	Ardnambuth	HL 118 215 08	Common mussels	11	1	0
Loch Eil	Duisky	HL 134 216 08	Common mussels	12	0	0
Loch Eil: Fassfern	Fassfern	HL 136 219 08	Common mussels	12	0	0
Loch Leven: Lower	Lower	HL 170 222 08	Common mussels	12	0	0
Loch Leven: Upper	Upper	HL 171 223 08	Common mussels	12	1	0
Loch Moidart	South Channel	HL 179 227 13	Pacific oysters	12	0	0
Loch Sunart	Liddisdale	HL 206 1237 08	Common mussels	12	1	0

2.2.8. Highland- Ross and Cromarty

Table 11. *E. coli* samples received from Highland Council: Ross and Cromarty area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Inner Loch Torridon	Dubh Aird	RC 090 1616 08	Common mussels	13	0	1

Little Loch Broom	Little Loch Broom	RC 805 2122 13	Pacific oysters	12	1	0
Loch Kanaird	Ardmair	RC 625 1233 13	Pacific oysters	12	0	0

2.2.9. Highland - Skye and Lochalsh

Table 12. *E. coli* samples received from Highland Council: Skye and Lochalsh area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Kyles of Scalpay	Kyles of Scalpay Cockles	SL 864 2348 04	Common cocles	19	2	1
Loch Eishort	Drumfearn	SL 137 281 08	Common mussels	13	0	1
Loch Harport Inner Cockles	Carbost	SL 159 286 04	Common cockles	12	2	0
Loch Harport: Inner	Carbost	SL 159 286 13	Pacific oysters	13	1	1
Sound of Sleat	Gleneig Bay	SL 833 2242 16	Razors	8	0	1

2.2.10. Highland - Sutherland

Table 13. *E. coli* samples received from Highland Council: Sutherland area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Kyle of Durness	Keoldale	HS 773 1984 13	Pacific oysters	14	0	2
Kyle of Tongue	Kyle of Tongue	HS 103 303 13	Pacific oysters	12	0	0
Loch Glencoul	Kylesku	HS 157 310 08	Common mussels	13	0	1
Loch Inchard	Loch Inchard - Site 1 - D. Ross	HS 162 311 08	Common mussels	13	0	1

Loch Laxford	Weavers Bay	HS 167 320 08	Common mussels	14	0	2

2.2.11. North Ayrshire

Table 14. *E. coli* samples received from North Ayrshire Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Fairlie	Southannan Sands	NA 065 332 13	Pacific oysters	12	0	0
Stevenston Sands Razors	Stevenston Sands Razors	NA 825 2169 16	Razors	7	2	0

2.2.12. Orkney Islands

Table 15. *E. coli* samples received from Orkney Islands Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Bay of Skaill	Westray	OI 871 2380 13	Pacific oysters	1	0	0
North Bay Oysters	Hoy	OI 865 234913	Pacific oysters	1	0	1

2.2.13. Shetland Islands

Table 16. *E. coli* samples received from the Shetland Islands Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Aith Voe Sletta	Slyde	SI 326 733 08	Common mussels	10	1	0
Baltasound Mussels	Baltasound Harbour	SI 010 395 08	Common mussels	10	1	0

Basta Voe Cove	Inner - Site 1 - Thomason	SI 324 399 08	Common mussels	10	0	0
Basta Voe Outer	Outer	SI 323 403 08	Common mussels	10	0	0
Brindister Voe	Brindister Voe	SI 023 406 08	Common mussels	10	0	0
Busta Voe Lee North	Hevden Ness	SI 327 755 08	Common mussels	10	0	0
Busta Voe Lee South	Greentaing	SI 328 767 08	Common mussels	10	0	0
Catfirth	Catfirth	SI 032 412 08	Common mussels	11	1	0
Catfirth Mussels 1	East of Little Holm	SI 816 2144 08	Common mussels	10	1	0
Catfirth Mussels 2	East of Brunt Hamarsland	SI 817 2147 08	Common mussels	10	1	0
Clift Sound Houss	Clift Sound Houss	SI 633 1270 08	Common mussels	12	0	0
Clift Sound: Booth	Booth	SI 036 413 08	Common mussels	12	0	0
Clift Sound: Stream Sound	East Hogaland	SI 035 414 08	Common mussels	12	0	0
Clift Sound: Whal Wick	Wester Quarff	SI 038 1522 08	Common mussels	12	0	0
Colla Firth	Colla Firth	SI 040 417 08	Common mussels	10	0	0
Dales Voe - Fora Ness	West Taing	SI 502 869 08	Common mussels	12	0	0
Dales Voe: Muckle Ayre	Muckle Ayre	SI 049 419 08	Common mussels	1	0	0
Dales Voe: Scarvar Ayre	Scarvar Ayre	SI 050 420 08	Common mussels	12	0	0
Gon Firth	Cole Deep	SI 076 1338 08	Common mussels	10	0	0
Gruting Voe: Braewick Voe	Braewick Voe	SI 080 424 08	Common mussels	10	0	0
Gruting Voe: Browland Voe	Browland Voe	SI 081 425 08	Common mussels	10	0	0

Gruting Voe: Quilse	Quilse	SI 083 427 08	Common mussels	10	1	0
Gruting Voe: Seli Voe	Seli Voe	SI 084 428 08	Common mussels	12	0	0
Hamar Voe	Hamar Voe	SI 655 1404 08	Common mussels	7	0	0
Hamnavoe	Copister	SI 348 736 08	Common mussels	10	0	0
Lang Sound	Lang Sound	SI 107 429 08	Common mussels	12	0	0
Laxfirth	Northwest of Skerby Ayre	SI 814 2142 08	Common mussels	1	0	0
Lee of Vollister	Whale Firth	SI 760 1920 08	Common mussels	13	0	0
Mid Yell Voe	Seafield	SI 216 432 08	Common mussels	10	0	0
Mid Yell Voe East	Bunya Sands	SI 797 2083 08	Common mussels	10	0	0
Muckle Roe	Pobies Geo	SI 221 433 08	Common mussels	10	0	0
North Uyea	North	SI 230 453 08	Common mussels	10	0	0
Olna Firth Inner	Inner	SI 232 435 08	Common mussels	10	0	0
Olna Firth Outer	Foula Wick	SI 232 434 08	Common mussels	10	1	0
Papa Little Voe	Millburn	SI 235 1350 08	Common mussels	10	0	0
Point of Hamna Ayre	Point of Hamna Ayre	SI 374 763 08	Common mussels	2	0	0
Ronas Voe East	Clifts	SI 523 919 08	Common mussels	3	0	0
Ronas Voe Mussels 2	West Of Black Well	SI 522 918 08	Common mussels	3	0	0
Sandsound Voe	Sandsound Voe	SI 242 443 08	Common mussels	10	2	0
Seli Voe	Garderhouse	SI 815 2143 08	Common mussels	1	0	0

South of Houss Holm	South of Houss Holm	SI 261 444 08	Common mussels	12	0	0
South Voe Mussels	South Voe Mussels	SI 421 825 08	Common mussels	12	1	0
Stream Sound: Ux Ness	Easterdale	SI 373 1096 08	Common mussels	12	0	0
Stromness Voe	Burra Holm	SI 273 467 08	Common mussels	11	1	0
Swining Voe	North West of Cul Houb	SI 820 2156 08	Common mussels	10	0	0
The Rona	Aith Ness	SI 517 944 08	Common mussels	10	0	0
Uyea Sound	Cow Head	SI 441 845 08	Common mussels	11	0	0
Vaila Sound - East Ward	Brandy Ayre	SI 858 2312 08	Common mussels	10	0	0
Vaila Sound Linga	Linga	SI 288 457 08	Common mussels	10	1	0
Vaila Sound: East of Linga and Galtaskerry	Whitesness	SI 288 1061 08	Common mussels	10	1	0
Vaila Sound: Riskaness	Riskaness	SI 289 458 08	Common mussels	10	0	0
Vementry North	Suthra Voe West	SI 322 464 08	Common mussels	10	0	0
Vementry South	Clousta Voe - Noonsbrough	SI 321 459 08	Common mussels	10	0	0
Wadbister Voe	Wadbister Voe	SI 294 466 08	Common mussels	11	1	0
Weisdale Voe	North Flotta	SI 297 469 08	Common mussels	10	0	0
Weisdale Voe Upper	Olligarth	SI 378 1521 08	Common mussels	10	0	0
West of Langa	Scalloway	SI 822 2160 08	Common mussels	1	0	0
West of Lunna	Cul Ness	SI 380 770 08	Common mussels	10	0	0

2.2.14. South Ayrshire

Table 17. *E. coli* samples received from South Ayrshire Council area

Production Area	Site Name	Site	Sample Species	Samples received	Outwiths	Rejected samples
Ayr Bay	Ayr Bay Razors	SA 841 2263 16	Razors	7	0	1
Croy Bay	Culzean Bay	SA 681 1482 16	Razors	10	1	0
Croy Bay South	Girvan Mains	SA 872 2381 16	Razors	5	0	0
Girvan South Razors	Girvan South Razors	SA 778 1997 16	Razors	10	0	0
Heads of Ayre	Heads of Ayre Razors	SA 866 2362 16	Razors	10	0	0
North Bay	Barassie	SA 337 719 16	Razors	7	1	0
Prestwick Shore	Prestwick Shore Razors	SA 840 2262 16	Razors	7	0	1
Troon South Beach	Troon South Beach Razors	SA 843 2267 16	Razors	7	1	0

2.3. Outwith results in 2020

The number of outwith results (i.e. those which exceeded the upper *E. coli* MPN/100g for the extant classification status) are reported for all classified production areas by local authority in Table 18.

Table 18. Outwith results reported in 2020

Local Authority	No. valid results reported	No. Outwith results	% Outwith
Argyll and Bute Council	500	47	9.4%
Comhairle nan Eilean Siar: Lewis & Harris	191	12	6.3%
Comhairle nan Eilean Siar: Uist & Barra	77	9	11.7%
Dumfries and Galloway Council	31	1	3.2%

East Lothian	33	5	15.2%
Fife Council	53	1	1.9%
Highland Council: Lochaber	135	4	3.0%
Highland Council: Ross & Cromarty	36	1	2.8%
Highland Council: Skye & Lochalsh	61	5	8.2%
Highland Council: Sutherland	60	0	0.0%
North Ayrshire Council	19	2	10.5%
Orkney Islands Council	1	0	0.0%
Shetland Islands Council	547	16	2.9%
South Ayrshire Council	60	3	5.0%
Total	1804	106	5.9%

3. Chemical contaminants

This section provides a summary of the chemical contaminants monitoring undertaken in Scottish shellfish under the FSS programme between January and March 2020. A full copy of the report produced by Fera and published in July 2020 is available on FSS' website.

Eighteen samples of shellfish, including species of common mussels (8 samples), Pacific oysters (3), common cockles (1), surf clams (2), and razor clams (4). The sampling schedule was timed to coincide with the period before annual spawning. This point in the annual cycle contaminant levels would likely be at their highest for optimum detection.

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) 1881/2006 and (EC) 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.

Five samples were analysed for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, dioxins), polychlorinated biphenyls (PCBs). All 18 samples were tested for polycyclic aromatic hydrocarbons (PAHs) and 16 samples for heavy metals/trace elements. The methodologies used for the analyses were UKAS accredited to ISO 17025 standard and followed EU commission regulations for data quality criteria.

The highest levels for both benzo[a]pyrene and for the sum of PAH4 all fell below the maximum permitted levels (MPL), of 5 µg/kg and 30 µg/kg respectively. PCDD/Fs and PCBs in the samples tested were below the maximum regulatory levels. Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits.

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We are the government's marine and freshwater science experts. We help keep our seas, oceans and rivers healthy and productive and our seafood safe and sustainable by providing data and advice to the UK Government and our overseas partners. We are passionate about what we do because our work helps tackle the serious global problems of climate change, marine litter, over-fishing and pollution in support of the UK's commitments to a better future (for example the UN Sustainable Development Goals and Defra's 25 year Environment Plan).

We work in partnership with our colleagues in Defra and across UK government, and with international governments, business, maritime and fishing industry, non-governmental organisations, research institutes, universities, civil society and schools to collate and share knowledge. Together we can understand and value our seas to secure a sustainable blue future for us all and help create a greater place for living.

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