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# Risk assessment of the FSA Scotland monitoring programme for biotoxins in shellfish harvested from classified inshore areas in Scotland: evaluation of the current scheme and development of improved alternatives based on historical data

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## EXECUTIVE SUMMARY

The aim of this study was to assess the monitoring programme conducted by the Food Standards Agency Scotland (FSAS) for determining the prevalence of toxins responsible for diarrhetic shellfish poisoning (DSP), paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP), in shellfish harvested from classified inshore production areas in Scotland. The toxicity patterns observed at designated sites throughout the year were established using data collected over a three-year period from April 2001 to March 2004.

The current (as implemented in 2003) FSAS monitoring programme was assessed for the risk of a toxic event at a particular site being undetected. Alternative schemes that offered a more targeted allocation of resources or an improved level of public health protection were also considered.

### *Analysis of monitoring data*

The data analysis was concerned with toxin concentrations of ASP, DSP and PSP detected in mussels, Pacific oysters, scallops, queen scallops, and cockles (2132, 389, 144, 88 and 77 samples, respectively). Data from April 2001 to March 2004 were used.

<u>Analysis of the monitoring data revealed the following.</u>

- Toxin levels of DSP, PSP and ASP varied significantly over time (between months and between years), across sites (with some sites showing a tendency for higher toxin levels) and across shellfish species.

- DSP was most often detected in queen scallops and mussels, with 18% of the queen scallop samples and 12% of the mussel samples giving a positive test result. For the remaining species less than 5% of the samples tested positive. DSP was present throughout the year but peaked in August, when for certain sites the probability of mussel samples being positive was estimated to be 30-60%.

- PSP levels exceeded the regulatory levels in cockles and mussels only. Less than 2% of the cockles and mussels analysed during the 3-year period exceeded the regulatory limit for PSP. PSP toxins were not detected in shellfish from October-March, and peaked in June, with a few sites having an estimated probability of 20-34% for samples to exceed field closure levels during May and June.

- ASP was most often present in King Scallops, with over 90% of the samples tested on the whole scallop (the standard procedure for testing scallops for DSP and PSP) exceeding the closure limit. When tested on the gonad, 37% of King Scallop samples were found to exceed the closure limit. ASP levels in gonad tissues peaked in August-November, with the chance of a sample exceeding field closure estimated to be 57-77% during this period. Although ASP was detected in all other species, it resulted in field closure for only a small number of mussel and queen scallop samples (3 out of 2043 and 3 out of 81, respectively).

- The data suggest that levels of PSP can change rapidly at a site, increasing at some sites from zero to field closure levels within one week.

- It is important to note that these findings are based on only three years of data and therefore there is a considerable amount of uncertainty in the estimates. There is no guarantee that sites (or species, or months) that were clear during this three-year period will remain clear in the future as toxin patterns may change. Therefore, some level of shellfish monitoring should be continued at all sites in order to reduce the risk of toxic events being overlooked.

***Risk assessment of present and alternative monitoring schemes***

The present monitoring programme consists of monthly sampling throughout the year with certain sites being sampled fortnightly during April-September. The monitoring data from April 2001-March 2004 provided sufficient information on levels of DSP in mussels, PSP in mussels and ASP in King scallops for each site during each month to enable a risk assessment to be carried out. The risk assessment was concerned with the monitoring programme failing to detect a toxic event, i.e. that a site could become *unknowingly* toxic (for example, a monthly sampling scheme would fail to detect that a site might become toxic only one week after a negative test result). This is referred to as the risk of non-detection.

The maximum risk of non-detection using the present monitoring scheme was determined as being 46% for DSP in mussels, 26% for PSP in mussels, and 57% for ASP in King Scallop gonads.

Alternative monitoring schemes were devised, based on a combination of monthly, fortnightly and weekly sampling. These schemes are toxin, species, site and month specific, based on the principle that when toxin levels are low monthly sampling would be sufficient, while weekly sampling would be required when toxin levels are high. Fortnightly sampling would apply for intermediate toxin levels. Furthermore, it was assumed that with weekly sampling the risk of non-detection is zero. Two schemes were considered, namely one where the risk of non-detection does not exceed 10% at any one time at any site, and a stricter scheme where the risk of non-detection does not exceed 5%.

<u>The risk assessment enabled the following recommendations to be made.</u>

- For the monitoring of PSP in mussels, sampling effort could be made more efficient, resulting in a reduced risk of non-detection while using fewer samples than is the case at present. This would require a more targeted allocation of samples to those sites and months that have historically experienced high PSP levels but would reduce the risk of non-detection from a maximum of 26% under the current scheme to 5% under a more targeted scheme.

- Under the current sampling scheme, fortnightly sampling is limited to April-September. This appears insufficient for DSP in mussels as DSP levels continued to peak in October-December. As a consequence, October had the highest number of sites having a large risk (exceeding 20%) of a field being unknowingly toxic. For several sites, weekly sampling during June-November would be required to reduce this risk to 10% or less.

- For ASP in scallops, toxin levels were high, particularly during August-December. Under the current scheme, the risk of non-detection is 20-57% during these months. Weekly sampling would be required during July-December in order to reduce this risk to 10% or less.

- Sampling frequencies may have to be adjusted if toxin levels start to change. For example, if continued monitoring indicates increased toxin levels at a particular site compared to those observed in the data used in this study, it would be advisable to increase sampling frequency at this site.

- The alternative schemes devised during this study were designed to reduce the risk of a site being unknowingly toxic to 10% or 5%. However, it should be emphasised that this is an arbitrary choice. Before the findings of this study are used to develop future monitoring schemes, the FSAS should first determine acceptable risk levels for each of the toxin groups.

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## GLOSSARY

| | | |
|---|---|---|
| ASP | : | Amnesic Shellfish Poison, measured in units of µg/g shellfish. Field closure when ASP levels exceed 20 µg/g. |
| Clams | : | Combination of clams, razors, spisula, venerupis and Native oysters. |
| DSP | : | Diarrhetic Shellfish Poison, measured as absence or presence. Field closure when DSP is present. |
| FSAS | : | Food Standards Agency Scotland. |
| GLM | : | Generalised Linear Model. |
| GLMM | : | Generalised Linear Mixed Model. |
| MBA | : | Mouse Bioassay, used for testing of DSP and PSP. |
| N. Oysters | : | Native oysters. |
| p | : | Probability that toxin levels exceed field closure limit. |
| $p_{high}$, $p_{low}$ | : | Cut-off levels that are used to construct alternative sampling schemes. Weekly sampling is applied when p exceeds $p_{high}$, while monthly sampling is sufficient when p is less than $p_{low}$. |
| P. Oysters | : | Pacific oysters. |
| PSP | : | Paralytic Shellfish Poison, measured in units of µg/100g shellfish. Field closure when PSP levels exceed 80µg/100g. |
| Queens | : | Queen scallops. |
| Risk of non-detection | : | Used in assessment of existing and alternative sampling schemes, and is defined as the probability that a field is unknowingly toxic. |
| $R_{max}$ | : | Maximum acceptable risk of non-detection. |
| Scallop | : | King scallops. |
| Scallop G and Scallop W | : | Used to indicate whether testing was performed on the gonad of the king scallop (Scallop G) or on the whole king scallop (Scallop W). |

# 1. AIMS AND OBJECTIVES OF THE INVESTIGATION

### *1.1. Introduction*

Shellfish harvested from inshore classified production areas in Scotland are monitored by the Food Standards Agency Scotland (FSAS, as the competent authority in Scotland under EU directive 91/492/EEC) for the toxins responsible for amnesic shellfish poisoning (ASP), diarrhetic shellfish poisoning (DSP) and paralytic shellfish poisoning (PSP).

In the UK, ASP toxins are monitored in bivalve molluscs using High Performance Liquid Chromatography (HPLC) as specified in Commission Decision 2002/226/EC. If ASP levels in sampled shellfish are detected at a concentration of 20 µg/g or above, harvesting areas are closed. Directive 91/492/EEC requires that both DSP and PSP toxins be monitored in shellfish using a mouse bioassay (MBA) method. For DSP, a positive MBA result (indicating the presence of toxin) leads to the closure of a harvesting area. In the case of PSP, harvesting areas are closed when toxin levels are found to be greater than or equal to 80 µg/100 g tissue by MBA.

Currently, the FSAS monitoring programme is based on testing sites where these toxins have been previously detected in shellfish. The frequency of monitoring ranges during the year from weekly to monthly. Areas that have been identified as toxin ‘hotspots’ are sampled fortnightly during summer and monthly from October to March. Other sites are tested periodically according to a timetable set by FSAS in conjunction with the monitoring laboratory (Fisheries Research Services, Aberdeen). The frequency of sampling at particular sites may increase if toxins are found, or if phytoplankton monitoring results suggest the presence of large numbers of causative organisms. Harvesting areas that are closed for ASP, DSP, or PSP toxins are not re-opened until two successive results below that of the statutory limit are produced, with at least 7 days between each acceptable result. When a harvesting site is closed, it is therefore in the harvester's interest to return samples at least weekly as it means it can be re-opened as soon as possible. The monitoring laboratory reports results to FSAS on a weekly basis.

This project assessed the current monitoring programme and considered alternative monitoring regimes that may offer increased levels of confidence in toxin detection, or may be more economical or practical for FSAS to implement. Using historical data from April 2001 to March 2004, both existing and any revised schemes were assessed by looking at the following.

- The distribution of toxin levels in shellfish from different sites.
- The risk that shellfish with toxin levels exceeding the accepted threshold are not detected through the monitoring programme.
- Whether there are regions or sites that are more likely to experience toxic events that are not detected by the current monitoring programme.

This information will aid the FSA in the design of the inshore shellfish toxin monitoring programme in the future.

### *1.2. State of the art*

Levels of PSP, DSP and ASP toxins have been monitored in Scottish shellfish for several years. However, although the existing monitoring programme appears to provide a sufficient level of public health protection there have been isolated cases of toxic samples reaching the consumer market. For example, in 2002 a DSP outbreak was recorded which was later found to be associated with mussels harvested from Loch Greshornish on the Isle of Skye g (pers. comm. Lorna Murray, FSAS). The mussels had been placed on the market before the monitoring results for that batch of mussels had been reported, which subsequently indicated the presence of DSP toxins.

Alternative monitoring schemes may be developed which are more effective in terms of consumer safety and which are more efficient, but these would require vigorous scientific evaluation before they could be introduced. To our knowledge, a statistical evaluation of the merits of the present and alternative monitoring schemes has not been undertaken before.

### *1.3. Scientific work undertaken*

1. Historical monitoring data from April 2001- March 2004, provided by FSAS, were used to develop statistical models that describe the deterministic and random components of variation in shellfish toxin levels. These included variation between sites and regions, seasonal variation, and variation between years. The statistical techniques used include generalised linear models, and fixed and random effects models. These approaches allowed the development of models that are capable of describing toxicity patterns over time and location for each of the ASP, DSP and PSP toxins.
2. These models were then used to assess the effectiveness of the existing monitoring programme in detecting toxic events.
3. Alternative monitoring schemes (which may provide an increased level of public health protection, or which are more practical or more economical) were assessed for their effectiveness in detecting toxic events.

### *1.4. Outcomes of the study*

The following information has been provided by this study.

1. Models describing the toxicity patterns of ASP, DSP and PSP over time (based on data from April 2001 to March 2004).
2. Assessment of the effectiveness of the existing monitoring regime (in terms of the risk of a contaminated field being undetected).
3. Assessment of alternative monitoring schemes which may provide an improved level of public health protection, or which are more economical or more practical.

Based on this information, a list of recommendations was constructed that will aid the FSA in developing more effective monitoring schemes.

# 2. MATERIALS AND METHODS

## *2.1. Data Handling*

### *2.1.1. Toxin Data*

The data consist of toxin levels recorded for Paralytic Shellfish Poison (PSP), Diarrhetic Shellfish Poison (DSP) and Amnesic Shellfish Poison (ASP), over a three-year period from 1 April 2001 to 31 March 2004.

- For DSP the data are recorded simply as absent (ascribed zero) or present (ascribed one).
- For PSP the toxin level, expressed as µg/100g shellfish, is given. The limit of detection is approximately 30 µg/100g and the field closure limit is set at 80 µg/100g.
- For ASP the toxin level is given as µg/g. The limit of detection is approximately 2.5 µg/g (Pers. Comm. Lorna Murray, FSAS) and field closure occurs at toxicity levels exceeding 20 µg/g.
- If DSP is present or PSP or ASP levels exceed field closure limits, the field is closed until 2 consecutive results below the closure level are obtained which are at least 7 days apart.

### *2.1.2. Categorisation of toxin levels*

For presentation purposes, PSP and ASP levels are categorised as follows.

For PSP, the categories are:

- 0
- $> 0$ and $< 40$ µg/100g
- $\geq 40$ and $< 80$ µg/100g
- $\geq 80$ µg/100g (field closure).

For ASP the categories are:

- 0
- 2.5 µg/g (limit of detection)
- $> 2.5$ and $< 20$ µg/g
- $\geq 20$ µg/g (field closure).

### *2.1.3. Definition of sites*

Prior to analysis, the data were cleansed as follows.

- Data from offshore sites were removed.
- Sites and bed locations were checked for consistency in names and spelling.
- Duplicate data entries were removed.
- Due to problems with testing for DSP in June 2003, several entries that were annotated with comments on the validity of the test were removed.

- The data contained some samples taken in the final week of March 2001. These entries were included assuming they were sampled on 1 April 2001.

This resulted in 2676, 2710 and 2922 samples for PSP, DSP and ASP, respectively. Checking the site names for consistency reduced the initial number of sites from 500 to 150. For many sites, however, the data were too limited to use in statistical analyses, and therefore sites were combined. This resulted in the following four different types of site.

- Well defined, intensively sampled locations with large data sets (e.g. Loch Torridon).
- Well defined but isolated locations with limited data, which could not obviously be combined with neighbouring sites (e.g. Arran).
- Group of locations in close geographic proximity, sharing the same sea inlet, but each with limited data (e.g. Shetland West).
- Group of locations which were not in close proximity geographically, and which each had a limited data set (e.g. the newly defined site 'East' comprises the Forth estuary, Montrose and Tay estuary).

Sites were only combined if their toxicity patterns were similar, as assessed by examination of plots. This reduced the total number of sites to 34. For convenience sites were grouped according to area, but note that this was for presentation purposes only. Full details of grouping of sites are given in Table 1 and Figure 1.

### *2.1.4. Definition of species*

The data sets included toxin values for the following species, with the maximum number of samples given in parentheses: clams (6), cockles (77), mussels (2132), Native oysters (N. oysters,14), Pacific oysters (P. Oysters, 389), queen scallops (88), razors (12), king scallops (145), spisula (14) and venerupis (6). Due to limited numbers of samples, clams, N. oysters, razors, spisula and venerupis were combined into one species denoted by the term 'clams'.

### *2.1.5. King scallops: gonads versus whole scallop*

For DSP and PSP, testing of king scallops takes place on the whole animal. For ASP, testing takes place on both the whole animal and the gonad. Previous scientific studies have indicated that most of the domoic acid (the toxin responsible for ASP) in contaminated King Scallops is associated with the offal (hepatopancreas, mantle and gills). The contamination of edible tissues (adductor muscle and gonad) can be minimised, if the offal is completely removed by shucking (McKenzie and Bavington, 2002). Effective shucking allows scallops harvested from a particular site which are found to contain over 20 μg/g ASP in the whole animal, but below 20 μg/g in the gonad, to be placed on the market. However, they must be taken to an approved processor for shucking before they may be considered safe for consumption.

In the present study, over 90% (132/145) of the king scallop samples tested for ASP gave a whole animal test result exceeding the field closure limit of 20 μg/g, whereas

38% of the gonad samples were found to contain toxin levels which were above the field closure limit. Because the majority of whole scallop samples resulted in field closure, the whole scallop results for ASP were excluded, and only the gonad results were included in the analysis. Therefore, for the purposes of this study, the risk of high ASP levels being detected in whole scallops was estimated as 100%.

### *2.2. Estimation of the probability that toxicity exceeds the field closure limit*

For each species and each toxin, the following model was constructed. Let p be the probability that a sample is positive (i.e. the toxin level exceeds the field closure limit). This probability is likely to depend on the time of year (e.g. high values are more likely to occur in summer than in winter). Likewise, p may depend on the location it was taken from (e.g. a sample is less likely to be positive when taken from the East Coast). To investigate such relationships, a binomial model with logistic link, which is a special case of a Generalised Linear Model (GLM, see McCullagh & Nelder, 1989, for details) was constructed. Let $y_{ms}$ and $n_{ms}$ be the number of positive samples and the total number of samples respectively, for month m at site s. Then y is assumed to follow a binomial distribution, where the probability of a sample being positive is modelled as a function of month and site:

$$y_{ms} \sim \text{Binomial}(n_{ms}, p)$$

A logistic model was assumed:

$$\ln [ p/(1-p) ] = \text{constant} + \text{Month}_m + \text{Site}_s + \ldots$$

with ln denoting the natural logarithm. This model was used to determine the significance of Month, Site, Year and the interactions of these three factors.

There is random variation present in the observations of numbers of positive samples at each site in each month. Thus particularly high or low observed proportions of positive samples in the dataset would not necessarily be repeatedly observed in the long term. It is likely however that site and month effects do exist, and so any prediction of risk must take account of them.

To take these factors into account, the probability of toxin levels in a field exceeding the field closure limit was estimated for the data presented in Tables A4-A8 using a Generalised Linear Mixed Model (GLMM, see Schall (1991)) with Site as a random effect and Month as a fixed effect. The GLMM model gave estimates for each site and each month on the logistic scale (i.e. for ln p/(1-p)), which were then back-transformed to the original scale (i.e. in terms of p). The Site effect being random means that although the estimated probability of a sample being toxic for a particular site is based on the data obtained from that site, the estimate is slightly shrunk towards the overall mean value. The amount of shrinkage depends on the number of samples and the magnitude of the random variation between sites. As a consequence, site effects were never estimated to be exactly zero, even if all the samples from a site were clear. This seems sensible as data from only three years were available, and the absence of toxin at a site during a particular period does not indicate that the site will always be clear.

All statistical analyses were conducted in Genstat 7th edition, release 7.1 (VSN International Ltd, Hemel Hempstead, Herts., UK).

### *2.3. Risk assessment of current and alternative sampling schemes*

#### *2.3.1. Present monitoring scheme*

Under the present monitoring scheme, the sampling frequency for a location is either:

- monthly all year round, or
- monthly in winter (October-March) and fortnightly in summer (April-September).

The sampling scheme adopted in 2003 included 74 locations. Table 11[1] shows how these 74 locations correspond to the 34 sites defined in this report. For most sites, the sampling frequencies of the corresponding locations are identical (e.g. the 'LewisHarris' site covers three locations that are all sampled monthly). Data were insufficient to assess the current sampling strategy for each of the 74 locations, therefore the current strategy was assessed for the 34 sites defined in the study (and used throughout this report) instead.

<u>The sampling frequencies for the present scheme were translated to the 34 sites as follows.</u>

- If a site covered one location only, the corresponding sampling frequency was adopted.
- If a site covered several locations, all with the same sampling frequency, then this sampling frequency was adopted (e.g. LewisHarris was assigned 'monthly sampling all year round' as it covers three locations that are each sampled monthly).
- Finally, if a site covered locations having 'monthly all year round' as well as locations with 'monthly in winter fortnightly in summer' sampling frequencies, the site was assigned the 'monthly in winter fortnightly in summer' frequency.

#### *2.3.2 Risk assessment*

The aim of the sampling strategy employed in the monitoring programme is to maximise confidence that a harvesting site is clear (i.e. toxin levels are below field closure). This is equivalent to minimising the risk that a site is unknowingly toxic. For the purposes of this study, this will be referred to as the 'risk of non-detection', and can be applied to any of the three toxins.

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[1] To keep tables in a sensible order, tables were numbered according to when they were first referred to in the Results and Discussion sections.

Risk of non-detection is defined as the chance that a site is unknowingly toxic

If a site is tested and is discovered to contain toxin levels that exceed the field closure limit, then it will remain closed until two consecutive samples, taken one week apart, are clear. Consequently, actively harvested sites at which the levels of ASP, DSP, or PSP are found to exceed the field closure limit are usually tested on a weekly basis until two negative results are obtained. Therefore, the risk that a site is unknowingly toxic is more likely to be associated with sites that are considered negative, and so may be sampled less frequently. Examination of the data shows that it is possible for a clear sample to be followed by a toxic sample only one week later. For example, in April 2003, PSP levels in mussels harvested from the Loch Striven site were found to increase from non-detectable levels to 112 μg/100g within 8 days (Table 20). Had the second sample not been taken from this site, it would have been unknowingly toxic.

The risk of non-detection was calculated as follows. Let the chance that the field is toxic be denoted by p. For each toxin/species combination, the GLMM model (see section 2.2) provides an estimate of p for each site for each of the twelve months of the year. For simplicity, it was assumed that a negative test result (i.e. toxin level below field closure limit) was valid for one week. This implies that if samples were to be taken every week, the risk of the field being unknowingly toxic was zero. Likewise, if samples were taken every fortnight, the risk was 0.5p (for every four weeks there were two weeks that the risk of non-detection was zero and two weeks that the risk of non-detection was p, so is (0+p+0+p)/4 = 0.5 p on average). If samples were taken every four weeks, the risk of non-detection was 0.75 p (for every four weeks there was one week with zero risk of non-detection and three weeks with risk of p, which gives (0 + p + p + p)/4 = 0.75 p on average). To summarise:

- Weekly sampling: risk of non-detection is zero
- Fortnightly sampling: risk of non-detection is 0.5p
- Monthly sampling: risk of non-detection is 0.75p.

The risk of non-detection depends on two factors, namely

a) the chance that the field is toxic (i.e. probability that toxin levels exceed the closure limit), and
b) the sampling frequency.

An increase in the chance that the field is toxic, and/or a decrease in the sampling frequency lead to an increased risk of non-detection. This is illustrated in Table 15 for various values of p. For example, for p=30%, the risk of non-detection is 22.5% for monthly sampling and 15% for fortnightly sampling.

Note that the risk assessment is concerned with the chance of non-detection for a given monitoring scheme, i.e. the chance that a toxic field is not detected because no sampling takes place. The situation where repeated sampling takes place following a positive test result is not considered here. Such repeated sampling is regarded as the responsibility of the shellfish farmer and falls outwith the aims of the monitoring scheme (namely monitoring of toxin levels over time).

*2.3.3. Risk assessment of the present monitoring scheme*

For each toxin/species combination, the GLMM model (see section 2.2) provides an estimate of p (the chance that toxin levels exceed the field closure limit) for each site for each of the twelve months of the year. Based on the sampling frequencies employed in the current monitoring scheme, the risk of non-detection was calculated for each site and each month. Findings were summarised by calculating the mean risk of non-detection and the maximum risk of non-detection.

*2.3.4. Risk assessment of alternative sampling schemes*

Alternative sampling schemes were developed considering three possible frequencies, namely once per month when toxin levels are unlikely to exceed the field closure limit, once per week when toxin levels are likely to exceed the field closure limit, and fortnightly otherwise. To put this in a mathematical context, let $p_{low}$ and $p_{high}$ be fixed values that are set in advance, so that for small p (which is the chance that toxin levels exceed the field closure limit), less than $p_{low}$ say, monthly monitoring will suffice, while for high p, exceeding $p_{high}$ say, weekly monitoring would be required:

- when low toxin levels occur (p less than $p_{low}$) monthly monitoring may be carried out,
- when high toxin levels occur (p exceeding $p_{high}$) monitoring should be carried out once per week,
- when intermediate toxin levels occur (p between $p_{low}$ and $p_{high}$), monitoring may be carried out once per fortnight.

For a given $p_{low}$ and $p_{high}$, and in combination with the estimated values of p for each site and each month (from the GLMM model), monitoring schemes can be developed that are site and time specific. This results in each site having its own monitoring scheme where sampling frequency may vary during the year.

Instead of choosing cut-off levels $p_{high}$ and $p_{low}$ and then deriving the corresponding risk of non-detection, it is more convenient to select an acceptable risk level first, and then derive the corresponding cut-off levels $p_{high}$ and $p_{low}$. This is done as follows. For a given maximum acceptable risk of non-detection, denoted by $R_{max}$, the most efficient (i.e. requiring the least samples) monitoring scheme is given by: monthly sampling for $p \leq 4/3\ R_{max}$, fortnightly sampling for $4/3\ R_{max} < p < 2\ R_{max}$, and weekly sampling for $p \geq 2\ R_{max}$, so that the corresponding cut-off points are given by $p_{high} = 2\ R_{max}$ and $p_{low} = 2/3\ p_{high}$.

<u>To summarise, alternative sampling schemes were developed as follows.</u>

- Let $R_{max}$ denote the maximum acceptable risk of the field being unknowingly toxic (to be decided by FSAS).
- Calculate $p_{high} = 2\ R_{max}$.
- Calculate $p_{low} = 2/3\ p_{high}$.
- Based on estimates of p (which is the chance that toxicity levels exceed the field closure limit), develop a new monitoring scheme that is site and month specific, as follows.

- When $p \le p_{low}$, monthly monitoring is carried out.
- When $p_{low} < p < p_{high}$, fortnightly monitoring is carried out.
- When $p \ge p_{high}$, weekly monitoring is necessary.

Appropriate values for the maximum acceptable risk of non-detection ($R_{max}$) should be set by FSAS, but to illustrate the approach outlined above, two alternative sampling schemes were used in this report, based on $R_{max}$ = 10% and $R_{max}$ = 5%.

- Scheme A: Maximum acceptable risk of non-detection is 10%, so that $p_{high}$ = 20% and $p_{low}$ = 13.3%. This corresponds to a sampling scheme where weekly sampling is carried out when $p \ge 20\%$, fortnightly sampling when $13.3\% < p < 20\%$ and monthly sampling when $p \le 13.3\%$.
- Scheme B: Maximum acceptable risk of non-detection is 5%, so that $p_{high}$ = 10% and $p_{low}$ = 6.67%. Sampling frequency should be once a week when $p \ge 10\%$, once a fortnight when $6.67\% < p < 10\%$ and once a month when $p \le 6.67\%$.

# 3. RESULTS

## *3.1. Summary of monitoring data*

The monitoring data from April 2001 to March 2004 contained 2676, 2710 and 2922 samples for PSP, DSP and ASP, respectively, from approximately 150 different locations. As for many of the locations only a limited amount of data was available, locations were combined into 34 sites (see Table 1 and Figure 1).

### *3.1.1. Numbers of samples per species across sites*

Mussels were the most frequently tested species (2132 samples, Table 2), followed by P. Oysters (389 samples), scallops (145 samples), queen scallops (88 samples), cockles (77 samples), and clams (51 samples). Mussels and P. Oysters were most widespread with over ten samples taken from 30 and 10 sites, respectively. The remaining species were less widespread, with more than ten samples of cockles, scallops, queen scallops and clams obtained from 4, 3, 2 and 2 sites respectively.

### *3.1.2. Prevalence of toxins in each species*

*DSP*. The largest percentages of positive DSP samples were observed in queen scallops and mussels (18% and 12%, respectively, Table 3). Clams and scallops tested positive for 5 and 2% of the samples respectively. For P. oysters less than 1.5% were positive (5 out of 351 samples), while for cockles all samples were negative.

For mussels, DSP was absent during January and February, but was detected during the remainder of the year (Table 4). For the remaining species, positive samples were identified during May-November, with the exception of one queen scallop sample that tested positive for DSP in January.

*PSP*. No PSP test results for clams, P. oysters, queen scallops and scallops led to field closure. For cockles and mussels, less than 2% of the samples exceeded the closure limit (1 out of 79 and 36 out of 1905, respectively, Table 3). PSP was absent from all species from October-March. Levels exceeding the field closure limit (mussels and cockles) were detected only during April-August (Table 4).

*ASP*. ASP was a major problem in scallops, with nearly all (132 out of 145) whole scallop samples (the standard procedure for DSP and PSP) giving a test result exceeding the field closure limit of 20µg/g. For about two-thirds of the samples, however, contamination of the edible tissue (gonad) was below 20µg/g, which means that after shucking (i.e. removal of the offal) these shellfish are considered safe for consumption. For these reasons, in subsequent analyses only ASP levels in scallop gonads are considered.

ASP was detected in all species, but did not lead to field closure for clams, cockles and P. oysters. For mussels and queen scallops, 3 out of 2043 and 3 out of 81 samples respectively resulted in field closure (Table 3). ASP was a major problem in scallop gonads, with a third of the samples exceeding the field closure limit (Table 3).

Levels of ASP above the field closure limit were observed from May-February for scallop gonads and from May-September for mussels and queen scallops (Table 4). The majority of scallop samples were found to contain 2.5 μg/g or above, and although during March and April ASP levels were below the field closure limit (20 μg/g), a maximum of 17 μg/g was observed. For clams, levels were always 2.5 μg/g or less, with the exception of July when a maximum level of 6 μg/g was observed. For cockles, mussels and P.oysters toxin concentrations of 2.5 μg/g or less were detected from December-April.

*3.1.3. Toxin level patterns over time*

In general, all three toxin groups showed a seasonal pattern with low toxin levels detected during the winter months and higher levels occurring in summer and autumn (Figure 2). Furthermore, levels tended to vary across years. For example, higher levels of PSP were detected in 2001 than in 2002 and 2003, whereas ASP levels in scallops and queen scallops levels tended to be lower in 2001 than during the other two years. For each of the toxin groups, peak levels tended to occur at approximately the same time in all shellfish species.

*3.1.4. Toxin levels across sites*

Toxin levels were found to vary across sites, with certain sites consistently testing negative for the presence of toxin and other sites giving a high proportion of samples testing positive. High levels of one toxin did not necessary correspond to high levels of the other toxins (shown for mussels in Figure 3, but similar findings were observed for the other species, see also Tables A1-A3).

### *3.2. Models for toxin levels over time and across sites*

Based on the historical data, statistical models (Generalised Linear Mixed Models, see Materials & Methods for details) were developed that relate the probability of a sample being toxic to location and time. For example, samples may be more likely to be toxic in summer than in winter, and samples from Shetland may be more likely to be toxic than samples from the east coast of Scotland, say. These models resulted in an estimated probability of a sample being toxic (i.e. toxin levels exceed closure limit) for each site during each month of the year.

The historical data from April 2001 to March 2004 were sufficiently detailed for DSP and PSP in mussels and ASP in scallops to allow for fitting of such models. Furthermore, although ASP levels in P. oysters and mussels were nearly always below the field closure limit, the data did contain sufficient information to allow for modelling of ASP levels exceeding the limit of detection (as opposed to exceeding the field closure limit). Data from the remaining species/toxin combinations were too limited for detailed modelling of toxin patterns over time and across sites.

*3.2.1. Models over time and across sites for toxin levels above field closure– DSP and PSP in mussels, ASP in scallops*

*Presence of DSP in mussels.* DSP was absent in mussels in January and February (Table 4). From June-November the mean probability of a positive sample was 10% or higher, and peaked in August. In August, all sites had a minimum observed probability of being positive of 5% or higher. For several sites the chance of being positive was high during August, exceeding 30% for Loch Fyne, Loch Striven, Orkney, Skye Scalpay and Lochaber, and exceeding 40% for Arran, Loch Ewe, Sutherland and Skye North (Table 5).

*PSP levels in mussels.* PSP in mussels did not exceed closure limits during September-March (Table 4). Levels peaked in June, with, on average, a 7% chance of PSP levels exceeding 80 µg/100g. This varied between sites, and several sites showed a much higher probability, with Lochaber, Shetland North and West, Skye Loch Eishort and Skye North giving 10-20% chances to exceed field closure limit. For Loch Striven, Loch Torridon and Orkney the chance exceeded 20% (Table 6).

*ASP levels in scallops.* ASP levels in scallop gonads were below 20 µg/g during March and April (Table 4). During August-November, the estimated probability of the toxin level exceeding the field closure limit was particularly high, at 56 to 76%. Three sites, namely Sound of Jura, Loch Ewe and Skye Scalpay, dominated the Scallop harvest. Although these sites are relatively widely separated geographically, there were no significant differences between these sites in terms of the probability of toxin levels exceeding closure levels (Table 7).

*3.2.2. Models over time and across sites for toxin levels above limit of detection – ASP in mussels and P. oysters*

The remaining data did not yield sufficient information for modelling the effects of month and site, either because the number of samples was insufficient (scallops for DSP and PSP, and clams, cockles and queen scallops for DSP, PSP and ASP) or because there were insufficient positive samples (P. oysters for DSP and PSP). However, although only three samples exceeded field closure for ASP in mussels and P. oysters, there were sufficient data to examine the probability of the sample containing ASP levels above the limit of detection (i.e. exceeding 2.5µg/g). Statistical analysis of these data provided an indication of when ASP levels were increasing so that sampling frequency may be adjusted if necessary.

*ASP in mussels (above limit of detection).* ASP levels in mussels were always observed to be less than, or equal to, the limit of detection (i.e. the ASP level was either recorded as 'not detected' or as 'limit of detection') during December-April (Table 4). The probability of ASP levels exceeding 2.5 µg/g was high during June-September and peaked in September, at an average of 10%. Shetland East, Skye North, LewisHarris and Loch Leurbost exceeded 20% during September, with a maximum of 29% (Table 8).

*ASP levels in P. Oysters (above limit of detection).* ASP levels in P. oysters were less than or equal to the limit of detection (i.e. the ASP level was either recorded as 'not detected' or as 'limit of detection') from November-April (Table 4). The data indicated that ASP levels in P. oysters were more likely to exceed the limit of detection during July and September, with an average probability of 14% that P. oysters contained ASP over 2.5µg/g in July. For particular sites this percentage was much higher, exceeding 30% for Seil Sound, Lochaber, Mull North and UistBarra in July, while the remaining sites were 13% or less (Table 9).

### *3.2.3. Models for toxin levels for remaining species/toxin combinations*

For the remaining species/toxin combinations, the probability of toxin levels exceeding field closure was estimated as a single probability, ignoring site effects and month effects (Table 10). Also presented are the lower and upper confidence limits for these estimates.

*DSP, PSP and ASP in P. oysters.* In P. oysters toxin concentrations rarely exceeded regulatory levels for any of the three toxin groups, and the number of field closures was relatively small. Of the 351 P. oyster samples tested, only 5 were positive for DSP, and none of the P. oyster samples tested exceeded the regulatory limit for PSP or ASP. Because of the large number of samples present, upper confidence limits for the probability of toxin levels exceeding field closure were low, namely 3%, 0.8% and 0.8% for DSP, PSP and ASP respectively.

*DSP in queen scallops*. Despite the small number of queen scallop samples tested for DSP, (88 in total), it is clear that prevalence of DSP was high in queen scallops, with 18% of the samples positive (with lower and upper confidence limits ranging from 12-27%).

*ASP in mussels.* Only 3 out of 2043 mussel samples tested contained ASP levels above regulatory levels. The probability of ASP levels exceeding regulatory levels was therefore estimated to be small, 0.1%, with an upper limit of 0.4%.

*DSP, PSP and ASP in clams and cockles; DSP and PSP in scallops; PSP and ASP in queen scallops*. These species and toxin combinations consisted of limited total numbers of samples, with only small numbers of positive samples. The probability of toxin levels exceeding field closure was estimated to be 4.7% or less, with an upper estimate of 14%.

## ***3.3. Risk assessment of sampling schemes***

The aim of the sampling strategy employed in the monitoring programme is to maximise confidence that a harvesting site is clear (i.e. toxin levels are below field closure). This is equivalent to minimising the risk that a site is unknowingly toxic. For the purposes of this study, this will be referred to as the 'risk of non-detection'. To illustrate, if a site becomes toxic one week after a negative test result, this toxic event would go undetected under a monthly sampling scheme.

The risk of non-detection depends on the chance of the field being toxic; when this is higher the risk of non-detection will be higher also. In addition, sampling frequency also plays a role; the more frequently a field is being sampled, the less likely it will be that a toxic event goes undetected. In order to keep the risk of non-detection low, sampling schemes should be site and month specific, such that frequent sampling takes place when there is a high chance of the field being toxic, with less frequent sampling being sufficient when the chance of the field being toxic is low.

For simplicity, it is assumed that a clear test result is valid for one week. This means that if weekly sampling takes place the risk of non-detection is zero. The relationship between sampling frequency, field toxicity and the risk of non-detection is as follows (details in Materials and Methods):

- weekly sampling: risk of non-detection is zero,
- fortnightly sampling: risk of non-detection is 0.5 p,
- monthly sampling: risk of non-detection is 0.75 p,

where p is the chance that toxin levels exceed the field closure limit (as given in Tables 5-7).

### *3.3.1. Risk assessment of present monitoring scheme*

Under the current sampling scheme, the sampling frequency for a site is either

- monthly sampling all year round, or
- monthly sampling during winter (October-March) and fortnightly sampling during summer (April-September).

The sampling scheme adopted in 2003 included 74 locations. Table 11 shows how these correspond to the 34 sites defined in this report. If locations belonging to the same site had different sampling frequencies, the site was assigned the more frequent strategy (further details in Materials & Methods).

The risk of non-detection associated with the current sampling scheme is shown for DSP and PSP in mussels, and ASP in scallops (Tables 12-14, respectively). These are the only data sets for which toxin levels resulted in field closure and that yielded sufficient information for assessing the changes in toxin levels throughout the year.

*DSP in mussels*. The risk of non-detection associated with the current sampling scheme was found to be less than 10% from December-May, with the exception of Arran, which had a risk of up to 18% in December (Table 12). From June-November approximately 50% of the sites had an associated risk of non-detection exceeding 10% under the current scheme. This occurred predominantly at sites that were sampled fortnightly, indicating that sampling once every two weeks is not sufficient. Several sites had a risk of non-detection exceeding 20%, the majority of which were found to occur in October (7 sites). This suggests that switching to monthly sampling across all sites from October onward may not be appropriate as the monitoring data indicates that certain sites continued to be positive for DSP during October-December (Table 5).

*PSP in mussels*. There tended to be a low risk of non-detection associated with the current sampling scheme for PSP in mussels, with the exception of May and June, when the risk of non-detection exceeded 10% for three sites (Loch Striven, Orkney, and Loch Torridon, Table 13). A risk of non-detection of 1% or less was observed for ten sites that were sampled fortnightly during summer, suggesting that it may be possible to reduce sampling effort at these sites (although this depends on the risk levels that are acceptable to the Food Standards Agency).

*ASP in scallops*. From July-December, the risk of non-detection exceeded 20%, with the highest risk of a field being unknowingly toxic (57%) observed at Sound of Jura in August (Table 14). Therefore, the current sampling scheme for this site (monthly sampling) appears to be insufficient for ASP monitoring. Although all remaining sites have a fortnightly sampling scheme in summer, the risk of non-detection remained high, with values of 27-39% in August-September. Sound of Jura would have fallen in this range also if fortnightly sampling had been applied. During October-November (monthly sampling) all sites showed a high risk of non-detection of 42-53%.

### *3.3.2. Introduction to alternative sampling schemes*

Risk assessment of the existing monitoring scheme indicated that to reduce the risk of non-detection, re-allocation of sampling effort (e.g. PSP in mussels) or increased sampling frequency (e.g. DSP in mussels during autumn) may be needed. The aim was to construct alternative sampling schemes such that the risk of non-detection does not exceed a pre-defined maximum value (denoted by $R_{max}$), while minimising the total number of samples required. Three possible sampling frequencies were considered, namely:

- once per month (monthly) when toxin levels are low,
- four times per month (weekly) when toxin levels are high,
- fortnightly for intermediate toxin levels,

where a month approximates four weeks. These alternative schemes were allowed to be site and time specific, so that each site has its own monitoring scheme for which the sampling frequency may vary during the year.

For various values of p, the probability that the toxin level in a sample exceeds the field closure limits, Table 15 shows how the monthly, fortnightly and weekly sampling frequencies influence the risk of non-detection. For example, for p = 30%, the risk of non-detection is 22.5% for monthly sampling while 15% for fortnightly sampling.

Let $p_{high}$ and $p_{low}$ be cut-off levels that determine whether weekly sampling is necessary or monthly sampling will suffice. For a given maximum acceptable risk of non-detection (denoted by $R_{max}$), alternative sampling schemes were constructed as follows.

- When toxin levels are high, with p exceeding $p_{high}$, weekly sampling is required.
- When toxin levels are low, with p less than $p_{low}$, monthly sampling will suffice.
- For intermediate toxin levels, with p exceeding $p_{low}$ but less than $p_{high}$, fortnightly sampling is applied.

To minimise the number of samples needed, $p_{high}$ and $p_{low}$ are chosen as follows (details in Materials & Methods):

- let $R_{max}$ denote the maximum acceptable risk of non-detection, which is set in advance,
- then $p_{high} = 2\ R_{max}$,
- and $p_{low} = 2/3\ p_{high}$.

To illustrate this approach, $R_{max}$ was arbitrarily set at 5% and 10%, but it should be noted that choosing the maximum acceptable risk of non-detection is for the Food Standards Agency to decide.

### *3.3.3. Risk assessment of alternative sampling schemes*

Based on the approach outlined in the previous section, the following two alternative sampling schemes were constructed.

- <u>Scheme A:</u> Maximum acceptable risk of non-detection is 10%, so that $p_{high}$ = 20% and $p_{low}$ = 13.3%. This corresponds to a sampling scheme where weekly sampling is carried out when p ≥ 20%, fortnightly sampling when 13.3% < p < 20% and monthly sampling when p ≤ 13.3%.
- <u>Scheme B:</u> Maximum acceptable risk of non-detection is 5%, so that $p_{high}$ = 10% and $p_{low}$ = 6.67%. Sampling frequency should be increased to once a week when p ≥ 10%, once a fortnight when 6.67% < p < 10% and once a month when p ≤ 6.67%.

These schemes were implemented for DSP in mussels, PSP in mussels and ASP in scallops, based on the values of p (chance that toxin levels exceed field closure limit) given in Tables 5-7. The sampling frequencies required for each site, which correspond to maximum acceptable risk of non-detection of 10% and 5%, are shown in Tables 16-18.

*DSP in mussels.* In order to reduce the risk of a site being unknowingly toxic for DSP to 10% or less, the data indicated that sampling frequency should be increased from monthly to at least fortnightly during October-December (Table 16). However, for certain sites that are currently sampled fortnightly during April-September, the sampling frequency could be reduced to once per month (e.g. Linnhe and Loch Eil/Leven). Increasing the total number of samples by 235 (an increase of 20%) would halve the average risk of non-detection (from 6 to 3%) and would reduce the maximum risk of non-detection from 46% to 10%. To reduce the maximum risk of non-detection further to 5% or less, it would be necessary to increase sampling frequency by 60% compared to the current scheme, with many sites which are currently sampled monthly or fortnightly from June to November requiring weekly sampling during this period.

*PSP in mussels.* Table 17 suggests that a more efficient allocation of resources would enable the maximum risk of non-detection for PSP in mussels to be reduced from 26% down to 10%, while using 25% less samples (862 as opposed to 1152 at present, Table 17). Even if the risk of non-detection were to be reduced to 5% or less, fewer samples would be required than are taken at present. The new schemes put high sampling effort at sites that are at high risk of PSP toxicity, particularly during the peak months of May and June. However, these alternative schemes enable the sampling effort to be reduced from fortnightly to monthly for sites that have not previously experienced high PSP toxicity levels.

*ASP in scallops.* Table 18 indicates that currently the average risk of non-detection is 21% for ASP in scallop gonads, with values increasing up to 57% in August. To reduce this to a maximum of 10%, it would be necessary to double sampling effort (from 328 samples at present to 600 samples) with all sites being sampled weekly during July-December. A further reduction in the maximum risk of non-detection down to 5%, would require weekly sampling from May through to the following February (756 samples).

*Remaining species/toxin combinations*. Results for the remaining species and toxin combinations are shown in Table 19. Although a relatively large number of P. oysters were tested (1126), only a small number exceeded field closure limits for any of the toxin groups. Therefore, monthly sampling appeared to be sufficient for P. oysters as it results in a maximum risk of non-detection of 2.3, 0.6, and 0.6 % for DSP, PSP, and ASP respectively.

For DSP in queen scallops there was a high risk of non-detection, and it may be appropriate to link the frequency of DSP testing in queen scallops to that of DSP in mussels. However, it should be noted that this is based on only a limited amount of data for queen scallops (248 samples).

For the other species and toxin combinations monthly sampling appeared to be sufficient, with the risk of non-detection being around 10% or less (based on a worst case scenario with the risk calculation based on the upper limit estimate for p). However, it should again be noted that this is based on limited data.

# 4 DISCUSSION

### *4.1. Issues arising from data and models*

*Agreement of model fit with data.* The estimated probabilities (Tables 5-9) show good agreement with the data (Tables A4-A8). Based on geographical characteristics, however, a higher incidence of DSP and PSP in mussels might have been expected for Loch Ryan, Solway and Mull Loch Spelve (pers. comm. T. Telfer, Inst. Aquaculture, Stirling). Data for these sites, however, were limited, with only up to six PSP samples per month available during the peak period May-July. For DSP only two or three samples were available per month for Loch Ryan and Solway, with up to eleven for Loch Spelve during the peak period July-August. This shows that for sites that have small numbers of samples, the results presented in Tables 5-9 should be treated with caution.

*Aggregation of bed locations*. Due to limited data, locations were aggregated to form ‘sites’ (see Table 1). In this study, it was assumed that the locations that form part of a site show similar toxicity patterns. This was confirmed before the data were combined, but it should be kept in mind that, in practice, geographical differences may exist between the locations that were aggregated into one site. For example, Loch Fyne consists of three locations, namely Stonefield which is nearest to open water, and Otter Ferry and Ardinglass, which are approximately 12 km and 50 km inland from Stonefield, respectively. As a consequence, Ardkinglass may have a different toxin profile as its geographical conditions differ from the other two locations in that it is further away from open water (pers. comm. T. Telfer). The data include only approximately 20 samples for each of these three locations, which was insufficient to allow the differences between these locations to be modelled. It may be necessary to reassess the appropriateness of the grouping of bed locations outlined in Table 1 when further data become available in future. A further problem with the data was that several of the samples lacked detail on bed location and it was therefore not always possible to assign samples to particular bed locations.

*Toxin levels change rapidly with time*. Toxin levels can change rapidly with time, as is illustrated in Table 20. For example, at Loch Striven, PSP levels were found to increase from zero to field closure (112 μg/100g) within one week (21-29 April 2003). Toxin levels were also found to decrease at this site from field closure (107 μg/100 g) back to zero also within one week (13-20 May 2003).

Likewise, differences in toxin concentrations were observed in samples taken on the same date at bed locations that are relatively close together geographically. Ob Gorm Beag and Ob Gorm Mhor are less than 1 km apart in Loch Torridon, but samples taken on the 21st May 2001indicated that no PSP was detected at the former bed whereas for the latter bed the PSP levels were at field closure (80 μg/100g). However, by the 10th June 2001, PSP levels at Ob Gorm Beag had increased to 123 μg/100g, but had decreased back to zero at Ob Gorm Mhor (Table 20). These data suggest a lag of approximately one week between the toxic event detected at Ob Gorm Beag compared to that detected at Ob Gorm Mhor. Unfortunately, there were insufficient data to include toxicity event mechanisms of this nature in the statistical models.

*Is a site always clear?* Although several sites were clear for the entire period covered by the data, this does not necessarily imply that toxins will always be absent from these. For example, PSP was not detected in mussels harvested from the site Loch Striven during 2001 and 2002, but was detected in 2003 (Table A2). If the data for 2003 had not been available it may have been incorrectly concluded that Loch Striven was always clear of PSP. The data available for this study covered only three years and this is not sufficient to make firm statements on sites being relatively 'safe'. There may be biological reasons however, that would justify such a statement. It is for this reason that the GLMM model was chosen for statistical analyses, as the estimated probability of a positive sample will never be zero. For sites for which all samples tested negative, the estimated probability of a positive sample will be somewhat above zero, instead of exactly zero, while for sites that had several positive samples the model will estimate the probability of a positive sample to be approximately equal to the proportion of positive samples in the data.

*Estimated values for each month.* The probability of a sample exceeding the field closure limit was estimated for each month for each site (as presented in Tables 5-7). This implies that it is assumed that, during a month, the probability of a toxic sample does not change, but that at the end of the month an instant change to a new probability occurs. For example, during May the chance of a positive DSP sample is 12% for Sutherland, which then, overnight, increases to 35% in June (Table 5). A more realistic approach would have been to allow the probability of a toxic sample to change smoothly with time, but the data were too limited for such an approach.

*Variation across years.* The data covered only a three year period, and as toxin levels tend to vary across years there is a certain amount of uncertainty associated with the monthly estimates of a field being toxic. For example, high toxin levels might have occurred in July-September for year 2001, and in August-September for 2002 and 2003. This suggests that the probability of field closure was higher in August-September (field closure in 2 out of 3 years) than in July (field closure in 1 out of 3 years), but when looking over a longer period of time it may be that high levels in July are equally likely as high levels in August. It is possible to include such random variation between years in the models, but as only three years of data were available, uncertainty in the year random effect would be too great for it to be of any use.

*Model assumptions.* The statistical analyses are based on the following assumptions.

1. It was assumed that the toxin levels found in the tested sample are representative of the shellfish toxin levels at that particular site. For example, if a sample tends to be taken from a location such that it is less likely to contain high toxin levels, then this would result in actual toxin levels being underestimated.

2. It was assumed that the test result is correct. It is known that, at least for PSP, the variation in test results is large. For example, when the true toxicity is 80μg/100g the estimated toxicity can vary from 40 to 120 μg/100g (Holtrop et al., 2004). Likewise, toxin levels are known to vary within a field (pers. comm. T. Telfer). These factors may result in a situation that a test result is below field closure, while in reality average toxin levels are above field closure (or vice versa). Such variation in test results has been ignored in the models used in this study.

3. It was assumed that repeated testing following field closure did not bias the data. When toxin levels in a sample exceed the statutory field closure limit, the field is closed until two consecutive samples, at least one week apart, are both below the limit. As shellfish farmers are likely to be keen for the field to be reopened, they may want to send off weekly samples following closure of the field. This has the potential for the data to be biased towards high toxin levels, as there might have been relatively more samples on occasions when toxin levels exceeded the field closure limit.

Violation of assumptions 1 and 3 could have consequences for the estimated chance of the field being toxic. No information on assumption 1 is available but inspection of the data for the validity of assumption 3 revealed that there was no significant increase in sampling effort following a positive sample (but it should be noted that several of the samples lacked detail on bed location so it was not always possible to trace the full history of each location). The data were also inspected for temporal autocorrelation, which might be thought of as positive or negative samples would tend to be followed by similar samples after a short time interval. After allowing for site and month effects, however, there was no clear indication of such patterns in the data for any of the toxins.

*More complex models.* The toxicity data were regarded as binary data (i.e. only two possible outcomes, namely toxin levels above or below field closure limit), resulting in relatively simple models of toxicity. Due to limitations in the data more sophisticated models were not considered. When more data become available, use of more complex statistical approaches might allow for more realistic models by looking at actual toxicity levels (as opposed to the current field open or closed approach), smooth changes of toxicity with time, modelling of relationships between toxin patterns of neighbouring sites, and inclusion of temporal autocorrelation in the models.

Despite the limitations of the data, which necessitated grouping of bed locations and aggregation of data to monthly values, we are confident that the analyses presented in this report give a good indication of when and where high toxin levels did occur during 2001-2003.

## 4.2. Issues arising from risk assessment

*Closure of field and retesting*. The risk assessment was concerned with asking: what is the chance of failing to detect a toxic event for the present and alternative monitoring schemes? It was assumed that the monitoring scheme is solely concerned with monitoring of toxin levels. Field closure and retesting following closure (so that field can be reopened when two successive results, at least 7 days apart, are below the statutory limit) were not considered in the risk assessment. As a consequence, it was assumed that monitoring is continued at its prescribed frequency even when a field is closed. In addition, the numbers of samples mentioned for each of the alternative sampling schemes, do not include extra samples that may be analysed on request of the shellfish producer with the aim to reopen the field.

*Fine-tuning of sampling schemes.* The two alternative scenarios were developed as follows. Based on the probability of a toxin exceeding field closure limits (given for each site and each month in Tables 5-7), a decision is made whether to sample monthly, fortnightly or weekly. Because the probabilities given in Tables 5-7 do not always increase or decrease smoothly with time, sampling frequencies under the alternative scenarios A and B also do not always increase or decrease smoothly with time. For practical purposes, the alternative scenarios presented in Tables 16-18 may require some fine-tuning to provide sampling strategies that are workable within the monitoring programme. For example, the scheme for PSP in mussels could be simplified to monthly sampling throughout, with the exception of the 10 sites for which the level of risk could be reduced to ≤ 5% by applying weekly sampling during May and June (Table 17).

*Application of high frequency, i.e. weekly, sampling schemes.* The choices of maximum acceptable risk of non-detection for scenarios A and B (10 and 5% respectively) are arbitrary. If the maximum acceptable risk is reduced any further the sampling scheme would move to sampling once every week all year round at each site. For mussels, this would require over 3000 samples to be taken every year (compared to 1170 based on the present scheme for DSP, 1405 for alternative A and 1881 for alternative B). If the maximum acceptable risk of non-detection is relaxed, the sampling frequency could move towards monthly sampling, which would require approximately 800 samples to be taken annually. As one aspect of the shellfish monitoring programme is to build information on changes in toxin levels throughout the year, sampling should take place at least once per month.

*Maximum acceptable risk of non-detection assumed the same for ASP, DSP and PSP.* The maximum acceptable risk of non-detection in scenarios A and B is arbitrarily assumed to be the same for all three toxins. This ignores differences in the severity of exposure to ASP, PSP and DSP. A higher risk of non-detection may be acceptable for DSP as it only results in mild clinical signs while for PSP a lower risk would be preferred as in extreme cases it may cause death. To develop such alternative sampling strategies, Tables 5-7 could be used as a starting point as they show when positive samples are most likely to occur. The relationship between increased sampling frequency and the reduction in the associated risk of a toxic field being missed by the monitoring programme is shown in Table 15.

*Combining the mouse bioassay with alternative test methods.* Currently, for PSP, the accepted method of analysis is based on the mouse bioassay (MBA). However, alternative chemical methods are now available for detecting this group of toxins, although they are not yet fully validated. It may be possible for FSAS to use a combination of the MBA and chemical detection methods, depending on the probability that a site will contain toxin levels that exceed field closure levels. For example, the MBA could be used during the summer months when PSP levels tend to peak and chemical tests could be used during October-March, as the data show that PSP was not detected during these months in 2001-2004. Samples, which test positive during this period using chemical detection methods, could be re-tested by the MBA to confirm toxicity (see also Holtrop et al. 2004). When chemical detection methods are optimised for the detection of DSP toxins, it may also be possible to adopt this approach (MBA in combination with chemical test) for the monitoring of DSP.

The scenarios treat each toxin separately, whereas current practice tends to be to take a shellfish sample and have it analysed for all three toxins. So it may be the case that for DSP in mussels a weekly sampling regime is required while for PSP a monthly regime suffices (this would be the case during July-October). This would require weekly sampling of mussels, and as PSP is much more toxic than DSP, an option might be to test for PSP using the mouse bioassay once a month, and during the remaining three weeks to test for PSP using the chemical method.

Likewise, there is scope to alternate between tests between locations that are in close proximity to each other so that each location is tested monthly with the MBA and chemical test in an alternating manner (use the MBA for month 1 at site A and month 2 at site B, while the chemical test is used for month 2 at site A and month 1 at site B). For example, this could be considered for PSP during the winter months (as conditions in winter are unsuitable for algae that produce the PSP toxin – pers. comm. T. Telfer), and for species that have low or absent toxin levels such as DSP in cockles.

### *4.3 Future data*

When further data become available, the following issues should be considered.

- Is the grouping of bed locations, as outlined in Table 1, still appropriate? In most cases, grouping of locations was based on limited data, so when more data become available this should be re-checked. Also, toxin patterns may change for some locations but not for others, which may require a different grouping of sites.

- Have toxin patterns changed? For example, sites that were previously non-toxic may have become toxic. Furthermore, the onset and duration of toxic events may change (e.g. previously high PSP levels occurred in May and June but new data may show a shift to high toxin levels occurring later in the year, say).

If changes as described above are observed then the models that describe the probability of a sample being toxic should be revised. As more data will become available with time it may be feasible to develop more realistic statistical models that describe actual toxin levels (as opposed to below/above field closure limit in the present model) that change smoothly with time (as opposed to the monthly stepwise changes in the present model). Furthermore, based on the new modelling results, monitoring schemes should be reassessed for the risk of not detecting a toxic event.

The present data (April 2001 – March 2004) only allowed for modelling of site and month specific toxin levels for DSP and PSP in mussels, and ASP in scallop gonads. When more data become available such detailed models may be possible also for other species/toxin combinations.

## 5. RECOMMENDATIONS

- ASP levels in whole scallops almost always exceeded the field closure limit during 2001-2004. Therefore, it is recommended that whole scallops are always 'shucked' before being placed on the market for human consumption.
- Accurate monitoring of changes in toxin levels across Scotland throughout the year requires sampling to be carried out at least monthly for every site.
- Sufficient data were available for only DSP and PSP in mussels and ASP in scallops to enable sampling schemes to be assessed. More data are required to extend the findings to other species and toxin combinations.
- The current sampling scheme is based on monthly sampling with fortnightly sampling during April-September for certain sites and is the same for all species and all three toxins. More efficient sampling is achieved when separate schemes are developed for each of the three toxins, allowing PSP testing to be relaxed during August and September while increasing ASP and DSP testing during October-December.
- Sampling schemes may be implemented in a more flexible manner, combining various testing methods.
    - For example, for PSP in mussels, during August-April monthly sampling is sufficient to keep the risk of a field being unknowingly toxic down to 5% or less. However, as PSP poisoning can have severe consequences on human health, it may be possible to use a chemical test (not accepted formally yet) to test mussel samples on a weekly or fortnightly basis during August-October and March-April, for example, while using the mouse bioassay (formally accepted test method) for monthly sampling.
    - Another relaxation may be to sample alternately, perhaps using the mouse bioassay, between two sites A and B that are geographically close, such that in year 1 site A is sampled in January and March and Site B in December and February, while in year 2 site A is sampled in December and February and site B in January and March. During those months that the mouse bioassay is not used a chemical test could be used instead.
- Sampling schemes may require modification in future, as toxin patterns may change and findings in this report are based on only three years' of data.
- It is therefore recommended that the risk assessment presented in this report is updated either on a yearly basis, or after a further three years of monitoring data has been collected.
- It will be necessary for the Food Standards Agency to set acceptable levels for the risk of non-detection on which to base suitable sampling schemes for future monitoring of all three toxin groups.

# 6. ACKNOWLEDGEMENTS

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# 7. REFERENCES

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## TABLES

Table 1: Definition of Area, Site and the locations covered by each site. Based on descriptions given in original data files, with the locations in parentheses given as additional information (but note that it is not exclusive, so Loch Linnhe (Cuil Bay, Lismore, Lynn of Lorne) may actually consist of more locations than the three mentioned, but these were not further specified in the original data files).

| Area | Site | Covers the following locations: |
|---|---|---|
| Clyde | Arran | Lamlash Bay, Pirnmill, Whiting Bay |
| | Clyde | Fairlie (Southannan), Greenock (Esplanade), Kames (Rubha Mhor), Lunderston Bay, Parklea |
| | Loch Fyne | Ardkinglass, Otter Ferry, Sawmill Bay, Stonefield |
| | Loch Striven | Loch Striven (Troustan) |
| East | East | Eyemouth, Forth Estuary (Anstruther, Burntisland, Elie, Granton, Largo Bay, Pittenweem), Montrose (Ferryden), Tay estuary |
| Jura | Colonsay Islay | Colonsay (The Strand), Islay (Loch Gruinart) |
| | Linnhe | Loch Creran (Rubha Mor, South Shian), Loch Linnhe (Cuil Bay, Lismore, Lynn of Lorne) |
| | Loch Eil/Leven | Loch Eil (Blaich), Loch Leven (Upper Loch Leven, Eilean Chonneich) |
| | Loch Etive | Kerrera Sound (Cutters Rock), Loch Etive (Achnacloich, Cadderlie, Craig Point, Upper Basin) |
| | Seil Sound | Ardencaple, Kilbrandon, North, Ardfad Bay, Seil Sound |
| | Sound of Jura | Loch Caolisport, Loch Melfort, Loch Crinan |
| | West Loch Tarbert | Loup Bay, Skipness |
| North | Orkney | Bay of Firth (Port na Coite), Burray, Hatston, Inganess (Berstane Bay, Yinstay), Mill Sands, Otterswick, Scapa Flow (Ehnaloch Bay, Scapa Pier, Swanbister, Watersound, Waukmill), Stromness |
| | Shetland E | Wadbister Voe, Dales Voe, Scarva Ayre, Catfirth |
| | Shetland N | North+South Uyea, Baltasound Voe (harbour), Basta Voe (Inner, Outer, North Ayre), Southwick Voe, Mid Yell Voe (Camb), Whalefirth Voe (Inner, Lea Cray) |
| | Shetland SW | Braewick Voe, Browland Voe, Clift Sound (Streamsound), Gruting/Seli Voe (Browland, Quilse, Maraness), Sandsound Voe, Vaila Sound (Linga, Riskness), Stromness Voe |
| | Shetland W | Busta Voe (Burgasto, Lee, Brae), Clousta Voe, East Burra Firth, Olna Firth (Parkgate), Papa Little, Ronas Voe, Ura Firth, Vementry Voe (Cribba Sound, Siggi Bight, Suthra Voe) |

Table 1 continued.

| Area | Site | Covers the following locations: |
|---|---|---|
| NorthWest | Loch Ewe | Loch Ewe (Isle Ewe, Thurnaig), Little Loch Broom, Ullapool |
| | Loch Torridon | Loch Torridon (Ob Gorm Beag, Ob Gorm Mhor, Inner Loch Torridon) |
| | Sutherland | Lochinver (Loch Kirkaig), Loch Laxford (Weavers Bay), Loch Eriboll, Kylesku (Allt Briste), Kyle of Tongue (Melness), Kinlochbervie (Loch Inchard), Enard Bay |
| Skye | Skye Loch Eishort | Loch Eishort |
| | Skye North | Loch Bracadale (Bracadale, Loch Caroy, Harport, Portnalong), Loch Dunvegan (Isay, Loch Bay), Loch Greshornish, Loch Snizort |
| | Skye Scalpay | Kyle (Badicaul), Loch Ainort, Loch Kishorn (Seafield), Loch Portree, Loch Sligachan, Loch Toscaig, Scalpay (Broadford Bay) |
| South West | Loch Ryan | Loch Ryan (Agnew Park, Scour Point, Seacat) |
| | Solway | Auchencairn, Dhoon Bay, Mersehead, Priestside, Rockcliffe,Powfoot, Wigtown Bay |
| Tain | Tain | Tain (Dornoch Firth, Whiteness sands), Udale Bay |
| West | Lochaber | Ardtoe (Loch Kentra), Arisaig (Loch Beag, Loch nan Ceol), Fascadale Bay, Glenuig Bay, Loch Ailort, Loch Hourn, Loch Moidart (South Channel), Loch Nevis, Loch Sunart (Camasinas), Loch Teacuis |
| | Mull Loch Scridain | Loch Sridain (Aird Fada) |
| | Mull Loch Spelve | Loch Spelve (Inverlussa) |
| | Mull North | Aros, Loch a Chumhainn, Loch na Keal (Port a Claidh, Soriby, Traigh Bhan, Ulva Sound), Tobermory (Port na Coite) |
| Western Isles | LewisHarris | Broad Bay (Tolsta Head), Killegray, Loch Ceann Dibig, Loch Seaforth, Loch Stockinish, Loch Tamnabaigh, Seilebost |
| | Loch Leurbost | Loch Leurbost (Creag An Rainich) |
| | Loch Roag | Loch Roag (Loch Drovinish, Loch Torranish, Miavaig) |
| | UistBarra | Barra (Cornaig Bay, Traigh Mhor), Liernish, Loch Carnan (Sandavaig), Loch Eport, Loch Eynort (Eilean Bhic Eachain, Riscay), Oitir Mhor (Benbecula), Sound of Eriskay, South Ford (Siusaigh) |

Table 2: Numbers of samples tested for each species at each site.

| | | Clams[1] | | | Cockles | | | Mussels | | | P.Oysters | | | Queen scallops | | | Scallops[2] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | DSP | PSP | ASP | DSP | PSP | ASP | DSP | PSP | ASP | DSP | PSP | ASP | DSP | PSP | ASP | DSP | PSP | ASP |
| Clyde | Arran | 4 | 4 | 5 | | | | 20 | 12 | 14 | | | | | | | | | |
| | Clyde | | | | | | | 66 | 55 | 55 | 14 | 12 | 13 | | | | | | |
| | Loch Fyne | 1 | 1 | 1 | | | | 66 | 56 | 64 | 44 | 44 | 52 | 46 | 42 | 43 | | | |
| | Loch Striven | | | | | | | 73 | 61 | 63 | 1 | | 1 | | | | | | |
| East | East | 13 | 11 | 11 | 5 | 4 | 4 | 46 | 40 | 39 | | | | | | | | | |
| Jura | Colonsay Islay | 1 | 1 | 1 | | | | | | | 37 | 33 | 34 | | | | | | |
| | Linnhe | | | | | | | 62 | 60 | 61 | 60 | 58 | 58 | | | | | | |
| | Loch Eil/Leven | | | | | | | 78 | 72 | 76 | | | | | | | | | |
| | Loch Etive | | | | | | | 62 | 57 | 58 | 1 | 1 | 1 | | | | | | |
| | Seil Sound | | | | | | | | | | 46 | 46 | 46 | | | | | | |
| | Sound of Jura | | | | | | | 9 | 6 | 8 | | | | | | | 19 | 25 | 27 |
| | West Loch Tarbert | 1 | 1 | 1 | | | | 1 | | | 36 | 37 | 35 | | | | | | |
| North | Orkney | | | | 13 | 14 | 16 | 62 | 63 | 63 | 2 | 5 | 5 | | | | | | |
| | Shetland E | | | | | | | 52 | 42 | 50 | | | | | | | | | |
| | Shetland N | | | | | | | 120 | 99 | 104 | 1 | 1 | 1 | 2 | 2 | 2 | | | |
| | Shetland SW | | | | | | | 136 | 118 | 144 | | | | | | | | | |
| | Shetland W | | | | | | | 180 | 162 | 183 | | | | 6 | 7 | 5 | 3 | 4 | 1 |
| NorthWest | Loch Ewe | | | | | | | 50 | 40 | 45 | | | | | | | 14 | 36 | 79 |
| | Loch Torridon | | | | | | | 55 | 50 | 51 | | | | | | | | | |
| | Sutherland | | | | | | | 122 | 111 | 115 | 27 | 22 | 24 | | | | | | |
| Skye | Skye Loch Eishort | | | | | | | 69 | 68 | 72 | | | | | | | | | |
| | Skye North | | | | | 1 | 1 | 91 | 78 | 80 | 28 | 29 | 28 | | | | | | |
| | Skye Scalpay | 1 | 1 | 1 | 4 | 12 | 11 | 47 | 42 | 42 | | 2 | 2 | 34 | 28 | 31 | 13 | 25 | 35 |
| South West | Loch Ryan | 3 | 4 | 4 | | | | 23 | 18 | 18 | | | | | | | | | |
| | Solway | | | | 7 | 8 | 8 | 34 | 30 | 34 | | | | | | | | | |
| Tain | Tain | | | | 4 | 3 | 2 | 52 | 48 | 47 | | | | | | | | | |
| West | Lochaber | 12 | 20 | 21 | | | | 124 | 104 | 114 | 25 | 43 | 44 | | | | 1 | 2 | 2 |
| | Mull Loch Scridain | | | | | | | 60 | 56 | 58 | | | | | | | | | |
| | Mull Loch Spelve | | | | | | | 56 | 53 | 57 | | 1 | 1 | | | | | | |
| | Mull North | | | | | | | 49 | 44 | 50 | 27 | 46 | 40 | | | | | | |
| Western Isles | LewisHarris | 6 | 6 | 5 | 4 | 17 | 16 | 23 | 25 | 24 | | | | | | | | | |
| | Loch Leurbost | | | | | | | 53 | 52 | 60 | | | | | | | | | |
| | Loch Roag | | | | | | | 145 | 139 | 146 | | | | | | | | | |
| | UistBarra | 1 | 1 | 1 | 8 | 18 | 11 | 46 | 44 | 48 | 2 | 6 | 4 | | | | | | |
| Grand Total | | 43 | 50 | 51 | 45 | 77 | 69 | 2132 | 1905 | 2043 | 351 | 386 | 389 | 88 | 79 | 81 | 50 | 92 | 144 |

[1]Clams: includes clams, razors, spisula, venerupis and N. Oysters.

[2]DSP and PSP tested on whole scallops, ASP tested on scallop gonads.

Table 3: Numbers of samples per toxin level for each species. Levels resulting in field closure are shown in bold.

| | DSP | | PSP category[1] | | | | ASP category[2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | **1** | 0 | 0-40 | 40-80 | **80+** | 0 | 2.5 | 2.5-20 | **20+** |
| Clams[3] | 41 | **2** | 50 | | | | 20 | 29 | 2 | |
| Cockles | 45 | | 74 | 1 | 1 | **1** | 33 | 30 | 6 | |
| Mussels | 1883 | **249** | 1791 | 32 | 46 | **36** | 914 | 1071 | 55 | **3** |
| P.Oysters | 346 | **5** | 384 | 2 | | | 187 | 187 | 15 | |
| Queens | 72 | **16** | 75 | 2 | 2 | | 14 | 51 | 13 | **3** |
| Scallops[4] | 49 | **1** | 88 | 4 | | | 2 | 19 | 69 | **54** |

[1]Categories for PSP are 0; > 0 and < 40 (denoted by 0-40), ≥ 40 and < 80 (denoted by 40-80) and ≥ 80 μg/100g shellfish (denoted by 80+, is also field closure limit).
[2]Categories for ASP are 0; 2.5 (limit of detection), > 2.5 and < 20 (denoted by 2.5 – 20), and ≥ 20 μg/g shellfish(denoted by 20+, is also field closure limit).
[3]Clams: includes clams, razors, spisula, venerupis and N. Oysters.
[4]DSP and PSP tested on whole scallops, ASP tested on scallop gonads.

Table 4: Maximum observed toxin level (DSP absence or presence; PSP µg/100g; ASP µg/g) for each month for each species. Levels resulting in field closure are shown in bold.

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Max[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DSP | Clams[2] | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | 0 | | | 1 |
| | Cockles | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Mussels | 0 | 0 | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | P.Oysters | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | **1** | **1** | **1** | 0 | **1** |
| | Queen scallops | **1** | 0 | 0 | 0 | **1** | **1** | **1** | **1** | **1** | **1** | **1** | 0 | **1** |
| | Scallops[3] | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | **1** |
| PSP | Clams[2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 |
| | Cockles | 0 | 0 | 0 | 0 | 0 | **152** | 0 | 0 | 0 | 0 | 0 | 0 | **152** |
| | Mussels | 0 | 0 | 0 | **112** | **211** | **405** | **127** | **169** | 44 | 0 | 0 | 0 | **405** |
| | P.Oysters | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 |
| | Queen scallops | 0 | 0 | 0 | 0 | 62 | 33 | 35 | 0 | 61 | 0 | 0 | | 62 |
| | Scallops[3] | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 32 | 0 | 0 | 0 | 0 | 38 |
| ASP | Clams[2] | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 6 | 2.5 | 2.5 | 2.5 | 2.5 | | 6 |
| | Cockles | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 3 | 14 | 2.5 | 0 | 2.5 | 14 |
| | Mussels | 2.5 | 2.5 | 2.5 | 2.5 | 5 | **27** | 8 | 13 | **22** | 8 | 6 | 2.5 | **27** |
| | P.Oysters | 2.5 | 2.5 | 2.5 | 2.5 | 7 | 3 | 10 | 4 | 9 | 3 | 2.5 | 2.5 | 10 |
| | Queen scallops | 4 | 2.5 | 2.5 | 3 | **31** | **28** | 7 | 4 | **55** | 5 | 7.36 | 8 | **55** |
| | Scallops[4] | **28** | **25** | 9 | 17 | **64** | **39** | **65** | **66** | **76** | **54.74** | **152** | **38.37** | **152** |

[1]Maximum over all months.
[2]Clams: includes clams, razors, spisula, venerupis and N. Oysters.
[3]Whole scallops.
[4]Scallop gonads.

Table 5: Estimated[1] probability (%) that field is positive for DSP in mussels, for each site per month. The value 0% represents a small positive number having a value of less than 0.5%. Probabilities of 10% and higher are shown in bold.

| Area | Site | n[2] | Avg[3] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | 0 | 1 | 3 | 5 | **17** | **18** | **21** | **17** | **17** | **11** | 6 |
| Clyde | Arran | 20 | **32** | 0 | 0 | 4 | **15** | **22** | **53** | **55** | **61** | **54** | **54** | **39** | **25** |
| Clyde | Clyde | 66 | **10** | 0 | 0 | 1 | 3 | 5 | **18** | **19** | **23** | **18** | **18** | **11** | 6 |
| Clyde | Loch Fyne | 66 | **15** | 0 | 0 | 1 | 5 | 9 | **27** | **28** | **33** | **27** | **27** | **17** | 9 |
| Clyde | Loch Striven | 73 | **18** | 0 | 0 | 2 | 7 | **10** | **31** | **32** | **38** | **31** | **31** | **20** | **11** |
| East | East | 46 | 10 | 0 | 0 | 1 | 3 | 5 | **17** | **18** | **22** | **17** | **17** | **10** | 6 |
| Jura | Linnhe | 62 | 2 | 0 | 0 | 0 | 1 | 1 | 3 | 4 | 5 | 3 | 3 | 2 | 1 |
| Jura | Loch Eil/Leven | 78 | 2 | 0 | 0 | 0 | 1 | 1 | 4 | 5 | 6 | 4 | 4 | 2 | 1 |
| Jura | Loch Etive | 62 | 2 | 0 | 0 | 0 | 1 | 1 | 3 | 4 | 5 | 3 | 3 | 2 | 1 |
| Jura | Sound of Jura | 9 | 5 | 0 | 0 | 0 | 2 | 3 | 10 | **10** | **13** | 10 | 10 | 6 | 3 |
| Jura | West Loch Tarbert | 1 | 8 | 0 | 0 | 1 | 2 | 4 | **13** | **14** | **18** | **14** | **14** | 8 | 4 |
| North | Orkney | 62 | **14** | 0 | 0 | 1 | 5 | 7 | **24** | **25** | **30** | **24** | **24** | **15** | 8 |
| North | Shetland E | 52 | 7 | 0 | 0 | 1 | 2 | 3 | **12** | **13** | **16** | **12** | **12** | 7 | 4 |
| North | Shetland N | 120 | 6 | 0 | 0 | 0 | 2 | 3 | **10** | **11** | **13** | **10** | **10** | 6 | 3 |
| North | Shetland SW | 136 | 5 | 0 | 0 | 0 | 1 | 2 | 8 | 9 | **11** | 8 | 8 | 5 | 2 |
| North | Shetland W | 180 | 9 | 0 | 0 | 1 | 3 | 5 | **16** | **17** | **21** | **16** | **16** | 10 | 5 |
| NorthWest | Loch Ewe | 50 | **20** | 0 | 0 | 2 | 8 | **12** | **35** | **37** | **42** | **35** | **35** | **23** | **13** |
| NorthWest | Loch Torridon | 55 | 9 | 0 | 0 | 1 | 3 | 5 | **16** | **17** | **21** | **17** | **17** | 10 | 5 |
| NorthWest | Sutherland | 122 | **20** | 0 | 0 | 2 | 8 | **12** | **35** | **37** | **42** | **35** | **35** | **23** | **13** |
| Skye | Skye Loch Eishort | 69 | 8 | 0 | 0 | 1 | 2 | 4 | **14** | **15** | **18** | **14** | **14** | 8 | 4 |
| Skye | Skye North | 91 | **19** | 0 | 0 | 2 | 7 | **11** | **34** | **35** | **41** | **34** | **34** | **22** | **13** |
| Skye | Skye Scalpay | 47 | **14** | 0 | 0 | 1 | 5 | 7 | **24** | **25** | **30** | **24** | **24** | **15** | 8 |
| South West | Loch Ryan | 23 | 3 | 0 | 0 | 0 | 1 | 2 | 6 | 6 | 8 | 6 | 6 | 3 | 2 |
| South West | Solway | 34 | 3 | 0 | 0 | 0 | 1 | 1 | 5 | 6 | 7 | 5 | 5 | 3 | 2 |
| Tain | Tain | 52 | 6 | 0 | 0 | 0 | 2 | 3 | **10** | **11** | **14** | **10** | **10** | 6 | 3 |
| West | Lochaber | 124 | **15** | 0 | 0 | 1 | 5 | 8 | **26** | **27** | **33** | **26** | **26** | **17** | 9 |
| West | Mull Loch Scridain | 60 | 8 | 0 | 0 | 1 | 2 | 4 | **13** | **14** | **17** | **13** | **13** | 8 | 4 |
| West | Mull Loch Spelve | 56 | 4 | 0 | 0 | 0 | 1 | 2 | 7 | 7 | 9 | 7 | 7 | 4 | 2 |
| West | Mull North | 49 | 4 | 0 | 0 | 0 | 1 | 2 | 8 | 8 | **10** | 8 | 8 | 4 | 2 |
| Western Isles | LewisHarris | 23 | 9 | 0 | 0 | 1 | 3 | 4 | **15** | **16** | **20** | **15** | **15** | 9 | 5 |
| Western Isles | Loch Leurbost | 53 | 5 | 0 | 0 | 0 | 2 | 3 | 9 | 10 | **12** | 9 | 10 | 6 | 3 |
| Western Isles | Loch Roag | 145 | 4 | 0 | 0 | 0 | 1 | 2 | 6 | 7 | 8 | 6 | 6 | 4 | 2 |
| Western Isles | UistBarra | 46 | 5 | 0 | 0 | 0 | 2 | 3 | 10 | **10** | **13** | 10 | 10 | 6 | 3 |

[1]From GLMM with Site as random effect and Month as fixed effect.

[2]Number of samples per site.

[3]For each site the average probability over 12 months was calculated, and for each month the average probability over all sites having 10 or more samples was calculated.

Table 6: Estimated[1] probability (%) that PSP levels in mussels are 80 µg/100g or above, for each site per month. The value 0% represents a small positive number having a value of less than 0.5%. Probabilities of 10% and higher are shown in bold.

| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | n[2] | Avg[3] | 0 | 0 | 0 | 0 | 5 | 7 | 2 | 1 | 0 | 0 | 0 | 0 |
| Clyde | Arran | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Clyde | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Loch Fyne | 56 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Loch Striven | 61 | 4 | 0 | 0 | 0 | 1 | **16** | **23** | 5 | 3 | 0 | 0 | 0 | 0 |
| East | East | 40 | 1 | 0 | 0 | 0 | 0 | 5 | 8 | 2 | 1 | 0 | 0 | 0 | 0 |
| Jura | Linnhe | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Loch Eil/Leven | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Loch Etive | 57 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Sound of Jura | 6 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| North | Orkney | 63 | 6 | 0 | 0 | 0 | 2 | **25** | **34** | 9 | 4 | 0 | 0 | 0 | 0 |
| North | Shetland E | 42 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| North | Shetland N | 99 | 3 | 0 | 0 | 0 | 1 | **13** | **19** | 4 | 2 | 0 | 0 | 0 | 0 |
| North | Shetland SW | 118 | 1 | 0 | 0 | 0 | 0 | 2 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| North | Shetland W | 162 | 3 | 0 | 0 | 0 | 1 | **13** | **18** | 4 | 2 | 0 | 0 | 0 | 0 |
| NorthWest | Loch Ewe | 40 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| NorthWest | Loch Torridon | 50 | 4 | 0 | 0 | 0 | 1 | **16** | **23** | 6 | 3 | 0 | 0 | 0 | 0 |
| NorthWest | Sutherland | 111 | 2 | 0 | 0 | 0 | 0 | 7 | 10 | 2 | 1 | 0 | 0 | 0 | 0 |
| Skye | Skye Loch Eishort | 68 | 2 | 0 | 0 | 0 | 1 | 9 | **13** | 3 | 1 | 0 | 0 | 0 | 0 |
| Skye | Skye North | 78 | 2 | 0 | 0 | 0 | 1 | 9 | **13** | 3 | 1 | 0 | 0 | 0 | 0 |
| Skye | Skye Scalpay | 42 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| South West | Loch Ryan | 18 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| South West | Solway | 30 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tain | Tain | 48 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Lochaber | 104 | 3 | 0 | 0 | 0 | 1 | **12** | **18** | 4 | 2 | 0 | 0 | 0 | 0 |
| West | Mull Loch Scridain | 56 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Mull Loch Spelve | 53 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Mull North | 44 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | LewisHarris | 25 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | Loch Leurbost | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | Loch Roag | 139 | 1 | 0 | 0 | 0 | 0 | 4 | 6 | 1 | 1 | 0 | 0 | 0 | 0 |
| Western Isles | UistBarra | 44 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

[1]From GLMM with Site as random effect and Month as fixed effect.
[2]Number of samples per site.
[3]For each site the average probability over 12 months was calculated, and for each month the average probability over all sites having 10 or more samples was calculated.

Table 7: Estimated[1] probability (%) that ASP levels in scallop gonads are 20 µg/g or above, for each site per month. The value 0% represents a small positive number having a value of less than 0.5%. Probabilities of 10% and higher are shown in bold.

| Area | Site | N[2] | Avg[3] | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **14** | **20** | 0 | 0 | **20** | **17** | **32** | **77** | **57** | **67** | **58** | **27** |
| Jura | Sound of Jura | 27 | **32** | **13** | **19** | 0 | 0 | **20** | **17** | **32** | **76** | **56** | **67** | **58** | **26** |
| North | Shetland W | 1 | **32** | **13** | **19** | 0 | 0 | **19** | **16** | **31** | **76** | **56** | **66** | **57** | **26** |
| North West | Loch Ewe | 79 | **34** | **15** | **22** | 0 | 0 | **22** | **19** | **35** | **79** | **60** | **70** | **62** | **29** |
| Skye | Skye Scalpay | 35 | **30** | **12** | **18** | 0 | 0 | **18** | **15** | **30** | **74** | **54** | **65** | **56** | **24** |
| West | Lochaber | 2 | **32** | **13** | **19** | 0 | 0 | **19** | **16** | **32** | **76** | **56** | **66** | **58** | **26** |

[1]From GLMM with Site as random effect and Month as fixed effect.
[2]Number of samples per site.
[3]For each site the average probability over 12 months was calculated, and for each month the average probability over all sites having 10 or more samples was calculated.

Table 8: Estimated[1] probability (%) that field exceeds limit of detection (> 2.5μg/g) for ASP in mussels, for each site per month. The value 0% represents a small positive number having a value of less than 5%. Probabilities of 10% and higher are shown in bold.

| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | n[2] | Avg[3] | 0 | 0 | 0 | 0 | 1 | 5 | 4 | 4 | 10 | 1 | 2 | 0 |
| Clyde | Arran | 14 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| Clyde | Clyde | 55 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 4 | 0 | 1 | 0 |
| Clyde | Loch Fyne | 64 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 6 | 1 | 1 | 0 |
| Clyde | Loch Striven | 63 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 4 | 0 | 1 | 0 |
| East | East | 39 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 3 | 8 | 1 | 1 | 0 |
| Jura | Linnhe | 61 | 3 | 0 | 0 | 0 | 0 | 1 | 6 | 5 | 4 | **12** | 1 | 2 | 0 |
| Jura | Loch Eil/Leven | 76 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 1 | 0 |
| Jura | Loch Etive | 58 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| Jura | Sound of Jura | 8 | 4 | 0 | 0 | 0 | 0 | 1 | 10 | 9 | 7 | **19** | 2 | 4 | 0 |
| North | Orkney | 63 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 1 | 0 |
| North | Shetland E | 50 | 5 | 0 | 0 | 0 | 0 | 1 | **12** | **11** | 9 | **24** | 3 | 5 | 0 |
| North | Shetland N | 104 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 3 | 9 | 1 | 1 | 0 |
| North | Shetland SW | 144 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| North | Shetland W | 183 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 5 | 0 | 1 | 0 |
| NorthWest | Loch Ewe | 45 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 5 | 0 | 1 | 0 |
| NorthWest | Loch Torridon | 51 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| NorthWest | Sutherland | 115 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| Skye | Skye Loch Eishort | 72 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 |
| Skye | Skye North | 80 | 7 | 0 | 0 | 0 | 0 | 2 | **15** | **14** | **12** | **29** | 3 | 6 | 0 |
| Skye | Skye Scalpay | 42 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 6 | 1 | 1 | 0 |
| South West | Loch Ryan | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| South West | Solway | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 5 | 0 | 1 | 0 |
| Tain | Tain | 47 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |
| West | Lochaber | 114 | 3 | 0 | 0 | 0 | 0 | 1 | 6 | 6 | 5 | **14** | 1 | 2 | 0 |
| West | Mull Loch Scridain | 58 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 6 | 1 | 1 | 0 |
| West | Mull Loch Spelve | 57 | 4 | 0 | 0 | 0 | 0 | 1 | 9 | 8 | 7 | **18** | 2 | 3 | 0 |
| West | Mull North | 50 | 3 | 0 | 0 | 0 | 0 | 1 | 6 | 5 | 5 | **13** | 1 | 2 | 0 |
| Western Isles | LewisHarris | 24 | 5 | 0 | 0 | 0 | 0 | 1 | **11** | 10 | 8 | **22** | 2 | 4 | 0 |
| Western Isles | Loch Leurbost | 60 | 6 | 0 | 0 | 0 | 0 | 2 | **14** | **13** | **11** | **28** | 3 | 6 | 0 |
| Western Isles | Loch Roag | 146 | 4 | 0 | 0 | 0 | 0 | 1 | 9 | 8 | 7 | **18** | 2 | 3 | 0 |
| Western Isles | UistBarra | 48 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 7 | 1 | 1 | 0 |

[1]From GLMM with Site as random effect and Month as fixed effect.
[2]Number of samples per site.
[3]For each site the average over 12 months was calculated, and for each month the average over all sites having 10 or more samples is calculated.

Table 9: Estimated[1] probability (presented as a percentage) that field exceeds limit of detection (> 2.5µg/g) for ASP in Pacific oysters, for each site per month. The value 0 represents a small positive number having a value of less than 0.5%. Probabilities of 10% and higher are shown in bold.

| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | n[2] | Avg[3] | 0 | 0 | 0 | 0 | 7 | 1 | **13** | 3 | 8 | 2 | 0 | 0 |
| Clyde | Clyde | 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 |
| Clyde | Loch Fyne | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Loch Striven | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 2 | 0 | 0 | 0 |
| Jura | Colonsay Islay | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Jura | Linnhe | 58 | 1 | 0 | 0 | 0 | 0 | 3 | 1 | 7 | 1 | 4 | 1 | 0 | 0 |
| Jura | Loch Etive | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 1 | 3 | 0 | 0 | 0 |
| Jura | Seil Sound | 46 | 8 | 0 | 0 | 0 | 0 | **18** | 4 | **34** | 9 | **23** | 5 | 0 | 0 |
| Jura | West Loch Tarbert | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| North | Orkney | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 |
| North | Shetland N | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 6 | 1 | 3 | 1 | 0 | 0 |
| NorthWest | Sutherland | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Skye | Skye North | 28 | 3 | 0 | 0 | 0 | 0 | 6 | 1 | **13** | 3 | 8 | 1 | 0 | 0 |
| Skye | Skye Scalpay | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 2 | 0 | 0 | 0 |
| West | Lochaber | 44 | 7 | 0 | 0 | 0 | 0 | **16** | 3 | **31** | 8 | **20** | 4 | 0 | 0 |
| West | Mull Loch Spelve | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 1 | 2 | 0 | 0 | 0 |
| West | Mull North | 40 | 8 | 0 | 0 | 0 | 0 | **20** | 4 | **37** | 10 | **25** | 5 | 0 | 0 |
| Western Isles | UistBarra | 4 | **33** | 0 | 0 | 0 | 0 | **78** | **40** | **89** | **61** | **82** | **45** | 0 | 0 |

[1]From GLMM with Site as random effect and Month as fixed effect.
[2]Number of samples per site.
[3]For each site the average probability over 12 months was calculated, and for each month the average probability over all sites having 10 or more samples was calculated.

Table 10: Estimated probability that toxin levels exceed field closure limit (denoted by p, %) for various species and toxin combinations that did not allow for modelling of site and month effects.

| toxin | species | Total samples | Field closure | p | lower limit[1] | upper limit[1] |
|---|---|---|---|---|---|---|
| DSP | Clams[2] | 43 | 2 | 4.7 | 2 | 14 |
| | cockles | 45 | 0 | 0.0 | 0 | 7 |
| | P.oysters | 351 | 5 | 1.4 | 0 | 3 |
| | Queen scallops | 88 | 16 | 18.2 | 12 | 27 |
| | Scallops[3] | 50 | 1 | 2.0 | 0 | 10 |
| PSP | Clams[2] | 50 | 0 | 0.0 | 0 | 6 |
| | Cockles | 77 | 1 | 1.3 | 0 | 6 |
| | P.oysters | 386 | 0 | 0.0 | 0 | 0.8 |
| | Queen scallops | 79 | 0 | 0.0 | 0 | 4 |
| | Scallops[3] | 92 | 0 | 0.0 | 0 | 4 |
| ASP | Clams[2] | 51 | 0 | 0.0 | 0 | 6 |
| | Cockles | 69 | 0 | 0.0 | 0 | 5 |
| | mussels | 2043 | 3 | 0.1 | 0 | 0.4 |
| | P.oysters | 389 | 0 | 0.0 | 0 | 0.8 |
| | Queen scallops | 81 | 3 | 3.7 | 0 | 10 |

[1]95% confidence interval for p, based on binomial model. For DSP in cockles, for example, the observed probability of positive samples is zero, but the observed data (zero positives out of 45 samples) might have resulted from any p between zero and 7% (but the data would have been unlikely to be observed for p exceeding 7%).
[2]Clams: includes clams, razors, spisula, venerupis and N. Oysters.
[3]Whole scallops.

Table 11: Sampling frequency for each site for 2003. The first column gives the sites as used in the report while the second column gives the site locations as used by FSAS. Based on information received from FSAS.

| Site in report | Site FSA | Fortnightly Apr-Sep Monthly Oct-Mar | Monthly |
|---|---|---|---|
| Arran | Arran | | 1 |
| Clyde | Fairlie | 1 | |
| Colonsay Islay | Colonsay | | 1 |
| Colonsay Islay | Islay | | 1 |
| East | Eyemouth | | 1 |
| East | Pittenweem | | 1 |
| LewisHarris | Loch Seaforth | | 1 |
| LewisHarris | Loch Tamnavay | | 1 |
| LewisHarris | Seilebost | | 1 |
| Linnhe | Loch Creran | 1 | |
| Linnhe | Loch Linnhe | | 1 |
| Loch Eil/Leven | Loch Eil | | 1 |
| Loch Eil/Leven | Loch Leven | 1 | |
| Loch Etive | Loch Etive | | 1 |
| Loch Ewe | Loch Ewe | 1 | |
| Loch Fyne | Loch Fyne Stonefield | 1 | |
| Loch Fyne | Loch Fyne Otter Ferry | | 1 |
| Loch Fyne | Loch Fyne Ardkinglass | 1 | |
| Loch Leurbost | Loch Leurbost | 1 | |
| Loch Roag | Loch Drovinish | | 1 |
| Loch Roag | Loch Roag | 1 | |
| Loch Ryan | Loch Ryan | | 1 |
| Loch Striven | Loch Striven | 1 | |
| Loch Torridon | Loch Torridon | 1 | |
| Lochaber | Ardtoe | 1 | |
| Lochaber | Glenuig Bay | | 1 |
| Lochaber | Loch Ailort | | 1 |
| Lochaber | Loch Hourn | 1 | |
| Lochaber | Loch Moidart | | 1 |
| Lochaber | Loch Teacuis | | 1 |
| Mull Loch Scridain | Loch Scridain | 1 | |
| Mull Loch Spelve | Loch Spelve | 1 | |
| Mull North | Loch a Chumhainn | | 1 |
| Mull North | Loch na Keal | 1 | |
| Mull North | Tobermory | | 1 |
| Orkney | Kirkwall | | 1 |
| Orkney | Scapa Bay | | 1 |
| Seil Sound | Seil Point | | 1 |
| Seil Sound | Seil Sound | | 1 |
| Shetland E | Dales Voe | | 1 |
| Shetland E | Wadbister Voe | 1 | |
| Shetland N | Baltasound | 1 | |
| Shetland N | Basta Voe | 1 | |
| Shetland N | Mid Yell Voe | 1 | |
| Shetland N | North Uyea | | 1 |
| Shetland SW | Cliftsound | | 1 |
| Shetland SW | Gruting/Seli Voe | 1 | |
| Shetland SW | Vaila Sound | 1 | |
| Shetland W | East Burra Firth | | 1 |
| Shetland W | Olna Firth | 1 | |

Table 11 continued.

| Site in report | Site FSA | Fortnightly Apr-Sep Monthly Oct-Mar | Monthly |
|---|---|---|---|
| Shetland W | Ura Firth | | 1 |
| Shetland W | Vementry Voe | 1 | |
| Skye Loch Eishort | Loch Eishort | 1 | |
| Skye North | Isay | 1 | |
| Skye North | Loch Greshornish | 1 | |
| Skye North | Loch Harport | 1 | |
| Skye Scalpay | Broadford Bay | 1 | |
| Skye Scalpay | Kyle | 1 | |
| Skye Scalpay | Loch Ainort | 1 | |
| Skye Scalpay | Loch Kishorn | 1 | |
| Skye Scalpay | Loch Sligachan | 1 | |
| Skye Scalpay | Scalpay | 1 | |
| Solway | Kirkcudbright Dhoon Bay | | 1 |
| Solway | Kirkcudbright Auchencairn | | 1 |
| Sound of Jura | Loch Crinan | | 1 |
| Sutherland | Kyle of Tongue | | 1 |
| Sutherland | Kylesku | | 1 |
| Sutherland | Loch Eriboll | | 1 |
| Sutherland | Loch Inchard | 1 | |
| Sutherland | Loch Laxford | 1 | |
| Tain | Tain | 1 | |
| UistBarra | Loch Carnan | | 1 |
| UistBarra | Loch Eynort | | 1 |
| West Loch Tarbert | West Loch Tarbert | 1 | |

Table 12: Current sampling scheme (1= once per month, 2 = fortnightly) and the associated risk of non-detection (%), i.e. probability that a site is unknowingly toxic, for DSP in mussels. Fortnightly sampling frequency shown in bold. Risk of non-detection of 10% or more shown in bold.

| | | | Current sampling scheme | | | | | | | | | | | | | Risk of non-detection | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | #beds[1] | J | F | M | A | M | J | J | A | S | O | N | D | #[2] | J | F | M | A | M | J | J | A | S | O | N | D |
| Clyde | Arran | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 3 | **11** | **17** | **40** | **41** | **46** | **40** | **40** | **29** | **18** |
| Clyde | Clyde | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 1 | 2 | 3 | 9 | 10 | **12** | 9 | **14** | 8 | 4 |
| Clyde | Loch Fyne | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 1 | 3 | 4 | **13** | **14** | **17** | **14** | **20** | **13** | 7 |
| Clyde | Loch Striven | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 1 | 3 | 5 | **15** | **16** | **19** | **16** | **23** | **15** | 8 |
| East | East | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 1 | 2 | 4 | **13** | **14** | **17** | **13** | **13** | 8 | 4 |
| Jura | Linnhe | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 3 | 1 | 1 |
| Jura | Loch Eil/Leven | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 1 |
| Jura | Loch Etive | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Jura | Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 1 | 2 | 7 | 8 | 9 | 7 | 7 | 4 | 2 |
| Jura | West Loch Tarbert | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 2 | 7 | 7 | 9 | 7 | **10** | 6 | 3 |
| North | Orkney | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 1 | 4 | 6 | **18** | **19** | **23** | **18** | **18** | **11** | 6 |
| North | Shetland E | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 1 | 2 | 6 | 6 | 8 | 6 | 9 | 5 | 3 |
| North | Shetland N | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 7 | 5 | 8 | 4 | 2 |
| North | Shetland SW | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 1 | 1 | 4 | 4 | 5 | 4 | 6 | 4 | 2 |
| North | Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 0 | 0 | 1 | 1 | 2 | 8 | 9 | **10** | 8 | **12** | 7 | 4 |
| NorthWest | Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 2 | 4 | 6 | **17** | **18** | **21** | **18** | **26** | **17** | 10 |
| NorthWest | Loch Torridon | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 1 | 1 | 2 | 8 | 9 | **11** | 8 | **12** | 7 | 4 |
| NorthWest | Sutherland | 5 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 90 | 0 | 0 | 2 | 4 | 6 | **17** | **18** | **21** | **18** | **26** | **17** | 10 |
| Skye | Skye Loch Eishort | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 2 | 7 | 7 | 9 | 7 | **11** | 6 | 3 |
| Skye | Skye North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 2 | 4 | 6 | **17** | **18** | **20** | **17** | **25** | **17** | 10 |
| Skye | Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 0 | 0 | 1 | 2 | 4 | **12** | **13** | **15** | **12** | **18** | **11** | 6 |
| South West | Loch Ryan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 6 | 5 | 5 | 3 | 1 |
| South West | Solway | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 1 | 1 | 4 | 4 | 5 | 4 | 4 | 2 | 1 |
| Tain | Tain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 7 | 5 | 8 | 5 | 2 |
| West | Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 0 | 0 | 1 | 3 | 4 | **13** | **14** | **16** | **13** | **20** | **12** | 7 |
| West | Mull Loch Scridain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 2 | 7 | 7 | 9 | 7 | **10** | 6 | 3 |
| West | Mull Loch Spelve | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 1 | 3 | 4 | 5 | 3 | 5 | 3 | 2 |
| West | Mull North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 1 | 1 | 4 | 4 | 5 | 4 | 6 | 3 | 2 |
| Western Isles | LewisHarris | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 0 | 0 | 1 | 2 | 3 | **11** | **12** | **15** | **11** | **11** | 7 | 4 |
| Western Isles | Loch Leurbost | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 6 | 5 | 7 | 4 | 2 |
| Western Isles | Loch Roag | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 4 | 3 | 5 | 3 | 1 |
| Western Isles | UistBarra | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 1 | 2 | 7 | 8 | 9 | 7 | 7 | 4 | 2 |
| Summary[3] | | | | | | | | | | | | | Total samples | 1170 | | | | | | | Avg risk 6%; max risk 46% | | | | | | |

[1]Number of location beds per site.

[2]Annual number of samples based on sampling frequency and number of beds.

[3]Average risk of non-detection and maximum risk of non-detection: calculated over all sites (with each site receiving equal weight) and all months.

Table 13: Current sampling scheme (1= once per month, 2 = fortnightly) and the associated risk of non-detection (%), i.e. probability that toxin levels at a site unknowingly exceed field closure limit, for PSP in mussels. Fortnightly sampling frequency shown in bold. Risk of non-detection of 10% or more shown in bold.

| | | | Current sampling scheme | | | | | | | | | | | | | Risk of non-detection | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | #beds[1] | J | F | M | A | M | J | J | A | S | O | N | D | #[2] | J | F | M | A | M | J | J | A | S | O | N | D |
| Clyde | Arran | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Clyde | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Loch Fyne | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clyde | Loch Striven | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 8 | **11** | 3 | 1 | 0 | 0 | 0 | 0 |
| East | East | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 0 | 4 | 6 | 1 | 1 | 0 | 0 | 0 | 0 |
| Jura | Linnhe | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Loch Eil/Leven | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Loch Etive | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jura | Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| North | Orkney | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 2 | **19** | **26** | 7 | 3 | 0 | 0 | 0 | 0 |
| North | Shetland E | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| North | Shetland N | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 0 | 0 | 0 | 1 | 6 | 9 | 2 | 1 | 0 | 0 | 0 | 0 |
| North | Shetland SW | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| North | Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 0 | 0 | 0 | 1 | 6 | 9 | 2 | 1 | 0 | 0 | 0 | 0 |
| NorthWest | Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| NorthWest | Loch Torridon | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 1 | 8 | **12** | 3 | 1 | 0 | 0 | 0 | 0 |
| NorthWest | Sutherland | 5 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 90 | 0 | 0 | 0 | 0 | 3 | 5 | 1 | 0 | 0 | 0 | 0 | 0 |
| Skye | Skye Loch Eishort | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 4 | 6 | 1 | 1 | 0 | 0 | 0 | 0 |
| Skye | Skye North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 0 | 5 | 7 | 1 | 1 | 0 | 0 | 0 | 0 |
| Skye | Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| South West | Loch Ryan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| South West | Solway | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tain | Tain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 0 | 0 | 0 | 0 | 6 | 9 | 2 | 1 | 0 | 0 | 0 | 0 |
| West | Mull Loch Scridain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Mull Loch Spelve | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| West | Mull North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | LewisHarris | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | Loch Leurbost | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | Loch Roag | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| Western Isles | UistBarra | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Summary[3] | | | | | | | | | | | | Total samples | | | 1152 | | | | | Avg risk 1%; max risk 26% | | | | | | | |

[1]Number of location beds per site.
[2]Annual number of samples based on sampling frequency and number of beds.
[3]Average risk of non-detection and maximum risk of non-detection: calculated over all sites (with each site receiving equal weight) and all months.

Table 14: Current sampling scheme (1= once per month, 2 = fortnightly) and the associated risk of non-detection (%), i.e. probability that toxin levels at a site unknowingly exceed field closure limit, for ASP in scallop gonads. Fortnightly sampling frequency shown in bold. Risk of non-detection of 10% or more shown in bold.

| | | | Current sampling scheme | | | | | | | | | | | | | Risk of non-detection | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | #beds[1] | J | F | M | A | M | J | J | A | S | O | N | D | #[2] | J | F | M | A | M | J | J | A | S | O | N | D |
| Jura | Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | **10** | **14** | 0 | 0 | **15** | **13** | **24** | **57** | **42** | **50** | **44** | **20** |
| North | Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 10 | **14** | 0 | 0 | 10 | 8 | **16** | **38** | **28** | **50** | **43** | **19** |
| NorthWest | Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | **11** | **16** | 0 | 0 | **11** | 9 | **18** | **39** | **30** | **53** | **46** | **22** |
| Skye | Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 9 | **13** | 0 | 0 | 9 | 8 | **15** | **37** | **27** | **48** | **42** | **18** |
| West | Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 10 | **14** | 0 | 0 | 10 | 8 | **16** | **38** | **28** | **50** | **43** | **19** |
| Summary[3] | | | | | | | | | | | | | Total samples | | 318 | | | | Avg risk 21%; max risk 57% | | | | | | | | |

[1]Number of location beds per site.
[2]Annual number of samples based on sampling frequency and number of beds.
[3]Average risk of non-detection and maximum risk of non-detection: calculated over all sites (with each site receiving equal weight) and all months.

Table 15: Risk of non-detection (%), for weekly, fortnightly or monthly sampling frequencies, shown for various values of p (which is the chance (%) of the toxin level exceeding field closure).

| p | Weekly[1] | fortnightly | monthly |
|---|---|---|---|
| 5 | 0 | 2.5 | 3.8 |
| 10 | 0 | 5.0 | 7.5 |
| 15 | 0 | 7.5 | 11.3 |
| 20 | 0 | 10.0 | 15.0 |
| 25 | 0 | 12.5 | 18.8 |
| 30 | 0 | 15.0 | 22.5 |
| 35 | 0 | 17.5 | 26.3 |
| 40 | 0 | 20.0 | 30.0 |
| 45 | 0 | 22.5 | 33.8 |
| 50 | 0 | 25.0 | 37.5 |
| 55 | 0 | 27.5 | 41.3 |
| 60 | 0 | 30.0 | 45.0 |
| 65 | 0 | 32.5 | 48.8 |
| 70 | 0 | 35.0 | 52.5 |
| 75 | 0 | 37.5 | 56.3 |
| 80 | 0 | 40.0 | 60.0 |

[1]It is assumed that a negative test result is valid for one week, hence zero risk of non-detection for weekly sampling.

Table 16: Sampling frequencies (1 = once per month; 2 = every fortnight; 4 = every week) for current sampling scheme, alternative scheme A (risk of non-detection of 10% or less) and alternative scheme B (risk of non-detection of 5% or less), for DSP in mussels. Also shown is the total number of samples required for each site (column '#') and the number of bed locations per site. Sampling frequencies exceeding once per month are shown in bold.

| | | Current sampling scheme | | | | | | | | | | | | | Alternative scheme A: risk of non-detection ≤ 10% | | | | | | | | | | | | | Alternative scheme B: risk of non-detection ≤ 5% | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | #beds | J | F | M | A | M | J | J | A | S | O | N | D | # | J | F | M | A | M | J | J | A | S | O | N | D | # | J | F | M | A | M | J | J | A | S | O | N | D | # |
| Arran | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 37 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 39 |
| Clyde | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 19 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 30 |
| Loch Fyne | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 84 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **2** | 96 |
| Loch Striven | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 30 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 36 |
| East | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 38 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 60 |
| Linnhe | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Loch Eil/Leven | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Loch Etive | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **2** | **2** | 1 | 1 | 21 |
| West Loch Tarbert | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 17 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 28 |
| Orkney | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 56 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **2** | 64 |
| Shetland E | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 26 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 56 |
| Shetland N | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 48 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | 1 | 1 | 108 |
| Shetland SW | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 57 |
| Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 76 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 112 |
| Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 30 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 37 |
| Loch Torridon | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 19 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 28 |
| Sutherland | 5 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 90 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 150 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 185 |
| Skye Loch Eishort | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 17 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 28 |
| Skye North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | 1 | 90 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 111 |
| Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 168 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **2** | 192 |
| Loch Ryan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 13 |
| Solway | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 26 |
| Tain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 13 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | 1 | 1 | 27 |
| Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 168 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **4** | **4** | **4** | **4** | **2** | 192 |
| Mull Loch Scridain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | 1 | 1 | 16 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 28 |
| Mull Loch Spelve | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 17 |
| Mull North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 57 |
| LewisHarris | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 51 | 1 | 1 | 1 | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **2** | 1 | 84 |
| Loch Leurbost | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | **4** | **2** | **2** | 1 | 1 | 19 |
| Loch Roag | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | **2** | 1 | 1 | 1 | 1 | 28 |
| UistBarra | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | **2** | **4** | **4** | **2** | **2** | 1 | 1 | 42 |
| Summary[1] | | Max risk 46%; avg risk 6%; total samples 1170 | | | | | | | | | | | | | Max risk 10%; avg risk 3%; total samples 1405 | | | | | | | | | | | | | Max risk 5%; avg risk 1%; total samples 1881 | | | | | | | | | | | | |

[1]Maximum and average risk of non-detection obtained from applying each of the three sampling schemes to the data. Total samples refers to the annual number of samples required.

Table 17: Sampling frequencies (1 = once per month; 2 = every fortnight; 4 = every week) for current sampling scheme, alternative scheme A (risk of non-detection 10% or less) and alternative scheme B (risk of non-detection 5% or less), for PSP in mussels. Also shown is the total number of samples required for each site (column '#') and the number of bed locations per site. Sampling frequencies exceeding once per month are shown in bold.

| | | Current sampling scheme | | | | | | | | | | | | | Alternative scheme A: risk of non-detection ≤ 10% | | | | | | | | | | | | | Alternative scheme B: risk of non-detection ≤ 5% | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | #beds | J | F | M | A | M | J | J | A | S | O | N | D | # | J | F | M | A | M | J | J | A | S | O | N | D | # | J | F | M | A | M | J | J | A | S | O | N | D | # |
| Arran | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Clyde | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Loch Fyne | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 |
| Loch Striven | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | **2** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 16 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 18 |
| East | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 26 |
| Linnhe | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Loch Eil/Leven | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Loch Etive | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Orkney | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | **4** | **4** | **2** | 1 | 1 | 1 | 1 | 1 | 38 |
| Shetland E | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Shetland N | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 52 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 72 |
| Shetland SW | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 |
| Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 52 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 72 |
| Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Loch Torridon | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | **2** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 16 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 18 |
| Sutherland | 5 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 90 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 60 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 65 |
| Skye Loch Eishort | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | **2** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| Skye North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 39 | 1 | 1 | 1 | 1 | **2** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 48 |
| Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 72 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 72 |
| Loch Ryan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Solway | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Tain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 | 78 | 1 | 1 | 1 | 1 | **4** | **4** | 1 | 1 | 1 | 1 | 1 | 1 | 108 |
| Mull Loch Scridain | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Mull Loch Spelve | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Mull North | 3 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 54 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 |
| LewisHarris | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 36 |
| Loch Leurbost | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Loch Roag | 2 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 36 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| UistBarra | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 24 |
| Summary[1] | | Max risk 26%; avg risk 1%; total samples 1152 | | | | | | | | | | | | | Max risk10%; avg risk 1%; total samples 865 | | | | | | | | | | | | | Max risk 5%; avg risk 0%; total samples 961 | | | | | | | | | | | | |

[1]Maximum and average risk of non-detection obtained from applying each of the three sampling schemes to the data. Total samples refers to the annual number of samples required.

Table 18: Sampling frequencies (1 = once per month; 2 = every fortnight; 4 = every week) for current sampling scheme, alternative scheme A (risk of non-detection of 10% or less) and alternative scheme B (risk of non-detection of 5% or less), for ASP in scallop gonads. Also shown is the total number of samples required for each site (column '#') and the number of bed locations per site. Sampling frequencies exceeding once per month are shown in bold.

| Site | #beds | Current sampling scheme: J | F | M | A | M | J | J | A | S | O | N | D | # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sound of Jura | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Shetland W | 4 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 72 |
| Loch Ewe | 1 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 18 |
| Skye Scalpay | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 |
| Lochaber | 6 | 1 | 1 | 1 | **2** | **2** | **2** | **2** | **2** | **2** | 1 | 1 | 1 | 108 |
| Summary[1] | | Max risk 57%; avg risk 21%; total samples 318 | | | | | | | | | | | | |

| Site | Alternative scheme A: risk of non-detection ≤ 10%: J | F | M | A | M | J | J | A | S | O | N | D | # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sound of Jura | **2** | **2** | 1 | 1 | **2** | **2** | **4** | **4** | **4** | **4** | **4** | **4** | 34 |
| Shetland W | 1 | **2** | 1 | 1 | **2** | **2** | **4** | **4** | **4** | **4** | **4** | **4** | 132 |
| Loch Ewe | **2** | **4** | 1 | 1 | **4** | **2** | **4** | **4** | **4** | **4** | **4** | **4** | 38 |
| Skye Scalpay | 1 | **2** | 1 | 1 | **2** | **2** | **4** | **4** | **4** | **4** | **4** | **4** | 198 |
| Lochaber | 1 | **2** | 1 | 1 | **2** | **2** | **4** | **4** | **4** | **4** | **4** | **4** | 198 |
| Summary[1] | Max risk 10%; avg risk 3%; total samples 600 | | | | | | | | | | | | |

| Site | Alternative scheme B: risk of non-detection ≤ 5%: J | F | M | A | M | J | J | A | S | O | N | D | # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sound of Jura | **4** | **4** | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 42 |
| Shetland W | **4** | **4** | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 168 |
| Loch Ewe | **4** | **4** | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 42 |
| Skye Scalpay | **4** | **4** | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 252 |
| Lochaber | **4** | **4** | 1 | 1 | **4** | **4** | **4** | **4** | **4** | **4** | **4** | **4** | 252 |
| Summary[1] | Max risk 0%; avg risk 0%; total samples 756 | | | | | | | | | | | | |

[1]Maximum and average risk of non-detection obtained from applying each of the three sampling schemes to the data. Total samples refers to the annual number of samples required.

Table 19: Risk of non-detection (%), i.e. probability that toxin levels unknowingly exceed field closure limit, for monthly and fortnightly sampling, based on the chance of toxin levels exceeding field closure (denoted by p, %) for various species and toxin combinations that did not allow for modelling of site and month effects. Risk exceeding 5% shown in bold.

| | | | | | | Risk of non-detection based on p | | Risk of non-detection based on upper limit for p | |
|---|---|---|---|---|---|---|---|---|---|
| toxin | species | Total samples | Field closure | p | upper limit[1] | monthly | fortnightly | monthly | fortnightly |
| DSP | Clams[2] | 43 | 2 | 4.7 | 14 | 3.5 | 2.3 | **10.5** | **7.0** |
| | cockles | 45 | 0 | 0.0 | 7 | 0.0 | 0.0 | **5.3** | 3.5 |
| | P.oysters | 351 | 5 | 1.4 | 3 | 1.1 | 0.7 | 2.3 | 1.5 |
| | Queen scallops | 88 | 16 | 18.2 | 27 | **13.6** | **9.1** | **20.3** | **13.5** |
| | Scallops[3] | 50 | 1 | 2.0 | 10 | 1.5 | 1.0 | **7.5** | **5.0** |
| PSP | Clams[2] | 50 | 0 | 0.0 | 6 | 0.0 | 0.0 | 4.5 | 3.0 |
| | cockles | 77 | 1 | 1.3 | 6 | 1.0 | 0.6 | 4.5 | 3.0 |
| | P.oysters | 386 | 0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.6 | 0.4 |
| | Queen scallops | 79 | 0 | 0.0 | 4 | 0.0 | 0.0 | 3.0 | 2.0 |
| | Scallops[3] | 92 | 0 | 0.0 | 4 | 0.0 | 0.0 | 3.0 | 2.0 |
| ASP | Clams[2] | 51 | 0 | 0.0 | 6 | 0.0 | 0.0 | 4.5 | 3.0 |
| | cockles | 69 | 0 | 0.0 | 5 | 0.0 | 0.0 | 3.8 | 2.5 |
| | mussels | 2043 | 3 | 0.1 | 0.4 | 0.1 | 0.1 | 0.3 | 0.2 |
| | P.oysters | 389 | 0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.6 | 0.4 |
| | Queen scallops | 81 | 3 | 3.7 | 10 | 2.8 | 1.9 | **7.5** | **5.0** |

[1]Upper limit of 95% confidence interval for p, based on binomial model.
[2]Clams: includes clams, razors, spisula, venerupis and N. Oysters.
[3]Whole scallops.

Table 20: PSP (μg/100g) in mussels for three bed locations, illustrating how PSP levels can change rapidly within a weeks' time. 'Site location' and 'bed location' are as recorded in the original data files.

| Site location | Bed Location | Date collected | PSP | #days previous sample |
|---|---|---|---|---|
| Loch Striven | Troustan | 21-Apr-2003 | ND[1] | |
| Loch Striven | Troustan | 29-Apr-2003 | 112 | 8 |
| Loch Striven | Troustan | 5-May-2003 | 124 | 6 |
| Loch Striven | Troustan | 13-May-2003 | 107 | 8 |
| Loch Striven | Troustan | 20-May-2003 | ND | 7 |
| Loch Torridon | Ob Gorm Beag | 21-May-2001 | ND | |
| Loch Torridon | Ob Gorm Beag | 4-Jun-2001 | 220 | 14 |
| Loch Torridon | Ob Gorm Beag | 10-Jun-2001 | 123 | 6 |
| Loch Torridon | Ob Gorm Beag | 23-Jun-2001 | 71 | 13 |
| Loch Torridon | Ob Gorm Beag | 3-Jul-2001 | 29 | 10 |
| Loch Torridon | Ob Gorm Mhor | 21-May-2001 | 80 | |
| Loch Torridon | Ob Gorm Mhor | 28-May-2001 | 69 | 7 |
| Loch Torridon | Ob Gorm Mhor | 4-Jun-2001 | 164 | 7 |
| Loch Torridon | Ob Gorm Mhor | 10-Jun-2001 | ND | 6 |

[1]ND; not detected

# FIGURES

Figure 1: Map of the locations mentioned in the original data files and after grouping of sites is applied. The (0,0) coordinates represent OS coordinate NV 000 000. See also Table 1 for further information on grouping of sites. Arran (a), Clyde (b), Colonsay Islay (c), East (d), LewisHarris (e), Linnhe (f), Loch Eil/Leven (g), Loch Etive (h), Loch Ewe (i), Loch Fyne (j), Loch Leurbost (k), Loch Roag (l), Loch Ryan (m), Loch Striven (n), Loch Torridon (o), Lochaber (p), Mull Loch Scridain (q), Mull Loch Spelve (r), Mull North (s), Orkney (t), Seil Sound (u), Shetland E (v), Shetland N (w), Shetland SW (x), Shetland W (y), Skye Loch Eishort (z), Skye North (1), Skye Scalpay (2), Solway (3), Sound of Jura (4), Sutherland (5), Tain (6), UistBarra (7), West Loch Tarbert (8).

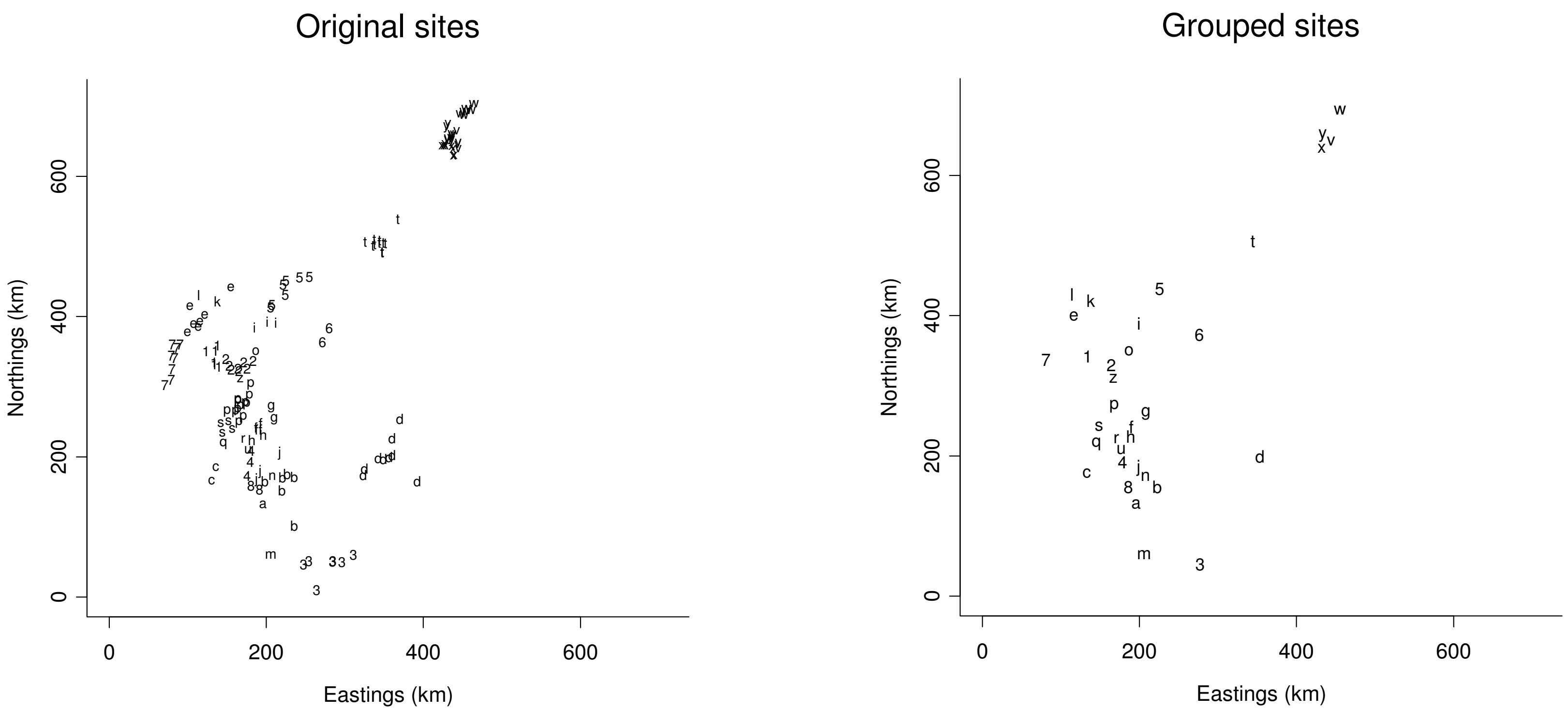
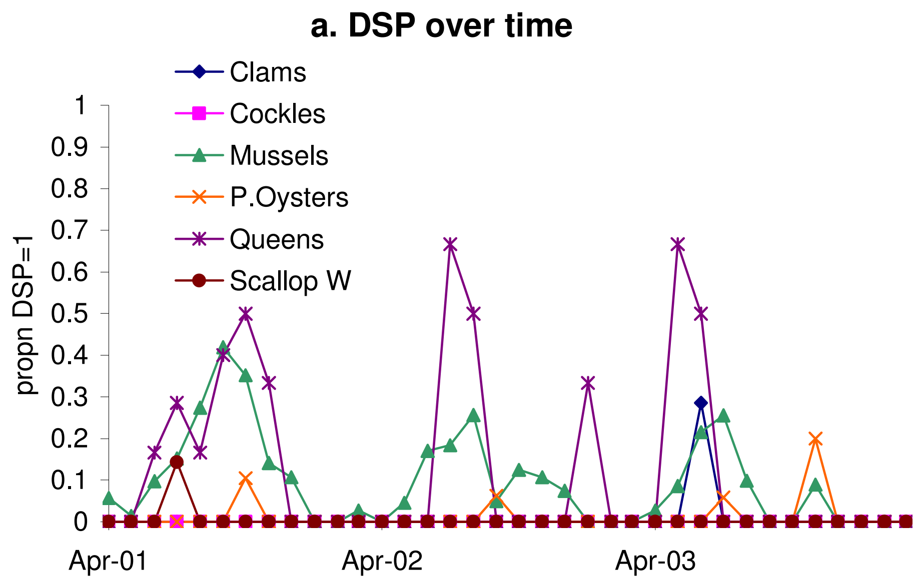
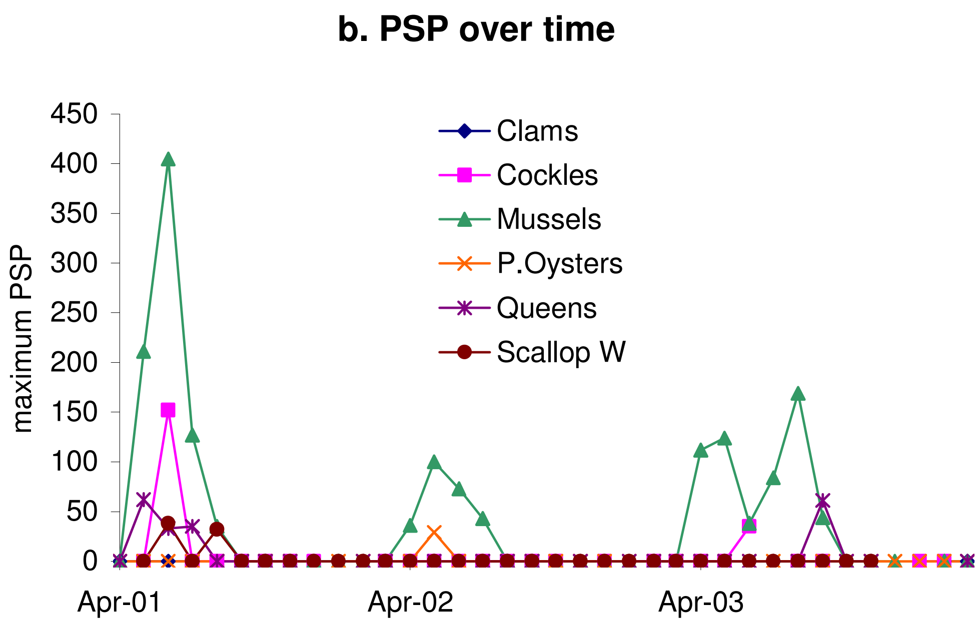


Figure 2: Toxin patterns over time for each species. For DSP, the proportion of positive samples for each month is plotted (Fig 1a), for PSP and ASP the maximum observed toxicity is plotted for each month (Figs 1b and c).



## c. ASP over time

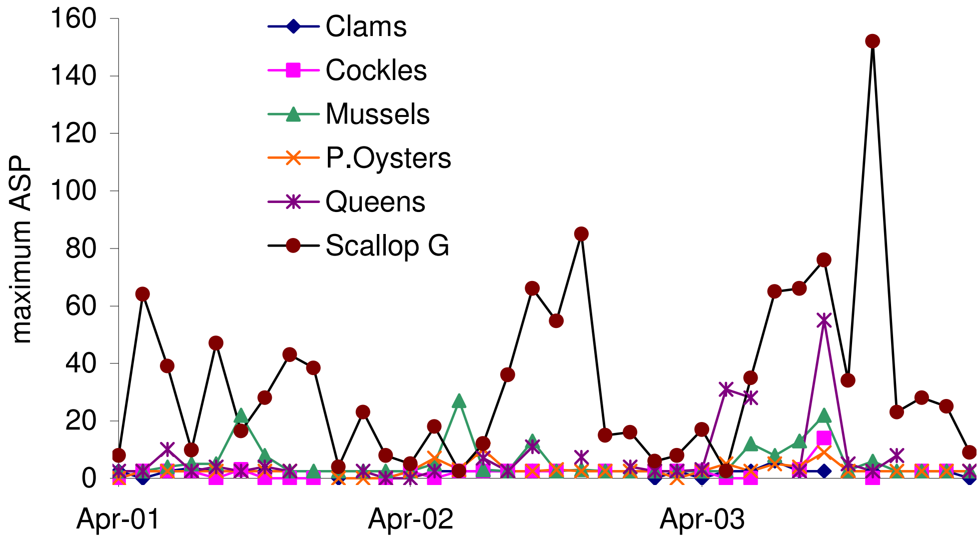
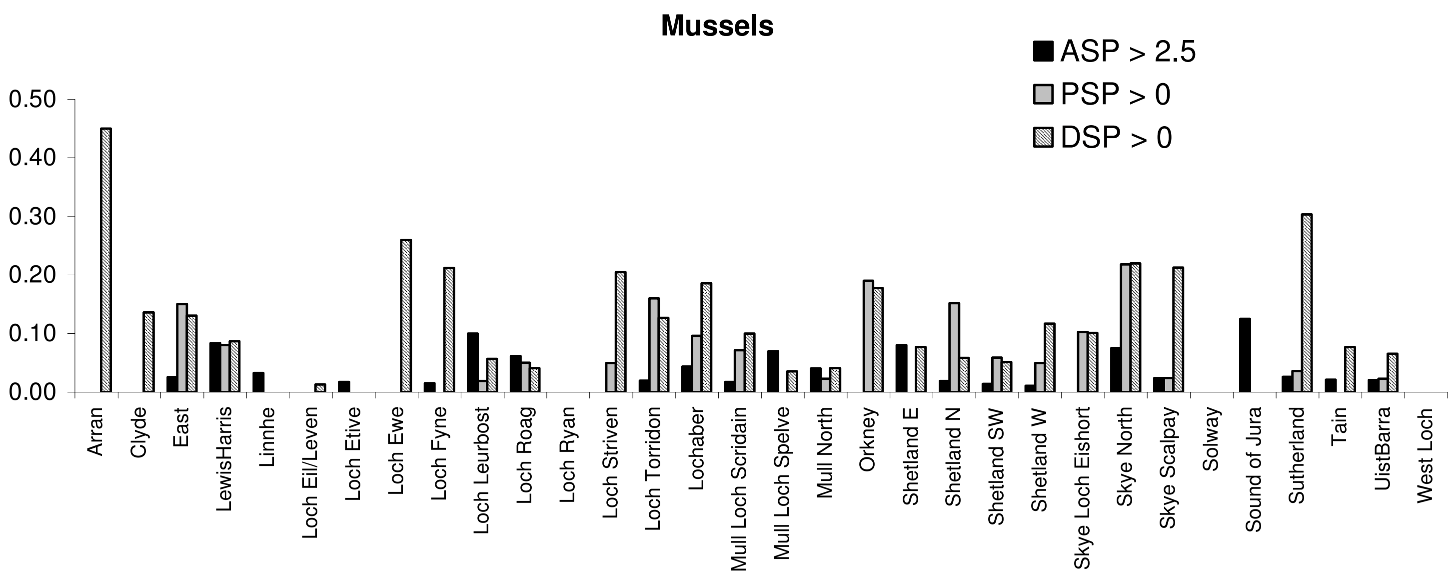


Figure 3: Proportion of mussel samples that are positive for ASP, PSP and DSP, for each site.



# APPENDIX

Tables are presented with the maximum observed toxin level per month for each site and each year for each species, for DSP (Table A1), PSP (Table A2) and ASP (Table A3). Note that ‘clams’ is the aggregate of clams, razors, spisula, venerupis and N. Oysters. Tables A4-A8 contain the data used for fitting GLMM models.

Table A1: Maximum value for DSP (0 or 1 for open or closed, respectively) per month per year. The column ‘grand total’ gives the maximum DSP level per site.

Clams maximum DSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | | | | | | | 0 | | 0 |
| Loch Fyne | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| East | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 1 | | 0 | 0 | 0 | | | 0 | 0 | | 1 |
| Colonsay Islay | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| West Loch Tarbert | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | 0 |
| Skye Scalpay | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | 0 |
| Loch Ryan | | | | | | | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | | | | 0 | 0 |
| Lochaber | | | | 0 | | | | | | | | | 0 | 0 | 0 | | | | | | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | | | | | | 0 |
| LewisHarris | | | | | | | | | | | | | | | | | | | | | | | | 0 | | 0 | 0 | | 0 | | | | | | | | 0 |
| UistBarra | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | 0 |

Cockles maximum DSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| East | | | | | | | | | | | | 0 | | | | | | | | | | | 0 | 0 | | | 0 | 0 | | | | | | | | | 0 |
| Orkney | | | 0 | 0 | 0 | 0 | | 0 | | | | | 0 | | | | | | | | | | | | | 0 | | | | | 0 | | | | | | 0 |
| Skye Scalpay | | 0 | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | 0 |
| Solway | | | | | | | 0 | | | | | 0 | | | | | | | | | | | | 0 | | | 0 | 0 | | | | | | | | | 0 |
| Tain | | | | | | | | | | | | | | | | | | | | | 0 | | 0 | | 0 | | | | | 0 | | | | | | | 0 |
| LewisHarris | | | | | | | | | | | | 0 | | 0 | 0 | | | | | | | | | | | 0 | | | | | | | | | | | 0 |
| UistBarra | | | | | | | | | | | | 0 | | | | | | | | | | | 0 | 0 | | | 0 | | 0 | | | | | | 0 | | 0 |

Mussels maximum DSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 0 | 0 | | 0 | 1 | 1 | | | 0 | 1 | | | | 0 | 1 |
| Clyde | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 |
| Loch Fyne | | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | | | 0 | 0 | 0 | 0 | 1 |
| Loch Striven | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | | 1 | | | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| East | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | | | | | | 0 | 0 | | 0 | | 1 | 0 | 1 | | 0 | | | | | 0 | 1 |
| Linnhe | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| Loch Eil/Leven | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Loch Etive | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sound of Jura | | | | | | 0 | | | | | | | | | | | | | | | | 0 | 0 | 0 | | 0 | | 0 | 0 | | | | | | 0 | 0 | 0 |
| West Loch Tarbert | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Orkney | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Shetland E | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | | 0 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 1 |
| Shetland N | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Shetland SW | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Shetland W | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | | 0 | | 0 | 1 |
| Loch Ewe | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | | 0 | | | | | | | | | | 0 | | | | | 1 |
| Loch Torridon | | 0 | 1 | 0 | | 1 | | 0 | | | 0 | | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 1 |
| Sutherland | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | | | 0 | | 0 | | 0 | 1 | 0 | 0 | 0 | 0 | | | | | 1 |
| Skye Loch Eishort | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | | 0 | | 0 | 1 |
| Skye North | 0 | 0 | 0 | 1 | 1 | | 1 | 1 | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 1 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | | 0 | | | 0 | | | | | | 1 |
| Skye Scalpay | | 0 | 0 | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | 0 | | | | | 0 | 1 |
| Loch Ryan | | 0 | | 0 | 0 | 0 | | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 | 0 | | 0 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| Solway | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tain | 0 | 0 | 0 | | 0 | 1 | 1 | 0 | | | 0 | | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | 1 |
| Lochaber | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Mull Loch Scridain | 0 | 0 | 0 | 1 | 0 | 1 | 0 | | | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 1 |
| Mull Loch Spelve | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | | | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mull North | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | | 1 |
| LewisHarris | | | | 0 | | 0 | | | | | | 0 | 0 | 0 | 0 | | 0 | 1 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | | 0 | | 0 | 0 | 0 | | 1 |
| Loch Leurbost | | | 0 | 0 | | 0 | | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | | 0 | 0 | 0 | 1 |
| Loch Roag | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 |
| UistBarra | 0 | | | 0 | 0 | 0 | | 0 | | | | 0 | | | 0 | | 1 | 0 | 0 | | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | | 1 |

P.Oysters maximum DSP

|  | 2001 |  |  |  |  |  |  |  |  | 2002 |  |  |  |  |  |  |  |  |  |  |  | 2003 |  |  |  |  |  |  |  |  |  |  |  | 2004 |  |  | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |  |
| Clyde | 0 |  |  |  |  | 0 | 1 |  |  | 0 |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |
| Loch Fyne | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 |  | 0 |  | 0 |  | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 1 | 0 | 0 |  |  | 0 |  |  | 0 | 1 |
| Loch Striven |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Colonsay Islay |  | 0 | 0 |  |  |  | 0 | 0 | 0 |  |  |  |  | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 |  | 0 |  | 0 | 1 |
| Linnhe |  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 |  |  |  |  |  | 0 | 1 |
| Loch Etive |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  | 0 |
| Seil Sound |  |  | 0 |  | 0 | 0 |  |  | 0 |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| West Loch Tarbert |  | 0 |  | 0 | 0 | 0 | 0 |  |  |  | 0 |  | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  | 0 |
| Orkney |  |  | 0 |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Shetland N |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Sutherland |  |  | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 |  | 0 |
| Skye North |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 |  | 0 |
| Lochaber |  | 0 |  |  |  | 0 |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  | 0 | 0 |  | 0 |
| Mull North |  |  |  |  |  |  |  | 0 |  |  |  |  |  | 0 | 0 |  | 0 |  | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  | 0 |
| UistBarra |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |

## Queens maximum DSP

|  | 2001 |  |  |  |  |  |  |  |  | 2002 |  |  |  |  |  |  |  |  |  |  |  | 2003 |  |  |  |  |  |  |  |  |  |  |  | 2004 |  |  | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |  |
| Loch Fyne | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |  |  |  | 0 | 0 | 0 |  | 1 | 1 |  |  |  |  | 1 | 0 | 0 | 0 | 1 | 1 |  | 0 | 0 |  | 0 |  |  |  | 0 | 1 |
| Shetland N | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 |
| Shetland W | 0 |  |  | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |  | 0 | 0 | 0 |  |  |  |  |  | 1 |
| Skye Scalpay | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |  |  |  |  | 0 |  | 1 | 0 | 0 |  | 0 |  | 0 |  | 0 | 0 |  |  |  | 0 | 0 |  |  | 0 |  |  |  | 1 |

Scallop whole, maximum DSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Sound of Jura | | | 0 | 0 | 0 | | | | | | | | | | | | | 0 | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | | | 0 |
| Shetland W | | | | | | | | | | | | | | | | | | 0 | | | | | | | 0 | | | | | | 0 | | | | | | 0 |
| Loch Ewe | | 0 | 0 | 0 | 0 | | | | | | | | | | | | 0 | 0 | | | | | | 0 | | | | | | | | | | 0 | | | 0 |
| Skye Scalpay | | | 0 | 1 | 0 | | | | | | | | | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | | | | | | | | | | | | 1 |
| Lochaber | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |

Table A2: Maximum value for PSP (µg/100g) per month per year. The column 'grand total' gives the maximum PSP level per site.

## Clams maximum PSP

| Site | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | | | | | | | 0 | | 0 |
| Loch Fyne | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| East | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | 0 | 0 | | | | | 0 | | 0 |
| Colonsay Islay | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| West Loch Tarbert | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | 0 |
| Skye Scalpay | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | 0 |
| Loch Ryan | | | | | | | 0 | | | 0 | | 0 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 |
| Lochaber | 0 | 0 | | 0 | | | | | | | | | | 0 | 0 | | 0 | 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 |
| LewisHarris | | | | | | | | | | | | | | | | | | | | | | | | 0 | | 0 | 0 | | 0 | | | | | | | | 0 |
| UistBarra | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | 0 |

## Cockles maximum PSP

| Site | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| East | | | | | | | | | | | | 0 | | | | | | | | | | | 0 | 0 | | | 0 | | | | | | | | | | 0 |
| Orkney | | | 152 | 0 | 0 | | | 0 | | | | | 0 | | | | | | 0 | | | | | | | 0 | | | | | | | | | | | 152 |
| Skye North | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | 0 |
| Skye Scalpay | | 0 | | | | 0 | | | | | | | | | 0 | 0 | | | | | | | 0 | 0 | 0 | | | | 0 | | | | | | | | 0 |
| Solway | | 0 | | | | | 0 | | | | | 0 | | | | | | | | | | | 0 | 0 | | | 0 | | | | | | | | | | 0 |
| Tain | | | | | | | | | | | | | | | | | | | | | 0 | | 0 | | 0 | | | | | | | | | | | | 0 |
| LewisHarris | | 0 | | | | 0 | | | 0 | | | | | 0 | | | 0 | 0 | | | 0 | | 0 | | | | 35 | | 0 | 0 | | | | 0 | | | 35 |
| UistBarra | | | | | | | | | | | | | | | | | 0 | 0 | | | | | 0 | 0 | | | 0 | | 0 | 0 | | | | 0 | 0 | | 0 |

## Mussels maximum PSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | | | | | | | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | | | | | 0 |
| Clyde | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| Loch Fyne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | | | 0 |
| Loch Striven | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 112 | 124 | 0 | | 0 | 0 | 0 | 0 | 0 | | | | 124 |
| East | 0 | 142 | 31 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 30 | 0 | 0 | 0 | | | | | 0 | 0 | | 0 | | | 0 | 0 | | 0 | | | | | | 142 |
| Linnhe | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | | | | 0 |
| Loch Eil/Leven | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | | | | 0 |
| Loch Etive | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| Sound of Jura | | | | | | 0 | 0 | | | | | | | | | | | | | | | 0 | 0 | | 0 | | | 0 | | | | | | | | | 0 |
| Orkney | 0 | 114 | 299 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | 299 |
| Shetland E | 0 | 0 | 0 | | 0 | | 0 | | | | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| Shetland N | 0 | 130 | 49 | 33 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 169 | 44 | 0 | 0 | 0 | | | | 169 |
| Shetland SW | 0 | 29 | 0 | 0 | 35 | 0 | 0 | 0 | | 0 | | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 84 | 28 | 0 | 0 | 0 | 0 | | 0 | 0 | 84 |
| Shetland W | 0 | 211 | 184 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | | | | | 211 |
| Loch Ewe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | | | | | | | | | 0 | | | | 0 | 0 | | | | | 0 | | | | | 0 |
| Loch Torridon | | 80 | 220 | 29 | | 0 | | 0 | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 220 |
| Sutherland | 0 | 69 | 277 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 277 |
| Skye Loch Eishort | 0 | 46 | 0 | 89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 73 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | | 0 | | 100 |
| Skye North | 0 | 31 | 405 | 52 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 63 | 47 | 43 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 49 | | 0 | | | 0 | | | | | | 405 |
| Skye Scalpay | | | 34 | | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | 0 | | | | | | 34 |
| Loch Ryan | 0 | 0 | 0 | 0 | | | 0 | 0 | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | | 0 | | | | 0 | 0 | | 0 | | | | 0 | | | | | 0 |
| Solway | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | | 0 | | | | | | | 0 |
| Tain | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | | | | 0 |
| Lochaber | 0 | 31 | 214 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 36 | 98 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 214 |
| Mull Loch Scridain | 0 | 0 | 79 | 0 | 0 | 0 | 0 | | | 0 | 0 | | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 35 | 0 | | 0 | 0 | 0 | 0 | 0 | | | 0 | 79 |
| Mull Loch Spelve | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| Mull North | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 56 |
| LewisHarris | | | | 39 | | 0 | | | | | | 0 | 0 | 0 | 0 | | 0 | 0 | | | | 0 | 0 | 0 | 0 | 0 | 38 | | 0 | | 0 | | 0 | | 0 | | 39 |
| Loch Leurbost | | 0 | 33 | 0 | | 0 | | | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | 33 |
| Loch Roag | 0 | 0 | 101 | 127 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 127 |
| UistBarra | 0 | | 38 | 0 | | 0 | | | | | | 0 | | | 0 | | 0 | 0 | 0 | | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | | | | | 38 |

## P.Oysters maximum PSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Clyde | 0 | | | | | 0 | 0 | | | 0 | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | 0 |
| Loch Fyne | | | 0 | | 0 | 0 | 0 | 0 | | 0 | | | | 0 | | 0 | 0 | 0 | | | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colonsay Islay | | 0 | 0 | | | | | 0 | | | 0 | | 0 | 28 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | | 0 | 28 |
| Linnhe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Loch Etive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | 0 |
| Seil Sound | | | 0 | | 0 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| West Loch Tarbert | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 |
| Orkney | | | 0 | 0 | | 0 | 0 | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Shetland N | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | 0 |
| Sutherland | | | 0 | | | 0 | | | | | | | | | 0 | 0 | | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skye North | | 0 | | | | | | 0 | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| Skye Scalpay | | | 0 | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Lochaber | 0 | | 0 | | | 0 | | | | | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mull Loch Spelve | | | | | | | | | | | | | | 29 | | | | | | | | | | | | | | | | | | | | | | | 29 |
| Mull North | | | 0 | | | | | 0 | | | 0 | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 0 | 0 |
| UistBarra | | | 0 | | | | | | | | | 0 | | | | | | | 0 | | | | 0 | 0 | | | | | | | | | | 0 | | | 0 |

## Queens maximum PSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Loch Fyne | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | | 0 | | 0 | 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | | | | 0 | 0 |
| Shetland N | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Shetland W | | 62 | | 35 | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | | 0 | 61 | 0 | | | | | | 62 |
| Skye Scalpay | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | | | 0 | | | 0 | | | 0 | 0 | | 0 | | 0 | | | 0 | | | | 0 | | | 0 | | | | | 33 |

## Scallop whole, maximum PSP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Sound of Jura | | | 0 | 0 | 0 | | | 0 | 0 | | | 0 | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| Shetland W | | | | | | 0 | | | | | | | | | | | | 0 | | | | | | | | | | | | | 0 | | | 0 | | | 0 |
| Loch Ewe | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | | | | | | | | | | | | | 0 |
| Skye Scalpay | | | 38 | 0 | 32 | 0 | 0 | | | | 0 | | | | 0 | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 | | | | 0 | | | | | | | | 38 |
| Lochaber | | | | 0 | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | 0 |

Table A3: Maximum value for ASP (µg/g) per month per year. The column 'grand total' gives the maximum ASP level per site.

Clams maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | 2.5 | | | | 2.5 | | | 2.5 | | 2.5 |
| Loch Fyne | | | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 |
| East | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 2.5 | | 2.5 | 2.5 | | | | | 0 | | 2.5 |
| Colonsay Islay | | | | | | | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 |
| West Loch Tarbert | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | 6 |
| Skye Scalpay | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | | | | | | 2.5 |
| Loch Ryan | | | | | | | 0 | | | 0 | | 0 | | | | | | | | | | | | | | | | | | | | | | | | 0 | 0 |
| Lochaber | 0 | 0 | | 3.54 | 2.5 | | | | | | | | | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | | | 0 | | 0 | 0 | 2.5 | 2.5 | 0 | 2.5 | | | | | 0 | 0 | 3.54 |
| LewisHarris | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | 2.5 | 2.5 | | 2.5 | | | | | | | | 2.5 |
| UistBarra | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | | | | 2.5 |

Cockles maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| East | | | | | | | | | | | | 0 | | | | | | | | | | | 2.5 | 2.5 | | | 0 | | | | | | | | | | 2.5 |
| Orkney | 0 | | 2.5 | 2.5 | 0 | 2.5 | | 0 | | | | | 2.5 | | | | | | 2.5 | | | | | | | 0 | | | | | | | | | | | 2.5 |
| Skye North | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | | | | | 2.5 |
| Skye Scalpay | | 2.5 | | | | 2.5 | | | | | | | | | 2.5 | 2.5 | | | | | | | 0 | 2.5 | 2.5 | | | | 3 | | | | | | | | 3 |
| Solway | 0 | | | | | | 0 | | | | | 0 | | | | | | | | | | | | 0 | | | 0 | | | | | 0 | | | | | 0 |
| Tain | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | 0 | | | | | | | | | | | | 2.5 |
| LewisHarris | | 2.5 | | 2.5 | | 3 | | | 0 | | | | | 0 | | | 0 | 2.5 | | | 2.5 | | 0 | | | | 0 | | 2.5 | 4 | | | | | 2.5 | | 4 |
| UistBarra | | | | | | | | | | | | | | | | | 2.5 | 0 | | | | | | 0 | | | | | 3 | 14 | | | | 2.5 | 2.5 | | 14 |

Mussels maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Arran | | | | | | | | | | | | | | | | | | | | 2.5 | 0 | | 2.5 | 2.5 | | 2.5 | 2.5 | 2.5 | | | 2.5 | 2.5 | | | | 2.5 | 2.5 |
| Clyde | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | | 2.5 | 2.5 | | 2.5 |
| Loch Fyne | 0 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 5 | 2.5 | | 0 | 0 | 0 | 2.5 | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | | 0 | 2.5 | 0 | 0 | 0 | 5 |
| Loch Striven | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | | 0 | 0 | 0 | 0 | | 2.5 | | | 2.5 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | 2.5 | 2.5 |
| East | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | 2.5 | 0 | | 0 | 2.5 | 2.5 | 2.5 | | | | | | 0 | | 0 | | 2.5 | 3 | | | 2.5 | | | | | | 3 |
| Linnhe | | 0 | 2.5 | 2.56 | 2.5 | | 2.5 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 5 | 2.5 | 2.5 | 0 | 0 | | 0 | 5 |
| Loch Eil/Leven | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | 0 | 0 | | 2.5 |
| Loch Etive | | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 0 | 0 | 0 | | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 4 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 4 |
| Sound of Jura | | | | | | 2.5 | 2.5 | | | | | | | | | | | | | | | | 2.5 | | 2.5 | | | 8 | 2.5 | | | 2.5 | | 2.5 | | | 8 |
| Orkney | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 0 | | | | | | | | | | | | | | | | | | | | | | | 2.5 |
| Shetland E | 0 | 2.5 | 2.5 | | 0 | | 2.5 | | | | | 0 | 2.5 | | 0 | 2.5 | 0 | 13 | 2.5 | 0 | | | 0 | | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 10 | 2.5 | 2.5 | 2.5 | 0 | | 0 | 13 |
| Shetland N | 2.5 | 2.5 | 0 | | 2.5 | 2.5 | 0 | 0 | | | 0 | 0 | 2.5 | 0 | | 3 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.85 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 3 |
| Shetland SW | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 0 | | 2.5 | | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 17 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 17 |
| Shetland W | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 0 | | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 5 | 2.5 | 2.5 | | 0 | 0 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 6 | 2.5 | 2.5 | 0 | 2.5 | 6 |
| Loch Ewe | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | | | | | | | | | 2.5 | | | | 2.5 | 2.5 | | | | | 0 | | | | | 2.5 |
| Loch Torridon | | 0 | 2.5 | 2.5 | | 2.5 | | 0 | | | 0 | | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 3 | 2.5 | 0 | 0 | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 3 |
| Sutherland | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 0 | 0 | | 0 | 2.5 | 2.5 | 2.5 | 4 | 2.5 | 2.5 | | | 2.5 | | 0 | | 2.5 | 2.5 | 2.5 | 5 | 2.5 | 2.5 | | | 0 | 2.5 | 5 |
| Skye Loch Eishort | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | 0 | 0 | 2.5 |
| Skye North | 0 | 0 | 2.5 | 2.5 | 5 | | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | | 5 | 6 | 3 | 2.5 | 0 | 2.5 | 2.5 | | 2.5 | | 2.5 | 0 | 2.5 | | 2.5 | | | 0 | | | | | | 6 |
| Skye Scalpay | | | 2.5 | | 5 | 2.5 | 0 | 2.5 | 0 | 0 | 2.5 | | 2.5 | | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | | | | | | 2.5 | 2.5 | 2.5 | 0 | | | | | | 5 |
| Loch Ryan | 0 | 0 | 2.5 | 2.5 | | | 0 | 2.5 | | | 0 | | | | 2.5 | | | | 2.5 | 2.5 | 2.5 | 2.5 | | | | 2.5 | | 2.5 | | | | 2.5 | 2.5 | | 2.5 | | 2.5 |
| Solway | 0 | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | | 2.5 | 0 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 2.5 | | 0 | | | 2.5 | | 0 | | 2.5 |
| Tain | 0 | 2.5 | 0 | | 2.5 | 2.5 | 2.5 | 0 | | | 2.5 | | | 2.5 | 2.5 | 3 | 2.5 | 2.5 | 2.5 | 2.5 | | | 2.5 | 2.5 | 2.5 | | 0 | 2.5 | | 2.5 | 2.5 | 2.5 | 0 | | 0 | | 3 |
| Lochaber | 0 | 0 | 2.5 | 3 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | | 2.5 | 2.5 | 0 | 3 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 2.5 | 9 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 9 |
| Mull Loch Scridain | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | | | 0 | 2.5 | | 2.5 | 0 | 27 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | | 0 | 27 |
| Mull Loch Spelve | 0 | 2.5 | 2.5 | 4.98 | | 2.5 | 2.5 | 0 | 2.5 | | | | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 13 | 22 | 2.5 | 2.5 | | 2.5 | 0 | 0 | 22 |
| Mull North | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 2.5 | 2.5 | 0 | 0 | 0 | 9.77 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | | 2.5 | 0 | 2.5 | | 2.5 | 9.77 |
| LewisHarris | | | | 2.5 | | 7 | | | | | | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 5 | | | | 0 | 2.5 | 0 | 0 | 2.5 | 2.5 | | 2.5 | | | 2.5 | 2.5 | 0 | 2.5 | 0 | 7 |
| Loch Leurbost | | 0 | 4 | 2.5 | | 2.5 | | | 2.5 | | 2.5 | 0 | 0 | 0 | 0 | 2.5 | 2.5 | 6 | 2.5 | 3 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 7 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 7 |
| Loch Roag | 0 | 0 | 2.5 | 2.5 | 2.5 | 22 | 8 | 2.5 | 0 | 2.5 | 0 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 8 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 12 | 2.5 | 12 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 0 | 22 |
| UistBarra | 0 | | 2.5 | 2.5 | 2.5 | 2.5 | | | | | | 0 | | | 0 | | 2.5 | 0 | 0 | | 2.5 | | | 0 | | 0 | 0 | | 2.5 | 17 | 2.5 | 2.5 | | 0 | 2.5 | | 17 |

## P.Oysters maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Clyde | 0 | | | | | 0 | 2.5 | | | 0 | | 0 | | | | | | | | | | | | 0 | | | | | | | | | | | | | 2.5 |
| Loch Fyne | 0 | | 0 | 2.5 | 0 | 2.5 | 2.5 | 0 | | 0 | | | | 0 | | 0 | 0 | 2.5 | | 2.5 | 0 | | | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 |
| Loch Striven | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | | | | | | | | | | | | 2.5 |
| Colonsay Islay | | 2.5 | | | | | 0 | 2.5 | | | 0 | | 2.5 | 2.5 | 0 | | 2.5 | 0 | 2.5 | 2.5 | 0 | 2.5 | 2.5 | 0 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 0 | | | | 2.5 | 2.5 |
| Linnhe | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | | 0 | 0 | 2.5 | 2.5 | | | 2.5 | 2.5 | 0 | 2.5 | | | 0 | 0 | 0 | 2.5 | 2.5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | | 2.5 | 0 | 5 |
| Loch Etive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | 2.5 |
| Seil Sound | | | 2.5 | | 2.5 | | | | | | | | 2.5 | 7 | 2.5 | 3 | 2.5 | 2.5 | 2.5 | 0 | | | 2.5 | 0 | 0 | 5 | | 4 | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 0 | 7 |
| West Loch Tarbert | | | 0 | 2.5 | | 2.5 | 2.5 | 2.5 | | | | | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 2.5 | | 0 | 0 | | 0 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | | | 0 | 2.5 | 0 | 2.5 |
| Orkney | | | 0 | 0 | | 0 | 0 | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Shetland N | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | | | | | | | | | | | | 2.5 |
| Sutherland | | | 2.5 | | 2.5 | | | | | | | | | | | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | | 2.5 | | 0 | 2.5 | 2.5 | 2.5 | | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 2.5 |
| Skye North | | 0 | | | | | | | | | | | | | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | 2.5 | 0 | 0 | 0 | | 2.5 | 2.5 | 2.5 | 2.5 | 3 | 0 | 2.5 | | 0 | 0 | 0 | 3 |
| Skye Scalpay | | | 2.5 | | | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 |
| Lochaber | 0 | | 0 | | | 2.5 | | | | | | | 0 | | 2.5 | 10 | 2.5 | 2.5 | 2.5 | 2.5 | | 0 | | 0 | 0 | 2.5 | 2.5 | 2.5 | 4 | 9 | 2.5 | 2.5 | 2.5 | 0 | 0 | 0 | 10 |
| Mull Loch Spelve | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Mull North | | | 0 | | | | | 0 | | | 0 | | 0 | | 3 | 2.5 | 2.5 | | 2.5 | 2.5 | 0 | 0 | 2.5 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | 4 | 4 | | 2.5 | | 2.5 | | 0 | 4 |
| UistBarra | | | 2.5 | | | | | | | | | | | | | | | | 3 | | | | | 0 | | | | | | | | | | 0 | | | 3 |

## Queens maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Loch Fyne | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 0 | 2.5 | 0 | | | | 0 | 0 | 2.5 | | 2.5 | 2.5 | | | | | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | | 2.5 | | | | 2.5 | 2.5 |
| Shetland N | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Shetland W | | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | 31 | 28 | | | 55 | 5 | | | | | | 55 |
| Skye Scalpay | 2.5 | 2.5 | 10 | 2.5 | 4 | 2.5 | 4 | 2.5 | | | 2.5 | | | 2.5 | | 7 | 2.5 | 11 | | 7.36 | | 4 | | | 3 | | | | | | | | 8 | | | | 11 |

Scallop gonads maximum ASP

| | 2001 | | | | | | | | | 2002 | | | | | | | | | | | | 2003 | | | | | | | | | | | | 2004 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| Sound of Jura | | | 39 | 3 | 47 | 13 | | | 12 | | 6 | 8 | | | | | | 11 | | | | 12 | 6 | 8 | 2.5 | 2.5 | 2.5 | 65 | 54 | 76 | | 152 | | 14 | | | 152 |
| Shetland W | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | 3 |
| Loch Ewe | 2.5 | 3 | 7 | 5.36 | | 16.46 | 28 | 43 | 19 | 4 | 10 | 3 | 5 | 18 | | 12 | 36 | 66 | 54.74 | 85 | 15 | | | 5 | 17 | | 35 | 46 | 66 | 43 | 34 | 51 | 23 | 28 | 25 | 9 | 85 |
| Skye Scalpay | | 64 | 9 | 9.8 | 26 | 12 | 5 | 3 | 38.37 | | 23 | 2.5 | | 4 | 2.5 | 11 | | 33.47 | | 7.61 | | 16 | 3 | | | | | 43 | 39 | 37 | | | | | | | 64 |
| Lochaber | 8 | | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | 8 |

Table A4: Number of positive samples (denoted by y) and total number of samples for each site for each month, for DSP in mussels. Used for fitting GLMM model.

| | | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Grand total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total |
| Clyde | Arran | | | 0 | 1 | 0 | 2 | | | 0 | 1 | 2 | 2 | 2 | 3 | | | | | 0 | 2 | 4 | 6 | 1 | 3 | 9 | 20 |
| Clyde | Clyde | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 5 | 0 | 7 | 1 | 10 | 0 | 5 | 1 | 8 | 2 | 6 | 3 | 9 | 1 | 5 | 1 | 2 | 9 | 66 |
| Clyde | Loch Fyne | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 3 | 0 | 5 | 3 | 9 | 4 | 8 | 2 | 8 | 3 | 11 | 1 | 5 | 1 | 3 | 0 | 4 | 14 | 66 |
| Clyde | Loch Striven | 0 | 4 | 0 | 5 | 0 | 7 | 0 | 6 | 0 | 3 | 2 | 6 | 1 | 5 | 1 | 6 | 0 | 6 | 5 | 10 | 5 | 9 | 1 | 6 | 15 | 73 |
| East | East | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 5 | 2 | 6 | 0 | 6 | 2 | 5 | 2 | 8 | 0 | 3 | 0 | 2 | 0 | 1 | 6 | 46 |
| Jura | Linnhe | 0 | 3 | 0 | 4 | 0 | 4 | 0 | 6 | 0 | 7 | 0 | 9 | 0 | 3 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 2 | 0 | 62 |
| Jura | Loch Eil/Leven | 0 | 5 | 0 | 6 | 0 | 4 | 0 | 7 | 1 | 5 | 0 | 10 | 0 | 7 | 0 | 9 | 0 | 7 | 0 | 6 | 0 | 7 | 0 | 5 | 1 | 78 |
| Jura | Loch Etive | 0 | 3 | 0 | 2 | 0 | 7 | 0 | 3 | 0 | 9 | 0 | 6 | 0 | 3 | 0 | 5 | 0 | 10 | 0 | 7 | 0 | 4 | 0 | 3 | 0 | 62 |
| Jura | Sound of Jura | 0 | 1 | 0 | 2 | 0 | 2 | | | 0 | 1 | | | 0 | 1 | 0 | 1 | 0 | 1 | | | | | | | 0 | 9 |
| Jura | West Loch Tarbert | | | | | 0 | 1 | | | | | | | | | | | | | | | | | | | 0 | 1 |
| North | Orkney | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 10 | 0 | 6 | 1 | 7 | 0 | 8 | 1 | 4 | 5 | 7 | 2 | 6 | 1 | 7 | 1 | 3 | 11 | 62 |
| North | Shetland E | | | 0 | 2 | 0 | 2 | 2 | 12 | 1 | 6 | 0 | 4 | 0 | 2 | 1 | 8 | 0 | 7 | 0 | 5 | 0 | 3 | 0 | 1 | 4 | 52 |
| North | Shetland N | 0 | 2 | 0 | 9 | 0 | 10 | 1 | 17 | 1 | 14 | 0 | 5 | 0 | 7 | 0 | 14 | 2 | 9 | 3 | 17 | 0 | 13 | 0 | 3 | 7 | 120 |
| North | Shetland SW | 0 | 12 | 0 | 4 | 0 | 10 | 0 | 18 | 1 | 11 | 1 | 14 | 1 | 10 | 3 | 25 | 0 | 8 | 1 | 13 | 0 | 9 | 0 | 2 | 7 | 136 |
| North | Shetland W | 0 | 11 | 0 | 5 | 0 | 12 | 2 | 20 | 0 | 9 | 3 | 15 | 5 | 15 | 2 | 21 | 4 | 29 | 4 | 19 | 1 | 24 | | | 21 | 180 |
| NorthWest | Loch Ewe | 0 | 2 | 0 | 3 | 0 | 1 | 0 | 8 | 0 | 3 | 4 | 4 | 1 | 3 | 3 | 5 | 1 | 5 | 4 | 8 | 0 | 6 | 0 | 2 | 13 | 50 |
| NorthWest | Loch Torridon | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 1 | 0 | 4 | 3 | 12 | 0 | 5 | 0 | 5 | 4 | 8 | 0 | 3 | 0 | 8 | 0 | 1 | 7 | 55 |
| NorthWest | Sutherland | 0 | 1 | 0 | 6 | 1 | 1 | 1 | 7 | 0 | 7 | 0 | 8 | 10 | 15 | 8 | 15 | 8 | 29 | 7 | 19 | 2 | 11 | 0 | 3 | 37 | 122 |
| Skye | Skye Loch Eishort | 0 | 3 | 0 | 3 | 0 | 5 | 0 | 6 | 1 | 6 | 2 | 7 | 2 | 9 | 2 | 9 | 0 | 10 | 0 | 5 | 0 | 5 | 0 | 1 | 7 | 69 |
| Skye | Skye North | 0 | 6 | 0 | 4 | 0 | 5 | 0 | 8 | 1 | 16 | 2 | 6 | 8 | 15 | 4 | 5 | 1 | 2 | 3 | 12 | 1 | 8 | 0 | 4 | 20 | 91 |
| Skye | Skye Scalpay | 0 | 1 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 7 | 3 | 7 | 4 | 11 | 1 | 6 | 1 | 3 | 1 | 3 | 10 | 47 |
| South West | Loch Ryan | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 23 |
| South West | Solway | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 34 |
| Tain | Tain | | | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 5 | 1 | 5 | 0 | 6 | 0 | 6 | 2 | 10 | 1 | 8 | 0 | 4 | | | 4 | 52 |
| West | Lochaber | 0 | 6 | 0 | 6 | 0 | 5 | 0 | 13 | 1 | 11 | 4 | 13 | 2 | 9 | 3 | 13 | 7 | 20 | 3 | 10 | 3 | 13 | 0 | 5 | 23 | 124 |
| West | Mull Loch Scridain | 0 | 4 | 0 | 2 | 0 | 2 | 0 | 6 | 0 | 4 | 1 | 6 | 1 | 7 | 2 | 8 | 2 | 10 | 0 | 7 | 0 | 3 | 0 | 1 | 6 | 60 |
| West | Mull Loch Spelve | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 5 | 0 | 6 | 0 | 3 | 0 | 4 | 2 | 7 | 0 | 11 | 0 | 6 | 0 | 4 | 0 | 3 | 2 | 56 |
| West | Mull North | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 5 | 0 | 7 | 1 | 5 | 0 | 6 | 0 | 4 | 1 | 4 | 0 | 3 | 2 | 49 |
| Western Isles | LewisHarris | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 1 | 2 | 1 | 4 | 0 | 1 | | | 0 | 2 | 2 | 23 |
| Western Isles | Loch Leurbost | 0 | 2 | 0 | 4 | 0 | 4 | 0 | 4 | 1 | 4 | 1 | 8 | 0 | 6 | 0 | 4 | 0 | 8 | 0 | 3 | 1 | 5 | 0 | 1 | 3 | 53 |
| Western Isles | Loch Roag | 0 | 7 | 0 | 6 | 0 | 8 | 0 | 8 | 1 | 14 | 0 | 15 | 1 | 17 | 2 | 18 | 0 | 21 | 2 | 17 | 0 | 9 | 0 | 5 | 6 | 145 |
| Western Isles | UistBarra | 0 | 1 | 0 | 2 | 0 | 5 | 0 | 1 | 0 | 2 | 0 | 5 | 0 | 3 | 3 | 6 | 0 | 10 | 0 | 5 | 0 | 4 | 0 | 2 | 3 | 46 |
| | Grand Total | 0 | 96 | 0 | 104 | 1 | 131 | 6 | 191 | 9 | 184 | 33 | 208 | 38 | 202 | 47 | 241 | 48 | 285 | 40 | 225 | 22 | 190 | 5 | 75 | 249 | 2132 |

Table A5: Number of positive samples (denoted by y, PSP level of 80µg/100g or above) and total number of samples for each site for each month, for PSP in mussels. Used for fitting GLMM model.

| | | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Grand total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | Y | total | y | total | y | total | y | total |
| Clyde | Arran | | | 0 | 1 | 0 | 1 | | | 0 | 1 | 0 | 1 | 0 | 1 | | | | | 0 | 2 | 0 | 4 | 0 | 1 | 0 | 12 |
| Clyde | Clyde | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 6 | 0 | 8 | 0 | 7 | 0 | 4 | 0 | 7 | 0 | 5 | 0 | 7 | 0 | 2 | 0 | 2 | 0 | 55 |
| Clyde | Loch Fyne | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 5 | 0 | 7 | 0 | 5 | 0 | 9 | 0 | 11 | 0 | 4 | 0 | 1 | 0 | 3 | 0 | 56 |
| Clyde | Loch Striven | 0 | 1 | 0 | 4 | 0 | 6 | 1 | 6 | 2 | 6 | 0 | 6 | 0 | 5 | 0 | 6 | 0 | 6 | 0 | 7 | 0 | 4 | 0 | 4 | 3 | 61 |
| East | East | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 3 | 1 | 5 | 0 | 6 | 0 | 6 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 1 | 0 | 1 | 1 | 40 |
| Jura | Linnhe | 0 | 2 | 0 | 4 | 0 | 3 | 0 | 6 | 0 | 7 | 0 | 9 | 0 | 3 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 2 | 0 | 60 |
| Jura | Loch Eil/Leven | 0 | 3 | 0 | 4 | 0 | 3 | 0 | 7 | 0 | 5 | 0 | 10 | 0 | 7 | 0 | 8 | 0 | 7 | 0 | 6 | 0 | 7 | 0 | 5 | 0 | 72 |
| Jura | Loch Etive | 0 | 2 | 0 | 1 | 0 | 6 | 0 | 2 | 0 | 9 | 0 | 6 | 0 | 3 | 0 | 5 | 0 | 9 | 0 | 6 | 0 | 5 | 0 | 3 | 0 | 57 |
| Jura | Sound of Jura | 0 | 1 | 0 | 1 | | | 0 | 1 | | | | | 0 | 1 | | | 0 | 1 | 0 | 1 | | | | | 0 | 6 |
| North | Orkney | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 9 | 1 | 6 | 5 | 9 | 0 | 8 | 0 | 5 | 0 | 8 | 0 | 4 | 0 | 7 | 0 | 3 | 6 | 63 |
| North | Shetland E | | | 0 | 1 | | | 0 | 11 | 0 | 3 | 0 | 4 | 0 | 2 | 0 | 7 | 0 | 5 | 0 | 6 | 0 | 3 | | | 0 | 42 |
| North | Shetland N | | | 0 | 8 | 0 | 4 | 0 | 15 | 1 | 11 | 0 | 4 | 0 | 5 | 2 | 15 | 0 | 10 | 0 | 17 | 0 | 8 | 0 | 2 | 3 | 99 |
| North | Shetland SW | 0 | 4 | 0 | 4 | 0 | 6 | 0 | 14 | 0 | 11 | 0 | 15 | 1 | 11 | 0 | 25 | 0 | 8 | 0 | 12 | 0 | 6 | 0 | 2 | 1 | 118 |
| North | Shetland W | 0 | 3 | 0 | 5 | 0 | 12 | 0 | 19 | 3 | 10 | 2 | 13 | 0 | 15 | 0 | 19 | 0 | 26 | 0 | 18 | 0 | 22 | | | 5 | 162 |
| NorthWest | Loch Ewe | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 6 | 0 | 3 | 0 | 4 | 0 | 1 | 0 | 5 | 0 | 3 | 0 | 7 | 0 | 4 | 0 | 2 | 0 | 40 |
| NorthWest | Loch Torridon | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | 1 | 5 | 3 | 11 | 0 | 5 | 0 | 5 | 0 | 7 | 0 | 2 | 0 | 7 | 0 | 1 | 4 | 50 |
| NorthWest | Sutherland | 0 | 1 | 0 | 7 | 0 | 1 | 0 | 6 | 0 | 6 | 2 | 10 | 0 | 18 | 0 | 12 | 0 | 27 | 0 | 15 | 0 | 7 | 0 | 1 | 2 | 111 |
| Skye | Skye Loch Eishort | 0 | 2 | 0 | 4 | 0 | 4 | 0 | 7 | 1 | 6 | 0 | 8 | 1 | 8 | 0 | 8 | 0 | 10 | 0 | 5 | 0 | 5 | 0 | 1 | 2 | 68 |
| Skye | Skye North | 0 | 5 | 0 | 3 | 0 | 4 | 0 | 7 | 0 | 14 | 3 | 8 | 0 | 14 | 0 | 3 | 0 | 2 | 0 | 10 | 0 | 6 | 0 | 2 | 3 | 78 |
| Skye | Skye Scalpay | 0 | 1 | 0 | 1 | | | 0 | 1 | | | 0 | 4 | 0 | 6 | 0 | 11 | 0 | 12 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 42 |
| South West | Loch Ryan | | | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 1 | | | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 18 |
| South West | Solway | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 5 | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 30 |
| Tain | Tain | | | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 6 | 0 | 9 | 0 | 7 | 0 | 4 | | | 0 | 48 |
| West | Lochaber | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 13 | 1 | 10 | 2 | 11 | 1 | 7 | 0 | 13 | 0 | 18 | 0 | 8 | 0 | 11 | 0 | 4 | 4 | 104 |
| West | Mull Loch Scridain | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 6 | 0 | 4 | 0 | 6 | 0 | 6 | 0 | 7 | 0 | 9 | 0 | 7 | 0 | 3 | 0 | 1 | 0 | 56 |
| West | Mull Loch Spelve | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 5 | 0 | 6 | 0 | 4 | 0 | 4 | 0 | 7 | 0 | 11 | 0 | 6 | 0 | 4 | 0 | 2 | 0 | 53 |
| West | Mull North | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 5 | 0 | 6 | 0 | 4 | 0 | 5 | 0 | 4 | 0 | 3 | 0 | 3 | 0 | 44 |
| Western Isles | LewisHarris | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 5 | 0 | 1 | | | 0 | 1 | 0 | 25 |
| Western Isles | Loch Leurbost | 0 | 1 | 0 | 4 | 0 | 3 | 0 | 3 | 0 | 5 | 0 | 10 | 0 | 6 | 0 | 3 | 0 | 7 | 0 | 3 | 0 | 5 | 0 | 2 | 0 | 52 |
| Western Isles | Loch Roag | 0 | 4 | 0 | 8 | 0 | 7 | 0 | 6 | 0 | 14 | 1 | 15 | 1 | 18 | 0 | 16 | 0 | 21 | 0 | 17 | 0 | 8 | 0 | 5 | 2 | 139 |
| Western Isles | UistBarra | | | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 2 | 0 | 7 | 0 | 2 | 0 | 5 | 0 | 11 | 0 | 5 | 0 | 2 | 0 | 2 | 0 | 44 |
| | Grand Total | 0 | 50 | 0 | 91 | 0 | 95 | 1 | 179 | 11 | 179 | 18 | 215 | 4 | 190 | 2 | 226 | 0 | 267 | 0 | 202 | 0 | 152 | 0 | 59 | 36 | 1905 |

Table A6: Number of positive samples (denoted by y, ASP level of 20µg/g or above) and total number of samples for each site for each month, for ASP in scallop gonads. Used for fitting GLMM models.

| | | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Grand total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | n |
| Jura | Sound of Jura | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 1 | 0 | 1 | 1 | 4 | 1 | 3 | 3 | 3 | 2 | 5 | | | 2 | 2 | 0 | 1 | 9 | 27 |
| North | Shetland W | | | | | | | | | | | | | | | | | 0 | 1 | | | | | | | 0 | 1 |
| NorthWest | Loch Ewe | 1 | 4 | 1 | 5 | 0 | 6 | 0 | 6 | 0 | 4 | 1 | 3 | 3 | 8 | 4 | 6 | 7 | 10 | 9 | 11 | 7 | 10 | 2 | 6 | 35 | 79 |
| Skye | Skye Scalpay | 0 | 1 | 1 | 3 | 0 | 2 | | | 2 | 5 | 0 | 5 | 1 | 3 | 3 | 4 | 2 | 3 | 0 | 2 | 0 | 3 | 1 | 4 | 10 | 35 |
| West | Lochaber | | | | | | | 0 | 1 | | | | | 0 | 1 | | | | | | | | | | | 0 | 2 |
| | Grand Total | 1 | 7 | 2 | 10 | 0 | 11 | 0 | 8 | 2 | 10 | 2 | 12 | 5 | 15 | 10 | 13 | 11 | 19 | 9 | 13 | 9 | 15 | 3 | 11 | 54 | 144 |

Table A7: Number of samples above limit of detection (exceeding 2.5 μg/g, denoted by y) and total number of samples for each site for each month, for ASP in mussels. Used for fitting GLMM models.

| | | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Grand total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total |
| Clyde | Arran | | | 0 | 1 | 0 | 2 | | | 0 | 1 | 0 | 1 | 0 | 2 | | | | | 0 | 2 | 0 | 4 | 0 | 1 | 0 | 14 |
| Clyde | Clyde | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 8 | 0 | 8 | 0 | 6 | 0 | 5 | 0 | 6 | 0 | 5 | 0 | 6 | 0 | 3 | | | 0 | 55 |
| Clyde | Loch Fyne | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 5 | 0 | 5 | 0 | 8 | 0 | 6 | 0 | 9 | 1 | 11 | 0 | 4 | 0 | 3 | 0 | 3 | 1 | 64 |
| Clyde | Loch Striven | 0 | 3 | 0 | 5 | 0 | 7 | 0 | 6 | 0 | 4 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 5 | 0 | 3 | 0 | 63 |
| East | East | | | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 5 | 0 | 6 | 1 | 6 | 0 | 5 | 0 | 6 | 0 | 3 | 0 | 1 | 0 | 1 | 1 | 39 |
| Jura | Linnhe | 0 | 3 | 0 | 4 | 0 | 4 | 0 | 6 | 0 | 7 | 0 | 8 | 1 | 4 | 0 | 6 | 1 | 5 | 0 | 6 | 0 | 6 | 0 | 2 | 2 | 61 |
| Jura | Loch Eil/Leven | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 8 | 0 | 5 | 0 | 10 | 0 | 8 | 0 | 8 | 0 | 7 | 0 | 5 | 0 | 7 | 0 | 5 | 0 | 76 |
| Jura | Loch Etive | 0 | 4 | 0 | 2 | 0 | 6 | 0 | 2 | 0 | 9 | 0 | 6 | 0 | 4 | 0 | 5 | 1 | 8 | 0 | 5 | 0 | 5 | 0 | 2 | 1 | 58 |
| Jura | Sound of Jura | 0 | 1 | 0 | 1 | | | 0 | 1 | | | | | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | | | 1 | 8 |
| North | Orkney | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 12 | 0 | 6 | 0 | 7 | 0 | 7 | 0 | 5 | 0 | 8 | 0 | 6 | 0 | 6 | 0 | 2 | 0 | 63 |
| North | Shetland E | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 13 | 0 | 2 | 0 | 5 | 0 | 2 | 0 | 7 | 4 | 6 | 0 | 5 | 0 | 4 | 0 | 1 | 4 | 50 |
| North | Shetland N | 0 | 2 | 0 | 9 | 0 | 7 | 0 | 12 | 0 | 11 | 0 | 5 | 1 | 6 | 0 | 11 | 0 | 10 | 1 | 16 | 0 | 12 | 0 | 3 | 2 | 104 |
| North | Shetland SW | 0 | 10 | 0 | 7 | 0 | 11 | 0 | 19 | 0 | 11 | 0 | 14 | 0 | 10 | 0 | 28 | 2 | 9 | 0 | 9 | 0 | 14 | 0 | 2 | 2 | 144 |
| North | Shetland W | 0 | 9 | 0 | 9 | 0 | 15 | 0 | 21 | 0 | 8 | 0 | 14 | 0 | 12 | 0 | 26 | 1 | 27 | 0 | 17 | 1 | 23 | 0 | 2 | 2 | 183 |
| NorthWest | Loch Ewe | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 9 | 0 | 4 | 0 | 3 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 6 | 0 | 5 | 0 | 3 | 0 | 45 |
| NorthWest | Loch Torridon | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 4 | 0 | 10 | 0 | 5 | 0 | 5 | 0 | 7 | 0 | 2 | 1 | 6 | 0 | 2 | 1 | 51 |
| NorthWest | Sutherland | 0 | 1 | 0 | 10 | 0 | 3 | 0 | 5 | 0 | 6 | 0 | 9 | 0 | 17 | 0 | 13 | 3 | 27 | 0 | 14 | 0 | 8 | 0 | 2 | 3 | 115 |
| Skye | Skye Loch Eishort | 0 | 2 | 0 | 5 | 0 | 5 | 0 | 7 | 0 | 6 | 0 | 8 | 0 | 9 | 0 | 9 | 0 | 10 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 72 |
| Skye | Skye North | 0 | 5 | 0 | 2 | 0 | 4 | 0 | 8 | 1 | 14 | 3 | 8 | 1 | 13 | 1 | 5 | 0 | 2 | 0 | 11 | 0 | 6 | 0 | 2 | 6 | 80 |
| Skye | Skye Scalpay | 0 | 1 | 0 | 1 | | | 0 | 1 | | | 0 | 4 | 0 | 5 | 1 | 12 | 0 | 11 | 0 | 3 | 0 | 2 | 0 | 2 | 1 | 42 |
| South West | Loch Ryan | 0 | 1 | 0 | 3 | | | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | | | | | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 18 |
| South West | Solway | 0 | 2 | 0 | 4 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 5 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 34 |
| Tain | Tain | | | 0 | 3 | 0 | 2 | 0 | 2 | 0 | 4 | 0 | 5 | 1 | 5 | 0 | 6 | 0 | 9 | 0 | 7 | 0 | 3 | 0 | 1 | 1 | 47 |
| West | Lochaber | 0 | 6 | 0 | 5 | 0 | 5 | 0 | 14 | 0 | 11 | 1 | 12 | 2 | 7 | 0 | 15 | 2 | 17 | 0 | 7 | 0 | 11 | 0 | 4 | 5 | 114 |
| West | Mull Loch Scridain | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 6 | 0 | 4 | 1 | 6 | 0 | 7 | 0 | 7 | 0 | 9 | 0 | 7 | 0 | 3 | 0 | 1 | 1 | 58 |
| West | Mull Loch Spelve | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 5 | 0 | 6 | 0 | 4 | 1 | 5 | 1 | 6 | 2 | 11 | 0 | 6 | 0 | 4 | 0 | 2 | 4 | 57 |
| West | Mull North | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 3 | 0 | 4 | 2 | 4 | 0 | 7 | 0 | 6 | 0 | 5 | 0 | 2 | 0 | 6 | 0 | 3 | 2 | 50 |
| Western Isles | LewisHarris | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 2 | 3 | | | 0 | 1 | 0 | 1 | 2 | 24 |
| Western Isles | Loch Leurbost | 0 | 2 | 0 | 6 | 0 | 5 | 0 | 4 | 0 | 6 | 2 | 9 | 0 | 7 | 1 | 4 | 2 | 7 | 0 | 3 | 1 | 5 | 0 | 2 | 6 | 60 |
| Western Isles | Loch Roag | 0 | 8 | 0 | 7 | 0 | 9 | 0 | 8 | 0 | 14 | 1 | 15 | 0 | 18 | 4 | 16 | 3 | 21 | 1 | 17 | 0 | 8 | 0 | 5 | 9 | 146 |
| Western Isles | UistBarra | 0 | 1 | 0 | 3 | 0 | 5 | 0 | 2 | 0 | 2 | 0 | 6 | 0 | 3 | 0 | 6 | 1 | 11 | 0 | 5 | 0 | 2 | 0 | 2 | 1 | 48 |
| | Grand Total | 0 | 89 | 0 | 120 | 0 | 125 | 0 | 198 | 1 | 174 | 10 | 208 | 9 | 195 | 8 | 242 | 25 | 264 | 2 | 189 | 3 | 173 | 0 | 66 | 58 | 2043 |

Table A8: Number of samples above limit of detection (exceeding 2.5 µg/g, denoted by y) and total number of samples for each site for each month, for ASP in Pacific oysters. Used for fitting GLMM models.

| | | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | | Grand total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Site | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total | y | total |
| Clyde | Clyde | 0 | 1 | | | 0 | 2 | 0 | 1 | | | | | | | | | 0 | 2 | 0 | 7 | | | | | 0 | 13 |
| Clyde | Loch Fyne | 0 | 4 | 0 | 2 | 0 | 4 | 0 | 3 | 0 | 4 | 0 | 5 | 0 | 5 | 0 | 6 | 0 | 9 | 0 | 3 | 0 | 5 | 0 | 2 | 0 | 52 |
| Clyde | Loch Striven | | | | | | | | | | | | | | | | | 0 | 1 | | | | | | | 0 | 1 |
| Jura | Colonsay Islay | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 3 | 0 | 6 | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 4 | 0 | 6 | 0 | 1 | 0 | 34 |
| Jura | Linnhe | | | 0 | 3 | 0 | 5 | 0 | 6 | 0 | 8 | 0 | 6 | 1 | 3 | 0 | 7 | 0 | 8 | 0 | 7 | 0 | 4 | 0 | 1 | 1 | 58 |
| Jura | Loch Etive | | | | | | | | | | | | | | | 0 | 1 | | | | | | | | | 0 | 1 |
| Jura | Seil Sound | 0 | 1 | 0 | 4 | 0 | 2 | 0 | 5 | 2 | 5 | 0 | 2 | 3 | 6 | 0 | 6 | 0 | 5 | 0 | 4 | 0 | 3 | 0 | 3 | 5 | 46 |
| Jura | West Loch Tarbert | 0 | 3 | 0 | 1 | 0 | 2 | 0 | 4 | 0 | 4 | 0 | 2 | 0 | 4 | 0 | 3 | 0 | 6 | 0 | 4 | 0 | 1 | 0 | 1 | 0 | 35 |
| North | Orkney | | | | | 0 | 1 | | | | | 0 | 1 | 0 | 1 | | | 0 | 1 | 0 | 1 | | | | | 0 | 5 |
| North | Shetland N | | | | | | | 0 | 1 | | | | | | | | | | | | | | | | | 0 | 1 |
| NorthWest | Sutherland | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 24 |
| Skye | Skye North | 0 | 2 | 0 | 3 | 0 | 2 | | | 0 | 4 | 0 | 2 | 0 | 2 | 0 | 4 | 1 | 4 | 0 | 2 | 0 | 2 | 0 | 1 | 1 | 28 |
| Skye | Skye Scalpay | | | | | | | | | | | 0 | 1 | | | | | 0 | 1 | | | | | | | 0 | 2 |
| West | Lochaber | 0 | 3 | 0 | 1 | 0 | 2 | 0 | 4 | 0 | 2 | 0 | 4 | 1 | 4 | 1 | 6 | 2 | 8 | 0 | 5 | 0 | 4 | 0 | 1 | 4 | 44 |
| West | Mull Loch Spelve | | | | | | | | | 0 | 1 | | | | | | | | | | | | | | | 0 | 1 |
| West | Mull North | 0 | 2 | 0 | 4 | 0 | 2 | 0 | 3 | 0 | 1 | 1 | 7 | 0 | 3 | 1 | 8 | 1 | 2 | 0 | 1 | 0 | 5 | 0 | 2 | 3 | 40 |
| Western Isles | UistBarra | 0 | 1 | | | 0 | 1 | | | | | 0 | 1 | | | | | | | 1 | 1 | | | | | 1 | 4 |
| | Grand Total | 0 | 19 | 0 | 23 | 0 | 27 | 0 | 31 | 2 | 36 | 1 | 35 | 5 | 32 | 2 | 46 | 4 | 52 | 1 | 41 | 0 | 33 | 0 | 14 | 15 | 389 |