Monitoring Programme for the Presence of Toxin Producing Plankton in Shellfish Production Areas in Scotland

Contract References: SO1007/PAU179A, FS315019
Food Standards Agency Scotland

February 2011

Reporting period: 01 January 2010 – 31 December 2010

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Summary

This report presents the results from the monitoring carried out to detect the presence of toxin-producing phytoplankton in shellfish production areas in Scotland over the period 01-Jan-10 to 31-Dec-10. A total of 947 seawater samples collected from 36 coastal locations were analyzed, by light microscopy, for the presence of eight potentially toxic genera or species of phytoplankton. The presence of other harmful species was also noted.

The diatom *Pseudo-nitzschia* spp. was present in almost 90% samples analyzed as part of the monitoring programme during 2010, and occurred above threshold level (50,000 cells per litre) in more than 16% of all samples. Blooms were widespread from June through to October, and over 32% of the samples collected in September had *Pseudo-nitzschia* present in potentially harmful numbers. Dense *Pseudo-nitzschia* concentrations were considerably more abundant at monitoring sites in Argyll & Bute during 2010 compared to 2009, with some extended periods of above-threshold cell counts. The dinoflagellate *Alexandrium* spp. was present in over 29% of the samples analyzed. It was most frequently observed in samples between April and June, occurring in 44% of all samples analyzed during May, and was also widespread in August. The dinoflagellate *Dinophysis* spp. was present in almost 55% of the samples analyzed, and occurred above threshold level (100 cells per litre) in over 20% of the total samples. Although not routinely identified to species level, *Dinophysis acuminata* was the most commonly observed species. The dinoflagellate *Prorocentrum lima* was observed in relatively low numbers, but was present in almost 19% of the samples analyzed, exceeding threshold level (100 cells per litre) in 3% of all samples.

Blooms of *Pseudo-nitzschia* were first recorded in 2010 on the Scottish east coast around Dornoch Firth in early March, and also around Shetland in mid March. Toxic blooms were present around Shetland and Argyll during May. *Pseudo-nitzschia* was also abundant around Shetland throughout June and was evident around the Western Isles and west coast of Sutherland. A bloom that developed in Argyll at Loch Fyne: Stonefield in late June, with a peak abundance of 452,080 cells per litre, resulted in detectable levels of ASP toxicity in queen scallops during the following three months. The largest recorded *Pseudo-nitzschia* bloom in 2010 was seen in SW Shetland (Vaila Sound: East of Linga) in mid July, with a maximum density of > 3.5 million cells per litre recorded on 12-July. A *Pseudo-nitzschia* bloom of similar density also developed in nearby Browland Voe, with a maximum cell density of > 3.2 million cells per litre on 13-July. These blooms were dominated by *Pseudo-nitzschia delicatissima* type cells of unknown toxicity. A toxic *Pseudo-nitzschia seriata* type bloom was present in nearby Vaila Sound: Riskaness, with a bloom maximum of >1.8 million cells per litre reached on 19-July. Toxic *Pseudo-nitzschia* blooms also occurred around Argyll in July and again in September. Blooms were frequently recorded during September around the NW Highlands (Ross & Cromarty, Sutherland and the Isle of Skye). The September bloom in Loch Laxford (Sutherland) reached a density of 277,448 cells per litre and was associated with ASP toxicity in common mussels. Although a bloom was present in Loch Eishort (Isle of Skye) from early September into mid October, no ASP toxicity was reported from this site. Blooms were also recorded in Shetland (Olna Firth and Busta Voe) throughout the whole of September and into October, with some low level ASP toxicity reported towards the end of the bloom period.

The densest *Alexandrium* bloom recorded in 2010 occurred in Loch Creran (Argyll). *Alexandrium* was present for a continuous period of eleven weeks from 10-March until 19-May, reaching a maximum cell density of 3,100 cells per litre on 05-May. The dominant species appeared to be the non-toxic *Alexandrium tamutum*. Another non-toxic A*lexandrium* bloom of density 1,360 cells per litre occurred in West Loch Tarbert: Loup Bay in late August. *Alexandrium* was present at other Argyll & Bute monitoring sites during March, and was detected in Loch Striven for a continuous period of nine weeks from 30-March until 25-May, with a maximum of 520 cells per litre on 27-April. Some shellfish toxicity was reported in the weeks following the bloom peak, as cell numbers were decreasing. Blooms in both Loch Fyne: Stonefield and Loch Scridain (Isle of Mull) also had associated PSP toxicity

during April, with toxic *Alexandrium* present in Loch Scridain for much of May and June. *Alexandrium* was recorded sporadically around the Highland region from early March through into October and although bloom concentrations were never particularly dense, low levels of PSP toxins were reported from mid March onwards, with quantifiable amounts reported in late March and in May from common mussels in Loch Beag, and also in mid June from Loch Ewe. Toxic *Alexandrium* was present on several occasions in Loch Eishort, occurring in March, May and July, and was widespread further up the NW coast in Sutherland at Loch Laxford and Kyle of Tongue, and also on the east coast in Dornoch Firth during May. *Alexandrium* was detected in almost two-thirds of the Shetland samples analyzed in May and June. Some PSP toxicity was reported in common mussels from Aith Voe in late May, associated with a bloom that reached a density of 280 cells per litre. *Alexandrium* was detected from early May for a continuous period of seven weeks in nearby Busta Voe, with a bloom maximum of 600 cells per litre on 07-June and quantifiable levels of PSP toxins reported in shellfish the following week. The 2010 *Alexandrium* data from Scottish coastal monitoring sites would suggest that similar to the 2009 pattern, relatively low-density toxic strains were widespread through April and May, particularly in Argyll & Bute and around the Highlands.

Dinophysis was first recorded in concentrations likely to be harmful in late March around Argyll & Bute in Loch Creran and Loch Scridain (Isle of Mull), and was frequently observed in Loch Striven, Loch Fyne, Loch Melfort, Loch Scridain and Loch Creran throughout the summer months, with prolonged DSP toxic events in Loch Striven, Loch Fyne: Stonefield and Loch Creran. Above-threshold *Dinophysis* counts were most prevalent from May to August. In Scapa Bay (Orkney), *Dinophysis* was recorded above threshold level throughout the whole of May, and cells reached a peak abundance of 2,520 cells per litre on 24-May, the highest recorded at any of the Scottish monitoring sites during 2010. *Dinophysis* was also abundant around the Western Isles in June, with the highest count for the region of 1,300 cells per litre occurring in Loch Roag: Eilean Teinish. In the Highland region, *Dinophysis* counts in Loch Eishort (Isle of Skye) were above threshold for seven consecutive weeks from mid July, with a maximum count of 1,620 cells per litre recorded in early August, and a subsequent DSP toxic event following the bloom peak. *Dinophysis* was most abundant around Shetland in late May, June and July, with several DSP toxic events occurring in late May and June. The highest recorded count for Shetland was 960 cells per litre in Vaila Sound: East of Linga in mid July. *Dinophysis* blooms also reached their peak abundance on the east coast of Scotland in July, with bloom maxima of 940 and 900 cells per litre recorded at Dornoch Firth and Elie (Fife), respectively. *Dinophysis* was abundant and DSP toxic events were widespread around the country in August, and there was an exceptional bloom in West Loch Tarbert (Argyll) in late August, with a *Dinophysis* cell count of 1,720 cells per litre.

Above-threshold levels of *Prorocentrum lima* occurred at eight of the monitoring sites and were recorded from mid April into early October. The maximum density was recorded in Kyle of Tongue (Sutherland), with a concentration of 900 cells per litre on 07-June. Cell counts were very variable between sampling weeks, but due to the epiphytic nature of this organism, it is unlikely that abundance in the water column is a true reflection of the actual abundance of this species.

Prorocentrum minimum was observed at many of the monitoring sites from early March through to mid October, and was present in more than 41% of the samples analyzed. Blooms were not particularly dense, but cells were most abundant from mid April to early June. A maximum count of 160,962 cells per litre was recorded at Loch Fyne: Ardkinglas on 17-May. This was the densest bloom of *Prorocentrum minimum* around the Scottish coast in 2010. *Prorocentrum minimum* was also recorded in Vaila Sound: East of Linga on 09-June, with a count of 133,848 cells per litre.

Similar to 2009, *Protoceratium reticulatum* was recorded at low concentrations in approximately 4% of the samples analyzed, mostly around Argyll & Bute and the Highlands.

It was seen in Loch Creran, Loch Fyne, Loch Melfort and Loch Scridain from May through to September, with the largest recorded concentration of 1,500 cells per litre occurring in Loch Creran on 07-July. *Lingulodinium polyedrum* was observed at three monitoring sites, two of which were in Argyll & Bute. A prolonged bloom developed in Loch Creran from late June and dissipated around mid September, with a maximum abundance of 2,100 cells per litre reached on 01-September.

The potentially problematic dinoflagellate *Karenia mikimotoi* was frequently observed from early June through to early October around Argyll & Bute. Cell counts increased rapidly in Loch Scridain (Isle of Mull) from mid July and into early August, with a peak abundance of 438,409 cells per litre in late July. Less dense blooms were also noted in Loch Striven and Loch Melfort in mid September. *Karenia mikimotoi* was abundant around the Highland region from early June to late August. Peak abundances were recorded in mid August, with a maximum observed density of 573,636 cells per litre in Loch Eishort (Isle of Skye) in mid August. Blooms reached peak abundance in the Western Isles from mid to late August and were widespread throughout the Shetland Islands from late August into early October, with the highest cell densities occurring from late August into mid September. The largest recorded *Karenia mikimotoi* bloom of 2010 was at Aith Voe Sletta: Slyde (Shetland) on 30-August with a density of >1.1 million cells per litre.

Introduction

In order to comply with EC regulation No. 854/2004 and amendments, there is a requirement for EU member states to monitor both the presence and geographic distribution of marine biotoxin-producing phytoplankton in shellfish harvesting areas on a regular basis. The regulation is directly applicable and in Scotland, phytoplankton monitoring has been carried out by the Scottish Association for Marine Science (SAMS) on behalf of the Food Standards Agency Scotland (FSAS), Food Law Enforcement Branch, since September 2005. In 2010, the testing of shellfish for the presence of biotoxins was carried out by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and the results of the biotoxin programme are reported elsewhere.

Phytoplankton are the organisms at the bottom of the marine food chain and are the primary food source for filter-feeding marine animals, such as bivalve molluscs. Active phytoplankton growth is therefore a pre-requisite for the commercial production of shellfish. Marine waters contain a diverse array of phytoplankton of different genera and species. The vast majority of these organisms are benign. However, under certain conditions, a relatively few species of phytoplankton produce toxins, some of which can accumulate in the tissue and organs of filter-feeding shellfish. Although the shellfish themselves may not be visibly affected, the concentration of the toxin could mean that humans or other mammals ingesting these shellfish will suffer subsequent ill health.

Water samples collected from designated shellfish harvesting areas are currently monitored, by light microscopy, for eight potentially toxic genera or species of phytoplankton. This analysis enables the concentration of potentially harmful phytoplankton species at the sample collection sites to be determined. However, as the toxicity of harmful species may vary with the condition of the water column or the physiological state of the cell, the analysis cannot currently be used to determine actual toxin production.

The presence of toxin-producing phytoplankton in the water column does not necessarily mean that toxin will be present. While the reasons for toxin production remain unclear, some phytoplankton may produce toxins as a deterrent for grazers (e.g. Bergkvist *et al*., 2008), with some species only becoming toxic as a stress response to nutrient unavailability or other, as yet poorly understood, environmental factors. For example, Fehling *et al*. (2004a) demonstrated that the diatom *Pseudo-nitzschia seriata* produced more of the neurotoxin domoic acid when either phosphate or especially silicate was limited. They also showed that in response to a longer photoperiod (18 hours of light compared with 9 hours), *Pseudo-nitzschia seriata* grew at an enhanced rate, produced more cells and had an overall higher level of total toxin production, although the toxin per individual cell was lower (Fehling *et al*., 2005). Nutrient limitation (usually phosphorous) has also been associated with elevated toxicity of *Alexandrium* species (John & Flynn, 2000; Touzet *et al*., 2007). Even when toxic phytoplankton are present in the water column, to some extent the amount ingested by filter-feeding shellfish will depend on the availability of other harmless phytoplankton species. However, some species may actually increase feeding rates in the presence of a mixed phytoplankton assemblage of toxic and non-toxic cells, and therefore can acquire a higher toxic burden than if feeding on a monospecific diet (Bricelj & Shumway, 1998).

Bivalves differ in their rates of biotoxin accumulation and retention (Sekiguchi *et al*., 2001). For example, the common or blue mussel (*Mytilus edulis*) is often used as a sentinel organism for monitoring the neurotoxins that cause paralytic shellfish poisoning, as it is relatively insensitive to saxitoxin compared with other bivalve species, and will continue to feed on toxic phytoplankton when the feeding rates of other species have declined (Bricelj *et al*., 1990). Scallops are more likely to acquire high levels of domoic acid (produced by some species of *Pseudo-nitzschia*) in their tissues and to retain this toxin for longer than mussels (or oysters), even when the mussels are harvested from the same geographic location (Tett & Edwards, 2002). Oysters accumulate relatively low levels of domoic acid in comparison to other bivalves (Mafra *et al*., 2009). However, with regard to human health, blue mussels

(*Mytilus edulis*) contaminated with domoic acid were identified as the cause of an outbreak of shellfish poisoning in Prince Edward Island, Canada in 1987, when over 150 cases of human illness and three deaths were reported (Bates *et al*., 1989). Mussels are known to accumulate PSP toxins faster than most other species of shellfish and also eliminate the poisons quickly (FAO, 2004; Mafra *et al*., 2010), and can thus act as a useful 'indicator' species.

Because diatoms such as *Pseudo-nitzschia* are not motile and are relatively heavy due to the silica within their walls, they tend to sink in water where turbulence is low. Scallops feed on the phytoplankton suspended in the layer above the seabed, whereas rope-grown mussels feed in near-surface waters and may therefore accumulate less domoic acid. However, there are a number of other factors that may control toxin uptake, even within species, including body size and physiological condition, as well genotype (Bricelj & Shumway, 1998). The practice of shucking, i.e. discarding the gut and mantle, may reduce the overall domoic acid content of scallops as it tends to accumulate in these organs rather than in the adductor muscle (Campbell *et al.,* 2001).

Phytoplankton analysis is thus used as an "early warning" of the state of the phytoplankton community and may indicate the possible occurrence of shellfish toxin events. Shellfish harvesting is therefore not suspended on the basis of phytoplankton analysis alone in Scotland, although EU854/2004 does allow for precautionary closure on the receipt of phytoplankton levels. The information can be used by the shellfish harvesting industry to inform a risk-based approach to harvesting. The Food Standards Agency Scotland provides results at alert level to industry to assist them with this process. Thus, good spatial and temporal monitoring of phytoplankton has the potential to track the development of harmful blooms and hence alert the industry and, as well as safeguard heath, minimize product recalls and subsequent financial loss.

Phytoplankton growth

All phytoplankton grow by harvesting light energy from the sun through the process of photosynthesis, primarily using the pigment chlorophyll. Phytoplankton are therefore characteristic of relatively shallow depths where sunlight can still penetrate into the water column. Photosynthesis allows phytoplankton to take up dissolved carbon dioxide from the water, along with inorganic nutrients such as nitrate, phosphate, silicate and trace metals, such as iron, which are also required for growth. Phytoplankton require sufficient light, warmth and nutrients to grow. In winter the water is too cold for growth to occur in most species. However, at this time, mixing of the water column returns nutrients to the surface layers. In spring, with increasing water temperatures and daylight, rapid phytoplankton growth begins. This growth phase is called the spring bloom and is, in Scottish waters, characterised by diatom species that are capable of rapid utilisation of available nutrients and fast growth. Figure 1 illustrates the general cycle of phytoplankton development throughout the year, in relation to some environmental constraints.

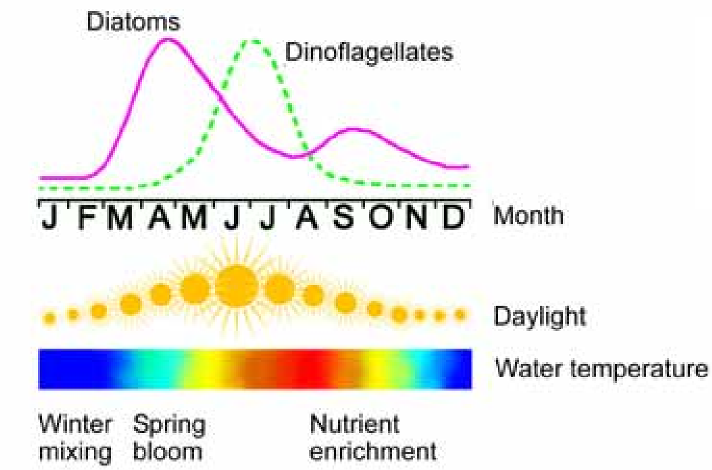


Figure 1. Succession of phytoplankton growth throughout the year.

Diatoms contain silica (SiO_2) within the walls of the cell, and tend to out-compete other phytoplankton groups if silica is available for uptake. Diatoms also tend to thrive in areas where the water column is well-mixed (sometimes as a result of tidal fronts, or the effects of wind and sea-surface cooling during winter). This is because diatoms are not motile and rely on turbulence to maintain them in the water column. Such mixing also ensures that there are plenty of nutrients available. Diatoms therefore often dominate the spring bloom. Early spring blooms may be large if the population of zooplankton grazers has not yet begun to increase. The spring bloom is terminated by the exhaustion of nutrients (usually nitrogen or silicon) in the water column, and a rapid decline in phytoplankton density may occur as cells die, or are grazed down. This will also serve to return some nutrients, particularly nitrogen, into the water.

During summer, the composition of the phytoplankton community is of a different character to that of spring and contains a greater proportion of dinoflagellate species. These organisms differ to diatoms in that they do not require silicon and they are generally capable of growing on lower concentrations of nitrogen. Dinoflagellates are motile and have two flagella that allow them to swim. During summer, mixed populations of both dinoflagellates and diatoms may be evident in Scottish waters. Autumnal phytoplankton blooms can also occur due to enhanced nutrient availability following water column mixing and the breakdown of any summer stratification.

The phytoplankton discussed above exhibit autotrophic growth (i.e. they utilize inorganic nutrients). The grazers of phytoplankton are termed heterotrophs (they utilize organic food). These grazers include zooplankton of various sizes and shellfish. However, some microbes, including potentially harmful organisms such as *Prorocentrum minimum*, exhibit what is called mixotrophic growth, being able to both photosynthesize and ingest smaller phytoplankton.

The eight genera or species of phytoplankton thought to be of greatest threat to the shellfish industry, and hence routinely monitored in Scottish coastal waters during 2010, are detailed as follows:

Pseudo-nitzschia (genus)
Alexandrium (genus)
Dinophysis (genus)
Prorocentrum lima
Prorocentrum minimum
Lingulodinium polyedrum
Protoceratium reticulatum
Protoperidinium crassipes

In addition, the monitoring programme will report unusually large occurrences of any of the other harmful species detailed on the International Oceanographic Commission (IOC) taxonomic reference list of toxic phytoplankton http://www.bi.ku.dk/ioc/

Harmful diatoms in Scottish waters

Pseudo-nitzschia

Most harmful phytoplankton are dinoflagellates, although a few genera of diatom are thought to produce toxin, including *Pseudo-nitzschia*. Diatoms belonging to the genus *Pseudo-nitzschia* have a global distribution and are widespread around the coast of Scotland. While pronounced seasonal changes in density occur, *Pseudo-nitzschia* can be present all year round in Scottish waters and spring and summer blooms may be prolonged, on a scale of weeks. During an extensive bloom, concentrations may be as high as several million cells per litre.

Not all species of *Pseudo-nitzschia* produce toxin, but those that do produce the neurotoxin domoic acid (DA), the ingestion of which may lead to amnesic shellfish poisoning (ASP). DA is a naturally occurring water soluble amino acid that mimics the excitatory neurotransmitter, L-glutamic acid. It strongly binds to the glutamate receptors in the brain, where it causes nerve cells to transmit impulses continuously until they die. The effects of ASP are characterized by the onset of severe gastrointestinal disorders usually within 24 hours, followed by neurological problems (confusion, memory loss, severe headache, seizures). Human and animal deaths have occurred in Canada and North America due to ASP. However, at least in part due to the active monitoring programme and enforcement regime in Scotland, no adverse heath affects have been reported here.

Toxin production by *Pseudo-nitzschia* is not continuous and is thought to relate to the stress imposed by nutrient deficiency. As DA molecules contain nitrogen, the lack of this element does not promote toxin production. However, cells deficient in either silicon or phosphorous or other micro-nutrients may produce DA. Active research programmes are currently attempting to better determine the relationship between nutrients and other environmental conditions, such as temperature and salinity, and the presence of bacteria, to toxin production. Recent evidence suggests that DA levels may be greater in higher salinity coastal waters compared with less saline estuaries (Doucette *et al*., 2008).

Nine species of *Pseudo-nitzschia* have been observed in Scottish coastal waters. It is not possible to routinely discriminate between species of *Pseudo-nitzschia* using standard light microscopy. Rather, electron microscopy or even genetic techniques are required, but such techniques cannot be conducted routinely on samples collected within a monitoring programme. Hence, determination of *Pseudo-nitzschia* is only carried out to genus level. However, to give some degree of taxonomic discrimination between *Pseudo-nitzschia* species, it is possible to categorize the cells into two groups using light microscopy.

- *Pseudo-nitzschia delicatissima* group <3 microns valve width and linear shape

- *Pseudo-nitzschia seriata* group > 3 microns valve width and lanceolate shape

(1 micron = 1 µm = $^{1}/_{1000}$ millimetre)

All diatoms are composed of two valves, an upper valve and a smaller lower valve that fits inside the larger one. Diatoms can undergo asexual reproduction by cell division and inside the dividing cell, two new valves are formed. These new valves become the lower valves of the daughter cells and the two valves of the original parent cell become the upper valves. Therefore there is an inverse relationship between *Pseudo-nitzschia* cell size and the number of divisions undergone, and an overall reduction in individual cell size as the bloom develops. When the cells reach approximately 30% of their original size (depending on the species) sexual reproduction may restore the population to its original cell size. Thus, cell size can vary in *Pseudo-nitzschia* belonging to the same species, depending on the number of cell divisions already undergone and classification by “type” can only be used as an approximate guide.

Under perfect conditions for growth, it is possible for the number of *Pseudo-nitzschia* cells to treble within two days (see Fehling *et al*., 2004a,b). *Pseudo-nitzschia* from the *delicatissima* group are more frequently observed during spring, whereas *P. seriata* type cells tend to dominate the late summer/autumn population, although both types may co-occur throughout the year. Such delineation is both of interest and of use, as the limited evidence that exists suggests that species within the *P. delicatissima* group are not toxic during spring. Individual cells may vary between 30 and 150 µm in length, although *Pseudo-nitzschia* can form long chains of more than 20 cells. Figure 2a shows a chain of four *Pseudo-nitzschia delicatissima* type cells from a sample collected from Vaila Sound: Riskaness (Shetland) on 11-January. About 87% of the *Pseudo-nitzschia* cells present in Loch Scridain (Argyll & Bute) on 04-May could be categorized as *seriata* type (Figure 2b).

Figure 2. Diatoms of the genus *Pseudo-nitzschia* in girdle view showing overlapping cells. 2a belongs to the *Pseudo-nitzschia delicatissima* type category and 2b to the *Pseudo-nitzschia seriata* type.

Worldwide, at least eleven species of *Pseudo-nitzschia* have been found to produce DA (see IOC-UNESCO website for a list of harmful microalgae), although only four of these have been reported to be responsible for major ASP events or fishery closures: *P. multiseries*, *P. australis*, *P. calliantha* and *P. seriata* (Fehling *et al.*, 2004b). All of these species have been recorded in Scottish waters, although their relative contribution to toxin production in the region remains unclear, with only a limited number of strains from Scottish waters having been tested. From this analysis, *P. australis* and *P. seriata* have been found to produce DA. However, as differences in toxin production may occur within species strains, further toxin testing of different species and strains is required before any definitive conclusions can be drawn.

Interestingly, the major species of concern elsewhere in the world, *Pseudo-nitzschia multiseries*, while present, is not thought to be a major component of the phytoplankton in Scottish waters. Although generally beneficial in terms of human health, this does mean that the bulk of research work carried out on this species in the US and Canada is not directly applicable to ASP in Scotland.

In Scotland, the toxicity of *Pseudo-nitzschia* is of greatest concern to the scallop industry, and king scallops in particular readily accumulate the toxin and depurate it only slowly. However, most recorded cases of serious illness and death from ASP worldwide have resulted from consumption of contaminated mussels. Monitoring of *Pseudo-nitzschia* in areas of cultivation and harvest therefore remains important.

Harmful dinoflagellates in Scottish waters

<u>Alexandrium</u>

Of the potentially harmful dinoflagellates in Scottish waters, the one of greatest current concern is the genus *Alexandrium*. *Alexandrium* species are associated with the production of saxitoxin (and derivatives), the cause of Paralytic Shellfish Poisoning (PSP). Saxitoxins interfere with signal transmission to the nervous system and symptoms of the disease develop fairly rapidly after ingestion of the shellfish. Effects include nausea, vomiting, dizziness, a numb sensation around the lips and tongue and, in extreme cases, respiratory paralysis and death. In contrast to ASP, for which relatively dense blooms of *Pseudo-nitzschia* are required before there is a cause for concern, the simple presence of *Alexandrium* is taken as an indication of the potential for a PSP event. PSP toxins have been detected in shellfish tissue using analytical methods, even when the associated phytoplankton cell count is below the limit of detection i.e. less than 20 cells per litre.

Alexandrium cells have a complicated life cycle and exhibit a motile phase that is evident within the water column. However, when conditions are not conducive for growth, they may also enter a resting cyst phase. Cysts may settle to the benthos and become concentrated in the sediment. When conditions are suitable, the cysts may be mixed into the surface layers and germinate, giving rise to new populations of *Alexandrium* (see Neale *et al*., 2007).

Of the 30 recognised species belonging to the genus *Alexandrium*, only four have been reported to occur in Scottish coastal waters: *Alexandrium tamarense*, *A. minutum*, *A. ostenfeldii* and *A. tamutum* (e.g. Collins *et al*., 2009), with *A. tamarense* being by far the most commonly reported. Genetic studies have shown that the *A. tamarense* species complex contains both toxic 'North American' and non-toxic 'Western European' strains. These have now been categorized as *A. tamarense* group I and group III, respectively by Lilly *et al*. (2007). The non-toxic *A. tamarense* strain has been found around the UK coast, and up until recently it was thought that the toxic strain dominated Scottish waters (Higman *et al*., 2001; John *et al*., 2003). However, Collins *et al.* (2009) showed that both non-toxic and toxic *Alexandrium tamarense* can be found around the Scottish coast, and recent studies by Touzet *et al.* (2010) and Davidson *et al.* (in press) used the molecular-based technique of whole cell fluorescent *in situ* hybridisation (WC-FISH), to show the co-existence in the water column around Shetland of both non-toxic Western European (type III) and toxic North American (type I) *Alexandrium tamarense*. The study by Collins *et al.* (2009) concluded that changes in environmental conditions, such as an increase in water temperature (up to 15ºC) and photoperiod, may have allowed the preferential hatching of non-toxic *Alexandrium*, although it was possible that other experimental factors had an affect.

Alexandrium minutum has only been reported in Scottish waters by one study in the Orkney Isles (Töbe *et al*., 2001), although recent studies (SAMS unpublished data) suggest that it is much more widespread around the Scottish coast. In the south of the UK and Ireland, the presence and toxicity of *A. minutum* is well established. *Alexandrium ostenfeldii* has also only been reported in Orkney (Töbe *et al.,* 2001; John *et al.,* 2003), but again may be more widely distributed in Scottish waters (Smayda, 2006; SAMS unpublished data). *Alexandrium ostenfeldii* is also considered to be toxic and as well as PSP, it is linked to the production of the toxin, spirolide. Spirolides are macrocyclic imines and are characterised by a "fast acting" symptomology observed when assayed by intraperitoneal administration into mice. However, the significance of spirolide toxins in Scottish waters has yet to be determined. *Alexandrium tamutum* is thought to be a non-toxic species (Montresor *et al*., 2004).

Historically, PSP events in Scottish waters have been sporadic (examples being in 1968 and 1990) and only in occasional cases were the shellfisheries closed due to the presence of saxitoxins above threshold levels. The Orkney Isles appear to be an exception, with shellfishery closures required more frequently in this location. *Alexandrium* was relatively abundant around the Scottish coast in 2007, resulting in PSP toxins above regulatory levels at sites in Argyll, Sutherland and Shetland. PSP-related site closures were generally much less of a problem in 2008, but the pattern of *Alexandrium* blooms in 2009 was very different, with relatively low-density toxic strains occurring from March through to May, followed by much denser, non-toxic *Alexandrium* blooms in June and July. This pattern would fit the Collins *et al*. (2009) hypothesis that the longer day length and warmer water temperatures of summer promote the growth of the benign strain of *Alexandrium tamarense*. Toxic *Alexandrium* was also widespread in March through to May in 2010, particularly on the west coast of Scotland, although dense blooms on the scale of those in 2009 were not observed during 2010.

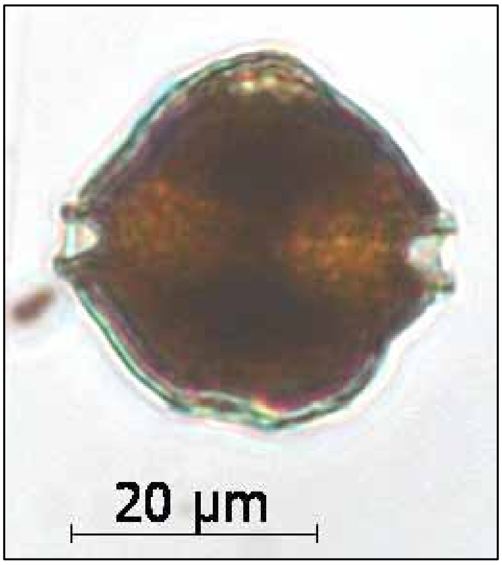


Figure 3. An armoured dinoflagellate belonging to the genus *Alexandrium*. Cells can vary between 20 and 50 µm in length (scale 20 µm = $^1/_{50}$ millimetre).

This cell was identified in a sample collected from Loch Scridain (Argyll & Bute) on 10-August. It is difficult to identify *Alexandrium* to species level in Lugol's-fixed samples, as the thecal plate structure is not clearly visible.

Two other dinoflagellates, *Gymnodinium catenatum* and *Pyrodinium bahamense* var. *compressum* have also been shown to promote paralytic shellfish toxins, but neither organism has been reported in Scottish waters.

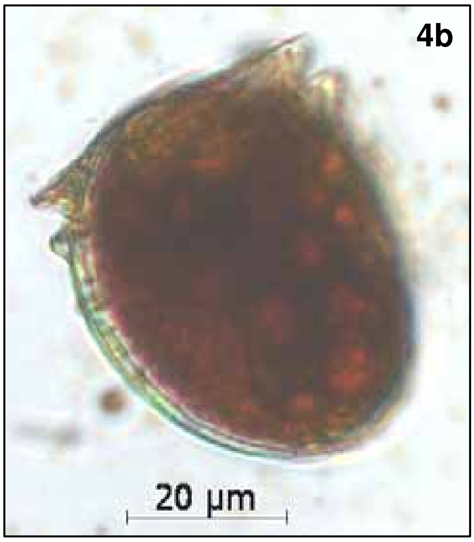
<u>*Dinophysis*</u>

There are more than 200 species belonging to the dinoflagellate genus *Dinophysis*, of which at least six can be found around the Scottish coast (e.g. Hart *et al.*, 2007). *Dinophysis* blooms tend to occur in the summer and can either arise locally, or may be advected in from offshore waters. Cell concentrations may reach several thousand cells per litre in Scottish coastal waters during summer. IOC-UNESCO lists eleven *Dinophysis* species as potential producers of okadaic acid (and derivatives), the cause of Diarrhetic Shellfish Poisoning (DSP), although toxin production has not been confirmed in all cases.

Figure 4 shows four species of *Dinophysis*, *D. acuminata, D. acuta*, *D. norvegica* and *D. rotundata*, all of which are capable of producing okadaic acid and dinophysistoxin-1 (DTX-1) (Smayda, 2006). *Dinophysis acuta* is thought to be able to produce almost four times as much okadaic acid as *Dinophysis acuminata*, and *Dinophysis rotundata* is a major DTX-1 producer. The mechanism of DSP toxin production is difficult to determine, as it is only relatively recently that species of *Dinophysis* have been successfully grown in laboratory culture (Park *et al.*, 2006). This work suggests that *Dinophysis* is mixotrophic i.e. it exhibits both autotrophic and heterotrophic growth.

As for *Alexandrium*, DSP toxins may be a cause for concern, even when *Dinophysis* is present in the water at relatively low abundances, and the threshold level is set at 100 cells per litre. On ingestion, DSP toxins bind to protein phosphatase receptors, building up phosphorylated proteins, which give rise to symptoms that may develop fairly rapidly and last for several days, including lethargy, severe abdominal pains, vomiting and diarrhoea. Death from DSP has not been reported and although the immediate effects of DSP are considered to be fairly short-term, chronic exposure to okadaic acid has been associated with the production of skin and stomach tumours.

Dinophysis acuminata



Dinophysis rotundata

Dinophysis acuta

Dinophysis norvegica

Figure 4. The dinoflagellate *Dinophysis acuminata* (Fig. 4a) is the most commonly observed member of the genus around the Scottish coast. This cell was observed in a sample from Loch Fyne: Ardkinglas (Argyll & Bute) collected on 25-May. *Dinophysis rotundata* (Fig. 4b), which is less frequently observed, was also recorded in this sample. *Dinophysis acuta* (Fig. 4c) is a slightly larger cell at 54-94 μm length, and was recorded in Loch Striven (Argyll & Bute) on 13-July. *Dinophysis norvegica* (Fig. 4d) was found in Browland Voe (Shetland), also on 13-July.

<u>*Prorocentrum lima*</u>

The benthic dinoflagellate *Prorocentrum lima* is also known to produce a number of toxins, some of which are associated with DSP. While it has been suggested to sometimes swarm pelagically (Maranda *et al*., 1999), it is not often found in the water column, but may occur in the pelagic environment if the sediment is disturbed, particularly after stormy weather (Morton *et al*., 2009). Although it is often associated with sandy sediments, it can also grow on surfaces such as aquaculture long lines and macroalgae (Foden *et al*., 2005) and can thus become dislodged. Indeed, the study by Morton *et al*. (2009) found that although *Prorocentrum lima* was rarely observed in planktonic seawater samples, maximum cell counts in the water column were associated with storm events. This study also found that planktonic cell counts did not reflect the availability and consumption of *Prorocentrum lima*, as indicated by the presence of cells in the hepatopancreas of mussels. Maranda *et al*. (2007) also demonstrated a poor correlation between the presence of DSP toxin producers and toxicity in shellfish.

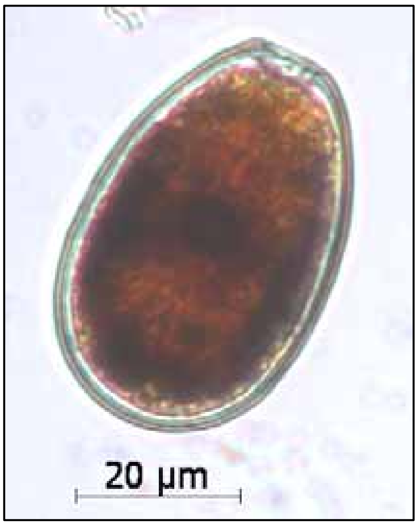


Figure 5. The benthic dinoflagellate *Prorocentrum lima*, identified from a sample collected in Vaila Sound: Riskaness (Shetland) on 31-May. This species is often observed at the same monitoring sites every year.

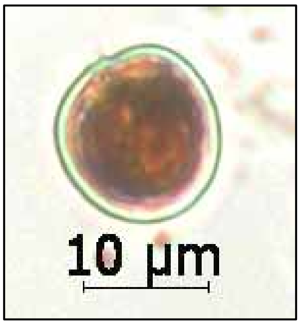


Figure 6. The dinoflagellate *Prorocentrum minimum* in a sample collected from Loch Striven (Argyll & Bute) on 01-June. Cells are small (10-15 µm in width), with a distinctive 'strawberry' or 'heart' shape. Although large blooms of densities > 1 million cells per litre have been observed in previous years, this species was not particularly abundant in Scottish waters during 2010.

Prorocentrum minimum

Prorocentrum minimum is a small dinoflagellate that can form highly dense blooms, often exceeding several million cells per litre, resulting in a visible discolouration of the water. Although *P. minimum* has been associated with the production of venerupin, a hepatotoxin, following an outbreak of food poisoning in Japan in 1942, there appears to be no conclusive evidence that *P. minimum* was the actual toxin producer in this case (Heil *et al.*, 2005). The majority of *P. minimum* grown in culture appears to be non-toxic, but one strain isolated from the French Mediterranean coast was found to be a neurotoxin producer (Denardou-Queneherve *et al.*, 1999). *Prorocentrum minimum* has also been implicated in human instances of shellfish poisoning occurring in Portugal and in China, although symptoms were reported to be more similar to PSP, than the hepatotoxic symptoms of the Japanese outbreak.

The toxicity of *P. minimum* around UK waters is currently unknown. However, this species may be regarded as harmful, due to the detrimental effects associated with blooms of high biomass e.g. oxygen depletion. A recent study (Hegaret *et al.*, 2009) also suggested a link between *Prorocentrum minimum* and parasitic diseases in filter-feeding shellfish.

Lingulodinium polyedrum

Lingulodinium polyedrum is often regarded as a warm-water species that tends to bloom somewhat irregularly in Scottish waters, although blooms of this species can lead to intense red tides and have been associated with both shellfish and finfish mortalities. Temporary cysts are produced near the end of a bloom and can remain in the plankton until conditions are once again favourable. *Lingulodinium polyedrum* is linked to the production of yessotoxin (YTX), which is both hepatotoxic and cardiotoxic when ingested above a certain level. The evidence that *L. polyedrum* produces toxins is contradictory and controversial (Lewis & Hallett, 1997) and is generally related to laboratory studies. Although human illness has not directly been reported in conjunction with blooms of this species, a study by Gladan *et al.* (2010) reported that YTXs, in addition to okadaic acid, were the main compounds responsible for the toxicity of lipophilic extracts in mussels from the Adriatic, and may be linked to toxic events in Croatian waters.

Figure 7. The armoured dinoflagellate *Lingulodinium polyedrum*. Cells can vary between 40 and 54 µm in length and are pentagonal in shape, without horns or spines. Distinct ridges can be seen along the plate sutures (7b). This specimen was observed in a sample from Loch Creran (Argyll & Bute) collected on 01-September.

Protoceratium reticulatum

The dinoflagellate *Protoceratium reticulatum* is also known to produce yessotoxin, with at least one isolate from UK waters having proved positive for this toxin (www.marlab.ac.uk/Uploads/Documents/AE15Shellfish.pdf).

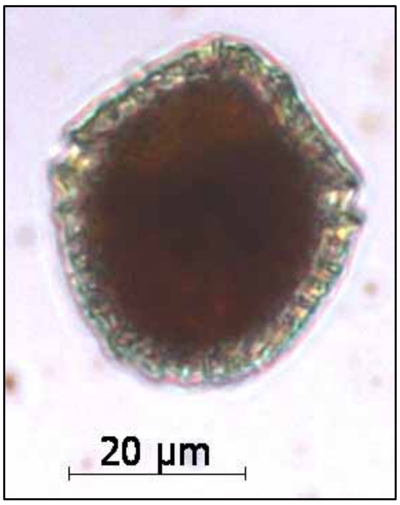


Figure 8. The dinoflagellate *Protoceratium reticulatum* identified from a sample collected in Loch Creran (Argyll & Bute) on 07-July. It can be distinguished by its heavily reticulated (ridged) surface and the upper half of the cell (epitheca) being smaller than the lower half (hypotheca). It was recorded between mid April and mid September at monitoring sites in Argyll & Bute and on the NW coast of Scotland, although never in larger numbers.

Azaspiracid producers

Although *Protoperidinium crassipes* has been previously implicated in azaspiracid poisoning (the symptoms of which are similar to those of DSP), due to the heterotrophic nature of feeding (i.e. it ingests smaller phytoplankton) it is now considered unlikely to be the causative organism as investigations have failed to find any correlation between azaspiracid toxins in shellfish and the presence of *P. crassipes* in the water column.

A recently described small thecate dinoflagellate approximately 7-11 µm in width and named *Azadinium spinosum* (Figure 9), has been identified as a producer of azaspiracids (Tillmann *et al*., 2009). This was originally isolated from net tow phytoplankton samples collected in the North Sea in 2007 and initially referred to as strain '3D9' (Krock *et al*., 2009). This dinoflagellate belongs to a new genus, *Azadinium*, and it is thought that there are several species belonging to this genus, not all of which produce toxins. AZA analogues were not detected in *Azadinium obesum*, also isolated from the east coast of Scotland (Tillmann *et al*., 2010).

As azaspiracid differs structurally to other known marine toxins, and due to its relatively recent discovery, the long-term impact of this toxin is not yet fully understood. *Azadinum spinosum* is difficult to accurately identify and enumerate using light microscopy, due to its small size and the lack of reference material currently available; it is therefore not reported as part of the phytoplankton monitoring programme.

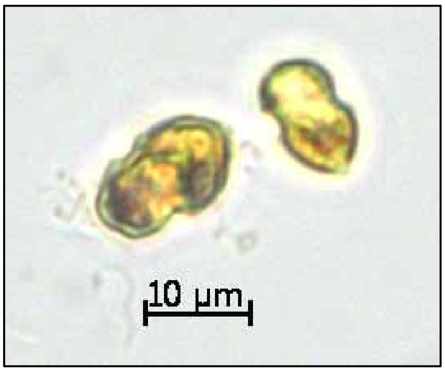


Figure 9. *Azadinium spinosum*, the small dinoflagellate now known to produce azaspiracids.

Methodology

EC regulation No. 854/2004 requires that shellfish from these areas are tested on a regular basis, as determined by seasonal risk, for the presence of biotoxins. Within the Scottish biotoxin monitoring programme, classified shellfish growing areas have been grouped into 'Pods', composed of a 'Representative Monitoring Point' (RMP) and 'Associated Harvesting Area/s' (AHA). RMPs were primarily chosen on a geographical basis, although factors such as toxin history, ease of access, and species present at the site were also taken into account. Shellfish samples are usually collected from RMPs by official control sampling officers and tested for the presence of biotoxins at CEFAS (Weymouth).

As it was not possible to monitor all of the shellfish sites that were active in 2010 for potentially toxic phytoplankton, a representative group of about 36 sites (most of which were also RMPs) were selected for seawater analysis. Almost two thirds of these phytoplankton monitoring sites were located in Argyll & Bute and in Shetland, as more than half of all the classified shellfish production sites fall within these local authority areas. Site selection was also based on previous knowledge of bloom occurrence, and geographic location.

A total of 947 seawater samples were returned from 39 coastal locations between 01-Jan-10 and 31-Dec-10 (Table 1, Figures 10 and 11). Some site locations changed during the reporting period, depending on shellfish harvesting activity at that specific site.

Region	**Area**	**Location**	**NGR (approx.)**	**No. of samples analyzed**
Dumfries and Galloway	Loch Ryan	Stranraer	NX059612	10
Argyll and Bute	Loch Striven	Loch Striven	NS060808	29
Argyll and Bute	Loch Fyne	Ardkinglas	NN167101	29
Argyll and Bute	Loch Fyne	Stonefield	NR864723	33
Argyll and Bute	West Loch Tarbert	Loup Bay	NR768584	28
Argyll and Bute	Colonsay	The Strand	NR355903	29
Argyll and Bute	Loch Melfort	Loch Melfort	NM806111	30
Argyll and Bute	Isle of Mull	Loch Scridain	NM454249	37
Argyll and Bute	Isle of Mull	Loch Spelve: Rhuba na Faing	NM703283	29
Argyll and Bute	Loch Etive (west)	Muckairn	NM963342	26
Argyll and Bute	Loch Creran	Inner Creran	NM956437	36
Highland	Lochaber	Loch Beag	NM728835	21
Highland	Skye & Lochalsh	Loch Eishort	NG666165	34
Highland	Ross & Cromarty	Loch Ewe	NG852891	29
Highland	Sutherland	Loch Laxford	NC213486	30
Highland	Sutherland	Kyle of Tongue	NC593590	24
Highland	Sutherland	Dornoch Firth	NH781868	29
Fife	Elie	Elie Ness	NT494998	27
Comhairle nan Eilean Siar: Lewis & Harris	Loch Stockinish	Stockinish	NG129918	24
Comhairle nan Eilean Siar: Lewis & Harris	Seilebost	Seilebost	NG082979	24
Comhairle nan Eilean Siar: Lewis & Harris	Loch Leurbost	Crosbost	NB386245	25
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag	Loch Barraglom	NB165339	28
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag	Eilean Teinish	NB117352	30
Comhairle nan Eilean Siar: Lewis & Harris	Loch Roag	Miavaig	NB095334	1
Orkney Islands	Scapa Bay	Scapa Pier	HY441081	27
Shetland Islands	Clift Sound	Booth	HU401378	19
Shetland Islands	Sandsound Voe	Sandsound Voe	HU352498	28
Shetland Islands	Gruting Voe	Browland Voe	HU263501	17
Shetland Islands	Vaila Sound	East of Linga	HU242480	25
Shetland Islands	Vaila Sound	Riskaness	HU233483	22
Shetland Islands	Vementry South	Seggi Bight	HU296593	21
Shetland Islands	Aith Voe Sletta	Slyde	HU350583	20
Shetland Islands	Olna Firth	Olna Firth	HU380648	27
Shetland Islands	Olna Firth	Parkgate	HU386650	1
Shetland Islands	Busta Voe	Busta Voe Lee	HU346650	33
Shetland Islands	Ronas Voe	Ronas Voe	HU327809	16
Shetland Islands	Basta Voe Outer	Inner - Site 1	HU533954	3
Shetland Islands	Basta Voe Outer	Outer	HU534954	25
Shetland Islands	North Uyea	North	HU604998	21
			Total =	947

Table 1. Location of sampling sites and number of samples analyzed between 01-Jan-10 and 31-Dec-10.

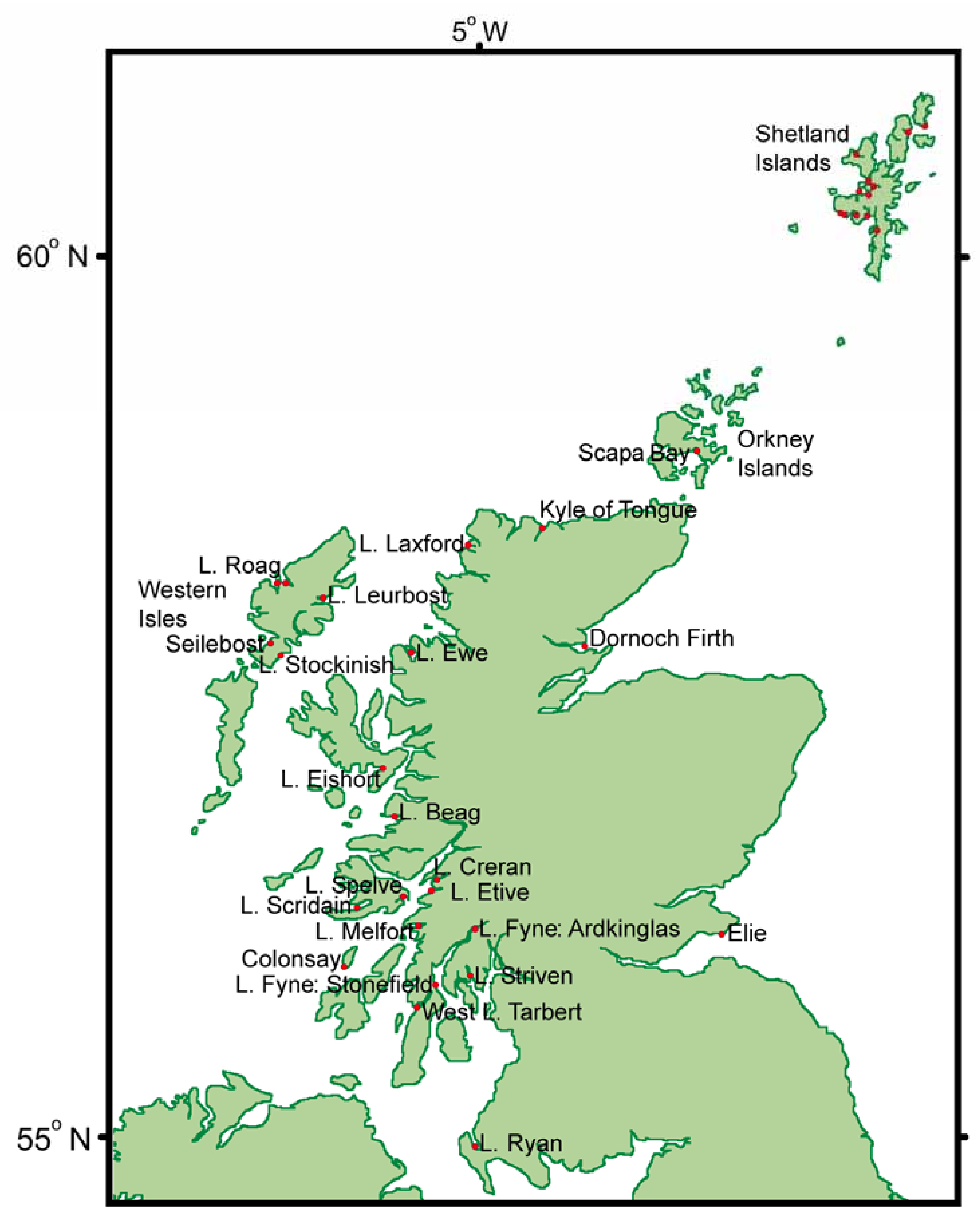


Figure 10. Location of coastal sites contributing to the Scottish phytoplankton monitoring programme between 01-Jan-10 and 31-Dec-10.

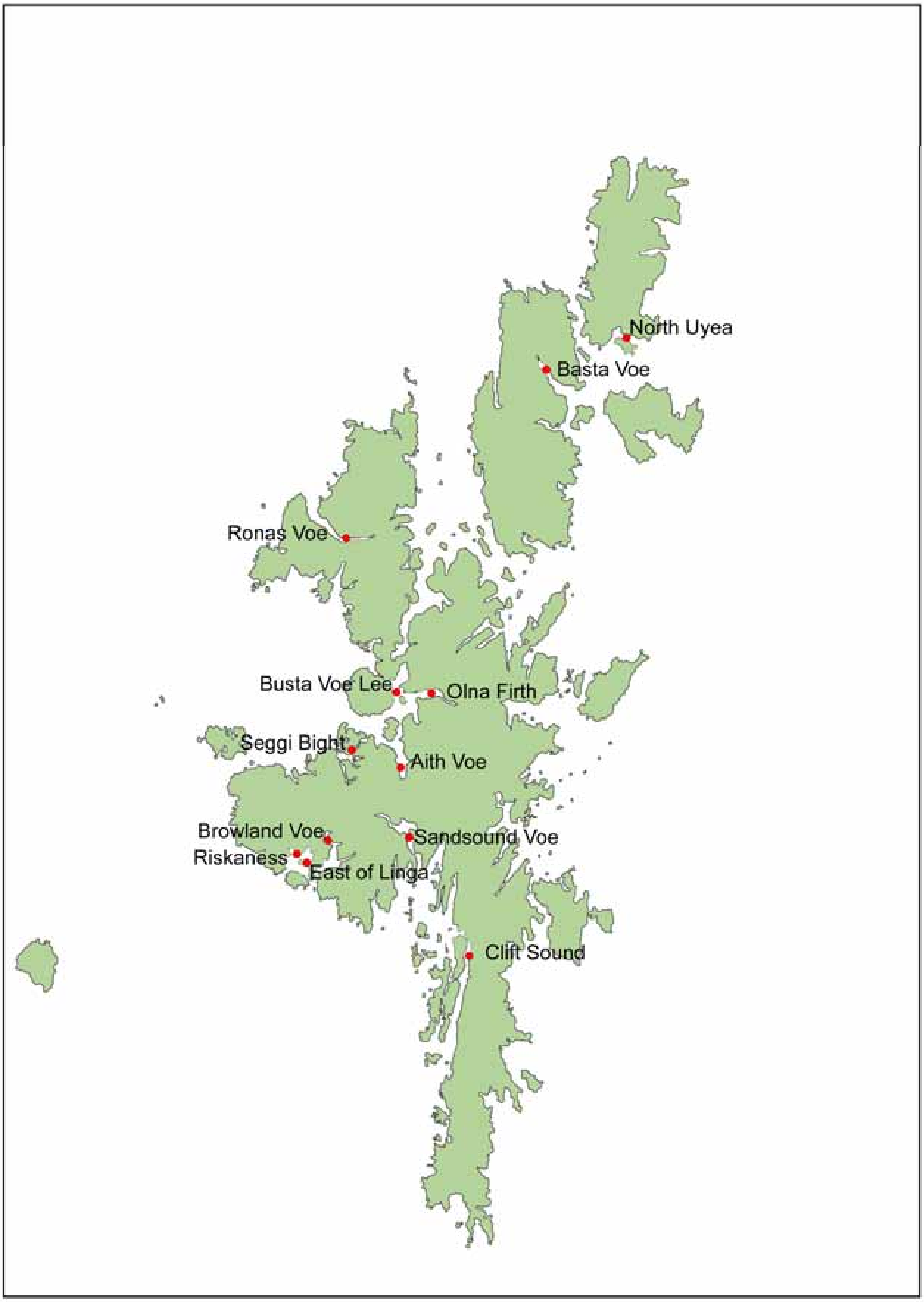


Figure 11. Location of coastal sites contributing to the Scottish phytoplankton monitoring programme around Shetland between 01-Jan-10 and 31-Dec-10.

The sampling protocol used follows that described by the National Reference Laboratory (NRL) Standard Operating Procedure for the collection of water samples for toxic phytoplankton analysis. The aim of this method is to collect samples of phytoplankton that are representative of the community in the water body being sampled. The water sample is taken as close to the shellfish bed as possible and at the location from where shellfish samples for tissue analysis are collected. The sampling method used depends on the depth of water at the site, and water samples are collected with either a PVC sample tube (the preferred method) or a bucket, as appropriate. Sampling should ideally be carried out at high tide (+/- 1 hour). A well-mixed 500 ml sub-sample of this water is then preserved using Lugol's iodine and returned (usually by post) to SAMS for analysis.

The NRL protocol for the identification and enumeration of potential toxin-producing phytoplankton is then used to analyze the water sample. In the laboratory, a sub-sample of between 10 and 50 ml volume (depending on cell concentration) is "settled" to allow phytoplankton cells to sink onto the base of a settling chamber (Figure 12). These cells are identified and enumerated using an inverted light microscope. Final cell densities are then calculated to express phytoplankton concentration as the number of cells per litre of sample.

Figure 12. The phytoplankton in a 50 ml seawater sub-sample fixed with Lugol's iodine are allowed to settle onto the base plate of a settling chamber for a period of more than 20 hours before analysis.

Trigger (threshold) levels for toxic phytoplankton concentrations in the water column have been determined by comparing phytoplankton count data with the presence of biotoxins in shellfish tissue and are as follows:

Genus/species	**Concentration (cells per litre)**
Pseudo-nitzschia (genus)	50,000
Alexandrium (genus)	presence
Dinophysis (genus)	100
Prorocentrum lima	100
Prorocentrum minimum	No trigger
Lingulodinium polyedrum	No trigger
Protoceratium reticulatum	No trigger
Protoperidinium crassipes	No trigger

Sampling frequency

Samples were requested on a weekly basis between April and early October 2010 from all sites. The number of sampling sites was reduced to ten over the winter, with monthly sampling in January and February, and again in November and December, when overall abundance of phytoplankton in the water column was low. A total of 947 samples were received during the reporting period, with an average sample return rate of more than 88%. Requested samples were not collected either due to bad weather, the absence of the Official Control Sampling Officer or shellfish grower, or other sites not being substituted for non-harvesting sites.

Results

The percentage of samples returned with phytoplankton concentrations above threshold levels is given in Figure 13. Summaries of the trends in phytoplankton concentrations by site location and month between January 2010 and December 2010 are presented for the genera *Pseudo-nitzschia*, *Alexandrium* and *Dinophysis* in Figures 14 to 16 (data have been grouped by the week in which the sample was collected). Data for all the genera or species monitored are given in Appendix 1.

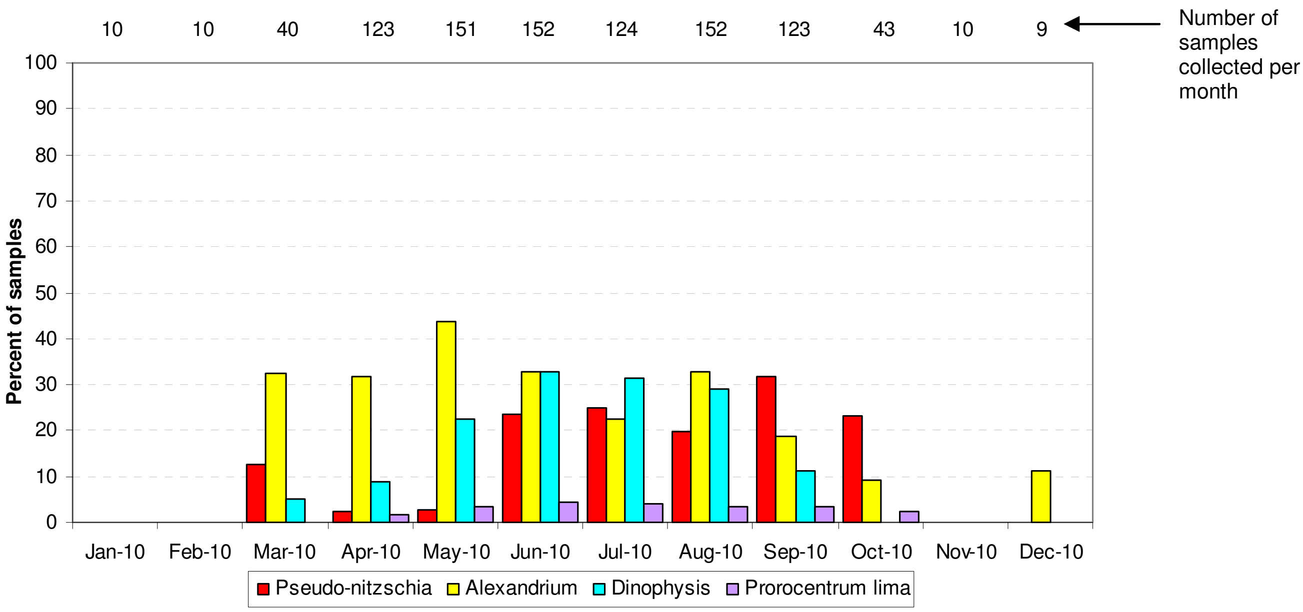


Figure 13. Percentage of samples returned with phytoplankton concentrations above threshold levels, by month. Total number of samples analyzed = 947.

Figure 14. Phytoplankton concentrations observed between Jan-10 and Dec-10 for *Pseudo-nitzschia* spp.

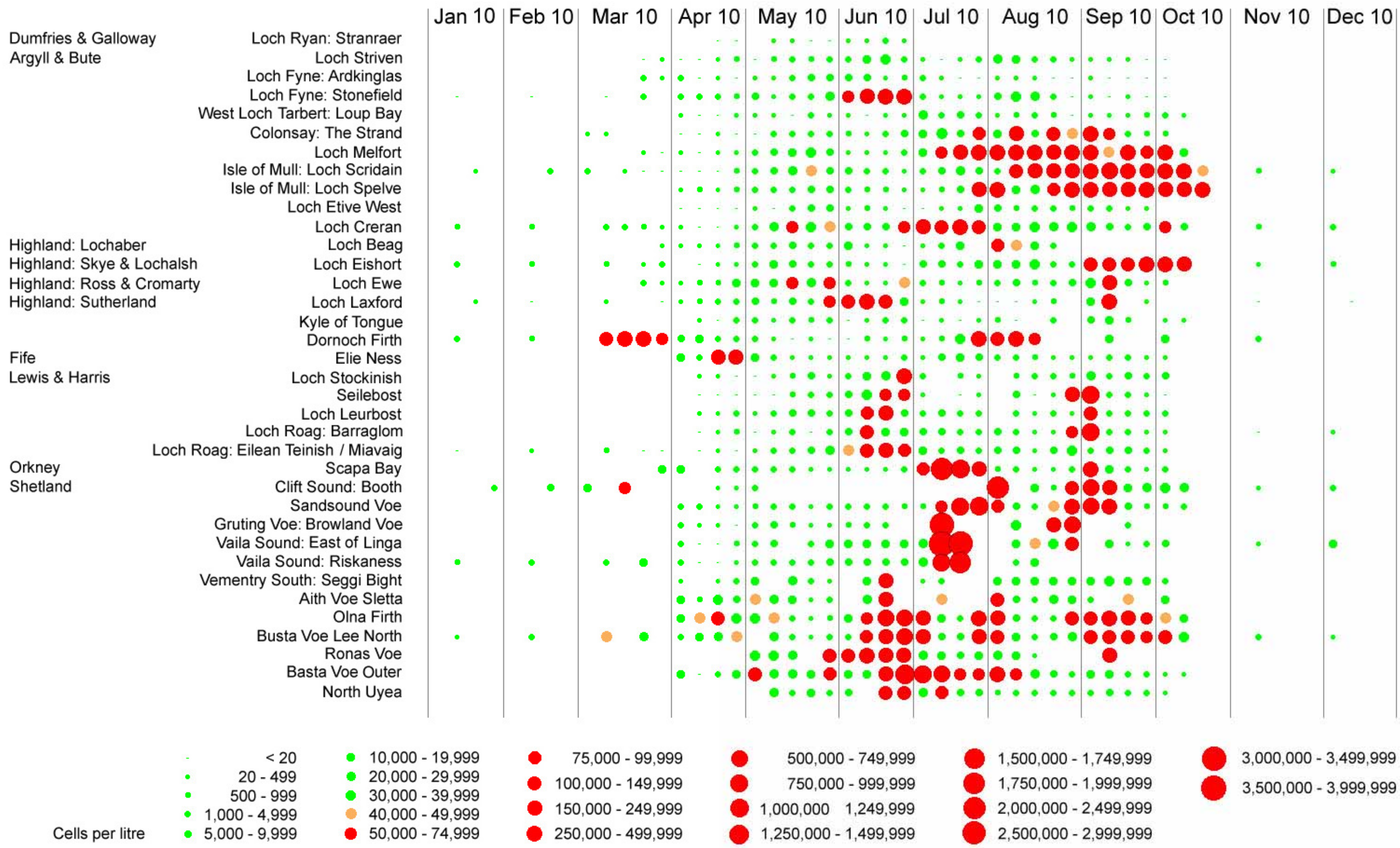


Figure 15. Phytoplankton concentrations observed between Jan-10 and Dec-10 for *Alexandrium* spp.

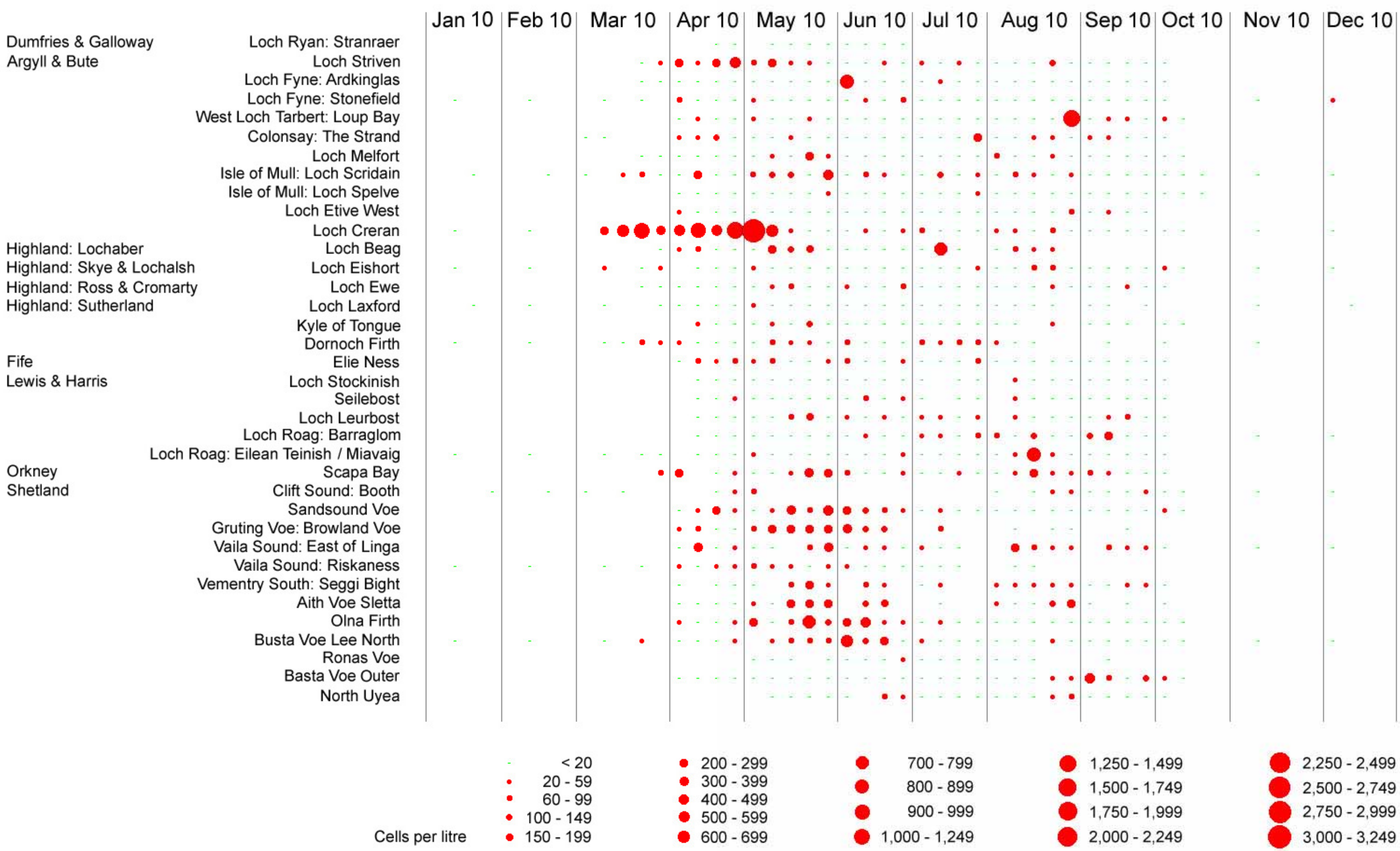
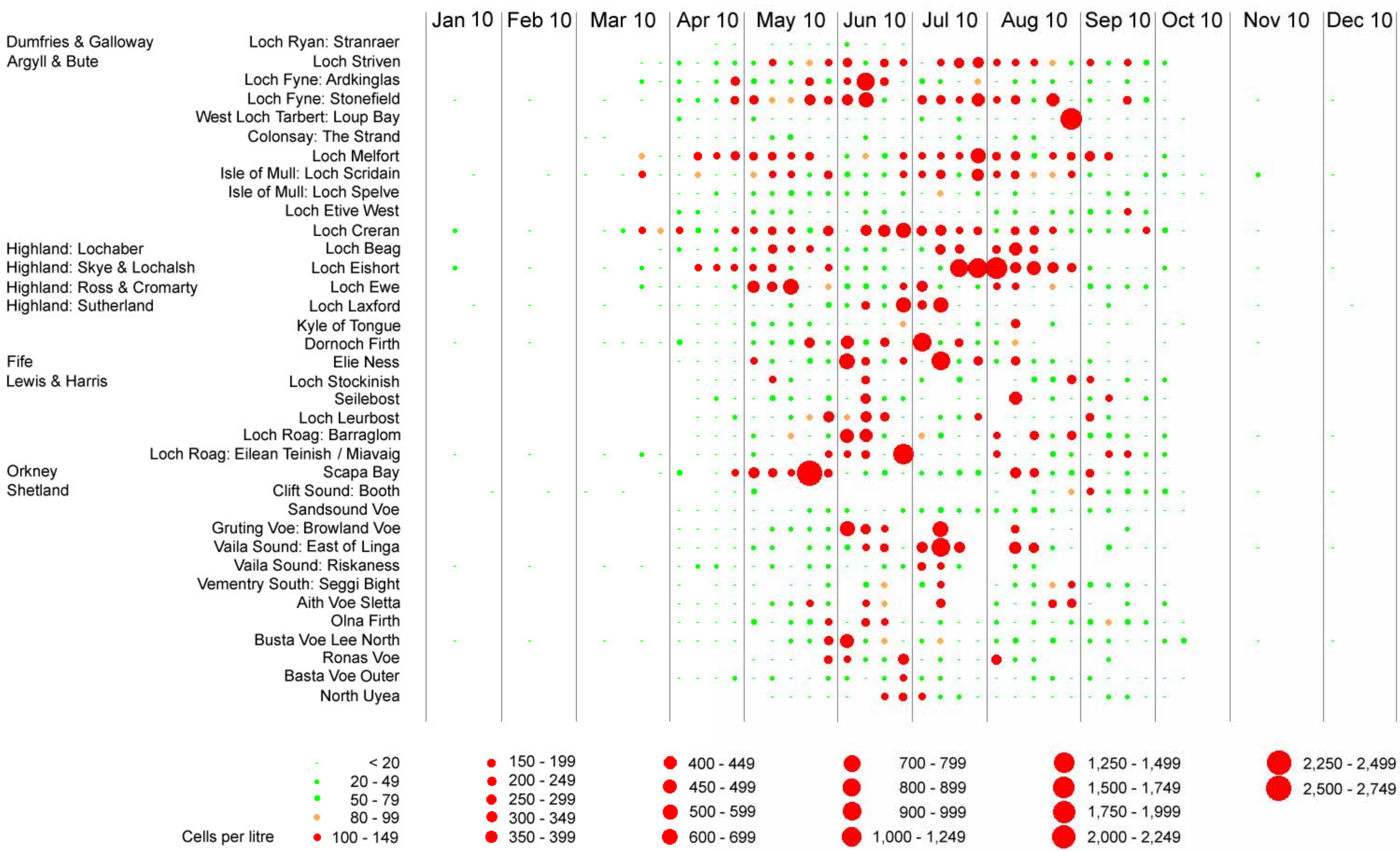


Figure 16. Phytoplankton concentrations observed between Jan-10 and Dec-10 for *Dinophysis* spp.



Summary by species

Pseudo-nitzschia spp.

The diatom *Pseudo-nitzschia* was present in almost 90% samples analyzed as part of the monitoring programme during 2010, and occurred above threshold level (50,000 cells per litre) in more than 16% of all the samples, compared with 8%, 10%, 13% and 12% of samples recorded above threshold for 2006, 2007, 2008 and 2009, respectively. Blooms were most abundant in September (Figure 13). Dense *Pseudo-nitzschia* concentrations were considerably more abundant at monitoring sites in Argyll & Bute during 2010, compared with 2009.

Similar to 2009, a *Pseudo-nitzschia* bloom was first recorded in 2010 on the Scottish east coast around Dornoch Firth in early March (Figure 14). This bloom reached a maximum density on 15-March, with a cell count of 484,485 cells per litre. An early bloom also occurred in Shetland (Clift Sound: Booth) in mid March. The early spring (March/April) blooms were dominated by *Pseudo-nitzschia delicatissima* type cells and no ASP toxicity was reported. Toxic blooms were present around Shetland and Argyll during May.

Blooms continued to develop around Shetland throughout June and were also evident around the Western Isles and west coast of Sutherland. These blooms were mostly composed of *Pseudo-nitzschia delicatissima* type cells and appeared to be non-toxic. However, a bloom of >0.5 million cells per litre occurring in Busta Voe on 28-June did have low levels of associated ASP toxicity (Figure 18b). Also of note was a mixed species bloom that developed in Loch Fyne: Stonefield in June, with a maximum density of 452,080 cells per litre observed on 28-June. This resulted in detectable levels of ASP toxicity in queen scallops during the following three months (Figure 18a). Common mussels were not tested for ASP due to site closure resulting from the prolonged presence of DSP in this species (CEFAS biotoxin data).

The largest recorded *Pseudo-nitzschia* bloom in 2010 was seen in SW Shetland (Vaila Sound: East of Linga) in mid July, with a maximum density of > 3.5 million cells per litre recorded on 12-July (Figure 17). Cell counts had been recorded at a density of 23,760 cells per litre the preceding week at this site, and the rapid development of this bloom would suggest that, assuming a growth rate of 0.55 d^{-1} (Fehling *et al.* 2004b), the rate of increase of cell abundance was greater than would be possible by vegetative growth alone. Local hydrography is likely to have been a factor in concentrating cells into the surface waters. A *Pseudo-nitzschia* bloom of similar density also developed in nearby Browland Voe, with a maximum cell density of > 3.2 million cells per litre on 13-July. These blooms were dominated by *Pseudo-nitzschia delicatissima* type cells of unknown toxicity. However, a toxic *Pseudo-nitzschia seriata* type bloom was present in nearby Vaila Sound: Riskaness, with a bloom maximum of >1.8 million cells per litre reached on 19-July and associated ASP toxicity of 2 µg/g in mussel tissue collected at the time (CEFAS data). Toxic *Pseudo-nitzschia seriata* type blooms also occurred in Argyll (Lochs Creran and Melfort) in July (Figure 18a).

Elsewhere in Scotland, cell counts were above threshold level for the whole of July in Scapa (Orkney), with a maximum density of >2 million cells per litre reached on 13-July. Non-toxic blooms of *Pseudo-nitzschia delicatissima* type cells occurred during early summer around the NW Highlands (Ross & Cromarty: Loch Ewe; Sutherland: Loch Laxford). Blooms were widespread throughout the summer months and into autumn in Argyll, particularly around the Isle of Mull (Loch Scridain and Loch Spelve), with some extended periods of above-threshold cell counts. CEFAS reported low-level ASP toxicity in common mussels from Loch Melfort and Loch Spelve during the autumn (Figure 18a). Less dense blooms were also recorded in Shetland (Olna Firth and Busta Voe) throughout the whole of September and into October, with some low level ASP toxicity reported towards the end of the bloom period.

A second bloom period occurred in September around the NW Highlands (Ross & Cromarty: Loch Ewe; Sutherland: Loch Laxford) and also around the Isle of Skye: Loch Eishort. The

September bloom in Loch Laxford reached a density of 277,448 cells per litre with both *P. seriata* and *P. delicatissima* type cells being present in approximately equal proportions. This bloom was associated with ASP toxicity in common mussels at 7 µg/g (CEFAS data), the highest reported value for any of the phytoplankton monitoring sites in 2010. Although the bloom was present in Loch Eishort from early September into mid October and was dominated by *P. seriata* type cells, no ASP toxicity was reported from this site. Two discreet bloom periods were noted around Lewis & Harris on both the east and west coasts, occurring in June and early autumn, similar to those on the other side of The Minch (Lochs Ewe and Laxford), with low levels of toxicity occurring at some sites.

Although the 2010 *Pseudo-nitzschia* bloom events followed the typical pattern of spring and early summer (March to June) domination by *Pseudo-nitzschia delicatissima* type cells, with *Pseudo-nitzschia seriata* type cells being more abundant from mid summer onwards (Fehling *et al.*, 2006), some toxicity was associated with *P. seriata* type spring blooms in Loch Creran (19-May) and around Shetland (Aith Voe on 03-May; Basta Voe on 04-May (see Figure 19)). The mid-summer *Pseudo-nitzschia delicatissima* type blooms resulted in high cell counts and some ASP toxicity, although this seemed to be location specific. For example, the Shetland blooms composed of mainly *P. delicatissima* type cells were toxic in Sandsound Voe, Olna Firth and Busta Voe (Figure 19), but not in Ronas Voe nor Basta Voe (when ASP testing was performed). Some strains of *Pseudo-nitzschia delicatissima* type species, for example *P. calliantha*, are known to produce toxins and have been previously recorded around the Scottish coast (Fehling *et al.*, 2004b, 2006). Nutrient limitation of cell growth may also be a contributory factor to enhanced toxicity (Fehling *et al.* 2004b).

Ongoing research suggests that, on a local or regional basis, it may be possible to relate *Pseudo-nitzschia* blooms to water chemistry and meteorological conditions. Analysis of *Pseudo-nitzschia* blooms in Loch Creran (Argyll & Bute) over a number of years has suggested that these are related to periods of poor weather (low air pressure and rainfall preceding the blooms). While some degree of predicative power has been achieved for this location, as yet, generalization of these correlations to other sea lochs on a predictive basis has proved problematic.

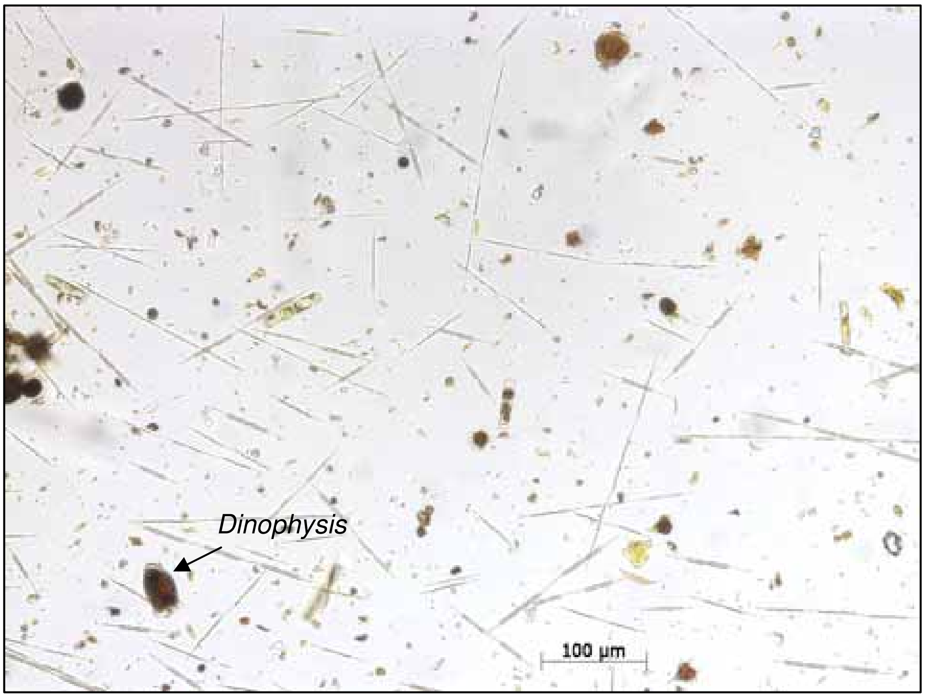


Figure 17. The *Pseudo-nitzschia* bloom in Vaila Sound: East of Linga on 12-July reached a concentration of over 3.5 million cells per litre and was dominated by *Pseudo-nitzschia delicatissima* type cells. *Dinophysis* was also present at a density of 960 cells per litre.

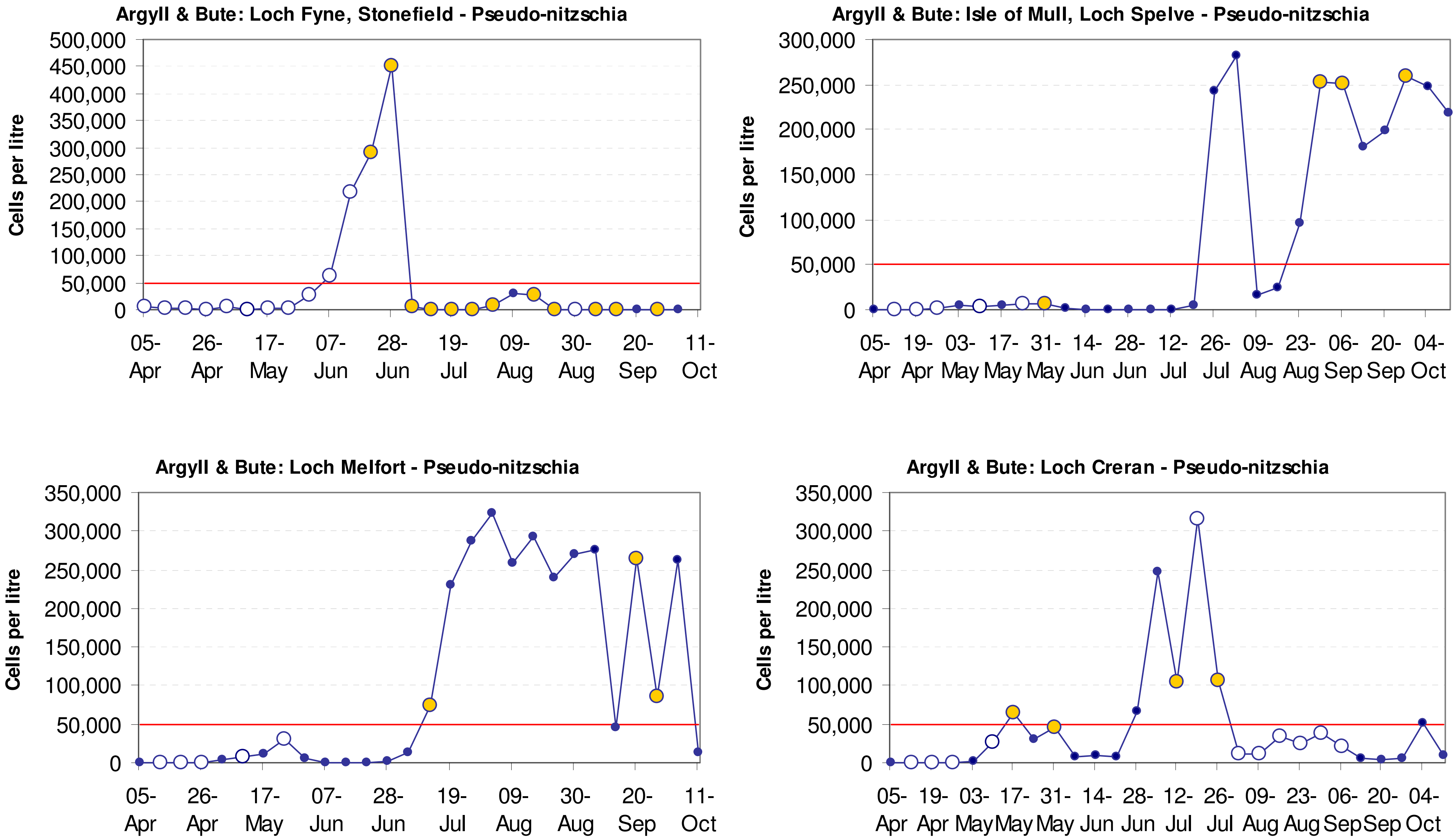


Figure 18a. See page 26 for figure legend. Note: ASP was detected in queen scallops from Loch Fyne, Stonefield (shown on graph). ASP analysis was not performed for common mussels from this site throughout most of the summer, due to the presence of DSP toxins (see Figure 21a).

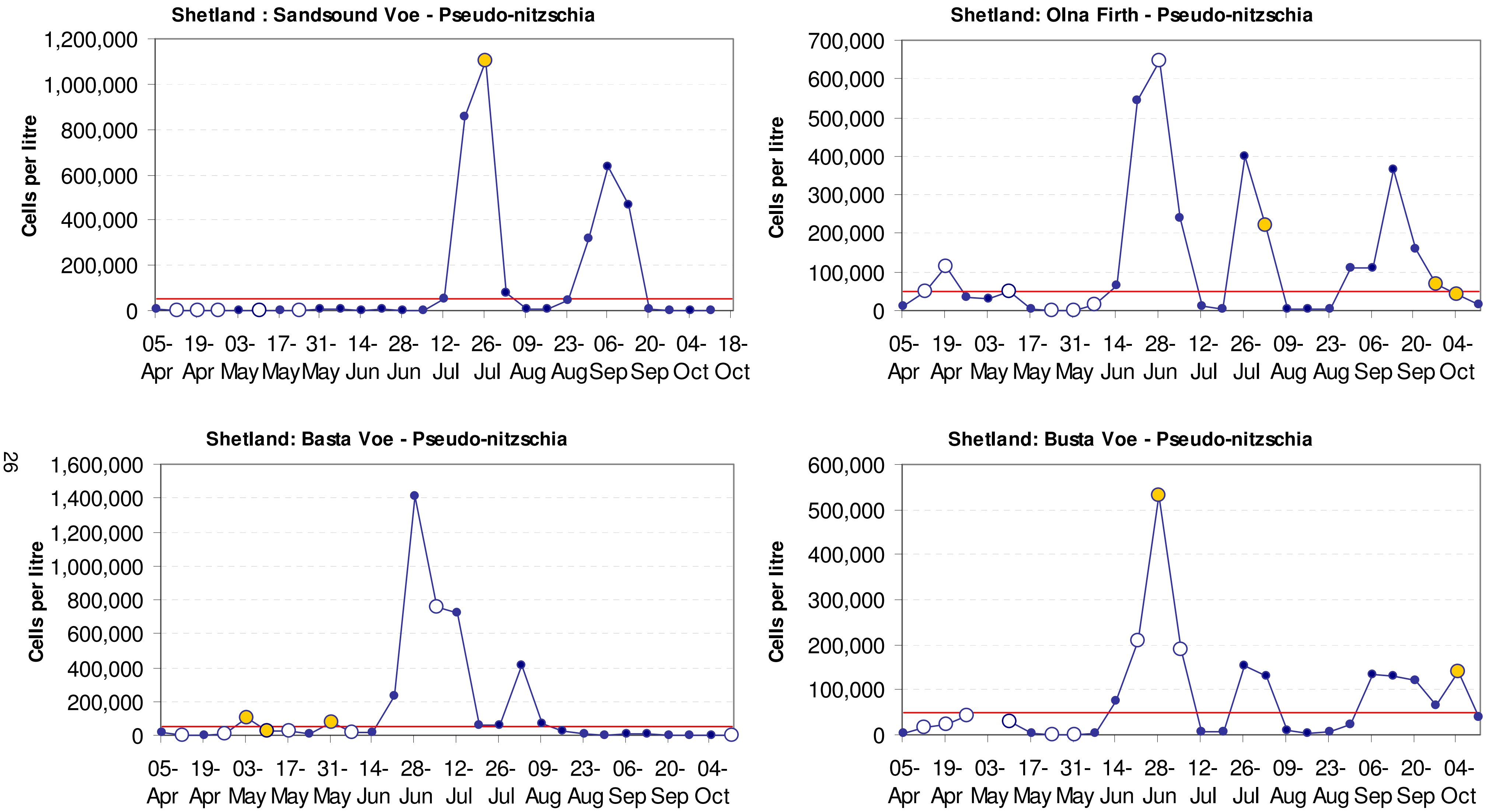


Figure 18b. Correlation between *Pseudo-nitzschia* cell counts and the presence of ASP toxins in shellfish tissue (indicated by ● when ASP toxins were detected above Limit of Quantification). The red line indicates the trigger level for this genus (50,000 cells per litre), above which ASP toxicity may be a problem. ○ indicates that an ASP biotoxin test was not performed. ASP toxin data collected by CEFAS, 2010.

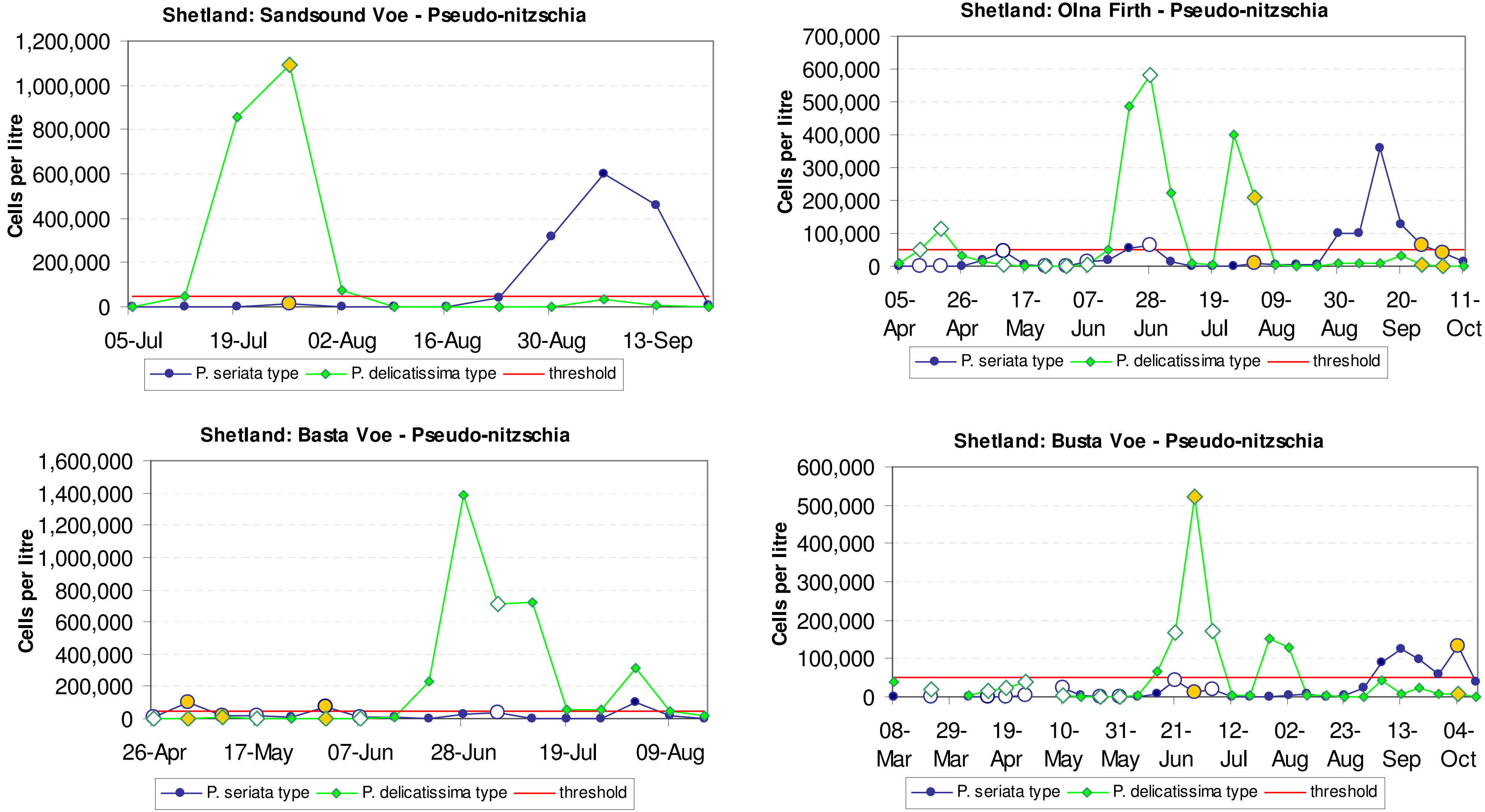


Figure 19. See Figure 18b legend. Although it is not possible to distinguish the genus *Pseudo-nitzschia* to species level using light microscopy, cells can be roughly categorized depending on whether the valve width is less than 3 µm (*P. delicatissima* type) or greater than 3 µm (*P. seriata* type). *Pseudo-nitzschia* blooms may be composed of different cell types, although one type often tends to dominate the bloom.

Alexandrium

Alexandrium spp. was observed in over 29% of the samples analyzed during 2010, a similar value to previous years (26% in 2006; 33% in 2007; 25% in 2008; 29% in 2009). It was most frequently observed in samples between April and June, occurring in 44% of all samples analyzed during May, and was also widespread in August (Figures 13 and 15).

The densest bloom recorded during 2010 was observed in Loch Creran (Argyll & Bute) and was present for a continuous period of eleven weeks from 10-March until 19-May, reaching a maximum cell density of 3,100 cells per litre on 05-May. However, screening of shellfish tissue using analytical methods (High Performance Liquid Chromatography (HPLC)) by CEFAS did not indicate any PSP toxicity associated with this bloom, and it is possible that the dominant species was the non-toxic *Alexandrium tamutum* (Figure 27). A non-toxic A*lexandrium* bloom of density 1,360 cells per litre occurred in West Loch Tarbert: Loup Bay on 30-August. The *Alexandrium* cells were mostly small in size (cf *minutum* or *tamutum*), although *Alexandrium tamarense* was also present.

Alexandrium was also observed during March in Loch Striven and Loch Scridain, and was detected in Loch Striven for a continuous period of nine weeks from 30-March until 25-May, with a maximum of 520 cells per litre on 27-April. Some shellfish toxicity was detected in the weeks following the bloom peak, as cell numbers were decreasing (Figure 20a). The blooms in both Loch Fyne: Stonefield and Loch Scridain also had associated PSP toxicity during April, with toxic *Alexandrium* sporadically present in Loch Scridain for much of May and June.

Alexandrium was recorded sporadically around the Highland region from early March through into October and although bloom concentrations were never particularly dense, low levels of PSP toxins were reported from mid March onwards, with quantifiable amounts reported in late March and in May from common mussels in Loch Beag, and also in mid June from Loch Ewe. Toxic *Alexandrium* was present on several occasions in Loch Eishort, occurring in March, May and July, and was widespread further up the NW coast at Loch Laxford and Kyle of Tongue, and also on the east coast in Dornoch Firth during May.

Alexandrium was detected in almost two-thirds of the Shetland samples analyzed in May and June. Some PSP toxicity was reported in common mussels from Aith Voe in late May, associated with a bloom that reached a density of 280 cells per litre on 31-May. *Alexandrium* was detected from early May for a continuous period of seven weeks in nearby Busta Voe, with a bloom maximum of 600 cells per litre on 07-June (Figure 20b). Quantifiable levels of PSP toxins were reported at this site on 14-June at 47 µg/100g (CEFAS data), the highest reported value for any of the phytoplankton monitoring sites in 2010.

The 2010 *Alexandrium* data from Scottish coastal monitoring sites would suggest that similar to the 2009 pattern, relatively low-density toxic strains were widespread through April and May, particularly in Argyll & Bute and around the Highlands. Toxic blooms were also present in parts of Shetland in late May and June, although no large non-toxic blooms were observed on the same scale as those of July 2009, when cell densities reached more than 60,000 cells per litre. A comparison of the data from the phytoplankton monitoring with those from CEFAS HPLC screening would suggest that in many cases, *Alexandrium* was present in the water column prior to PSP toxins being detected in shellfish tissue. Although the delay in the accumulation of PSP toxins in harmful quantities may be affected by the rate of filter feeding in bivalves (and indeed the availability of other non-toxic food sources), mussels are known to accumulate PSP toxins faster than most other species of shellfish and also eliminate the poisons quickly (FAO, 2004). Nutrient limitation (usually phosphorous) has been associated with elevated toxicity of *Alexandrium* species (Touzet *et al.*, 2007; John & Flynn, 2000), and it may be that there is a delay in the production of toxin by the algal cells, possibly as a result of nutrient limitation.

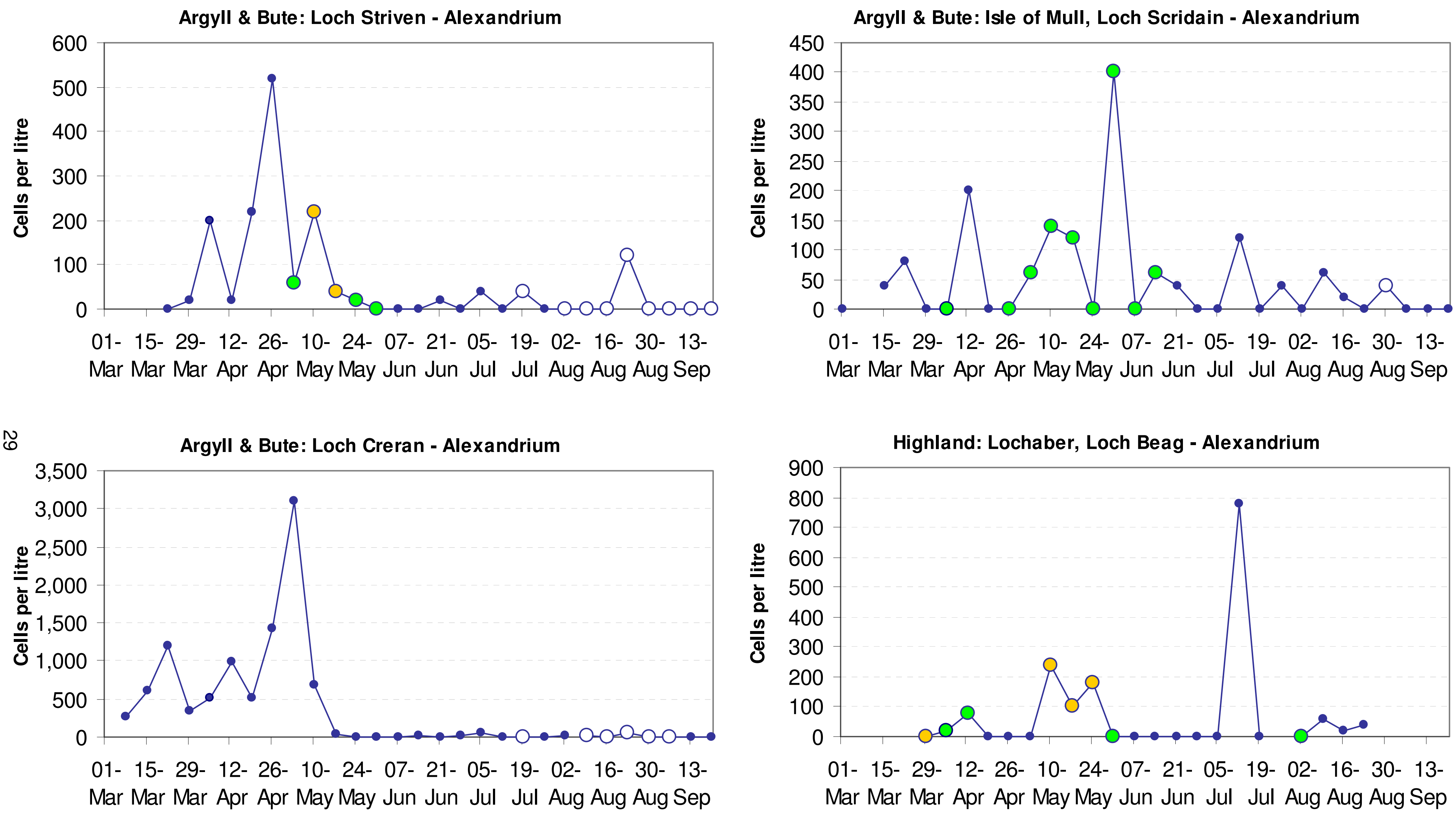


Figure 20a. See page 30 for figure legend.

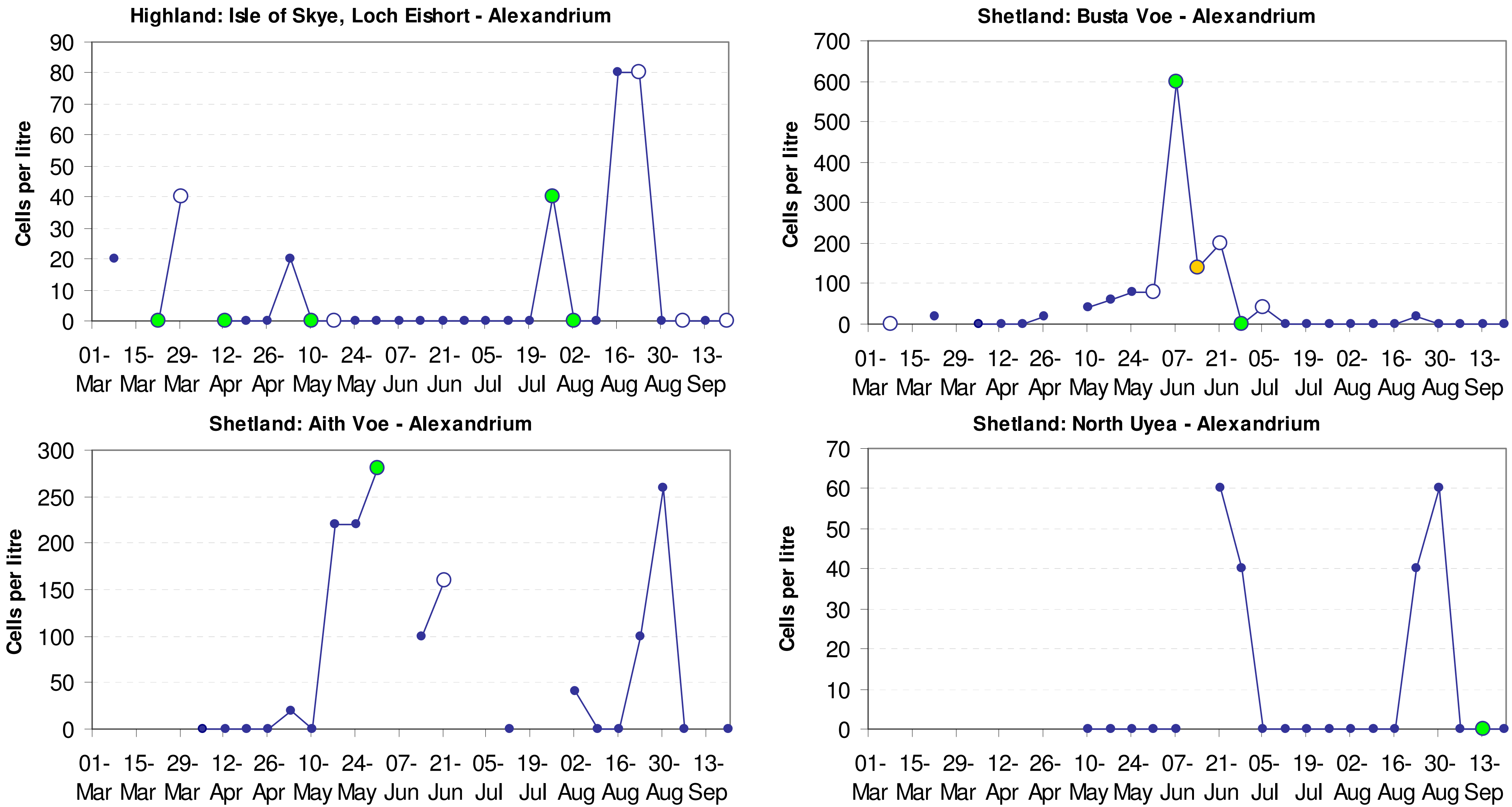


Figure 20b. Correlation between *Alexandrium* cell counts and the presence of PSP toxins, as measured by analytical methods (data collected by CEFAS) during 2010. Positive results are indicated by ● where PSP toxins were detected, or ● where quantitative measurements of PSP toxins were determined. PSP toxins did not exceed the permitted level of 80µg/100g in shellfish tissue. ○ indicates that a PSP biotoxin test was not performed on tissue collected by the biotoxin monitoring programme. This was occasionally due to site closure because of the presence of DSP toxins.

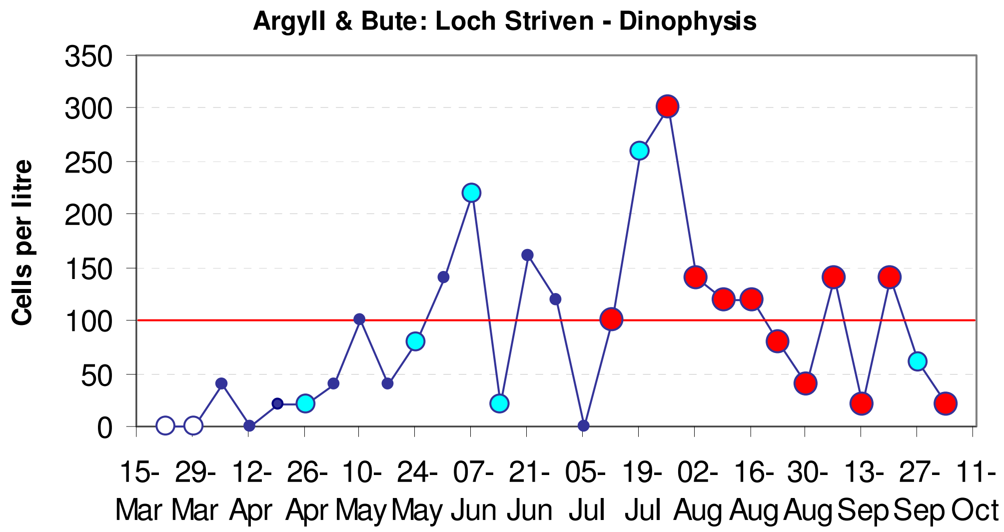
Dinophysis spp.

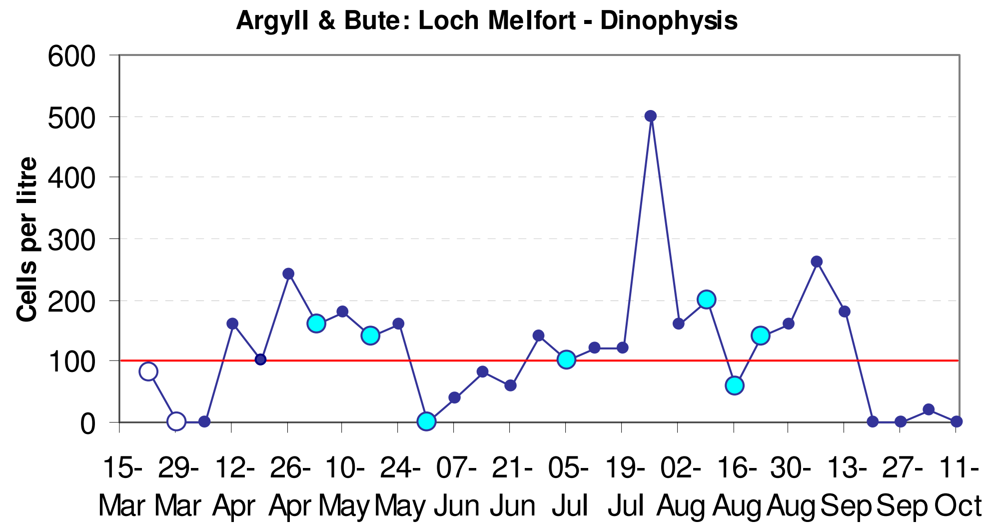
The dinoflagellate *Dinophysis* was present in almost 55% of the samples analyzed during 2010, and occurred above threshold level (100 cells per litre) in over 20% of the total samples (Figure 16), compared with the 19%, 13%, 6% and 15% recorded above threshold for 2006, 2007, 2008 and 2009, respectively. Although not routinely identified to species level, *Dinophysis acuminata* was the most commonly observed species.

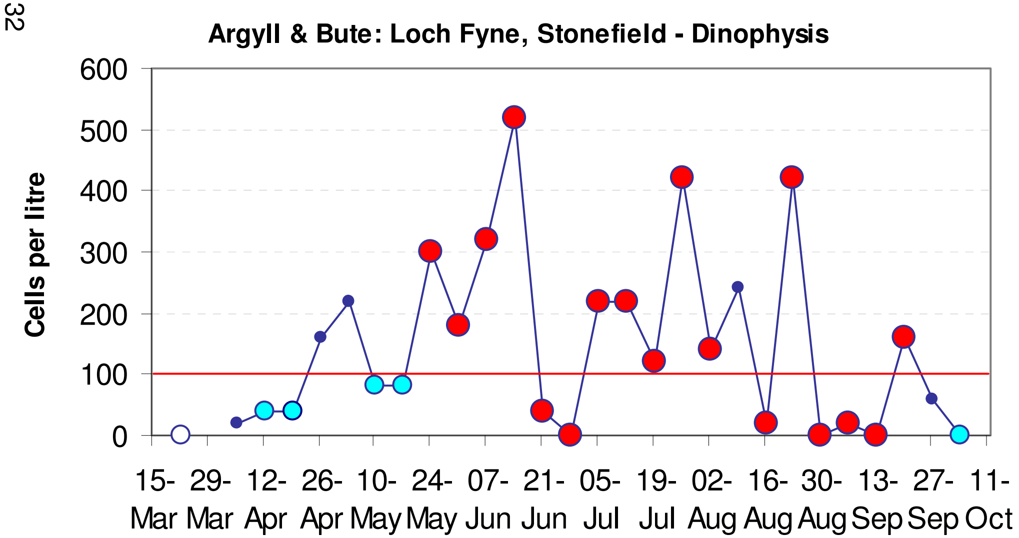
During 2010, *Dinophysis* was not observed in blooms on the same scale as those seen around Argyll & Bute during 2009. It was first recorded in concentrations likely to be harmful in late March 2010 around Argyll & Bute in Loch Creran and Loch Scridain (Isle of Mull), and was frequently observed in Loch Striven, Loch Fyne, Loch Melfort, Loch Scridain and Loch Creran throughout the summer months, with prolonged DSP toxic events in Loch Striven, Loch Fyne: Stonefield and Loch Creran (Figure 21a,b).

Figures 13 and 16 show that above-threshold *Dinophysis* counts were most prevalent from May to August. In Scapa Bay (Orkney), *Dinophysis* was recorded above threshold level throughout the whole of May, and cells reached a peak abundance of 2,520 cells per litre on 24-May, the highest recorded at any of the Scottish monitoring sites during 2010. *Dinophysis* was also abundant around the Western Isles in June, with the highest count for the region of 1,300 cells per litre occurring in Loch Roag: Eilean Teinish on 28-June. In the Highland region, *Dinophysis* counts in Loch Eishort (Isle of Skye) were above threshold for seven consecutive weeks from mid July, with a maximum count of 1,620 cells per litre recorded on 02-August, and a subsequent DSP toxic event following the bloom peak (Figure 21b). *Dinophysis* was most abundant around Shetland in late May, June and July, with several DSP toxic events occurring in late May and June. The highest recorded count for Shetland was 960 cells per litre in Vaila Sound: East of Linga on 12-July. *Dinophysis* blooms also reached their peak abundance on the east coast of Scotland in July, with a maximum of 940 and 900 cells per litre, recorded on 05-July and 12-July at Dornoch Firth and Elie (Fife), respectively. *Dinophysis* was abundant and DSP toxic events were widespread around the country in August, and there was an exceptional bloom in West Loch Tarbert: Loup Bay on 30-August, with a maximum *Dinophysis* cell count of 1,720 cells per litre.

The biotoxin data available suggest that DSP positive results were often preceded by an increased concentration of *Dinophysis* observed in the phytoplankton samples (Figure 21). However, the link between the presence of known DSP toxin producers (*Dinophysis* and *Prorocentrum lima*) in the water column and DSP toxicity in shellfish is not always clear. Positive DSP events were occasionally reported by CEFAS, particularly around Shetland in spring that did not appear to be associated with the presence of these algae, a similar pattern to that which occurred around Shetland in 2009, although to a lesser extent in 2010. A recent study in the Black Sea (Morton *et al.*, 2009) found that although the presence of *Dinophysis* in mussel hepatopancreas and in the plankton was often correlated, there were occasions, particularly after stormy weather, when it could be found in the mussels but not in the water column.







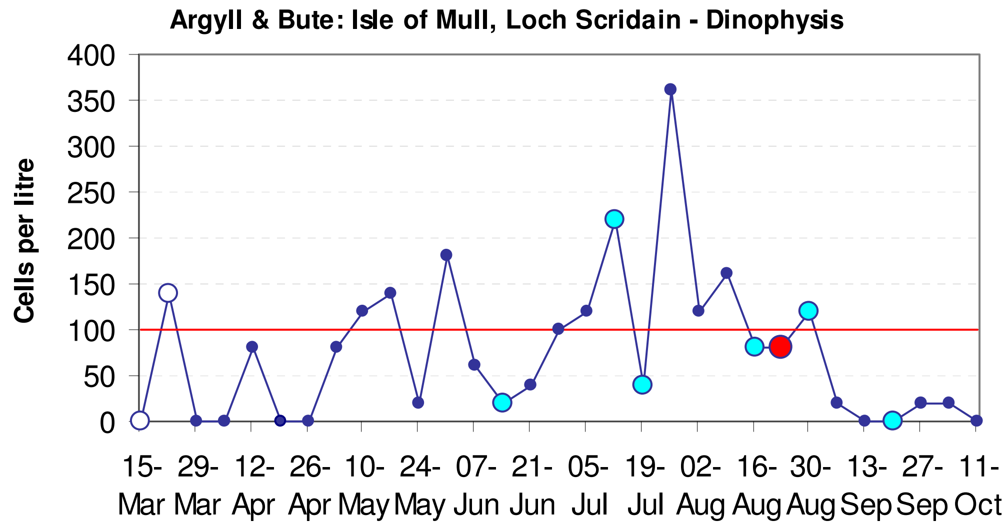


Figure 21a. See page 33 for figure legend.

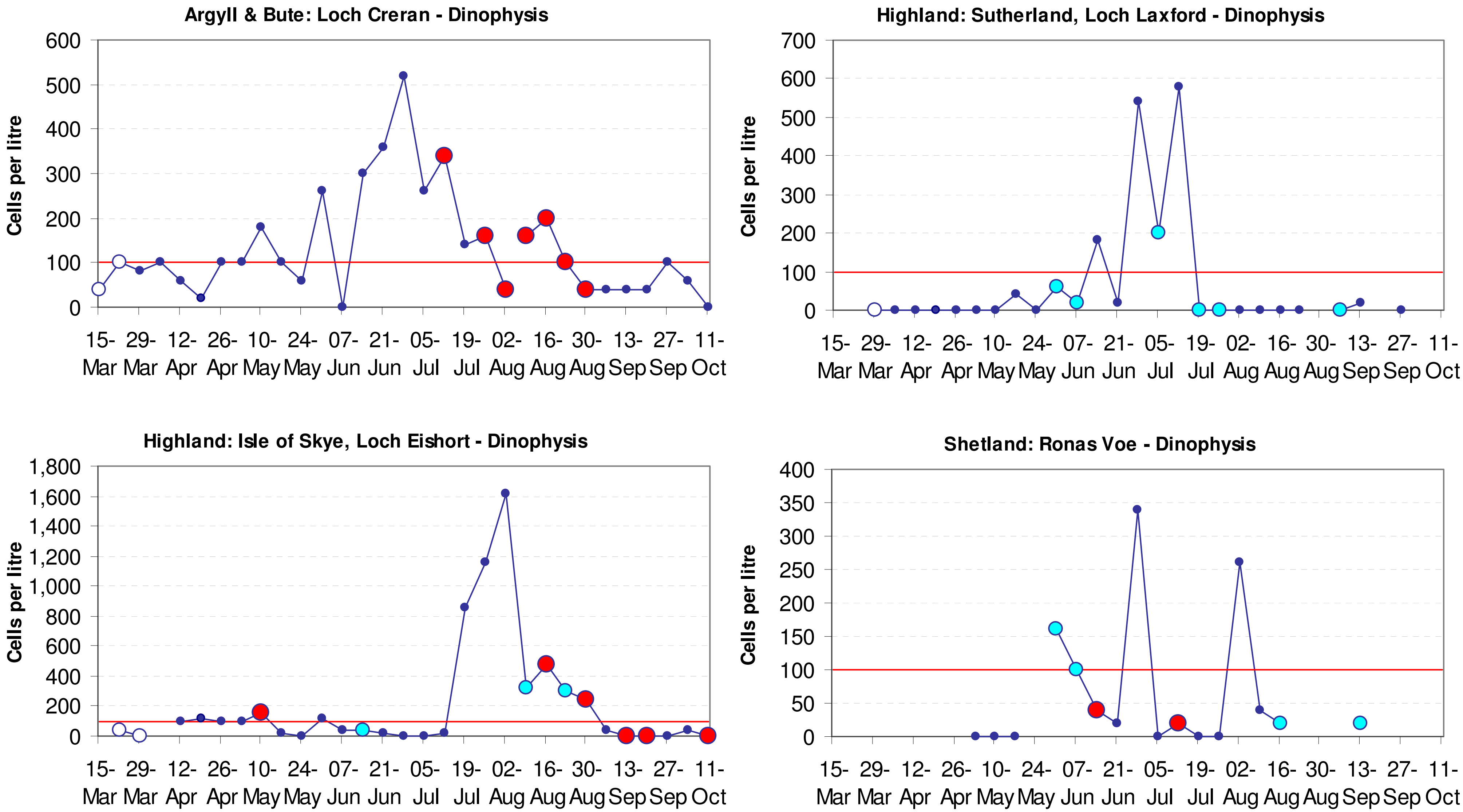


Figure 21b. Correlation between *Dinophysis* cell counts in 2010 and positive DSP toxin results in shellfish tissue (indicated by red circle), or by cyan circle where clinical signs were observed during the bioassay. The trigger level for *Dinophysis* is 100 cells per litre (indicated by the red line), above which DSP toxicity may be a problem. The DSP biotoxin data was collected by CEFAS.

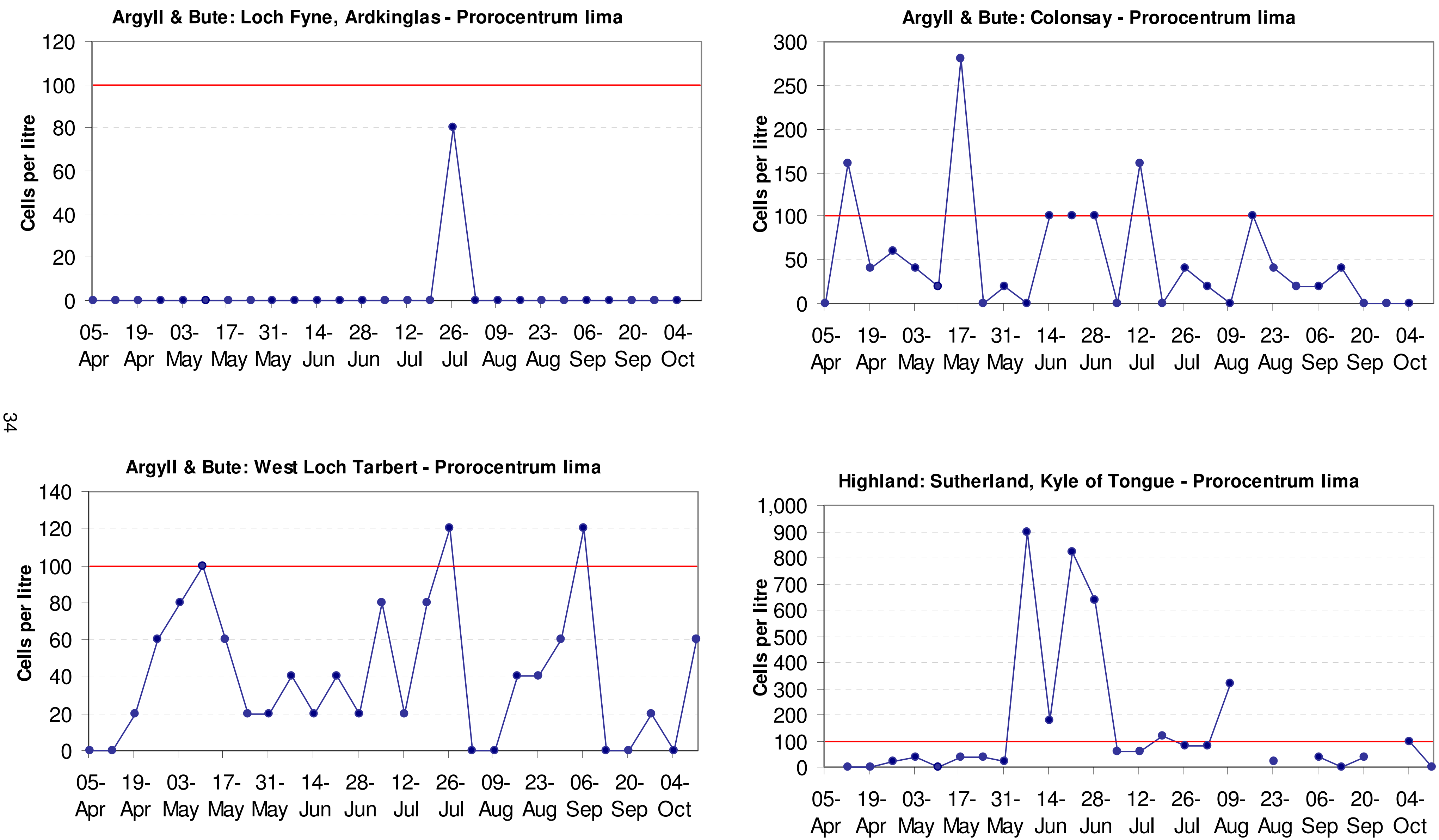


Figure 22a. See page 35 for figure legend.

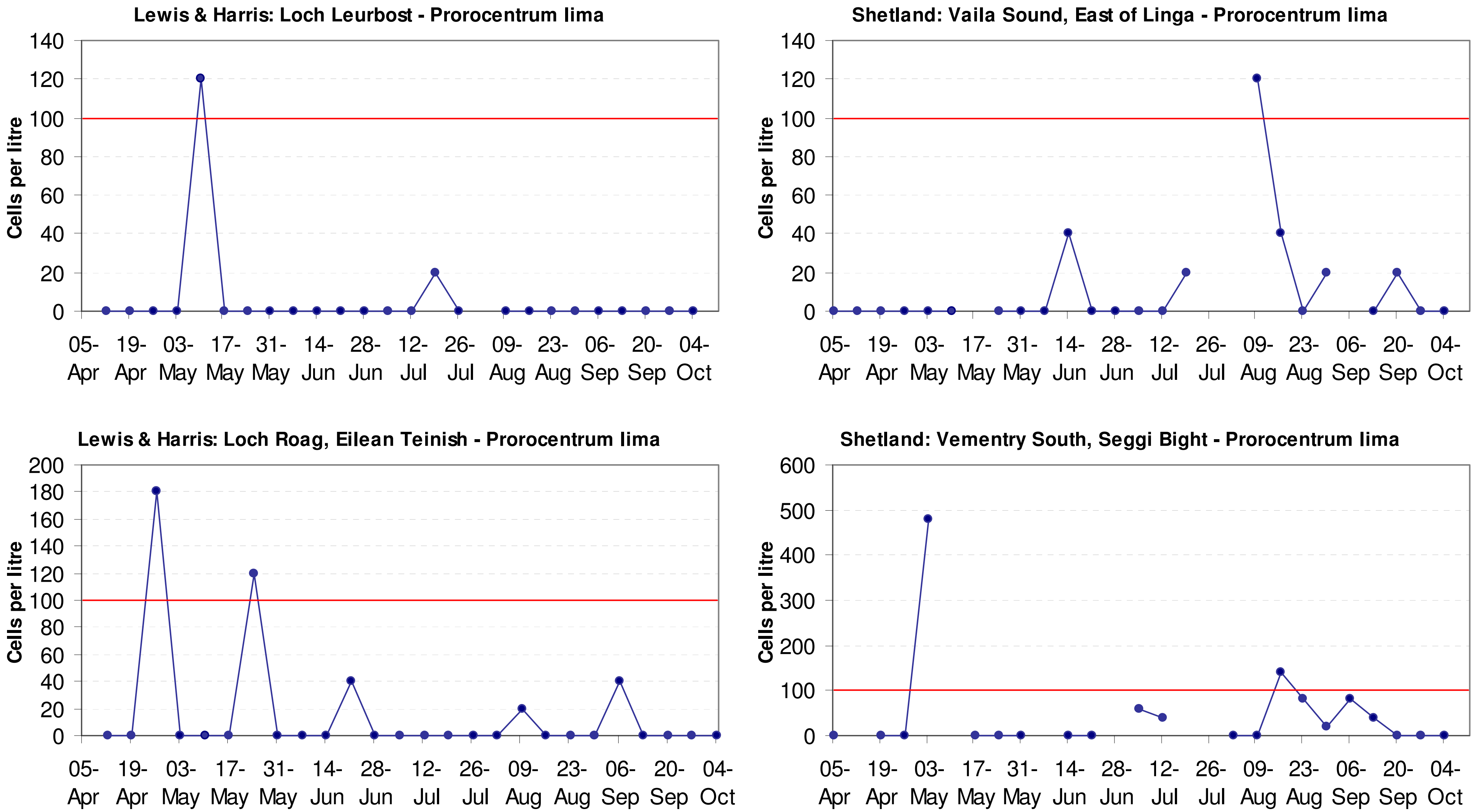


Figure 22b. *Prorocentrum lima* was frequently observed at a number of sites, although it is not always seen in the plankton. This species has been associated with the production of DSP toxins and the trigger level is 100 cells per litre (indicated by the red line), above which toxicity may be a problem.

Prorocentrum lima

Prorocentrum lima, associated with the production of DSP toxins, was observed in relatively low numbers during 2010, often occurring at the same sites from where it was reported in 2009. It was present in almost 19% of all samples analyzed, but exceeded threshold level (100 cells per litre) in only 3% of samples. Above-threshold levels occurred at eight of the monitoring sites and were recorded from mid April into early October. The maximum density was recorded from Kyle of Tongue, with a concentration of 900 cells per litre on 07-June (Figure 22a). Cell counts were very variable between sampling weeks, but due to the epiphytic nature of this organism, it is unlikely that abundance in the water column is a true reflection of the actual abundance of this species. Both Levasseur *et al*. (2003) and Morton *et al*. (2009) identified *P. lima* cells in the digestive glands of mussels, even when they had not been detected in the water column.

Prorocentrum minimum

Prorocentrum minimum was observed at many of the monitoring sites from early March through to mid October in 2010, and was present in more than 41% of the samples analyzed. Blooms were not particularly dense, but cells were most abundant from mid April to early June. A maximum count of 160,962 cells per litre was recorded at Loch Fyne: Ardkinglas on 17-May (Figure 23a). This was the densest bloom of *Prorocentrum minimum* around the Scottish coast in 2010. *Prorocentrum minimum* was also recorded in Vaila Sound: East of Linga on 09-June, with a count of 133,848 cells per litre (Figure 23b).

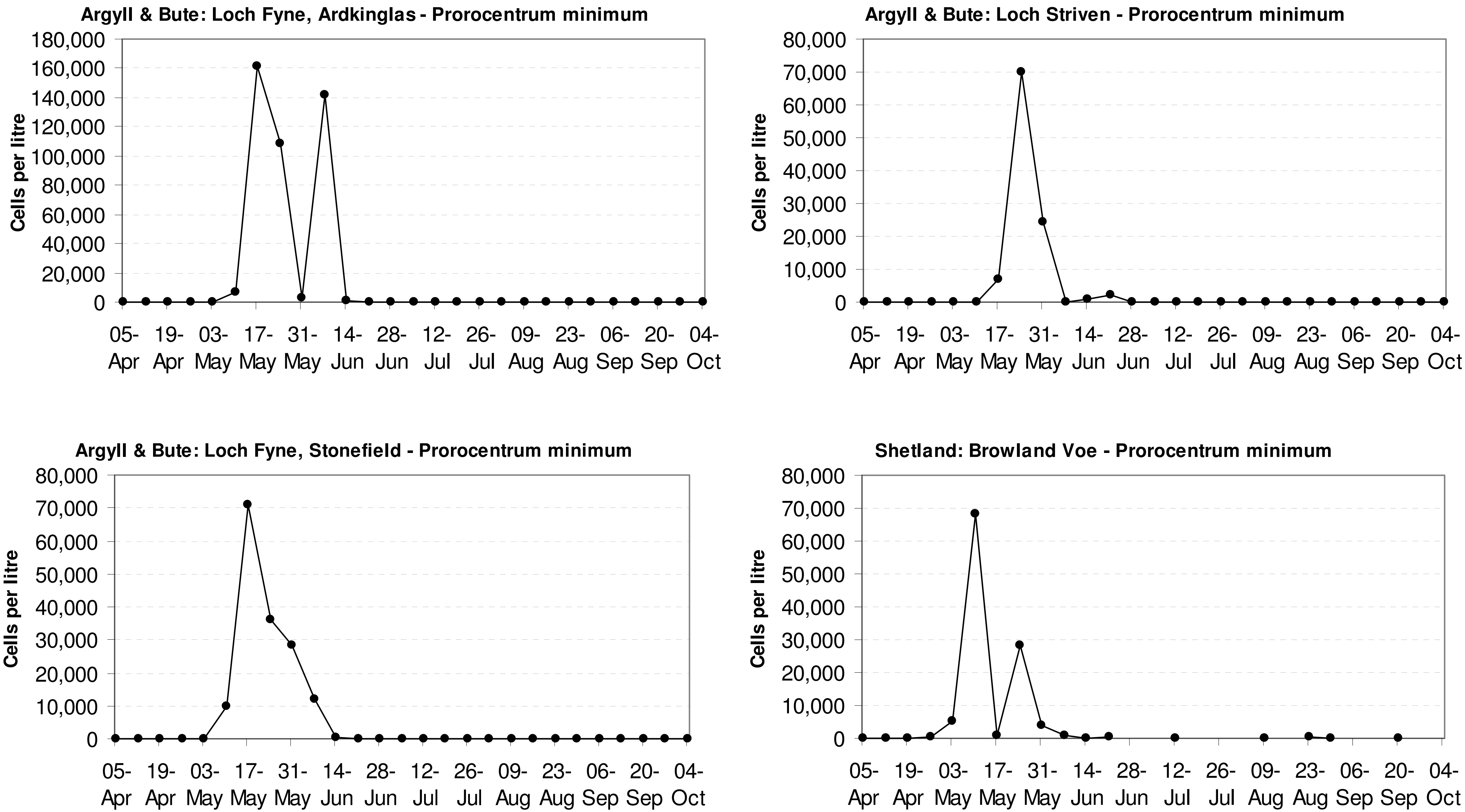


Figure 23a. See page 38 for figure legend.

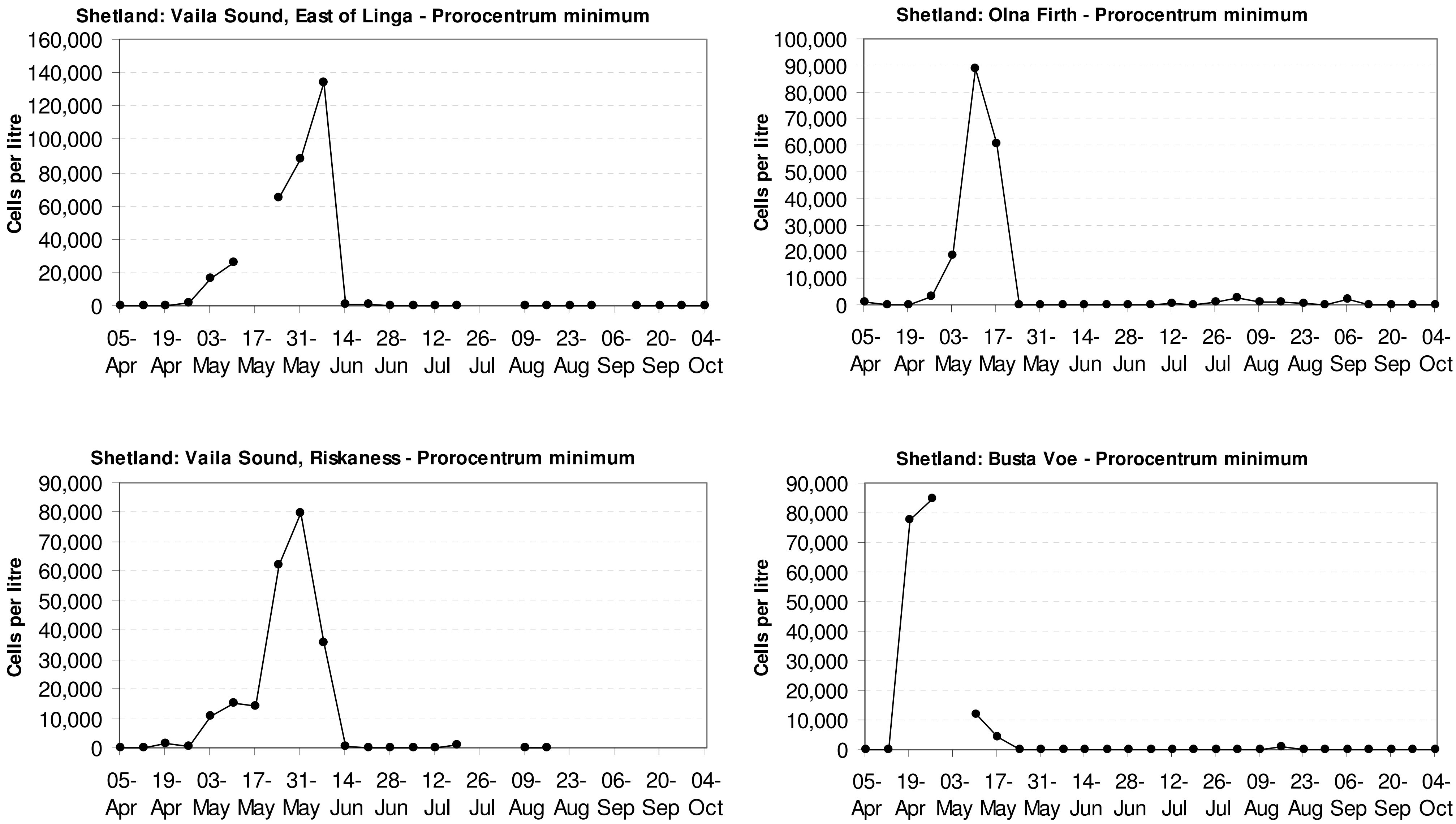
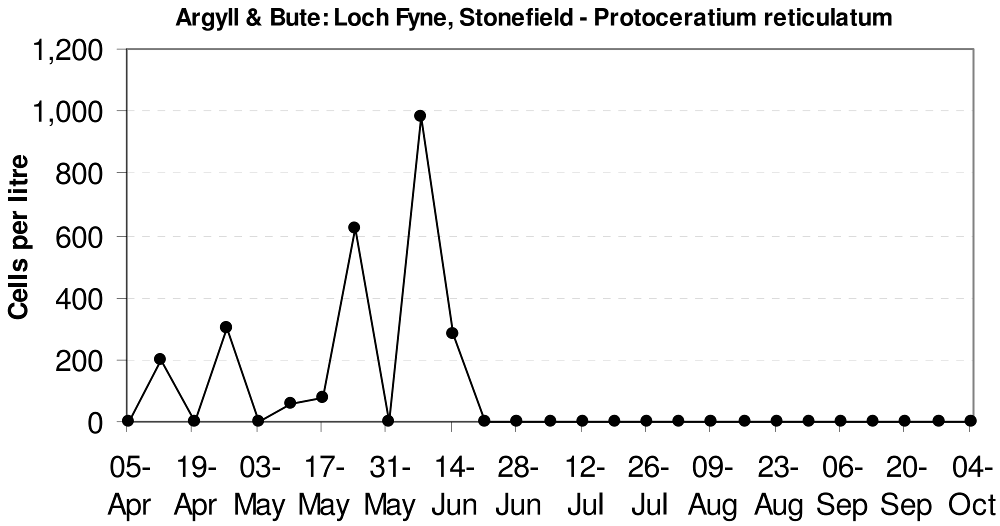


Figure 23b. *Prorocentrum minimum* can bloom in high densities and was particularly abundant during May.

Other harmful species

Similar to 2009, *Protoceratium reticulatum* was recorded at low concentrations in approximately 4% of the samples analyzed during 2010, mostly around Argyll & Bute and the Highlands. It was seen in Loch Creran, Loch Fyne (Stonefield and Ardkinglas), Loch Melfort and Loch Scridain from May through to September, with the largest recorded concentration of 1,500 cells per litre in Loch Creran on 07-July.



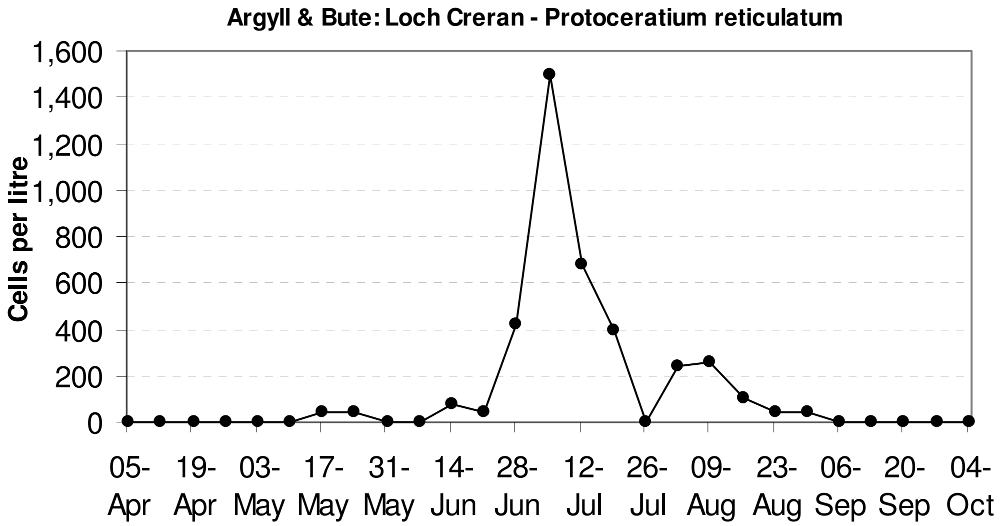


Figure 24. The dinoflagellate *Protoceratium reticulatum* recorded in Loch Fyne: Stonefield and Loch Creran in 2010. The data from 2009 from these two sites show almost identical profiles for *Protoceratium reticulatum*, although cell counts were slightly higher in 2010.

Lingulodinium polyedrum was observed at three monitoring sites during 2010, two of which were in Argyll & Bute (Loch Creran and West Loch Tarbert). A prolonged bloom developed in Loch Creran from late June and dissipated around mid September, with a maximum abundance of 2,100 cells per litre reached on 01-September (Figure 25). *Lingulodinium polyedrum* was also recorded on one occasion in Highland: Loch Ewe on 07-June at a density of 40 cells per litre.

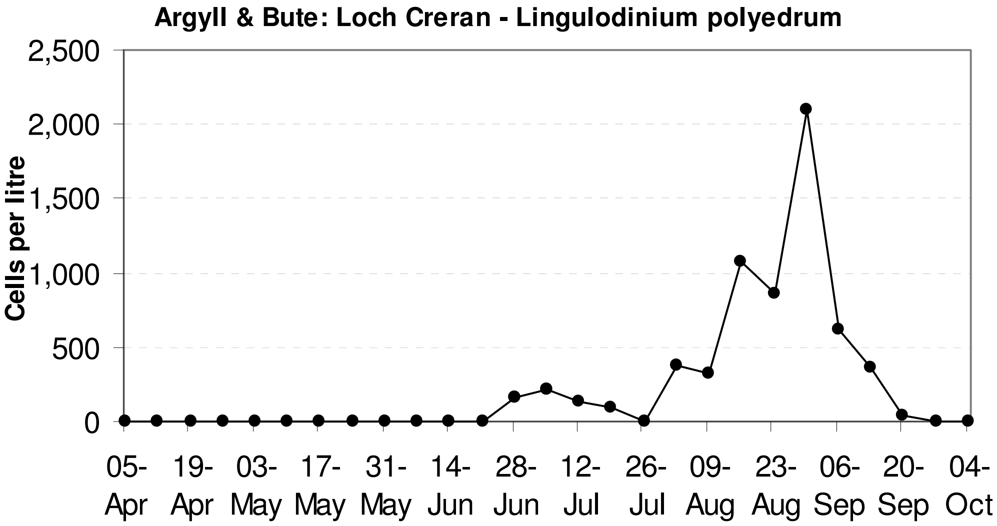


Figure 25. Development of a bloom of the dinoflagellate *Lingulodinium polyedrum* in Loch Creran. The bloom peak occurred on 01-September-10, with a density of 2,100 cells per litre. This bloom was less dense then that recorded in Loch Creran in 2009, which had a maximum abundance of 23,680 cells per litre on 02-September-09.

Although phytoplankton belonging to the genus *Protoperidinium* were frequently observed in all samples throughout the year, *Protoperidinium crassipes* was relatively rare, occurring in less than 3% of the samples analyzed. The maximum abundance was recorded from Loch Ewe (Highland: Ross & Cromarty), with a count of 220 cells per litre on 06-September.

Summary by area

Dumfries & Galloway

A total of 10 samples were obtained from Loch Ryan between April and June 2010. *Pseudo-nitzschia* counts remained below threshold level throughout the reporting period, with a maximum *Pseudo-nitzschia* count of 4,400 cells per litre on 23-June. *Alexandrium* was not observed throughout the sampling period, and *Dinophysis* was only recorded on one occasion, with a density of 20 cells per litre noted on 09-June. However, no samples were obtained from July onwards, and it may be that as in 2009, these dinoflagellates were present later on in the year.

Argyll & Bute

A total of 306 samples were obtained from 10 sites during the reporting period. Dense *Pseudo-nitzschia* concentrations were considerably more abundant at monitoring sites in Argyll & Bute during 2010, compared with 2009. Blooms were widespread throughout the summer months and into autumn, with some extended periods of above-threshold cell counts. The largest bloom observed in the region occurred in Loch Scridain on 14-September, where a density of 535,834 cells per litre was recorded. A bloom was present above threshold levels in Loch Fyne: Stonefield throughout the whole of June, with a maximum density of 452,080 cells per litre observed on 28-June. The bloom was predominantly *Pseudo-nitzschia delicatissima* type cells, which varied between 60% and 80% of the total. This bloom resulted in detectable levels of ASP toxicity in queen scallops from late June through to late September. Common mussels were not tested for ASP as the site was closed due to the prolonged presence of DSP reported in this species (CEFAS biotoxin data). Low levels of ASP toxicity were reported in common mussels from Loch

Creran in mid May and again in July. *Pseudo-nitzschia seriata* type cells dominated the blooms on both these occasions (see Figure 26). Toxic *Pseudo-nitzschia* also occurred at Colonsay in July and in Loch Melfort during July and September. High *Pseudo-nitzschia* cell counts were recorded for 13 consecutive weeks in Loch Melfort, from 14-July until 04-October. Both *Pseudo-nitzschia* types were present throughout, although *Pseudo-nitzschia seriata* type cells were most frequently observed. A predominantly *Pseudo-nitzschia seriata* type bloom that developed in Loch Spelve from mid August and remained at above threshold levels into late October also had associated ASP shellfish toxicity (see Figure 18a).

Alexandrium was observed on at least one occasion at all monitoring sites in the Argyll & Bute region during 2010. Cells were observed during March in Loch Striven, Loch Scridain and Loch Creran. A bloom developed in Loch Creran and was present for a continuous period of eleven weeks from 10-March until 19-May, reaching a maximum cell density of 3,100 cells per litre on 05-May. This was the highest *Alexandrium* cell density recorded in the Argyll & Bute region, and indeed the whole of Scotland, in 2010. However, PSP toxicity was not reported in shellfish, and it is possible that although there were several *Alexandrium* species present, the bloom was dominated by the non-toxic *Alexandrium tamutum* (Figure 27). *Alexandrium* was present in Loch Striven for a continuous period of nine weeks from 30-March until 25-May and although cell densities were lower than in Loch Creran, with a maximum of 520 cells per litre on 27-April, CEFAS HPLC screening detected low levels of PSP toxicity. Figure 20a shows that shellfish became toxic in the weeks following the bloom peak, as cell numbers were decreasing. Spring blooms of *Alexandrium* in Loch Fyne: Stonefield and Loch Scridain also had associated PSP toxicity, with toxic *Alexandrium* sporadically present in Loch Scridain for much of April, May and June. A maximum *Alexandrium* count of 400 cells per litre was recorded in Loch Scridain on 01-June. *Alexandrium* present at a concentration of 60 cells per litre on 04-August in Loch Melfort resulted in low-level shellfish toxicity the following week.

Figure 26. A bloom of predominantly *Pseudo-nitzschia seriata* type cells developed in Loch Creran in July, with low levels of ASP toxicity reported.

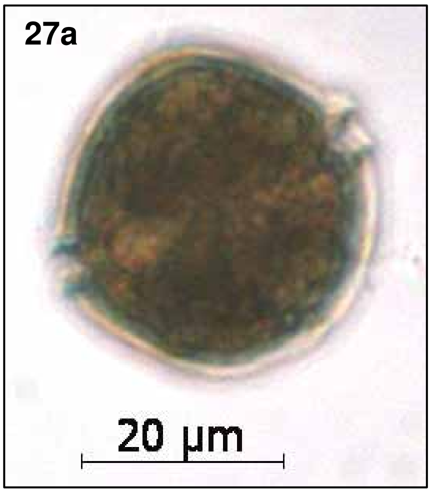


Figure 27a. An *Alexandrium tamutum* cell identified from the prolonged bloom in Loch Creran. Although it was not possible to examine all the cells, the majority had the small, slightly elongate form of the non-toxic *Alexandrium tamutum* group.

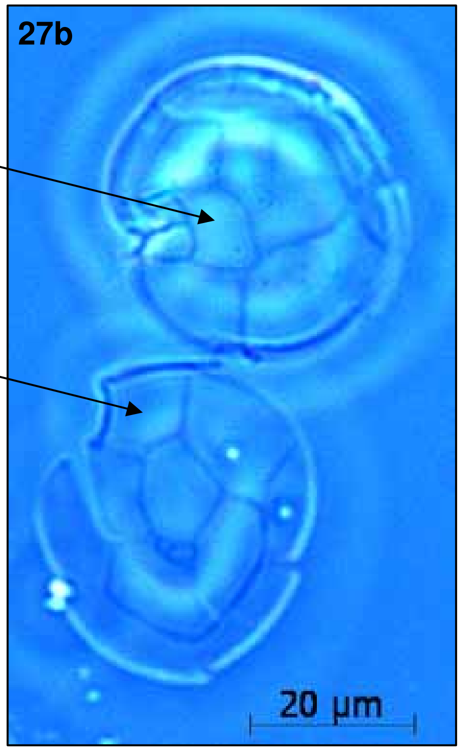


Figure 27b. The thecal plate structure of an *Alexandrium tamutum* cell. The shape of the posterior sulcal plate is wider than it is long, and the 6th pre-cingular plate is roughly equal in length and width. See Figures 29 and 30 for plate descriptions of other *Alexandrium* species.

In 2010, *Dinophysis* was not observed in blooms on the same scale as those around Argyll & Bute during 2009. The maximum cell count for the region (1,720 cells per litre) was recorded in West Loch Tarbert: Loup Bay on 30-August. This appeared to be quite an exceptional event, coinciding with a bloom of *Alexandrium* of density 1,360 cells per litre and also the presence of *Lingulodinium polyedrum*, along with an abundance of other dinoflagellate species including *Karenia mikimotoi*, *Gonyaulax verior*, *Prorocentrum micans*, *Ceratium minutum* and *Ceratium fusus*. The *Alexandrium* cells were mostly small in size (cf *minutum* or *tamutum*), although *Alexandrium tamarense* was also present. The *Dinophysis* bloom was dominated by *D. acuminata* with other species (*D. acuta*, *D. rotundata*, *D. dens*) also noted (Figure 28). Clinical signs were detected in the CEFAS bioassay the following week (06-September) and a positive DSP result was obtained for Pacific oysters one week later on 13-September. However, the DSP positive result may have been related to the toxin producing benthic dinoflagellate *Prorocentrum lima*, which was also present. *Dinophysis* was frequently observed in Loch Striven, Loch Fyne, Loch Melfort, Loch Scridain and Loch Creran throughout the summer months, with prolonged DSP toxic events in Loch Striven, Loch Fyne: Stonefield and Loch Creran (Figure 21a,b).

Similar to 2009, *Prorocentrum lima* was observed frequently in samples collected from the Pacific oyster sites in West Loch Tarbert: Loup Bay and Colonsay: The Strand, with cell counts reaching a maximum of 280 cells per litre at Colonsay on 19-May (Figure 22a). *Prorocentrum lima* cells were present in almost 77% of all samples collected in Loup Bay from April until the end of September, and in 69% of Colonsay samples analyzed over the same period, although the threshold level of 100 cells per litre was only exceeded in 11% of Loup Bay and 27% of Colonsay samples. Occasional DSP positive results were reported from Colonsay without *Dinophysis* being present above threshold in the water column, and it is possible that some of these results may be related to the presence of *Prorocentrum lima*.

Prorocentrum minimum was observed in May and June, particularly in Loch Striven and in Loch Fyne (Stonefield and Ardkinglas) and although blooms were never very dense, a maximum count of 160,962 cells per litre was recorded at Loch Fyne: Ardkinglas on 18-May (Figure 23a). This was the densest bloom of *Prorocentrum minimum* around the Scottish coast in 2010.

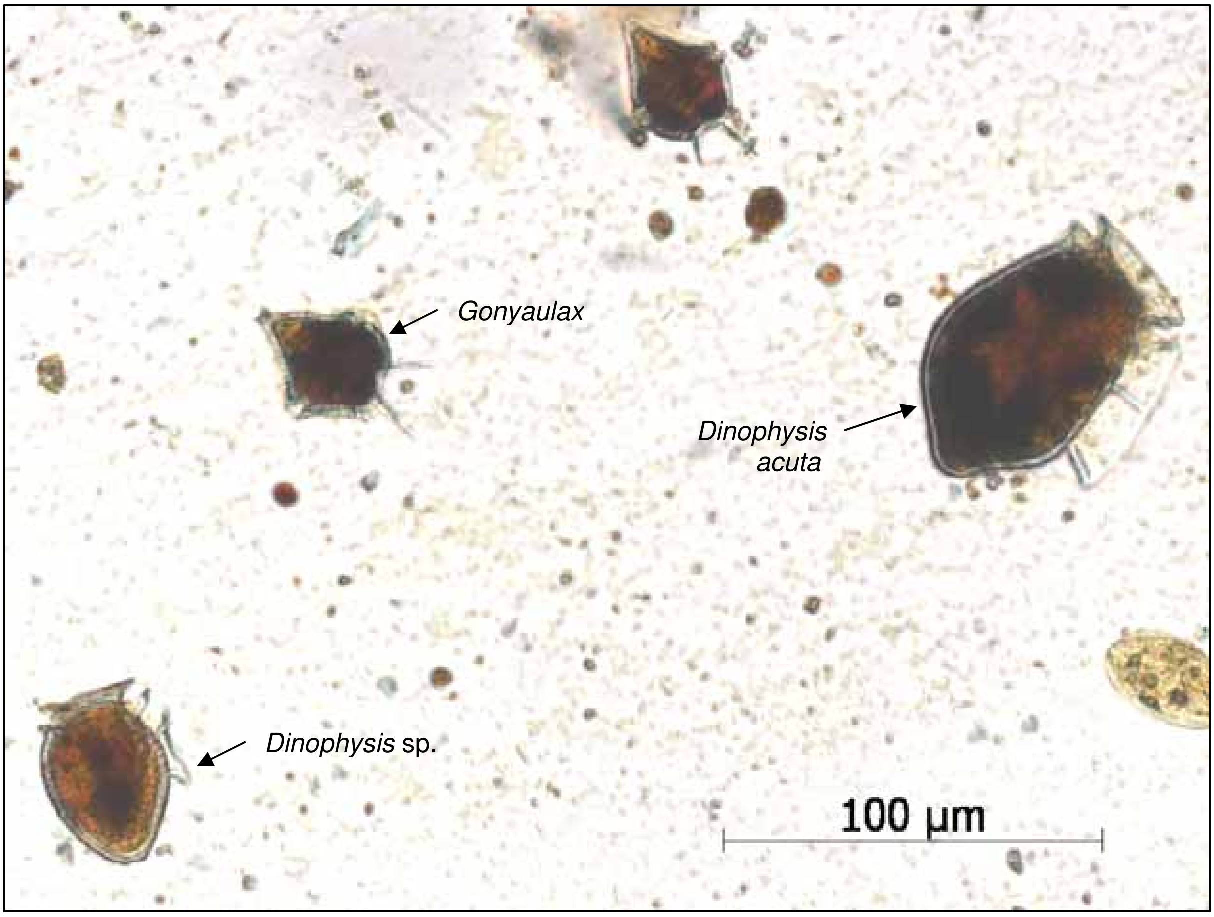


Figure 28. Numerous dinoflagellates were observed in West Loch Tarbert: Loup Bay on 30-August. The genus *Dinophysis* was present at a density of 1,720 cells per litre.

Protoceratium reticulatum was seen in Loch Creran, Loch Fyne (Stonefield and Ardkinglas), Loch Melfort and Loch Scridain from May through to September, with the largest recorded concentration of 1,500 cells per litre in Loch Creran on 07-July (Figure 24). *Lingulodinium polyedrum* was observed at two monitoring sites during 2010, Loch Creran and West Loch Tarbert: Loup Bay, with a prolonged bloom developing in Loch Creran from late June and dissipating around mid September, and a maximum abundance of 2,100 cells per litre on 01-September (Figure 25).

The dinoflagellate *Karenia mikimotoi* was widespread around Argyll & Bute, from early June through to early October. Cell counts increased rapidly in Loch Scridain from mid July and into early August, with a peak abundance of 438,409 cells per litre on 27-July. Bloom densities of 99,703 cells per litre and 219,894 cells per litre were also noted in Loch Striven and Loch Melfort on 07-September and 15-September, respectively.

Highland

A total of 167 samples were obtained from six sites in the Highland region during 2010. An early bloom of *Pseudo-nitzschia delicatissima* type was observed on the east coast at Dornoch Firth, with a count of 484,485 cells per litre being recorded on 15-March. A second bloom period of similar size and duration also occurred from late July into August at this site. Non-toxic blooms of *Pseudo-nitzschia delicatissima* type cells occurred during early summer around the NW Highlands (Ross & Cromarty: Loch Ewe; Sutherland: Loch Laxford) followed by a second bloom period in September at these sites. The September bloom in Loch Laxford was composed of both *P. seriata* and *P. delicatissima* type cells in approximately equal proportions and reached a density of 277,448 cells per litre on 14-September. This bloom was associated with ASP toxicity in common mussels at 7 µg/g (CEFAS data), the highest reported value for any of the phytoplankton monitoring sites in 2010. A bloom was present in Loch Eishort from early September into mid October and was dominated by *P. seriata* type cells, although no ASP toxicity was reported from this site (note: ASP testing was not carried out weekly due to the presence of DSP). One bloom occurred in Loch Beag in early August and none were recorded above threshold levels in the Kyle of Tongue.

Alexandrium was recorded sporadically around the Highland region from early March through into October. Bloom concentrations were never particularly dense and were generally less than 100 cells per litre, although a maximum density of 780 cells per litre was observed in Loch Beag on 12-July. A sample was not obtained in late July, but low levels of PSP toxins were detected in early August. PSP toxins were also present from mid March onwards, with quantifiable amounts reported in late March and in May from common mussels in Loch Beag (Figure 20a), and also in mid June from Loch Ewe (CEFAS data). Toxic *Alexandrium* was present on several occasions in Loch Eishort, occurring in March, May and July (Figure 20b), and was widespread further up the NW coast at Loch Laxford and Kyle of Tongue, and also on the east coast in Dornoch Firth during May.

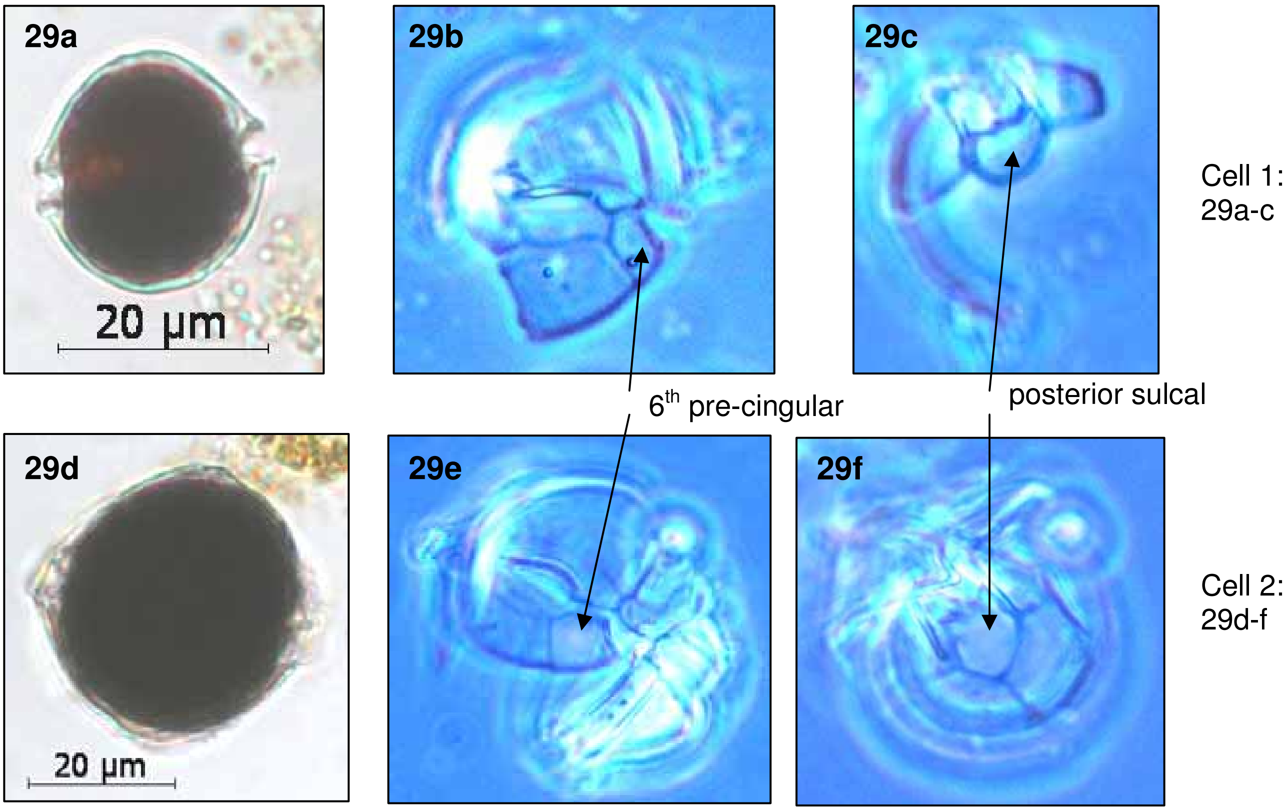


Figure 29. The thecal plate structure of two species of *Alexandrium* from Loch Beag. In Figures 29b and 29c (Cell 1), the shape of the 6th pre-cingular plate is longer than it is broad, and the posterior sulcal plate is wider than it is long, indicating that the cell is *Alexandrium minutum*. This was present in the bloom on 12-July. In contrast, Figures 29e and 29f (Cell 2) show *Alexandrium tamarense* (from 25-May), with the 6th pre-cingular plate roughly equal in length and width, and the posterior sulcal plate longer than wide. See Figure 27b for *Alexandrium tamutum* plate structure.

Dinophysis was observed at all the Highland region monitoring sites during 2010. Cell counts in Loch Eishort were above threshold (100 cells per litre) for seven consecutive weeks from mid July, with a maximum count of 1,620 cells per litre recorded on 02-August, and a subsequent DSP toxic event following the bloom peak (Figure 21b). A smaller scale bloom earlier in the year at this site, beginning in mid April and lasting five weeks, also had associated DSP toxicity.

Prorocentrum lima was recorded sporadically at all the Highland sites, except for Dornoch Firth. It was most prevalent in samples from Kyle of Tongue, and was present in 100% of the samples analyzed from mid May to mid August, exceeding threshold level in 46% of them. A peak abundance of 900 cells per litre was recorded on 07-June (Figure 22a). *Prorocentrum minimum* was observed at relatively low concentrations at all sites in the region, with a maximum density of 10,180 cells per litre recorded in Kyle of Tongue on 12-May. Low cell counts of *Protoceratium reticulatum* were recorded at all monitoring sites in the region, except for Kyle of Tongue, with a maximum abundance of 100 cells per litre in Loch Eishort on 26-July. *Lingulodinium polyedrum* was recorded on one occasion in Loch Ewe on 07-June at a density of 40 cells per litre.

Karenia mikimotoi was observed at all the monitoring sites, from early June to late August. Peak abundances were recorded as follows: Loch Eishort 10-August 573,636 cells per litre; Loch Laxford 10-August 382,480 cells per litre; Kyle of Tongue 11-August 256,770; Loch Ewe 16-August 144,484 cells per litre.

Comhairle nan Eilean Siar: Lewis & Harris

A total of 132 samples covering five locations (six sampling sites) were collected in 2010. Two discreet bloom periods were noted around Lewis & Harris on both the east and west coasts, occurring in June and in early autumn. The June blooms were mostly dominated by *Pseudo-nitzschia delicatissima* type cells and did not appear to be toxic. The largest bloom in this region was recorded on the west coast of Lewis in Loch Barraglom (Loch Roag), where a cell density of 817,311 cells per litre was observed on 06-September. Further south, on the west coast of Harris at Seilebost, a bloom of 788,067 cells per litre occurred on 07-September. Both these blooms were dominated by *Pseudo-nitzschia delicatissima* type cells, with no reported toxicity. Some low-level ASP toxicity was reported in common mussels from Loch Stockinish (east coast of Harris) on 07-September, where cell concentrations reached 27,320 cells per litre (90% *Pseudo-nitzschia seriata* type) and in Loch Roag: Eilean Teinish (west coast of Lewis) on 06-September where the cell concentration was 1,980 cells per litre (approx. 70% *Pseudo-nitzschia seriata* type), although density had reached 35,060 cells per litre the previous week at this site. While rapid bloom formation and dispersion between sample points cannot be discounted, the consistency of results between these sites suggests that highly toxic strains of *Pseudo-nitzschia* may have been present in the region.

Alexandrium counts were generally fairly low throughout 2010, with no reported PSP toxicity, apart from on one occasion when PSP was detected in common mussels from Loch Leurbost, which coincided with a bloom of maximum density 160 cells per litre on 26-May. The largest bloom recorded in this region was 860 cells per litre in Loch Roag: Eilean Teinish on 16-August. *Alexandrium* was detected sporadically at all monitoring sites in the region and Figure 30 shows *Alexandrium ostenfeldii* detected in a sample from Seilebost on 10-August.

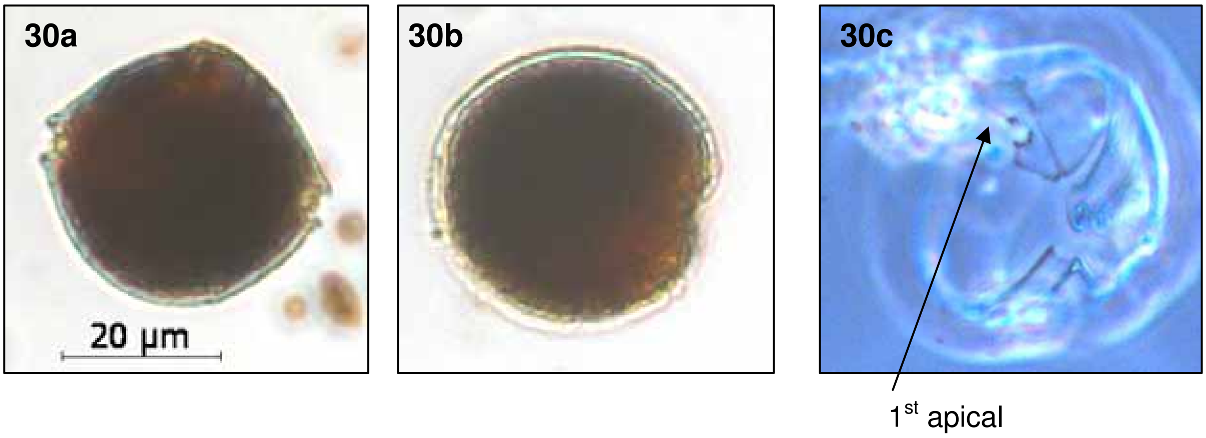


Figure 30. *Alexandrium ostenfeldii* from Seilebost. Figures 30c shows the characteristic 'notch' present on the 1st apical plate.

Dinophysis was most abundant in June, although above-threshold counts in Loch Roag: Eilean Teinish in mid September were associated with DSP toxicity. The highest recorded count for the region was 1,300 cells per litre in Loch Roag: Eilean Teinish on 28-June.

Prorocentrum lima was never particularly abundant around the Western Isles, but was observed occasionally around Harris (Loch Stockinish, Seilebost) and Lewis (Loch Leurbost, Loch Roag: Barraglom and Eilean Teinish), with a maximum count of 180 cells per litre from Loch Roag: Elilean Teinish on 28-April.

Prorocentrum minimum was observed at all monitoring sites in the Western Isles, with the densest blooms occurring during May. Cell counts were not high in comparison to the large blooms of 2008, when *P. minimum* cell counts of > 4 million cells per litre were observed in Loch Barraglom in early June. The largest bloom in this region during 2010 occurred in Loch Stockinish on 18-May, with a density of 5,100 cells per litre.

Neither *Protoceratium reticulatum* nor *Lingulodinium polyedrum* were recorded during 2010. *Karenia mikimotoi* was observed at all the monitoring sites from late May through to early October. Peak abundances were recorded as follows: Seilebost 10-August 146,136 cells per litre; Loch Leurbost 11-August 39,800 cells per litre; Loch Stockinish 17-August 106,425 cells per litre; Loch Roag: Barraglom 23-August 116,648 cells per litre; Loch Roag: Eilean Teinish 23-August 76,485.

Orkney Islands

Twenty-seven samples were analyzed from Scapa Bay in 2010. *Pseudo-nitzschia* counts were above threshold level for the whole of July, with a maximum density of >2 million cells per litre reached on 13-July. *Alexandrium* was observed in every month from March through to September, with a maximum abundance of 340 cells per litre recorded on 24-May. *Dinophysis* was recorded above threshold level throughout the whole of May, and cells reached a peak abundance of 2,520 cells per litre on 24-May, the highest recorded at any of the Scottish monitoring sites during 2010. *Prorocentrum lima* was recorded regularly in samples and was observed in 72% of all samples analyzed from mid April until early October, being above threshold levels in 24% of the samples. *Prorocentrum minimum* was observed frequently between April and May in low abundance, with a peak count of 9,480 cells per litre on 24-May.

Protoceratium reticulatum and *Lingulodinium polyedrum* were not recorded. The dinoflagellate *Karenia mikimotoi* was first noted in late June, with a peak abundance of 75,119 cells per litre observed on 23-August.

Shetland Islands

A total of 278 samples were obtained from 12 areas (14 sites) during 2010. *Pseudo-nitzschia* was evident in Busta Voe in early spring, with an abundance of 40,840 cells per litre recorded on 08-March. In nearby Olna Firth, a bloom of density 49,242 cells per litre was present on 12-April, increasing to an above-threshold level of 115,427 cells per litre the following week. No toxicity appeared to be associated with these *P. delicatissima* type cells. However, a mid summer bloom of *P. delicatissima* type cells in Olna Firth (with maximum of 400,287 cells per litre on 26-July) was toxic (see Figure 19). Blooms occurring in early May also produced toxins, notably a bloom of concentration 47,653 cells per litre at Aith Voe Sletta: Slyde on 03-May (approx. 76% *P. seriata* type) and 105,167 cells per litre in Basta Voe on 04-May (100% *P. seriata t*ype – see Figure 19). *Pseudo-nitzschia* blooms were widespread on the west and north-east coasts of Shetland throughout most of June, although cell counts remained low in the south west during this time. The largest recorded *Pseudo-nitzschia* bloom in 2010 was observed in SW Shetland (Vaila Sound: East of Linga) in mid July, with a maximum density of > 3.5 million cells per litre recorded on 12-July. A *Pseudo-nitzschia* bloom of similar density also developed in nearby Browland Voe, with a maximum cell density of > 3.2 million cells per litre on 13-July. These blooms were dominated by *Pseudo-nitzschia delicatissima* type cells of unknown toxicity (regular ASP testing was not carried out at these sites during this period). A toxic *Pseudo-nitzschia seriata* type bloom was present in nearby Vaila Sound: Riskaness, with a bloom maximum of >1.8 million cells per litre reached on 19-July and associated ASP toxicity of 2 µg/g in mussel tissue collected at the time (CEFAS data). Blooms of *Pseudo-nitzschia seriata* type cells were recorded in Olna Firth and Busta Voe throughout the whole of September and into October, with some low level ASP toxicity reported towards the end of the bloom period.

The presence of *Alexandrium* was noted in approximately 62% of the Shetland samples analyzed in May and June, although it was only present in about 17% of the July samples. However, it was mostly absent in samples from both NW Shetland (Ronas Voe) and NE Shetland (Basta Voe, North Uyea) in May and early June. *Alexandrium* cell counts were considerably lower compared with 2009, and the largest recorded bloom of 2010 around Shetland occurred on 24-May, with a maximum count of 740 cells per litre observed in Olna Firth. Some PSP toxicity was detected in common mussels from Aith Voe in late May, associated with a bloom that reached a density of 280 cells per litre on 31-May. *Alexandrium* was detected from early May for a continuous period of seven weeks in nearby Busta Voe, with a bloom maximum of 600 cells per litre on 07-June. This bloom was associated with PSP toxicity in common mussels at 47 µg/100g on 14-June (CEFAS data), which was the highest reported value for any of the phytoplankton monitoring sites in 2010, although this was still below the permitted level of 80 µg/100g.

Dinophysis was most abundant around Shetland in late May, June and July, with several DSP toxic events occurring in late May and June. The highest recorded count for the region was 960 cells per litre in Vaila Sound: East of Linga on 12-July. *Prorocentrum lima* was occasionally observed in samples from all monitoring sites around Shetland, apart from Ronas Voe. It was most prevalent in Vementry South: Seggi Bight and a value of 480 cells per litre was recorded on 03-May. *Prorocentrum minimum* was most abundant in late April through to early June, and the densest bloom was recorded in Vaila Sound: East of Linga on 09-June, with a count of 133,848 cells per litre.

Protoceratium reticulatum and *Lingulodinium polyedrum* were not recorded. K*arenia mikimotoi* was widespread throughout the Shetland Islands from late August into early October. Peak abundances were recorded as follows: Aith Voe Sletta: Slyde 30-August 1,107,664 cells per litre (the densest bloom recorded around Scotland in 2010); Vementry South: Seggi Bight 30-August 201,202 cells per litre; Busta Voe 06-September 63,008 cells per litre; Basta Voe 07-September 784,191 cells per litre; North Uyea 07-September 165,693 cells per litre; Olna Firth 13-September 40,500 cells per litre; Sandsound Voe 13-September

160,257 cells per litre; Clift Sound: Booth 15-September 347,291 cells per litre; Vaila Sound: East of Linga 15-September 196,967 cells per litre.

Fife

Twenty-seven samples were collected from Elie, Fife during 2010. Densities of *Pseudo-nitzschia* were relatively low, although an above-threshold bloom occurred on mid April, with a maximum count of 241,972 cells per litre on 26-April. *Alexandrium* was sporadically observed from April until the end of July, although bloom densities were low and always less than 100 cells per litre. *Dinophysis* was recorded above threshold levels on seven occasions, with a maximum of 900 cells per litre on 12-July. *Prorocentrum lima* was observed at low density on only on two occasions, on 13-June and 30-August. *Prorocentrum minimum* was recorded in relatively low concentrations (maximum 2,220 cells per litre on 12-July). *Protoceratium reticulatum* and *Lingulodinium polyedrum* were not recorded.

Other harmful algal species

The potentially problematic species *Karenia mikimotoi* (Figure 31) was frequently observed from June through to October at the Scottish phytoplankton monitoring sites during 2010. This species can reach concentrations in the order of millions of cells per litre, forming visible red/brown tides. It also has the potential to negatively affect farmed fish through both the production of haemolytic cytotoxins and, if in sufficient density, hypoxia. However, it should not be confused with another alga of the same genus, *Karenia brevis*. *Karenia brevis*, which blooms regularly to cause ‘red tides’ in the Gulf of Mexico and the eastern United States, produces brevetoxins and can cause neurotoxic shellfish poisoning (NSP), and also respiratory irritation and dermatitis in humans.

Karenia mikimotoi has been regularly identified in Scottish waters with few major environmental consequences, although a bloom in Shetland during 2003 caused the mortality of 53,000 farmed fish. Widespread and prolonged blooms of *Karenia mikimotoi* occurred around the Scottish coast during the summer of 2006 (Davidson *et al*., 2007, 2009a,b) and again in 2009, when an exceptionally large bloom of *Karenia mikimotoi* was observed off south west Scotland, with various reports of associated invertebrate mortalities. *Karenia mikimotoi* blooms during 2010 were not exceptionally dense, although a bloom of >1.1 million cells per litre was observed in Shetland in late August. Cell abundances were at their maximum in late July and again in early September around Argyll & Bute. Counts reached a peak in early and mid August in the Highland region, around the Western Isles and in Orkney, but *Karenia mikimotoi* was most abundant around Shetland in late August and September.

Figure 31. The unarmoured dinoflagellate, *Karenia mikimotoi*, observed in a sample collected from Loch Scridain (Argyll & Bute) on 13-July. This species is dorso-ventrally flattened, with a characteristic ‘lobed’ appearance and the nucleus offset to one side of the cell. Although it has had little effect to date, *Karenia mikimotoi* has the potential to cause a major impact on Scottish aquaculture.

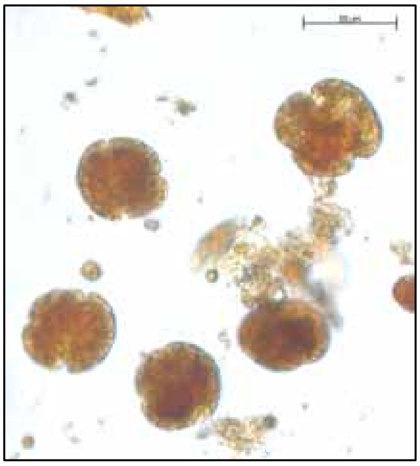


Figure 32. *Karenia mikimotoi*, in a sample from Basta Voe (Shetland) on 07-September. Bloom density was recorded at 784,191 cells per litre.

Other algae that may be classed as harmful in large numbers include the genus *Phaeocystis* (Figure 33), which is commonly found around the North Sea. Individual cells are small in size and often solitary, but can form gelatinous colonies up to several millimetres in diameter. Although not toxic, the cells are embedded in mucous that can clog the gills of both finfish and shellfish. Dense blooms regularly occur in areas of high nutrient input and are often associated with the unsightly foam found along shorelines. Colonies of the genus *Phaeocystis* were occasionally recorded in samples, although no large blooms were observed.

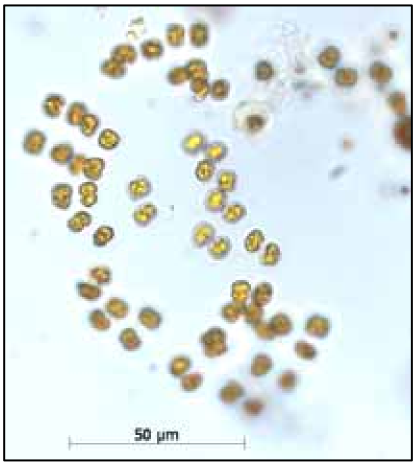


Figure 33. A *Phaeocystis* colony identified from a sample collected in Olna Firth (Shetland) on 05-April.

Summary

The phytoplankton monitoring programme is intended to act as an early warning for the potential occurrence of shellfish toxin events. Harmful algal blooms can occur rapidly in response to events such as a sudden nutrient influx or a period of warm weather, and fundamentally depend on the phytoplankton species being 'in the right place at the right time'. For monitoring to be effective, a good temporal and spatial spread of samples is required. SAMS will continue to monitor the presence of other potentially problematic species, which although not necessarily associated with biotoxin accumulation in shellfish, may be responsible for red tide events and subsequent fish kills.

Acknowledgements

We would like to acknowledge the assistance of the many volunteers, shellfish farmers, Official Control Sampling Officers and Environmental Health Officers who have taken part in the phytoplankton monitoring programme.

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Figure 34. Dense blooms of *Karenia mikimotoi*

Appendix 1

Observed concentrations (cells per litre) of phytoplankton, by location between 01-Jan-10 and 31-Dec-10. Limit of detection = 20 cells per litre.

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Dumfries and Galloway										
Loch Ryan	Stranraer	19-Apr-10	0	0	0	0	0	0	0	0
Loch Ryan	Stranraer	27-Apr-10	0	0	0	0	0	0	0	0
Loch Ryan	Stranraer	11-May-10	100	0	0	0	40	0	0	0
Loch Ryan	Stranraer	18-May-10	40	0	0	0	0	0	0	0
Loch Ryan	Stranraer	24-May-10	0	0	0	0	360	0	0	0
Loch Ryan	Stranraer	31-May-10	0	0	0	0	740	0	0	0
Loch Ryan	Stranraer	09-Jun-10	200	0	20	0	0	0	0	0
Loch Ryan	Stranraer	16-Jun-10	40	0	0	0	0	0	0	0
Loch Ryan	Stranraer	23-Jun-10	4,400	0	0	0	0	0	0	0
Loch Ryan	Stranraer	29-Jun-10	320	0	0	0	0	0	0	0
Argyll and Bute										
Loch Striven	Loch Striven	23-Mar-10	0	0	0	0	0	0	0	0
Loch Striven	Loch Striven	30-Mar-10	20	20	0	0	0	0	0	0
Loch Striven	Loch Striven	06-Apr-10	0	200	40	0	0	0	0	0
Loch Striven	Loch Striven	13-Apr-10	0	20	0	0	20	0	0	0
Loch Striven	Loch Striven	20-Apr-10	180	220	20	0	0	0	0	0
Loch Striven	Loch Striven	27-Apr-10	740	520	20	0	0	0	0	0
Loch Striven	Loch Striven	04-May-10	0	60	40	0	0	0	0	0
Loch Striven	Loch Striven	11-May-10	800	220	100	0	0	0	0	0
Loch Striven	Loch Striven	18-May-10	1,400	40	40	0	6,740	0	0	0
Loch Striven	Loch Striven	25-May-10	620	20	80	0	69,891	0	0	20
Loch Striven	Loch Striven	01-Jun-10	2,720	0	140	0	24,380	0	0	0
Loch Striven	Loch Striven	08-Jun-10	2,960	0	220	0	20	0	0	0
Loch Striven	Loch Striven	15-Jun-10	19,940	0	20	0	860	0	0	0
Loch Striven	Loch Striven	22-Jun-10	30,240	20	160	0	2,080	0	0	0
Loch Striven	Loch Striven	29-Jun-10	1,240	0	120	0	0	0	0	0
Loch Striven	Loch Striven	06-Jul-10	240	40	0	0	20	0	0	0
Loch Striven	Loch Striven	13-Jul-10	0	0	100	0	20	0	0	0
Loch Striven	Loch Striven	20-Jul-10	400	40	260	0	120	0	0	0
Loch Striven	Loch Striven	27-Jul-10	2,720	0	300	0	0	0	0	0
Loch Striven	Loch Striven	03-Aug-10	22,400	0	140	0	0	0	0	0
Loch Striven	Loch Striven	10-Aug-10	16,580	0	120	0	0	0	0	0
Loch Striven	Loch Striven	17-Aug-10	1,900	0	120	0	0	0	0	0
Loch Striven	Loch Striven	24-Aug-10	2,020	120	80	0	0	0	0	0
Loch Striven	Loch Striven	31-Aug-10	120	0	40	0	0	0	0	20
Loch Striven	Loch Striven	07-Sep-10	360	0	140	0	0	0	0	140
Loch Striven	Loch Striven	14-Sep-10	60	0	20	0	0	0	0	60
Loch Striven	Loch Striven	21-Sep-10	140	0	140	0	0	0	0	0
Loch Striven	Loch Striven	28-Sep-10	0	0	60	0	0	0	0	40
Loch Striven	Loch Striven	05-Oct-10	0	0	20	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Argyll and Bute										
Loch Fyne	Ardkinglas	23-Mar-10	1,900	0	20	0	0	0	0	0
Loch Fyne	Ardkinglas	30-Mar-10	360	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	07-Apr-10	3,560	0	20	0	0	0	0	0
Loch Fyne	Ardkinglas	13-Apr-10	0	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	20-Apr-10	120	0	20	0	0	0	0	0
Loch Fyne	Ardkinglas	27-Apr-10	0	0	200	0	180	0	0	0
Loch Fyne	Ardkinglas	04-May-10	100	0	60	0	0	0	0	0
Loch Fyne	Ardkinglas	11-May-10	180	0	40	0	7,140	0	0	0
Loch Fyne	Ardkinglas	18-May-10	3,520	0	20	0	160,962	0	0	0
Loch Fyne	Ardkinglas	25-May-10	7,680	0	180	0	109,073	0	20	0
Loch Fyne	Ardkinglas	01-Jun-10	8,760	0	60	0	3,260	0	0	0
Loch Fyne	Ardkinglas	08-Jun-10	9,580	840	120	0	142,043	0	0	40
Loch Fyne	Ardkinglas	15-Jun-10	7,600	0	820	0	880	0	40	0
Loch Fyne	Ardkinglas	22-Jun-10	140	0	180	0	0	0	0	0
Loch Fyne	Ardkinglas	29-Jun-10	840	0	0	0	20	0	0	0
Loch Fyne	Ardkinglas	06-Jul-10	1,480	0	60	0	0	0	0	0
Loch Fyne	Ardkinglas	13-Jul-10	20	20	20	0	60	0	0	60
Loch Fyne	Ardkinglas	20-Jul-10	0	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	27-Jul-10	0	0	80	80	0	0	0	0
Loch Fyne	Ardkinglas	03-Aug-10	60	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	10-Aug-10	80	0	40	0	0	0	0	0
Loch Fyne	Ardkinglas	17-Aug-10	260	0	40	0	0	0	0	0
Loch Fyne	Ardkinglas	24-Aug-10	0	0	20	0	60	0	0	0
Loch Fyne	Ardkinglas	31-Aug-10	0	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	07-Sep-10	40	0	20	0	0	0	0	0
Loch Fyne	Ardkinglas	14-Sep-10	0	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	21-Sep-10	0	0	20	0	40	0	0	0
Loch Fyne	Ardkinglas	28-Sep-10	0	0	0	0	0	0	0	0
Loch Fyne	Ardkinglas	05-Oct-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	11-Jan-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	09-Feb-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	08-Mar-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	22-Mar-10	1,820	0	0	0	0	0	0	0
Loch Fyne	Stonefield	08-Apr-10	4,900	60	20	0	100	0	0	0
Loch Fyne	Stonefield	12-Apr-10	3,460	0	40	0	0	0	200	0
Loch Fyne	Stonefield	19-Apr-10	2,100	0	40	0	0	0	0	0
Loch Fyne	Stonefield	26-Apr-10	960	0	160	0	0	0	300	80
Loch Fyne	Stonefield	05-May-10	5,260	40	220	0	0	0	0	0
Loch Fyne	Stonefield	10-May-10	340	0	80	0	9,920	0	60	0
Loch Fyne	Stonefield	17-May-10	2,320	0	80	0	70,950	0	80	0
Loch Fyne	Stonefield	24-May-10	3,960	0	300	0	36,005	0	620	20
Loch Fyne	Stonefield	31-May-10	28,140	0	180	0	28,600	0	0	0
Loch Fyne	Stonefield	07-Jun-10	61,420	0	320	0	12,180	0	980	0
Loch Fyne	Stonefield	14-Jun-10	217,616	20	520	0	260	0	280	0
Loch Fyne	Stonefield	21-Jun-10	291,668	0	40	0	0	0	0	0
Loch Fyne	Stonefield	28-Jun-10	452,080	60	0	0	0	0	0	0
Loch Fyne	Stonefield	05-Jul-10	4,180	0	220	0	0	0	0	0
Loch Fyne	Stonefield	12-Jul-10	240	0	220	0	0	0	0	0
Loch Fyne	Stonefield	19-Jul-10	300	0	120	0	0	0	0	0
Loch Fyne	Stonefield	26-Jul-10	480	0	420	0	0	0	0	0
Loch Fyne	Stonefield	02-Aug-10	7,600	0	140	0	0	0	0	0
Loch Fyne	Stonefield	09-Aug-10	31,240	0	240	0	0	0	0	0
Loch Fyne	Stonefield	16-Aug-10	26,280	0	20	0	0	0	0	0
Loch Fyne	Stonefield	23-Aug-10	1,280	0	420	0	0	0	0	40
Loch Fyne	Stonefield	30-Aug-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	08-Sep-10	40	0	20	0	0	0	0	20
Loch Fyne	Stonefield	13-Sep-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	20-Sep-10	40	0	160	0	0	0	0	80
Loch Fyne	Stonefield	29-Sep-10	0	0	60	0	0	0	0	20
Loch Fyne	Stonefield	06-Oct-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	10-Nov-10	0	0	0	0	0	0	0	0
Loch Fyne	Stonefield	06-Dec-10	0	40	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*

Argyll and Bute

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
West Loch Tarbert	Loup Bay	06-Apr-10	140	0	40	0	180	0	0	0
West Loch Tarbert	Loup Bay	12-Apr-10	0	20	0	0	0	0	0	0
West Loch Tarbert	Loup Bay	19-Apr-10	0	0	0	20	0	0	0	0
West Loch Tarbert	Loup Bay	26-Apr-10	320	0	0	60	0	0	0	0
West Loch Tarbert	Loup Bay	04-May-10	40	20	40	80	20	0	0	0
West Loch Tarbert	Loup Bay	10-May-10	40	0	0	100	0	0	0	0
West Loch Tarbert	Loup Bay	17-May-10	0	0	0	60	0	0	0	0
West Loch Tarbert	Loup Bay	24-May-10	1,080	20	0	20	160	0	0	0
West Loch Tarbert	Loup Bay	31-May-10	140	0	0	20	20	0	0	0
West Loch Tarbert	Loup Bay	07-Jun-10	120	0	0	40	100	0	0	0
West Loch Tarbert	Loup Bay	14-Jun-10	0	0	0	20	0	0	0	0
West Loch Tarbert	Loup Bay	21-Jun-10	100	0	0	40	0	0	0	0
West Loch Tarbert	Loup Bay	30-Jun-10	340	0	0	20	0	0	0	0
West Loch Tarbert	Loup Bay	05-Jul-10	23,980	0	20	80	0	0	0	0
West Loch Tarbert	Loup Bay	12-Jul-10	4,580	0	0	20	0	0	0	0
West Loch Tarbert	Loup Bay	19-Jul-10	8,540	0	20	80	220	0	0	0
West Loch Tarbert	Loup Bay	26-Jul-10	1,560	0	0	120	0	0	0	0
West Loch Tarbert	Loup Bay	02-Aug-10	380	0	0	0	0	0	0	0
West Loch Tarbert	Loup Bay	09-Aug-10	860	0	0	0	0	0	0	0
West Loch Tarbert	Loup Bay	16-Aug-10	3,960	0	0	40	0	0	0	0
West Loch Tarbert	Loup Bay	23-Aug-10	680	0	0	40	0	0	0	0
West Loch Tarbert	Loup Bay	30-Aug-10	0	1,360	1,720	60	20	100	0	0
West Loch Tarbert	Loup Bay	06-Sep-10	140	0	0	120	0	0	0	0
West Loch Tarbert	Loup Bay	13-Sep-10	100	40	0	0	20	0	0	0
West Loch Tarbert	Loup Bay	20-Sep-10	440	40	0	0	100	0	0	0
West Loch Tarbert	Loup Bay	29-Sep-10	560	0	0	20	0	0	0	0
West Loch Tarbert	Loup Bay	04-Oct-10	1,000	20	0	0	0	0	0	0
West Loch Tarbert	Loup Bay	11-Oct-10	80	0	0	60	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Colonsay	The Strand	01-Mar-10	100	0	0	0	0	0	0	0
Colonsay	The Strand	08-Mar-10	80	0	0	0	0	0	0	0
Colonsay	The Strand	08-Apr-10	0	20	0	0	0	0	0	0
Colonsay	The Strand	14-Apr-10	0	20	0	160	0	0	0	0
Colonsay	The Strand	21-Apr-10	20	140	0	40	0	0	0	0
Colonsay	The Strand	28-Apr-10	0	0	0	60	0	0	0	0
Colonsay	The Strand	05-May-10	0	0	0	40	0	0	0	0
Colonsay	The Strand	12-May-10	1,400	0	20	20	120	0	0	0
Colonsay	The Strand	19-May-10	2,580	20	60	280	180	0	0	0
Colonsay	The Strand	27-May-10	3,500	0	0	0	0	0	0	0
Colonsay	The Strand	03-Jun-10	2,640	0	0	20	0	0	0	0
Colonsay	The Strand	10-Jun-10	900	0	0	0	0	0	0	0
Colonsay	The Strand	17-Jun-10	240	0	40	100	100	0	0	0
Colonsay	The Strand	23-Jun-10	1,700	0	0	100	0	0	0	0
Colonsay	The Strand	01-Jul-10	5,480	0	0	100	0	0	0	0
Colonsay	The Strand	08-Jul-10	18,260	0	0	0	0	0	0	0
Colonsay	The Strand	15-Jul-10	35,840	0	0	160	0	0	0	0
Colonsay	The Strand	22-Jul-10	5,760	0	20	0	0	0	0	0
Colonsay	The Strand	29-Jul-10	85,470	220	0	40	0	0	0	0
Colonsay	The Strand	04-Aug-10	14,500	0	0	20	0	0	0	0
Colonsay	The Strand	11-Aug-10	220,040	0	20	0	0	0	0	0
Colonsay	The Strand	18-Aug-10	8,000	20	40	100	0	0	0	0
Colonsay	The Strand	25-Aug-10	121,556	20	0	40	0	0	0	0
Colonsay	The Strand	02-Sep-10	42,800	0	0	20	0	0	0	0
Colonsay	The Strand	09-Sep-10	263,152	20	0	20	0	0	0	0
Colonsay	The Strand	16-Sep-10	60,800	20	0	40	0	0	0	0
Colonsay	The Strand	23-Sep-10	1,380	0	0	0	0	0	0	0
Colonsay	The Strand	29-Sep-10	720	0	0	0	0	0	0	0
Colonsay	The Strand	07-Oct-10	740	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Argyll and Bute										
Loch Melfort	Loch Melfort	22-Mar-10	320	0	80	0	20	0	0	0
Loch Melfort	Loch Melfort	29-Mar-10	0	0	0	0	100	0	0	0
Loch Melfort	Loch Melfort	06-Apr-10	20	0	0	0	0	0	0	0
Loch Melfort	Loch Melfort	12-Apr-10	0	0	160	0	0	0	0	0
Loch Melfort	Loch Melfort	19-Apr-10	80	0	100	0	40	0	0	0
Loch Melfort	Loch Melfort	26-Apr-10	240	0	240	0	320	0	0	0
Loch Melfort	Loch Melfort	05-May-10	4,700	0	160	0	240	0	0	0
Loch Melfort	Loch Melfort	10-May-10	6,780	20	180	0	140	0	0	0
Loch Melfort	Loch Melfort	17-May-10	11,680	0	140	0	0	0	0	0
Loch Melfort	Loch Melfort	26-May-10	30,900	200	160	20	160	0	0	0
Loch Melfort	Loch Melfort	02-Jun-10	5,980	20	0	0	140	0	0	0
Loch Melfort	Loch Melfort	07-Jun-10	380	0	40	0	740	0	40	0
Loch Melfort	Loch Melfort	14-Jun-10	40	0	80	20	40	0	0	0
Loch Melfort	Loch Melfort	23-Jun-10	360	0	60	0	0	0	0	0
Loch Melfort	Loch Melfort	28-Jun-10	1,100	0	140	0	0	0	0	0
Loch Melfort	Loch Melfort	05-Jul-10	13,220	0	100	0	240	0	0	0
Loch Melfort	Loch Melfort	14-Jul-10	74,620	0	120	0	20	0	0	0
Loch Melfort	Loch Melfort	21-Jul-10	229,454	0	120	0	0	0	0	0
Loch Melfort	Loch Melfort	26-Jul-10	287,394	0	500	0	0	0	0	0
Loch Melfort	Loch Melfort	04-Aug-10	323,695	60	160	20	0	0	40	0
Loch Melfort	Loch Melfort	11-Aug-10	259,502	0	200	20	0	0	0	0
Loch Melfort	Loch Melfort	18-Aug-10	293,332	0	60	40	40	0	0	0
Loch Melfort	Loch Melfort	25-Aug-10	239,854	40	140	0	20	0	100	0
Loch Melfort	Loch Melfort	30-Aug-10	270,035	0	160	20	0	0	20	0
Loch Melfort	Loch Melfort	06-Sep-10	275,330	0	260	20	0	0	0	0
Loch Melfort	Loch Melfort	15-Sep-10	44,720	0	180	0	0	0	40	0
Loch Melfort	Loch Melfort	22-Sep-10	264,445	0	0	0	0	0	0	0
Loch Melfort	Loch Melfort	30-Sep-10	86,160	0	0	0	0	0	0	0
Loch Melfort	Loch Melfort	04-Oct-10	261,563	0	20	0	0	0	0	0
Loch Melfort	Loch Melfort	11-Oct-10	13,340	0	0	20	0	0	0	0
Loch Etive West	Muckairn	07-Apr-10	0	20	20	0	0	0	0	0
Loch Etive West	Muckairn	12-Apr-10	0	0	20	0	0	0	0	0
Loch Etive West	Muckairn	19-Apr-10	0	0	0	0	0	0	0	0
Loch Etive West	Muckairn	26-Apr-10	0	0	0	0	0	0	0	0
Loch Etive West	Muckairn	05-May-10	20	0	20	0	0	0	0	0
Loch Etive West	Muckairn	10-May-10	0	0	20	0	40	0	0	0
Loch Etive West	Muckairn	17-May-10	1,760	0	20	0	0	0	0	0
Loch Etive West	Muckairn	24-May-10	5,700	0	0	0	0	0	0	0
Loch Etive West	Muckairn	31-May-10	6,300	0	0	0	0	0	0	0
Loch Etive West	Muckairn	07-Jun-10	120	0	0	0	20	0	0	0
Loch Etive West	Muckairn	14-Jun-10	560	0	20	0	0	0	0	0
Loch Etive West	Muckairn	21-Jun-10	80	0	20	0	0	0	0	0
Loch Etive West	Muckairn	28-Jun-10	0	0	0	0	0	0	0	0
Loch Etive West	Muckairn	05-Jul-10	0	0	0	0	0	0	0	0
Loch Etive West	Muckairn	12-Jul-10	200	0	0	20	0	0	0	0
Loch Etive West	Muckairn	19-Jul-10	320	0	0	0	0	0	0	0
Loch Etive West	Muckairn	26-Jul-10	11,960	0	0	0	0	0	0	0
Loch Etive West	Muckairn	02-Aug-10	8,240	0	40	0	0	0	0	0
Loch Etive West	Muckairn	09-Aug-10	760	0	40	0	0	0	0	0
Loch Etive West	Muckairn	16-Aug-10	1,400	0	0	0	0	0	0	0
Loch Etive West	Muckairn	23-Aug-10	3,340	0	40	0	0	0	0	0
Loch Etive West	Muckairn	30-Aug-10	940	60	20	0	0	0	0	0
Loch Etive West	Muckairn	06-Sep-10	4,760	0	60	0	0	0	0	0
Loch Etive West	Muckairn	13-Sep-10	3,520	20	20	0	0	0	0	0
Loch Etive West	Muckairn	20-Sep-10	460	0	100	0	0	0	0	0
Loch Etive West	Muckairn	30-Sep-10	180	0	20	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Argyll and Bute										
Isle of Mull	Loch Scridain	19-Jan-10	200	0	0	0	0	0	0	0
Isle of Mull	Loch Scridain	16-Feb-10	1,200	0	0	0	0	0	0	0
Isle of Mull	Loch Scridain	02-Mar-10	1,860	0	0	0	0	0	0	0
Isle of Mull	Loch Scridain	16-Mar-10	40	40	0	0	0	0	0	0
Isle of Mull	Loch Scridain	23-Mar-10	0	80	140	0	60	0	0	0
Isle of Mull	Loch Scridain	30-Mar-10	0	0	0	0	0	0	0	0
Isle of Mull	Loch Scridain	06-Apr-10	0	0	0	0	580	0	0	0
Isle of Mull	Loch Scridain	13-Apr-10	0	200	80	0	0	0	0	0
Isle of Mull	Loch Scridain	20-Apr-10	0	0	0	0	0	0	20	0
Isle of Mull	Loch Scridain	27-Apr-10	640	0	0	0	980	0	0	0
Isle of Mull	Loch Scridain	04-May-10	3,380	60	80	0	580	0	0	0
Isle of Mull	Loch Scridain	11-May-10	8,420	140	120	0	80	0	0	0
Isle of Mull	Loch Scridain	18-May-10	26,820	120	140	0	20	0	0	0
Isle of Mull	Loch Scridain	25-May-10	44,300	0	20	0	140	0	0	0
Isle of Mull	Loch Scridain	01-Jun-10	7,860	400	180	0	60	0	0	0
Isle of Mull	Loch Scridain	08-Jun-10	5,020	0	60	0	20	0	0	0
Isle of Mull	Loch Scridain	15-Jun-10	3,480	60	20	0	0	0	20	0
Isle of Mull	Loch Scridain	22-Jun-10	2,860	40	40	20	0	0	0	0
Isle of Mull	Loch Scridain	29-Jun-10	240	0	100	0	40	0	0	0
Isle of Mull	Loch Scridain	06-Jul-10	1,200	0	120	0	0	0	0	0
Isle of Mull	Loch Scridain	13-Jul-10	7,340	120	220	0	80	0	0	0
Isle of Mull	Loch Scridain	20-Jul-10	26,240	0	40	0	0	0	0	0
Isle of Mull	Loch Scridain	27-Jul-10	9,560	40	360	0	20	0	0	0
Isle of Mull	Loch Scridain	03-Aug-10	3,140	0	120	0	0	0	0	0
Isle of Mull	Loch Scridain	10-Aug-10	101,660	60	160	0	20	0	0	0
Isle of Mull	Loch Scridain	17-Aug-10	178,920	20	80	0	0	0	0	0
Isle of Mull	Loch Scridain	24-Aug-10	228,206	0	80	0	20	0	0	0
Isle of Mull	Loch Scridain	31-Aug-10	228,099	40	120	0	0	0	0	0
Isle of Mull	Loch Scridain	07-Sep-10	486,473	0	20	0	80	0	0	0
Isle of Mull	Loch Scridain	14-Sep-10	535,834	0	0	20	0	0	0	0
Isle of Mull	Loch Scridain	21-Sep-10	307,628	0	0	0	40	0	0	0
Isle of Mull	Loch Scridain	28-Sep-10	241,747	0	20	0	0	0	0	0
Isle of Mull	Loch Scridain	05-Oct-10	294,933	0	20	0	20	0	0	0
Isle of Mull	Loch Scridain	12-Oct-10	394,766	0	0	0	20	0	0	0
Isle of Mull	Loch Scridain	19-Oct-10	46,740	0	0	0	0	0	0	0
Isle of Mull	Loch Scridain	09-Nov-10	720	0	20	0	0	0	0	0
Isle of Mull	Loch Scridain	07-Dec-10	300	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	06-Apr-10	40	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	13-Apr-10	640	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	20-Apr-10	380	0	20	0	20	0	0	0
Isle of Mull	Loch Spelve	27-Apr-10	860	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	04-May-10	4,220	0	40	0	0	0	0	0
Isle of Mull	Loch Spelve	11-May-10	2,460	0	20	0	0	0	0	0
Isle of Mull	Loch Spelve	18-May-10	4,560	0	60	0	0	0	0	0
Isle of Mull	Loch Spelve	25-May-10	6,620	0	40	0	60	0	0	0
Isle of Mull	Loch Spelve	01-Jun-10	6,560	20	40	0	0	0	0	0
Isle of Mull	Loch Spelve	08-Jun-10	1,420	0	40	0	100	0	0	0
Isle of Mull	Loch Spelve	15-Jun-10	540	0	20	0	0	0	0	0
Isle of Mull	Loch Spelve	22-Jun-10	560	0	0	0	40	0	0	0
Isle of Mull	Loch Spelve	29-Jun-10	100	0	20	0	0	0	0	0
Isle of Mull	Loch Spelve	06-Jul-10	300	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	13-Jul-10	720	0	80	0	0	0	0	0
Isle of Mull	Loch Spelve	20-Jul-10	5,200	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	27-Jul-10	243,112	20	20	0	0	0	0	0
Isle of Mull	Loch Spelve	03-Aug-10	282,052	0	0	0	40	0	0	0
Isle of Mull	Loch Spelve	10-Aug-10	15,660	0	40	0	0	0	0	0
Isle of Mull	Loch Spelve	17-Aug-10	25,060	0	0	0	20	0	0	0
Isle of Mull	Loch Spelve	24-Aug-10	95,439	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	31-Aug-10	252,138	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	07-Sep-10	251,307	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	14-Sep-10	180,556	0	20	20	0	0	0	0
Isle of Mull	Loch Spelve	21-Sep-10	198,831	0	40	0	80	0	0	40
Isle of Mull	Loch Spelve	28-Sep-10	259,445	0	0	0	0	0	0	0
Isle of Mull	Loch Spelve	05-Oct-10	247,210	0	0	0	40	0	0	0
Isle of Mull	Loch Spelve	12-Oct-10	218,146	0	0	0	20	0	0	0
Isle of Mull	Loch Spelve	19-Oct-10	404,952	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Argyll and Bute										
Inner Loch Creran	Inner Creran	13-Jan-10	560	0	20	0	0	0	0	0
Inner Loch Creran	Inner Creran	10-Feb-10	640	0	0	0	0	0	0	0
Inner Loch Creran	Inner Creran	10-Mar-10	1,780	260	0	0	20	0	0	0
Inner Loch Creran	Inner Creran	17-Mar-10	3,220	600	40	0	240	0	0	0
Inner Loch Creran	Inner Creran	24-Mar-10	660	1,200	100	0	140	0	0	0
Inner Loch Creran	Inner Creran	29-Mar-10	280	340	80	0	120	0	0	0
Inner Loch Creran	Inner Creran	07-Apr-10	100	520	100	0	40	0	0	0
Inner Loch Creran	Inner Creran	14-Apr-10	0	980	60	0	0	0	0	0
Inner Loch Creran	Inner Creran	21-Apr-10	0	520	20	0	0	0	0	0
Inner Loch Creran	Inner Creran	28-Apr-10	160	1,420	100	0	20	0	0	0
Inner Loch Creran	Inner Creran	05-May-10	2,080	3,100	100	0	0	0	0	0
Inner Loch Creran	Inner Creran	12-May-10	26,580	680	180	0	0	0	0	0
Inner Loch Creran	Inner Creran	19-May-10	64,067	40	100	0	60	0	40	0
Inner Loch Creran	Inner Creran	26-May-10	30,420	0	60	20	20	0	40	0
Inner Loch Creran	Inner Creran	02-Jun-10	45,400	0	260	0	60	0	0	0
Inner Loch Creran	Inner Creran	09-Jun-10	8,280	0	0	0	60	0	0	0
Inner Loch Creran	Inner Creran	16-Jun-10	8,820	20	300	0	0	0	80	0
Inner Loch Creran	Inner Creran	23-Jun-10	6,660	0	360	0	0	0	40	0
Inner Loch Creran	Inner Creran	30-Jun-10	67,420	20	520	0	60	160	420	0
Inner Loch Creran	Inner Creran	07-Jul-10	246,738	60	260	0	20	220	1,500	0
Inner Loch Creran	Inner Creran	14-Jul-10	104,308	0	340	20	0	140	680	0
Inner Loch Creran	Inner Creran	21-Jul-10	315,500	0	140	20	0	100	400	0
Inner Loch Creran	Inner Creran	28-Jul-10	106,180	0	160	0	20	0	0	0
Inner Loch Creran	Inner Creran	04-Aug-10	11,760	20	40	0	0	380	240	0
Inner Loch Creran	Inner Creran	11-Aug-10	11,380	20	160	0	0	320	260	20
Inner Loch Creran	Inner Creran	18-Aug-10	34,140	0	200	0	0	1,080	100	0
Inner Loch Creran	Inner Creran	25-Aug-10	25,500	60	100	0	0	860	40	0
Inner Loch Creran	Inner Creran	01-Sep-10	37,980	0	40	0	0	2,100	40	0
Inner Loch Creran	Inner Creran	08-Sep-10	20,240	0	40	0	0	620	0	0
Inner Loch Creran	Inner Creran	15-Sep-10	6,300	0	40	0	0	360	0	0
Inner Loch Creran	Inner Creran	22-Sep-10	4,000	0	40	0	40	40	0	0
Inner Loch Creran	Inner Creran	29-Sep-10	6,460	0	100	0	0	0	0	0
Inner Loch Creran	Inner Creran	06-Oct-10	52,060	0	60	0	0	0	0	0
Inner Loch Creran	Inner Creran	13-Oct-10	9,020	0	0	0	0	0	0	0
Inner Loch Creran	Inner Creran	10-Nov-10	880	0	0	0	0	0	0	0
Inner Loch Creran	Inner Creran	08-Dec-10	1,400	0	0	0	0	0	0	0
Highland										
Lochaber	Loch Beag	29-Mar-10	400	0	0	0	0	0	0	0
Lochaber	Loch Beag	05-Apr-10	20	20	40	0	80	0	0	0
Lochaber	Loch Beag	12-Apr-10	40	80	0	0	220	0	0	0
Lochaber	Loch Beag	19-Apr-10	240	0	40	0	0	0	0	0
Lochaber	Loch Beag	27-Apr-10	880	0	40	0	7,120	0	0	0
Lochaber	Loch Beag	05-May-10	4,580	0	20	0	2,120	0	0	0
Lochaber	Loch Beag	12-May-10	2,380	240	240	20	380	0	0	0
Lochaber	Loch Beag	18-May-10	5,860	100	120	0	580	0	0	0
Lochaber	Loch Beag	25-May-10	1,180	180	100	0	200	0	0	0
Lochaber	Loch Beag	01-Jun-10	2,320	0	20	0	60	0	0	0
Lochaber	Loch Beag	07-Jun-10	11,660	0	20	0	0	0	0	0
Lochaber	Loch Beag	14-Jun-10	220	0	20	0	0	0	0	0
Lochaber	Loch Beag	22-Jun-10	40	0	20	0	160	0	0	0
Lochaber	Loch Beag	28-Jun-10	0	0	0	0	0	0	0	0
Lochaber	Loch Beag	06-Jul-10	120	0	40	0	0	0	0	0
Lochaber	Loch Beag	12-Jul-10	2,840	780	260	0	40	0	20	0
Lochaber	Loch Beag	19-Jul-10	15,520	0	240	0	60	0	80	0
Lochaber	Loch Beag	02-Aug-10	85,246	0	180	0	0	0	0	0
Lochaber	Loch Beag	09-Aug-10	44,040	60	400	0	0	0	0	0
Lochaber	Loch Beag	16-Aug-10	10,900	20	180	0	20	0	0	0
Lochaber	Loch Beag	24-Aug-10	4,660	40	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Highland										
Skye & Lochalsh	Loch Eishort	11-Jan-10	1,700	0	20	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	08-Feb-10	600	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	08-Mar-10	600	20	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	22-Mar-10	60	0	40	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	29-Mar-10	1,400	40	0	0	80	0	0	0
Skye & Lochalsh	Loch Eishort	12-Apr-10	0	0	100	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	19-Apr-10	320	0	120	0	60	0	0	0
Skye & Lochalsh	Loch Eishort	25-Apr-10	120	0	100	0	180	0	0	0
Skye & Lochalsh	Loch Eishort	04-May-10	3,680	20	100	20	540	0	0	0
Skye & Lochalsh	Loch Eishort	10-May-10	12,660	0	160	0	40	0	0	0
Skye & Lochalsh	Loch Eishort	17-May-10	5,540	0	20	40	780	0	0	0
Skye & Lochalsh	Loch Eishort	24-May-10	4,520	0	0	0	240	0	0	0
Skye & Lochalsh	Loch Eishort	31-May-10	4,760	0	120	80	0	0	0	0
Skye & Lochalsh	Loch Eishort	07-Jun-10	620	0	40	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	14-Jun-10	140	0	40	0	480	0	0	0
Skye & Lochalsh	Loch Eishort	21-Jun-10	20	0	20	0	40	0	0	0
Skye & Lochalsh	Loch Eishort	28-Jun-10	0	0	0	20	60	0	0	0
Skye & Lochalsh	Loch Eishort	06-Jul-10	5,080	0	0	20	160	0	0	0
Skye & Lochalsh	Loch Eishort	12-Jul-10	6,380	0	20	0	40	0	0	0
Skye & Lochalsh	Loch Eishort	19-Jul-10	4,640	0	860	0	20	0	0	0
Skye & Lochalsh	Loch Eishort	26-Jul-10	14,460	40	1,160	0	0	0	100	0
Skye & Lochalsh	Loch Eishort	02-Aug-10	11,800	0	1,620	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	10-Aug-10	13,500	0	320	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	17-Aug-10	36,740	80	480	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	23-Aug-10	2,380	80	300	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	30-Aug-10	2,580	0	240	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	06-Sep-10	102,719	0	40	0	20	0	0	0
Skye & Lochalsh	Loch Eishort	13-Sep-10	123,932	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	20-Sep-10	146,136	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	27-Sep-10	259,445	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	04-Oct-10	273,061	20	40	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	11-Oct-10	184,250	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	08-Nov-10	400	0	0	0	0	0	0	0
Skye & Lochalsh	Loch Eishort	06-Dec-10	900	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	22-Mar-10	1,100	0	20	0	0	0	0	0
Ross & Cromarty	Loch Ewe	29-Mar-10	360	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	05-Apr-10	220	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	12-Apr-10	600	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	19-Apr-10	780	0	0	0	240	0	0	0
Ross & Cromarty	Loch Ewe	26-Apr-10	15,080	0	40	0	3,040	0	0	0
Ross & Cromarty	Loch Ewe	03-May-10	14,860	0	380	0	1,440	0	0	0
Ross & Cromarty	Loch Ewe	10-May-10	14,480	40	260	0	600	0	0	0
Ross & Cromarty	Loch Ewe	17-May-10	69,891	60	680	0	3,260	0	0	20
Ross & Cromarty	Loch Ewe	24-May-10	27,340	0	0	0	5,900	0	20	0
Ross & Cromarty	Loch Ewe	31-May-10	73,068	0	80	0	3,340	0	20	0
Ross & Cromarty	Loch Ewe	07-Jun-10	3,040	20	60	0	0	40	0	0
Ross & Cromarty	Loch Ewe	14-Jun-10	300	0	60	0	0	0	0	0
Ross & Cromarty	Loch Ewe	21-Jun-10	40	0	40	0	0	0	60	0
Ross & Cromarty	Loch Ewe	28-Jun-10	46,594	60	120	0	0	0	80	0
Ross & Cromarty	Loch Ewe	05-Jul-10	1,260	0	300	0	0	0	0	0
Ross & Cromarty	Loch Ewe	12-Jul-10	660	0	20	0	40	0	0	0
Ross & Cromarty	Loch Ewe	19-Jul-10	140	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	26-Jul-10	920	0	20	0	0	0	0	0
Ross & Cromarty	Loch Ewe	02-Aug-10	4,800	0	120	0	0	0	0	0
Ross & Cromarty	Loch Ewe	09-Aug-10	6,400	0	100	0	0	0	0	0
Ross & Cromarty	Loch Ewe	16-Aug-10	640	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	23-Aug-10	1,140	20	80	0	60	0	0	100
Ross & Cromarty	Loch Ewe	30-Aug-10	8,440	0	0	0	0	0	0	0
Ross & Cromarty	Loch Ewe	06-Sep-10	36,460	0	60	0	0	0	0	220
Ross & Cromarty	Loch Ewe	13-Sep-10	220,040	0	40	0	0	0	0	20
Ross & Cromarty	Loch Ewe	20-Sep-10	7,480	20	20	0	0	0	0	0
Ross & Cromarty	Loch Ewe	25-Sep-10	340	0	20	20	0	0	0	0
Ross & Cromarty	Loch Ewe	04-Oct-10	540	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Highland										
Sutherland	Loch Laxford	19-Jan-10	40	0	0	0	0	0	0	0
Sutherland	Loch Laxford	10-Feb-10	0	0	0	0	0	0	0	0
Sutherland	Loch Laxford	09-Mar-10	340	0	0	0	0	0	0	0
Sutherland	Loch Laxford	30-Mar-10	0	0	0	0	0	0	0	0
Sutherland	Loch Laxford	06-Apr-10	220	0	0	0	40	0	0	0
Sutherland	Loch Laxford	13-Apr-10	680	0	0	0	0	0	0	0
Sutherland	Loch Laxford	20-Apr-10	3,060	0	0	0	80	0	0	0
Sutherland	Loch Laxford	27-Apr-10	1,220	0	0	0	0	0	0	0
Sutherland	Loch Laxford	04-May-10	7,360	20	0	0	220	0	0	0
Sutherland	Loch Laxford	11-May-10	980	0	0	0	340	0	0	0
Sutherland	Loch Laxford	18-May-10	9,380	0	40	0	3,940	0	0	0
Sutherland	Loch Laxford	25-May-10	2,980	0	0	0	1,040	0	0	0
Sutherland	Loch Laxford	01-Jun-10	61,949	0	60	0	460	0	0	0
Sutherland	Loch Laxford	08-Jun-10	126,546	0	20	0	220	0	0	0
Sutherland	Loch Laxford	15-Jun-10	289,531	0	180	0	0	0	0	0
Sutherland	Loch Laxford	22-Jun-10	130,252	0	20	0	0	0	0	0
Sutherland	Loch Laxford	29-Jun-10	11,720	0	540	0	20	0	20	0
Sutherland	Loch Laxford	06-Jul-10	460	0	200	0	0	0	0	0
Sutherland	Loch Laxford	13-Jul-10	880	0	580	0	0	0	0	0
Sutherland	Loch Laxford	20-Jul-10	20	0	0	0	0	0	0	0
Sutherland	Loch Laxford	27-Jul-10	0	0	0	40	0	0	0	0
Sutherland	Loch Laxford	03-Aug-10	0	0	0	0	20	0	0	0
Sutherland	Loch Laxford	10-Aug-10	0	0	0	0	0	0	0	0
Sutherland	Loch Laxford	17-Aug-10	60	0	0	0	100	0	0	0
Sutherland	Loch Laxford	24-Aug-10	660	0	0	0	0	0	0	0
Sutherland	Loch Laxford	07-Sep-10	16,120	0	0	0	0	0	0	0
Sutherland	Loch Laxford	14-Sep-10	277,448	0	20	0	0	0	0	0
Sutherland	Loch Laxford	28-Sep-10	60	0	0	0	0	0	0	0
Sutherland	Loch Laxford	09-Nov-10	0	0	0	0	0	0	0	0
Sutherland	Loch Laxford	14-Dec-10	0	0	0	0	0	0	0	0
Sutherland	Kyle of Tongue	14-Apr-10	80	20	0	0	0	0	0	0
Sutherland	Kyle of Tongue	21-Apr-10	0	0	0	0	0	0	0	0
Sutherland	Kyle of Tongue	28-Apr-10	3,260	0	0	20	440	0	0	0
Sutherland	Kyle of Tongue	05-May-10	1,780	0	20	40	380	0	0	0
Sutherland	Kyle of Tongue	12-May-10	340	20	40	0	10,180	0	0	0
Sutherland	Kyle of Tongue	19-May-10	1,880	0	20	40	140	0	0	0
Sutherland	Kyle of Tongue	26-May-10	580	100	40	40	140	0	0	0
Sutherland	Kyle of Tongue	02-Jun-10	2,580	0	0	20	0	0	0	0
Sutherland	Kyle of Tongue	07-Jun-10	0	0	0	900	0	0	0	0
Sutherland	Kyle of Tongue	16-Jun-10	200	0	0	180	0	0	0	0
Sutherland	Kyle of Tongue	23-Jun-10	2,460	0	0	820	0	0	0	0
Sutherland	Kyle of Tongue	30-Jun-10	2,060	0	80	640	0	0	0	0
Sutherland	Kyle of Tongue	07-Jul-10	0	0	0	60	0	0	0	0
Sutherland	Kyle of Tongue	14-Jul-10	380	0	0	60	0	0	0	0
Sutherland	Kyle of Tongue	21-Jul-10	0	0	0	120	0	0	0	0
Sutherland	Kyle of Tongue	28-Jul-10	180	0	40	80	0	0	0	0
Sutherland	Kyle of Tongue	04-Aug-10	540	0	0	80	0	0	0	0
Sutherland	Kyle of Tongue	11-Aug-10	0	0	220	320	0	0	0	0
Sutherland	Kyle of Tongue	25-Aug-10	1,000	20	20	20	0	0	0	0
Sutherland	Kyle of Tongue	08-Sep-10	8,640	0	0	40	0	0	0	0
Sutherland	Kyle of Tongue	14-Sep-10	12,100	0	0	0	0	0	0	0
Sutherland	Kyle of Tongue	21-Sep-10	760	0	0	40	0	0	0	0
Sutherland	Kyle of Tongue	04-Oct-10	140	0	0	100	20	0	0	0
Sutherland	Kyle of Tongue	13-Oct-10	100	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia spp.*	*Alexandrium spp.*	*Dinophysis spp.*	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Highland										
Sutherland	Dornoch Firth	12-Jan-10	2,280	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	09-Feb-10	840	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	10-Mar-10	118,636	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	15-Mar-10	484,485	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	24-Mar-10	258,480	60	0	0	0	0	0	0
Sutherland	Dornoch Firth	29-Mar-10	52,948	20	0	0	0	0	0	0
Sutherland	Dornoch Firth	07-Apr-10	6,040	40	60	0	20	0	0	0
Sutherland	Dornoch Firth	12-Apr-10	10,300	0	0	0	20	0	0	0
Sutherland	Dornoch Firth	19-Apr-10	2,980	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	26-Apr-10	3,600	0	0	0	100	0	20	0
Sutherland	Dornoch Firth	04-May-10	1,020	0	20	0	0	0	0	0
Sutherland	Dornoch Firth	10-May-10	100	60	20	0	0	0	0	0
Sutherland	Dornoch Firth	17-May-10	0	20	60	0	0	0	0	0
Sutherland	Dornoch Firth	24-May-10	40	40	280	0	1,480	0	0	0
Sutherland	Dornoch Firth	31-May-10	0	0	20	0	0	0	0	0
Sutherland	Dornoch Firth	07-Jun-10	0	60	400	0	0	0	0	0
Sutherland	Dornoch Firth	14-Jun-10	700	0	60	0	40	0	0	0
Sutherland	Dornoch Firth	21-Jun-10	280	0	200	0	0	0	0	0
Sutherland	Dornoch Firth	28-Jun-10	640	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	05-Jul-10	80	80	940	0	0	0	0	0
Sutherland	Dornoch Firth	12-Jul-10	980	20	40	0	0	0	0	0
Sutherland	Dornoch Firth	19-Jul-10	38,740	60	160	0	60	0	0	0
Sutherland	Dornoch Firth	26-Jul-10	442,645	80	20	0	0	0	0	0
Sutherland	Dornoch Firth	02-Aug-10	128,134	20	40	0	0	0	0	0
Sutherland	Dornoch Firth	09-Aug-10	291,214	0	80	0	0	0	0	0
Sutherland	Dornoch Firth	16-Aug-10	58,840	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	13-Sep-10	10,660	0	0	0	0	0	0	0
Sutherland	Dornoch Firth	05-Oct-10	10,260	0	0	0	20	0	0	0
Sutherland	Dornoch Firth	10-Nov-10	1,600	0	0	0	0	0	0	0
Fife										
Elie	Elie Ness	05-Apr-10	11,240	0	0	0	0	0	0	0
Elie	Elie Ness	12-Apr-10	2,380	80	0	0	0	0	0	0
Elie	Elie Ness	19-Apr-10	159,799	20	0	0	0	0	0	0
Elie	Elie Ness	26-Apr-10	241,972	80	0	0	0	0	0	0
Elie	Elie Ness	03-May-10	11,820	20	100	0	20	0	0	0
Elie	Elie Ness	09-May-10	1,160	80	20	0	80	0	0	0
Elie	Elie Ness	17-May-10	360	0	0	0	0	0	0	0
Elie	Elie Ness	23-May-10	140	0	60	0	140	0	0	0
Elie	Elie Ness	31-May-10	140	20	40	0	1,420	0	0	0
Elie	Elie Ness	06-Jun-10	260	60	660	0	200	0	0	0
Elie	Elie Ness	13-Jun-10	100	0	180	20	20	0	0	0
Elie	Elie Ness	20-Jun-10	40	0	40	0	20	0	0	0
Elie	Elie Ness	28-Jun-10	4,360	20	120	0	600	0	0	0
Elie	Elie Ness	04-Jul-10	180	0	0	0	0	0	0	0
Elie	Elie Ness	12-Jul-10	9,620	0	900	0	2,220	0	0	0
Elie	Elie Ness	18-Jul-10	18,080	0	20	0	0	0	0	0
Elie	Elie Ness	26-Jul-10	8,300	80	240	0	20	0	0	0
Elie	Elie Ness	02-Aug-10	2,100	0	20	0	0	0	0	0
Elie	Elie Ness	09-Aug-10	1,620	0	200	0	0	0	0	0
Elie	Elie Ness	15-Aug-10	800	0	40	0	0	0	0	0
Elie	Elie Ness	23-Aug-10	40	0	40	0	140	0	0	0
Elie	Elie Ness	30-Aug-10	180	0	0	40	20	0	0	0
Elie	Elie Ness	06-Sep-10	240	0	20	0	100	0	0	0
Elie	Elie Ness	12-Sep-10	2,840	0	0	0	0	0	0	0
Elie	Elie Ness	20-Sep-10	2,020	0	0	0	0	0	0	0
Elie	Elie Ness	26-Sep-10	220	0	0	0	0	0	0	0
Elie	Elie Ness	03-Oct-10	60	0	20	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Comhairle nan Eilean Siar: Lewis & Harris										
Isle of Harris	Loch Stockinish	12-Apr-10	120	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	20-Apr-10	20	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	27-Apr-10	0	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	04-May-10	0	0	0	0	80	0	0	0
Isle of Harris	Loch Stockinish	11-May-10	360	0	120	0	200	0	0	0
Isle of Harris	Loch Stockinish	18-May-10	640	0	20	0	5,100	0	0	0
Isle of Harris	Loch Stockinish	25-May-10	8,000	0	0	80	680	0	0	0
Isle of Harris	Loch Stockinish	01-Jun-10	360	0	0	20	0	0	0	0
Isle of Harris	Loch Stockinish	08-Jun-10	2,240	0	0	0	120	0	0	0
Isle of Harris	Loch Stockinish	16-Jun-10	11,940	0	160	0	160	0	0	0
Isle of Harris	Loch Stockinish	22-Jun-10	24,520	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	29-Jun-10	437,350	0	0	0	20	0	0	0
Isle of Harris	Loch Stockinish	06-Jul-10	2,000	0	20	0	60	0	0	0
Isle of Harris	Loch Stockinish	19-Jul-10	620	0	60	0	0	0	0	0
Isle of Harris	Loch Stockinish	26-Jul-10	420	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	10-Aug-10	920	20	0	0	20	0	0	0
Isle of Harris	Loch Stockinish	17-Aug-10	1,900	0	60	0	100	0	0	0
Isle of Harris	Loch Stockinish	24-Aug-10	3,740	0	60	0	0	0	0	0
Isle of Harris	Loch Stockinish	31-Aug-10	640	0	240	0	0	0	0	0
Isle of Harris	Loch Stockinish	07-Sep-10	27,320	0	120	20	0	0	0	0
Isle of Harris	Loch Stockinish	14-Sep-10	1,740	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	21-Sep-10	6,780	0	20	0	120	0	0	0
Isle of Harris	Loch Stockinish	28-Sep-10	1,060	0	0	0	0	0	0	0
Isle of Harris	Loch Stockinish	05-Oct-10	7,820	0	40	0	0	0	0	0
Isle of Harris	Seilebost	12-Apr-10	0	0	0	0	20	0	0	0
Isle of Harris	Seilebost	20-Apr-10	0	0	20	0	0	0	0	0
Isle of Harris	Seilebost	27-Apr-10	0	40	0	0	0	0	0	0
Isle of Harris	Seilebost	04-May-10	0	0	0	0	440	0	0	0
Isle of Harris	Seilebost	11-May-10	0	0	60	0	200	0	0	0
Isle of Harris	Seilebost	18-May-10	940	0	20	0	1,260	0	0	0
Isle of Harris	Seilebost	25-May-10	1,900	0	0	0	0	0	0	0
Isle of Harris	Seilebost	01-Jun-10	2,500	0	60	0	80	0	0	0
Isle of Harris	Seilebost	08-Jun-10	9,360	0	0	0	0	0	0	0
Isle of Harris	Seilebost	15-Jun-10	38,300	80	260	0	20	0	0	0
Isle of Harris	Seilebost	22-Jun-10	57,713	0	20	0	0	0	0	0
Isle of Harris	Seilebost	29-Jun-10	53,200	20	40	0	0	0	0	0
Isle of Harris	Seilebost	06-Jul-10	140	0	0	0	20	0	0	0
Isle of Harris	Seilebost	19-Jul-10	0	0	0	0	0	0	0	0
Isle of Harris	Seilebost	26-Jul-10	460	0	0	20	0	0	0	0
Isle of Harris	Seilebost	10-Aug-10	7,620	40	420	0	60	0	0	0
Isle of Harris	Seilebost	17-Aug-10	0	0	0	0	0	0	0	0
Isle of Harris	Seilebost	24-Aug-10	180	0	20	0	0	0	0	0
Isle of Harris	Seilebost	31-Aug-10	175,749	0	0	0	0	0	0	0
Isle of Harris	Seilebost	07-Sep-10	788,067	0	20	20	0	0	0	0
Isle of Harris	Seilebost	14-Sep-10	1,740	0	100	20	0	0	0	0
Isle of Harris	Seilebost	21-Sep-10	1,460	0	0	40	0	0	0	0
Isle of Harris	Seilebost	28-Sep-10	180	0	20	0	0	0	0	0
Isle of Harris	Seilebost	05-Oct-10	0	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Comhairle nan Eilean Siar: Lewis & Harris										
Isle of Lewis	Loch Leurbost	14-Apr-10	240	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	21-Apr-10	100	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	28-Apr-10	1,600	0	20	0	0	0	0	0
Isle of Lewis	Loch Leurbost	05-May-10	340	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	12-May-10	1,160	0	0	120	1,300	0	0	0
Isle of Lewis	Loch Leurbost	19-May-10	7,020	80	20	0	860	0	0	0
Isle of Lewis	Loch Leurbost	26-May-10	8,020	160	80	0	4,520	0	0	0
Isle of Lewis	Loch Leurbost	02-Jun-10	1,840	0	300	0	140	0	0	0
Isle of Lewis	Loch Leurbost	09-Jun-10	5,040	20	80	0	0	0	0	0
Isle of Lewis	Loch Leurbost	16-Jun-10	77,304	0	320	0	20	0	0	0
Isle of Lewis	Loch Leurbost	23-Jun-10	195,908	20	240	0	0	0	0	0
Isle of Lewis	Loch Leurbost	30-Jun-10	8,300	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	07-Jul-10	1,780	20	0	0	120	0	0	0
Isle of Lewis	Loch Leurbost	12-Jul-10	7,720	20	20	0	160	0	0	0
Isle of Lewis	Loch Leurbost	21-Jul-10	3,480	0	20	20	0	0	0	0
Isle of Lewis	Loch Leurbost	28-Jul-10	3,000	20	120	0	20	0	0	0
Isle of Lewis	Loch Leurbost	11-Aug-10	3,620	40	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	18-Aug-10	120	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	25-Aug-10	1,280	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	30-Aug-10	160	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	08-Sep-10	132,370	0	160	0	0	0	0	0
Isle of Lewis	Loch Leurbost	15-Sep-10	4,220	40	20	0	0	0	0	0
Isle of Lewis	Loch Leurbost	22-Sep-10	3,720	60	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	29-Sep-10	3,980	0	0	0	0	0	0	0
Isle of Lewis	Loch Leurbost	06-Oct-10	1,620	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	13-Apr-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	19-Apr-10	20	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	26-Apr-10	500	0	0	0	160	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	03-May-10	0	0	20	0	480	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	10-May-10	440	0	0	0	940	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	17-May-10	2,460	0	80	0	3,000	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	26-May-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	01-Jun-10	3,720	0	20	20	60	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	07-Jun-10	5,220	0	480	0	40	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	15-Jun-10	114,727	20	400	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	21-Jun-10	11,700	0	40	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	28-Jun-10	10,600	0	0	0	20	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	05-Jul-10	7,640	20	80	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	12-Jul-10	9,180	40	60	40	20	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	20-Jul-10	4,100	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	26-Jul-10	3,720	60	0	0	40	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	02-Aug-10	9,620	80	120	0	180	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	09-Aug-10	4,580	0	0	60	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	16-Aug-10	80	140	200	20	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	23-Aug-10	120	0	40	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	30-Aug-10	67,060	0	200	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	06-Sep-10	817,311	120	60	60	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	13-Sep-10	4,160	200	60	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	20-Sep-10	3,480	0	20	0	40	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	27-Sep-10	240	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	04-Oct-10	160	0	20	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	08-Nov-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Loch Barraglom	06-Dec-10	60	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Comhairle nan Eilean Siar: Lewis & Harris										
I. of Lewis: L. Roag	Eilean Teinish	13-Jan-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	08-Feb-10	80	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	08-Mar-10	960	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	24-Mar-10	0	0	20	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	29-Mar-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	13-Apr-10	0	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	20-Apr-10	60	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	28-Apr-10	0	0	0	180	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	03-May-10	100	20	20	0	180	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	10-May-10	1,840	0	0	0	4,020	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	17-May-10	2,440	0	0	0	460	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	24-May-10	6,360	0	0	120	620	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	31-May-10	20,440	0	120	0	60	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	07-Jun-10	41,080	0	100	0	1,080	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	16-Jun-10	146,902	0	160	0	20	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	22-Jun-10	169,359	0	0	40	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	28-Jun-10	83,334	40	1,300	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	05-Jul-10	10,240	0	0	0	20	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	12-Jul-10	1,900	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	20-Jul-10	5,600	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	26-Jul-10	1,700	0	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	04-Aug-10	6,960	0	120	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	09-Aug-10	7,440	40	0	20	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	16-Aug-10	40	860	0	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	23-Aug-10	5,180	20	60	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	31-Aug-10	35,060	0	20	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	06-Sep-10	1,980	0	0	40	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	13-Sep-10	9,620	0	120	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	20-Sep-10	9,820	0	120	0	0	0	0	0
I. of Lewis: L. Roag	Eilean Teinish	27-Sep-10	2,560	0	20	0	0	0	0	0
I. of Lewis: L. Roag	Miavaig	05-Oct-10	120	0	20	0	0	0	0	0
Orkney Islands										
Scapa Bay	Scapa Pier	29-Mar-10	10,540	60	0	0	100	0	0	0
Scapa Bay	Scapa Pier	06-Apr-10	15,940	220	60	0	320	0	0	0
Scapa Bay	Scapa Pier	19-Apr-10	3,920	0	0	40	1,580	0	0	0
Scapa Bay	Scapa Pier	26-Apr-10	4,060	40	100	0	780	0	0	0
Scapa Bay	Scapa Pier	05-May-10	1,920	0	320	20	1,400	0	0	0
Scapa Bay	Scapa Pier	10-May-10	3,400	0	200	0	180	0	0	0
Scapa Bay	Scapa Pier	17-May-10	1,960	20	100	0	920	0	0	0
Scapa Bay	Scapa Pier	24-May-10	300	340	2,520	40	9,480	0	0	60
Scapa Bay	Scapa Pier	31-May-10	180	220	160	0	2,880	0	0	0
Scapa Bay	Scapa Pier	07-Jun-10	60	80	0	100	1,580	0	0	0
Scapa Bay	Scapa Pier	15-Jun-10	40	0	40	60	0	0	0	0
Scapa Bay	Scapa Pier	21-Jun-10	20	0	60	0	0	0	0	0
Scapa Bay	Scapa Pier	28-Jun-10	1,680	20	0	20	60	0	0	0
Scapa Bay	Scapa Pier	05-Jul-10	77,851	0	20	80	0	0	0	0
Scapa Bay	Scapa Pier	13-Jul-10	2,032,059	0	20	120	0	0	0	0
Scapa Bay	Scapa Pier	20-Jul-10	1,152,148	40	60	40	0	0	0	0
Scapa Bay	Scapa Pier	27-Jul-10	155,449	0	60	20	0	0	0	0
Scapa Bay	Scapa Pier	04-Aug-10	640	0	0	0	0	0	0	0
Scapa Bay	Scapa Pier	10-Aug-10	1,780	40	320	40	0	0	0	0
Scapa Bay	Scapa Pier	17-Aug-10	120	200	200	60	0	0	0	0
Scapa Bay	Scapa Pier	23-Aug-10	260	40	20	160	0	0	0	0
Scapa Bay	Scapa Pier	30-Aug-10	2,640	20	60	0	0	0	0	0
Scapa Bay	Scapa Pier	08-Sep-10	401,875	80	160	140	0	0	0	0
Scapa Bay	Scapa Pier	13-Sep-10	17,480	20	0	100	0	0	0	0
Scapa Bay	Scapa Pier	21-Sep-10	1,320	0	20	20	0	0	0	0
Scapa Bay	Scapa Pier	27-Sep-10	300	0	0	180	0	0	0	0
Scapa Bay	Scapa Pier	04-Oct-10	1,940	0	0	20	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia spp.*	*Alexandrium spp.*	*Dinophysis spp.*	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Shetland										
Clift Sound	Booth	27-Jan-10	1,480	0	0	0	0	0	0	0
Clift Sound	Booth	17-Feb-10	7,240	0	0	0	0	0	0	0
Clift Sound	Booth	03-Mar-10	12,700	0	0	0	0	0	0	0
Clift Sound	Booth	17-Mar-10	52,820	0	0	0	0	0	0	0
Clift Sound	Booth	21-Apr-10	40	0	0	0	480	0	0	0
Clift Sound	Booth	28-Apr-10	200	20	0	0	1,460	0	0	0
Clift Sound	Booth	05-May-10	1,400	80	60	0	1,860	0	0	0
Clift Sound	Booth	04-Aug-10	2,005,349	0	0	0	0	0	0	0
Clift Sound	Booth	18-Aug-10	19,040	0	20	40	0	0	0	0
Clift Sound	Booth	25-Aug-10	920	20	0	20	540	0	0	0
Clift Sound	Booth	01-Sep-10	139,253	20	80	20	380	0	0	0
Clift Sound	Booth	08-Sep-10	678,803	0	120	0	0	0	0	0
Clift Sound	Booth	15-Sep-10	197,505	0	40	20	0	0	0	0
Clift Sound	Booth	22-Sep-10	10,580	0	60	20	0	0	0	0
Clift Sound	Booth	29-Sep-10	28,220	40	20	0	0	0	0	0
Clift Sound	Booth	06-Oct-10	35,380	0	60	0	0	0	0	0
Clift Sound	Booth	13-Oct-10	28,280	0	0	0	0	0	0	0
Clift Sound	Booth	10-Nov-10	200	0	0	0	0	0	0	0
Clift Sound	Booth	08-Dec-10	3,060	0	0	0	0	0	0	0
Sandsound Voe	Sandsound Voe	05-Apr-10	3,420	0	0	0	0	0	0	0
Sandsound Voe	Sandsound Voe	12-Apr-10	1,800	40	0	0	320	0	0	0
Sandsound Voe	Sandsound Voe	19-Apr-10	420	240	0	0	20	0	0	0
Sandsound Voe	Sandsound Voe	26-Apr-10	260	20	0	0	1,220	0	0	0
Sandsound Voe	Sandsound Voe	03-May-10	660	0	0	0	6,400	0	0	0
Sandsound Voe	Sandsound Voe	10-May-10	2,180	20	0	0	8,680	0	0	0
Sandsound Voe	Sandsound Voe	17-May-10	1,200	320	0	0	3,840	0	0	0
Sandsound Voe	Sandsound Voe	24-May-10	320	80	20	0	1,360	0	0	0
Sandsound Voe	Sandsound Voe	31-May-10	4,700	400	20	0	2,900	0	0	0
Sandsound Voe	Sandsound Voe	07-Jun-10	3,440	260	40	0	120	0	0	0
Sandsound Voe	Sandsound Voe	14-Jun-10	2,480	100	0	0	0	0	0	0
Sandsound Voe	Sandsound Voe	21-Jun-10	3,500	80	0	0	0	0	0	0
Sandsound Voe	Sandsound Voe	28-Jun-10	500	40	20	0	20	0	0	0
Sandsound Voe	Sandsound Voe	05-Jul-10	680	0	20	20	260	0	0	0
Sandsound Voe	Sandsound Voe	12-Jul-10	52,040	20	60	0	120	0	0	0
Sandsound Voe	Sandsound Voe	19-Jul-10	857,909	0	20	0	0	0	0	0
Sandsound Voe	Sandsound Voe	26-Jul-10	1,102,377	0	40	0	120	0	0	0
Sandsound Voe	Sandsound Voe	02-Aug-10	75,186	0	40	40	20	0	0	0
Sandsound Voe	Sandsound Voe	09-Aug-10	5,700	0	40	20	0	0	0	0
Sandsound Voe	Sandsound Voe	16-Aug-10	3,540	0	60	20	0	0	0	0
Sandsound Voe	Sandsound Voe	23-Aug-10	43,000	0	20	0	0	0	0	0
Sandsound Voe	Sandsound Voe	30-Aug-10	315,570	0	0	0	840	0	0	0
Sandsound Voe	Sandsound Voe	06-Sep-10	633,731	0	40	0	900	0	0	0
Sandsound Voe	Sandsound Voe	13-Sep-10	464,745	0	40	0	0	0	0	0
Sandsound Voe	Sandsound Voe	20-Sep-10	5,160	0	0	20	0	0	0	0
Sandsound Voe	Sandsound Voe	27-Sep-10	860	0	0	0	0	0	0	0
Sandsound Voe	Sandsound Voe	04-Oct-10	740	20	0	0	140	0	0	0
Sandsound Voe	Sandsound Voe	11-Oct-10	1,060	0	0	0	0	0	0	0
Ronas Voe	Ronas Voe	04-May-10	34,160	0	0	0	120	0	0	0
Ronas Voe	Ronas Voe	10-May-10	36,240	0	0	0	100	0	0	0
Ronas Voe	Ronas Voe	17-May-10	22,680	0	0	0	40	0	0	0
Ronas Voe	Ronas Voe	01-Jun-10	115,919	0	160	0	4,480	0	0	0
Ronas Voe	Ronas Voe	07-Jun-10	127,671	0	100	0	80	0	0	0
Ronas Voe	Ronas Voe	14-Jun-10	353,742	0	40	0	0	0	0	0
Ronas Voe	Ronas Voe	21-Jun-10	223,441	0	20	0	140	0	0	0
Ronas Voe	Ronas Voe	28-Jun-10	229,454	40	340	0	200	0	0	0
Ronas Voe	Ronas Voe	05-Jul-10	20,960	0	0	0	0	0	0	0
Ronas Voe	Ronas Voe	12-Jul-10	15,100	0	20	0	640	0	0	0
Ronas Voe	Ronas Voe	19-Jul-10	7,400	0	0	0	0	0	0	0
Ronas Voe	Ronas Voe	26-Jul-10	16,440	0	0	0	3,540	0	0	0
Ronas Voe	Ronas Voe	02-Aug-10	23,180	0	260	0	9,040	0	0	0
Ronas Voe	Ronas Voe	09-Aug-10	14,380	0	40	0	0	0	0	0
Ronas Voe	Ronas Voe	16-Aug-10	60	0	20	0	120	0	0	0
Ronas Voe	Ronas Voe	13-Sep-10	161,716	0	20	0	0	0	0	20

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Shetland										
Gruting Voe	Browland Voe	07-Apr-10	4,380	20	0	0	80	0	0	0
Gruting Voe	Browland Voe	14-Apr-10	320	60	0	0	0	0	0	0
Gruting Voe	Browland Voe	21-Apr-10	80	0	0	0	0	0	0	0
Gruting Voe	Browland Voe	28-Apr-10	0	0	0	0	400	0	0	0
Gruting Voe	Browland Voe	05-May-10	3,120	60	0	20	5,300	0	0	0
Gruting Voe	Browland Voe	12-May-10	6,820	240	20	0	68,290	0	0	0
Gruting Voe	Browland Voe	19-May-10	560	240	20	20	1,040	0	0	0
Gruting Voe	Browland Voe	26-May-10	420	280	40	0	28,062	0	0	0
Gruting Voe	Browland Voe	02-Jun-10	280	280	20	20	4,120	0	0	0
Gruting Voe	Browland Voe	09-Jun-10	560	380	500	0	900	0	0	0
Gruting Voe	Browland Voe	15-Jun-10	1,940	100	260	40	0	0	0	0
Gruting Voe	Browland Voe	23-Jun-10	2,240	140	140	0	460	0	0	0
Gruting Voe	Browland Voe	13-Jul-10	3,280,658	80	680	60	0	0	0	0
Gruting Voe	Browland Voe	11-Aug-10	38,880	0	180	60	0	0	0	0
Gruting Voe	Browland Voe	25-Aug-10	191,212	0	0	0	600	0	0	0
Gruting Voe	Browland Voe	01-Sep-10	501,249	0	0	0	0	0	0	0
Gruting Voe	Browland Voe	22-Sep-10	2,860	0	20	40	0	0	0	0
Vaila Sound	East of Linga	07-Apr-10	3,080	0	0	0	40	0	0	0
Vaila Sound	East of Linga	14-Apr-10	0	340	0	0	360	0	0	0
Vaila Sound	East of Linga	21-Apr-10	0	0	0	0	60	0	0	0
Vaila Sound	East of Linga	28-Apr-10	520	40	0	0	2,060	0	0	0
Vaila Sound	East of Linga	05-May-10	4,280	0	40	0	16,820	0	0	0
Vaila Sound	East of Linga	12-May-10	5,120	0	20	0	26,080	0	0	0
Vaila Sound	East of Linga	24-May-10	4,080	80	40	0	64,597	0	0	0
Vaila Sound	East of Linga	31-May-10	13,220	320	20	0	88,094	0	0	0
Vaila Sound	East of Linga	09-Jun-10	14,320	0	60	0	133,848	0	0	0
Vaila Sound	East of Linga	14-Jun-10	15,200	40	100	40	500	0	0	0
Vaila Sound	East of Linga	21-Jun-10	13,860	20	180	0	860	0	0	0
Vaila Sound	East of Linga	28-Jun-10	19,740	0	0	0	0	0	0	0
Vaila Sound	East of Linga	05-Jul-10	23,760	20	300	0	0	0	0	0
Vaila Sound	East of Linga	12-Jul-10	3,502,150	0	960	0	0	0	0	0
Vaila Sound	East of Linga	19-Jul-10	3,022,516	0	340	20	0	0	0	0
Vaila Sound	East of Linga	09-Aug-10	11,160	260	360	120	80	0	0	0
Vaila Sound	East of Linga	16-Aug-10	48,000	60	260	40	40	0	0	0
Vaila Sound	East of Linga	25-Aug-10	34,940	40	20	0	20	0	0	0
Vaila Sound	East of Linga	01-Sep-10	144,775	20	0	20	0	0	0	0
Vaila Sound	East of Linga	15-Sep-10	15,480	60	60	0	20	0	0	0
Vaila Sound	East of Linga	22-Sep-10	240	20	0	20	0	0	0	0
Vaila Sound	East of Linga	29-Sep-10	4,780	20	0	0	0	0	0	0
Vaila Sound	East of Linga	06-Oct-10	8,440	0	0	0	0	0	0	0
Vaila Sound	East of Linga	10-Nov-10	80	0	0	0	0	0	0	0
Vaila Sound	East of Linga	07-Dec-10	11,480	0	0	0	0	0	0	0
Vaila Sound	Riskaness	11-Jan-10	940	0	0	0	0	0	0	0
Vaila Sound	Riskaness	08-Feb-10	1,900	0	0	0	0	0	0	0
Vaila Sound	Riskaness	08-Mar-10	2,700	0	0	0	20	0	0	0
Vaila Sound	Riskaness	22-Mar-10	11,840	0	0	0	720	0	0	0
Vaila Sound	Riskaness	05-Apr-10	3,020	40	0	0	0	0	0	0
Vaila Sound	Riskaness	12-Apr-10	0	0	20	0	0	0	0	0
Vaila Sound	Riskaness	19-Apr-10	0	20	20	0	1,240	0	0	0
Vaila Sound	Riskaness	26-Apr-10	480	20	0	0	580	0	0	0
Vaila Sound	Riskaness	03-May-10	2,820	60	0	0	10,780	0	0	0
Vaila Sound	Riskaness	10-May-10	3,940	40	20	0	15,040	0	0	0
Vaila Sound	Riskaness	17-May-10	4,340	40	0	0	14,240	0	0	0
Vaila Sound	Riskaness	24-May-10	2,360	0	20	0	61,966	0	0	0
Vaila Sound	Riskaness	31-May-10	8,760	40	40	20	79,951	0	0	0
Vaila Sound	Riskaness	07-Jun-10	8,160	20	0	0	35,791	0	0	0
Vaila Sound	Riskaness	14-Jun-10	8,000	0	0	0	540	0	0	0
Vaila Sound	Riskaness	21-Jun-10	8,620	0	20	0	40	0	0	0
Vaila Sound	Riskaness	28-Jun-10	7,760	0	20	20	120	0	0	0
Vaila Sound	Riskaness	05-Jul-10	23,940	0	180	20	0	0	0	0
Vaila Sound	Riskaness	12-Jul-10	920,549	0	120	20	0	0	0	0
Vaila Sound	Riskaness	19-Jul-10	1,803,409	0	40	20	820	0	0	0
Vaila Sound	Riskaness	09-Aug-10	1,900	0	40	20	0	0	0	0
Vaila Sound	Riskaness	16-Aug-10	11,620	0	40	20	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Shetland										
Vementry South	Seggi Bight	05-Apr-10	460	0	0	0	20	0	0	0
Vementry South	Seggi Bight	19-Apr-10	400	0	0	0	220	0	0	0
Vementry South	Seggi Bight	26-Apr-10	3,880	0	0	0	240	0	0	0
Vementry South	Seggi Bight	03-May-10	12,040	0	0	480	0	0	0	0
Vementry South	Seggi Bight	17-May-10	20,460	60	0	0	3,360	0	0	0
Vementry South	Seggi Bight	24-May-10	3,280	220	0	0	1,400	0	0	0
Vementry South	Seggi Bight	31-May-10	160	20	40	0	460	0	0	0
Vementry South	Seggi Bight	14-Jun-10	10,960	60	60	0	320	0	0	0
Vementry South	Seggi Bight	21-Jun-10	195,309	40	80	0	0	0	0	0
Vementry South	Seggi Bight	05-Jul-10	200	0	60	60	0	0	0	0
Vementry South	Seggi Bight	12-Jul-10	2,200	40	140	40	0	0	0	0
Vementry South	Seggi Bight	02-Aug-10	14,960	40	0	0	0	0	0	0
Vementry South	Seggi Bight	09-Aug-10	18,600	20	20	0	180	0	0	0
Vementry South	Seggi Bight	16-Aug-10	10,700	40	40	140	20	0	0	0
Vementry South	Seggi Bight	23-Aug-10	19,080	20	80	80	60	0	0	0
Vementry South	Seggi Bight	30-Aug-10	19,700	20	120	20	0	0	0	0
Vementry South	Seggi Bight	06-Sep-10	16,600	0	60	80	40	0	0	0
Vementry South	Seggi Bight	13-Sep-10	39,600	0	20	40	0	0	0	0
Vementry South	Seggi Bight	20-Sep-10	16,440	20	20	0	0	0	0	0
Vementry South	Seggi Bight	27-Sep-10	11,220	20	0	0	0	0	0	0
Vementry South	Seggi Bight	04-Oct-10	2,000	0	0	0	0	0	0	0
Aith Voe Sletta	Slyde	05-Apr-10	12,600	0	0	40	1,580	0	0	0
Aith Voe Sletta	Slyde	12-Apr-10	620	0	0	0	0	0	0	0
Aith Voe Sletta	Slyde	19-Apr-10	35,740	0	0	0	0	0	0	0
Aith Voe Sletta	Slyde	26-Apr-10	7,360	0	0	0	1,140	0	0	0
Aith Voe Sletta	Slyde	03-May-10	47,653	20	0	0	11,480	0	0	0
Aith Voe Sletta	Slyde	10-May-10	29,420	0	40	0	24,460	0	0	0
Aith Voe Sletta	Slyde	17-May-10	16,840	220	20	0	1,400	0	0	0
Aith Voe Sletta	Slyde	24-May-10	360	220	100	0	20	0	0	0
Aith Voe Sletta	Slyde	31-May-10	1,920	280	40	0	480	0	0	0
Aith Voe Sletta	Slyde	14-Jun-10	23,480	100	100	0	100	0	0	0
Aith Voe Sletta	Slyde	21-Jun-10	211,539	160	80	20	0	0	0	0
Aith Voe Sletta	Slyde	12-Jul-10	40,220	0	200	0	140	0	0	0
Aith Voe Sletta	Slyde	02-Aug-10	134,488	40	40	20	1,100	0	0	0
Aith Voe Sletta	Slyde	09-Aug-10	5,680	0	0	0	120	0	0	0
Aith Voe Sletta	Slyde	16-Aug-10	2,420	0	40	0	220	0	0	0
Aith Voe Sletta	Slyde	23-Aug-10	26,100	100	160	20	140	0	0	0
Aith Voe Sletta	Slyde	30-Aug-10	14,980	260	220	20	0	0	0	0
Aith Voe Sletta	Slyde	06-Sep-10	1,520	0	0	20	40	0	0	0
Aith Voe Sletta	Slyde	20-Sep-10	45,440	0	20	0	20	0	0	0
Aith Voe Sletta	Slyde	04-Oct-10	11,000	0	20	40	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia spp.*	*Alexandrium spp.*	*Dinophysis spp.*	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Shetland										
Olna Firth	Olna Firth	05-Apr-10	10,580	20	0	0	800	0	0	0
Olna Firth	Olna Firth	12-Apr-10	49,242	0	0	0	40	0	0	0
Olna Firth	Olna Firth	19-Apr-10	115,427	0	0	0	0	0	0	0
Olna Firth	Olna Firth	26-Apr-10	33,660	20	0	0	3,420	0	0	0
Olna Firth	Olna Firth	03-May-10	30,680	280	60	0	18,880	0	0	0
Olna Firth	Olna Firth	10-May-10	49,740	0	0	0	88,777	0	0	0
Olna Firth	Olna Firth	17-May-10	4,060	60	20	0	60,890	0	0	20
Olna Firth	Olna Firth	24-May-10	200	740	60	0	160	0	0	0
Olna Firth	Olna Firth	31-May-10	560	140	120	0	240	0	0	0
Olna Firth	Olna Firth	07-Jun-10	17,080	200	0	0	140	0	0	0
Olna Firth	Olna Firth	14-Jun-10	65,660	440	180	0	20	0	0	0
Olna Firth	Olna Firth	21-Jun-10	542,223	40	100	0	0	0	0	0
Olna Firth	Olna Firth	28-Jun-10	647,389	40	0	0	0	0	0	0
Olna Firth	Olna Firth	05-Jul-10	238,249	0	0	20	0	0	0	0
Olna Firth	Olna Firth	12-Jul-10	10,840	20	40	0	340	0	0	0
Olna Firth	Olna Firth	19-Jul-10	2,960	0	0	0	0	0	0	0
Olna Firth	Olna Firth	26-Jul-10	400,287	0	0	0	800	0	0	0
Olna Firth	Olna Firth	02-Aug-10	222,223	0	40	0	2,440	0	0	0
Olna Firth	Olna Firth	09-Aug-10	5,420	0	0	0	1,140	0	0	0
Olna Firth	Olna Firth	16-Aug-10	3,240	0	40	40	920	0	0	0
Olna Firth	Olna Firth	23-Aug-10	3,940	0	0	20	580	0	0	0
Olna Firth	Olna Firth	30-Aug-10	109,264	0	20	0	0	0	0	0
Olna Firth	Olna Firth	06-Sep-10	111,191	0	60	0	2,020	0	0	0
Olna Firth	Olna Firth	13-Sep-10	366,454	0	80	0	0	0	0	0
Olna Firth	Olna Firth	20-Sep-10	160,390	0	60	0	120	0	0	40
Olna Firth	Olna Firth	04-Oct-10	41,920	0	0	0	20	0	0	0
Olna Firth	Olna Firth	11-Oct-10	16,540	0	0	0	140	0	0	0
Olna Firth	Parkgate	27-Sep-10	68,740	0	20	0	20	0	0	0
Busta Voe	Busta Voe Lee	11-Jan-10	180	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	08-Feb-10	2,320	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	08-Mar-10	40,840	0	0	0	200	0	0	0
Busta Voe	Busta Voe Lee	22-Mar-10	21,520	20	0	0	280	0	0	0
Busta Voe	Busta Voe Lee	05-Apr-10	2,320	0	0	0	120	0	0	0
Busta Voe	Busta Voe Lee	12-Apr-10	16,400	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	19-Apr-10	22,880	0	0	0	77,851	0	0	0
Busta Voe	Busta Voe Lee	26-Apr-10	41,600	20	0	0	84,680	0	0	0
Busta Voe	Busta Voe Lee	10-May-10	28,720	40	0	0	11,900	0	0	0
Busta Voe	Busta Voe Lee	17-May-10	2,480	60	40	0	4,140	0	0	0
Busta Voe	Busta Voe Lee	24-May-10	40	80	20	0	120	0	0	20
Busta Voe	Busta Voe Lee	01-Jun-10	1,620	80	200	0	160	0	0	0
Busta Voe	Busta Voe Lee	07-Jun-10	3,880	600	460	0	60	0	0	0
Busta Voe	Busta Voe Lee	14-Jun-10	75,186	140	40	0	60	0	0	20
Busta Voe	Busta Voe Lee	21-Jun-10	207,602	200	80	0	0	0	0	0
Busta Voe	Busta Voe Lee	28-Jun-10	532,657	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	05-Jul-10	188,480	40	20	20	0	0	0	0
Busta Voe	Busta Voe Lee	12-Jul-10	5,240	0	80	20	180	0	0	0
Busta Voe	Busta Voe Lee	19-Jul-10	5,520	0	0	0	220	0	0	0
Busta Voe	Busta Voe Lee	26-Jul-10	153,847	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	02-Aug-10	131,117	0	20	0	0	0	0	0
Busta Voe	Busta Voe Lee	09-Aug-10	11,300	0	60	0	60	0	0	0
Busta Voe	Busta Voe Lee	16-Aug-10	3,760	0	0	0	1,000	0	0	0
Busta Voe	Busta Voe Lee	23-Aug-10	5,520	20	60	0	0	0	0	0
Busta Voe	Busta Voe Lee	30-Aug-10	23,140	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	06-Sep-10	134,488	0	20	0	20	0	0	0
Busta Voe	Busta Voe Lee	13-Sep-10	129,751	0	40	20	180	0	0	0
Busta Voe	Busta Voe Lee	20-Sep-10	120,721	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	27-Sep-10	64,560	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	04-Oct-10	139,783	0	20	0	0	0	0	0
Busta Voe	Busta Voe Lee	11-Oct-10	39,540	0	60	0	480	0	0	0
Busta Voe	Busta Voe Lee	08-Nov-10	1,540	0	0	0	0	0	0	0
Busta Voe	Busta Voe Lee	06-Dec-10	120	0	0	0	0	0	0	0

Area	Location	Date	*Pseudo-nitzschia* spp.	*Alexandrium* spp.	*Dinophysis* spp.	*Prorocentrum lima*	*Prorocentrum minimum*	*Lingulodinium polyedrum*	*Protoceratium reticulatum*	*Protoperidinium crassipes*
Shetland										
Basta Voe	Inner - Site 1	05-Apr-10	13,120	0	0	0	140	0	0	0
Basta Voe	Inner - Site 1	13-Apr-10	0	0	0	0	0	0	0	0
Basta Voe	Inner - Site 1	20-Apr-10	2,340	0	0	0	200	0	0	0
Basta Voe	Outer	27-Apr-10	11,440	0	40	0	660	0	0	0
Basta Voe	Outer	04-May-10	105,167	0	0	0	1,360	0	0	0
Basta Voe	Outer	11-May-10	24,060	0	20	0	3,120	0	0	0
Basta Voe	Outer	18-May-10	23,220	0	0	20	66,924	0	0	0
Basta Voe	Outer	25-May-10	10,320	0	0	0	12,660	0	0	0
Basta Voe	Outer	01-Jun-10	75,321	0	20	0	50,748	0	0	0
Basta Voe	Outer	08-Jun-10	13,260	0	40	0	4,860	0	0	0
Basta Voe	Outer	15-Jun-10	15,580	0	0	0	3,200	0	0	0
Basta Voe	Outer	22-Jun-10	230,853	0	20	0	80	0	0	0
Basta Voe	Outer	29-Jun-10	1,413,603	0	120	0	340	0	0	0
Basta Voe	Outer	06-Jul-10	753,922	0	40	0	0	0	0	0
Basta Voe	Outer	13-Jul-10	723,827	0	40	0	0	0	0	0
Basta Voe	Outer	20-Jul-10	57,500	0	0	0	0	0	0	0
Basta Voe	Outer	27-Jul-10	60,060	0	0	40	0	0	0	0
Basta Voe	Outer	03-Aug-10	416,668	0	0	0	0	0	0	0
Basta Voe	Outer	10-Aug-10	65,340	0	0	0	0	0	0	0
Basta Voe	Outer	17-Aug-10	21,660	0	20	0	0	0	0	0
Basta Voe	Outer	24-Aug-10	6,240	20	20	0	60	0	0	0
Basta Voe	Outer	31-Aug-10	3,880	20	0	0	0	0	0	0
Basta Voe	Outer	07-Sep-10	11,760	420	20	20	0	0	0	0
Basta Voe	Outer	13-Sep-10	10,680	60	0	0	60	0	0	0
Basta Voe	Outer	21-Sep-10	1,740	0	0	0	0	0	0	0
Basta Voe	Outer	28-Sep-10	1,000	100	0	0	0	0	0	0
Basta Voe	Outer	05-Oct-10	320	40	0	0	20	0	0	0
Basta Voe	Outer	11-Oct-10	320	0	0	0	0	0	0	0
North Uyea	North	11-May-10	21,960	0	0	0	2,940	0	0	0
North Uyea	North	18-May-10	1,600	0	0	0	2,180	0	0	0
North Uyea	North	25-May-10	11,040	0	0	0	21,980	0	0	0
North Uyea	North	01-Jun-10	3,560	0	0	0	41,299	0	0	0
North Uyea	North	08-Jun-10	6,140	0	0	40	8,980	0	0	0
North Uyea	North	22-Jun-10	105,896	60	120	0	1,080	0	0	0
North Uyea	North	28-Jun-10	122,922	40	160	0	860	0	0	0
North Uyea	North	06-Jul-10	24,660	0	100	40	60	0	0	0
North Uyea	North	13-Jul-10	88,141	0	20	20	0	0	0	0
North Uyea	North	20-Jul-10	8,860	0	20	0	0	0	0	0
North Uyea	North	27-Jul-10	6,460	0	0	0	120	0	0	0
North Uyea	North	03-Aug-10	540	0	0	0	0	0	0	0
North Uyea	North	10-Aug-10	3,660	0	0	0	0	0	0	0
North Uyea	North	16-Aug-10	1,400	0	0	0	100	0	0	0
North Uyea	North	24-Aug-10	3,220	40	0	0	0	0	0	0
North Uyea	North	31-Aug-10	2,020	60	0	0	0	0	0	0
North Uyea	North	07-Sep-10	1,320	0	0	0	20	0	0	0
North Uyea	North	13-Sep-10	5,760	0	20	0	0	0	0	0
North Uyea	North	21-Sep-10	2,860	0	20	0	0	0	0	0
North Uyea	North	28-Sep-10	1,520	0	0	0	0	0	0	0
North Uyea	North	05-Oct-10	440	0	0	0	0	0	0	0