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Project Number	S01007
Full Report Title	Monitoring of Toxin Producing Phytoplankton in Scottish Coastal Waters 01 April 2003 – 31 March 2004
Length in pages (each part separately)	24 plus results
Agency contact name for further information	Lorna Murray
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Project Abstract for Food Standards News (approximately 150 words)	The phytoplankton monitoring programme in Scotland fulfils the requirements of the EU directive 91/492/EEC, which requires member states to monitor their coastal water for the presence of toxin producing cells. This report presents the results from the phytoplankton monitoring programme in Scotland obtained from 1st April 2003 – 31st March 2004. During this time 738 samples were analysed by light microscopy for the presence of toxin producing cells. 10 samples were also analysed using transmission electron microscopy to identify the *Pseudo-nitzschia* cells present to species level. Six different species were observed in Scottish waters, five of which have the potential to synthesise domoic acid. These were *P. australis, P. cf. delicatissima, P. pungens, P. cf. pseudodelicatissima* and P. *cf seriata.*
Any additional information or instructions	

S01007

FISHERIES RESEARCH SERVICES | CONTRACT REPORT

Fisheries Research Services Contract Report No 12/04

MONITORING PROGRAMME FOR TOXIN PRODUCING PHYTOPLANKTON IN SCOTTISH COASTAL WATERS 1 APRIL 2003 – 31 MARCH 2004

PROJECT CODE: S01007

FRS MARINE LABORATORY, ABERDEEN

PERIOD COVERED BY REPORT: 1 APRIL 2003 – 31 MARCH 2004

S Fraser, E Bresnan and C Moffat

Not to be quoted without prior reference to the authors

Fisheries Research Services Contract Report No 12/04

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August 2004

Fisheries Research Services
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REPORT INFORMATION SHEET

Title: Monitoring Programme for Toxin Producing Phytoplankton in Scottish Coastal Waters: 1 April 2003 – 31 March 2004

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MONITORING PROGRAMME FOR TOXIN PRODUCING PHYTOPLANKTON IN SCOTTISH COASTAL WATERS 1 APRIL 2003 – 31 MARCH 2004

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1. SUMMARY

This paper reports the findings of the toxin producing phytoplankton monitoring programme conducted in Scottish coastal waters throughout the period April 2003 – March 2004 in fulfilment of the EU Shellfish Hygiene Directive 91/492/EEC.

Twenty-three coastal sites were selected to participate in the monitoring programme. Sample collectors were requested to supply seawater samples for light microscope (LM) analysis on a weekly basis from April to October and monthly from November to March. The sample return rate from coastal sites varied from 3–100%. An additional 232 samples were collected from a total of 79 offshore sites as directed by the Food Standard Agency Scotland (FSAS).

In total 738 LM samples (506 coastal and 232 offshore) were analysed from both coastal and offshore sites. High density blooms of *Alexandrium* spp. were observed at a number of sites around the Scottish Coast during 2003. The highest number of *Alexandrium* spp. observed since the monitoring programme began in 1996 was observed at Sandsound in July 2003 with a concentration of 18,860 cells.l^{-1}. *Dinophysis* spp. was frequently observed during the summer months. The maximum number of *Dinophysis* cells detected was 4,960 cells.l^{-1} recorded at Isle of Ewe in June 2003. This was lower than the cell maxima observed in several previous years. *Pseudo-nitzschia* spp. was a common part of the phytoplankton community during 2003. The highest concentration of *Pseudo-nitzschia* species cells observed was 1,489,440 cells.l^{-1}, in the scallop fishing box M10 during April 2003. *Protoperidinium* spp. were observed at most sites at low cell densities. The maximum number observed during 2003/04 was 7,020 cells.l^{-1} at Stonehaven in June 2003. *Prorocentrum lima*, *Protoceratium reticulatum* and *Lingulodinium polyedrum* were infrequently observed and all at cell densities less than 1,000 cells.l^{-1}.

Ten samples were analysed by Transmission Electron Microscopy (TEM) to identify *Pseudo-nitzschia* cells present to species level. Six *Pseudo-nitzschia* species were identified; *P. australis, P. cf. delicatissima, P.* cf. *heimii, P. pungens, P.* cf. *pseudodelicatissima* and *P.* cf. *seriata.* With the exception of *P.* cf. *heimii* the other *Pseudo-nitzschia* species observed have the potential to synthesise domoic acid.

2. INTRODUCTION

In fulfilment of the EU directive 91/492/EEC, a toxin producing phytoplankton monitoring programme has been in operation in Scotland since 1996. This programme has been funded by the Food Standards Agency Scotland (FSAS) since 2001. This report presents the data obtained under this programme from samples collected between 1 April 2003 and 31 March 2004.

Samples were monitored for the following genera and species:

1. Dinoflagellates belonging to the genus *Alexandrium*, commonly associated with the production of Paralytic Shellfish Toxins (PSTs);

2. Dinoflagellates belonging to the genus *Dinophysis*, the benthic/epiphytic species *Prorocentrum lima, Protoceratium reticulatum, Lingulodinium polyedrum,* and *Protoperidinium* spp. These species are known or suspected of being associated with the production of a number of different toxins of the Diarrhetic Shellfish Toxin group (DSTs) such as okadaic acid (OA), dinophysistoxins (DTXs), pectenotoxins (PTXs), yessotoxins (YTXs) and azaspiracids (AZAs); and

3. Diatoms belonging to the genus *Pseudo-nitzschia* commonly associated with the production of Amnesic Shellfish Toxins (ASTs).

Light microscopy (LM) methods were used to both identify and quantify the presence of potential toxin producing species (see Table 3.1). In addition a selected number of samples were also analysed using transmission electron microscopy (TEM) to identify any *Pseudo-nitzschia* cells present to species level.

3. METHODOLOGY

3.1 Sampling Sites

The 23 coastal sites around Scotland selected to participate in the monitoring programme (Fig. 3.1) were chosen on the basis of their location in relation to shellfish harvesting areas, previous history of toxic events and also geographic position around the Scottish coastline. The 79 offshore sites targeted for water collection (Fig. 3.2) were selected by the FSAS to provide a wide geographical coverage of the commercial harvesting areas.

3.2 Sampling Protocol

The sampling method described in Kelly and Fraser (1998) was used to take seawater samples for the identification and enumeration of potential toxin producing cells. Integrated water samples were taken using a 10 m tube sampler, one litre of which was preserved with Lugol's iodine and sent to FRS for analysis. Samples were requested to be collected monthly in winter (November – March) and weekly during the summer (April – October).

Six sites, Stonehaven (north-east Scotland), Scapa (Orkney), Scalloway (Shetland), Loch Maddy (Outer Hebrides) and sites A and B at the Isle of Ewe (west Scotland) were sampled weekly throughout the year as these sites were also part of an FRS coastal ecosystem monitoring project. Two sites, Dhoon (Solway) and Loch Ryan (Clyde), were sampled monthly due to the limited availability of the collectors. To increase sample return three sites, Vaila Sound (Shetland), Basta Voe (Shetland) and Loch Leven (south west Scotland), were requested to participate in the programme during the summer.

3.3 Light Microscopy

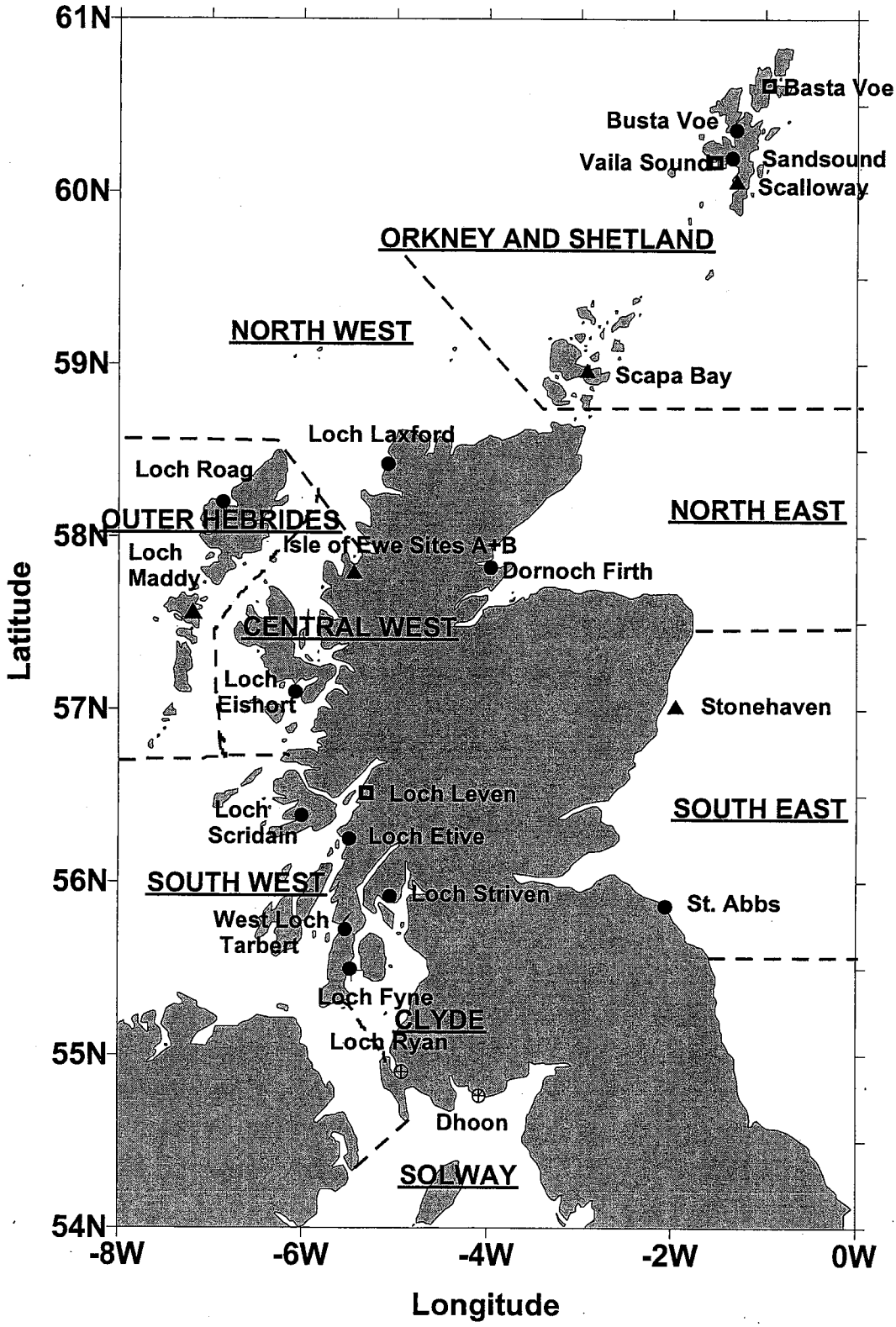
A subsample of the preserved sample (50 ml) was examined using the Utermöhl technique (Throndsen 1995) for the presence of toxin producing cells. This method has a sensitivity of 20 cells.l^{-1}. The target species monitored and their associated toxin are presented in Table 3.1.

3.4 Transmission Electron Microscopy

Ten samples with >20,000 cells.l^{-1} *Pseudo-nitzschia* spp. as determined by LM, were selected for analysis by transmission electron microscopy (TEM). The cells in a 900 ml aliquot of sample were allowed to settle and the top 850 ml gently siphoned off. The remaining 50ml was concentrated to a volume of 5 ml by centrifuging at 2500 rpm for 15-20 minutes and the supernatant discarded. The diatoms were then cleaned using the method of Christensen (1988). Cleaned samples were rinsed with distilled water and concentrated using centrifugation to a volume of 1-2 ml in distilled water.

Samples were mounted on a 150 or 200 mesh formvar-coated TEM grid using a Pasteur pipette and left overnight to air-dry. The samples were then analysed using a Phillips 301 TEM at the Electron Microscope Unit, Department of Zoology, University of Aberdeen.

Figure 3.1 **Location of coastal sites selected for inclusion in the phytoplankton monitoring programme from 1 April 2003 – 31 March 2004. Dashed lines indicate borders to the coastal regions.**



● Site specific to toxin-producing phytoplankton programme (weekly)
▲ Part of FRS ecosystem monitoring network
⊕ Site specific to toxin-producing phytoplankton programme (monthly)
□ Participation requested during the summer

Figure 3.2. **Offshore sites selected for monitoring during 1 April 2003 – 31 March 2004. The sites arise from a crude subdivision of the ICES fishing boxes IVb, Va, VIa. The dimensions of the individual boxes are 15 nautical miles square.**

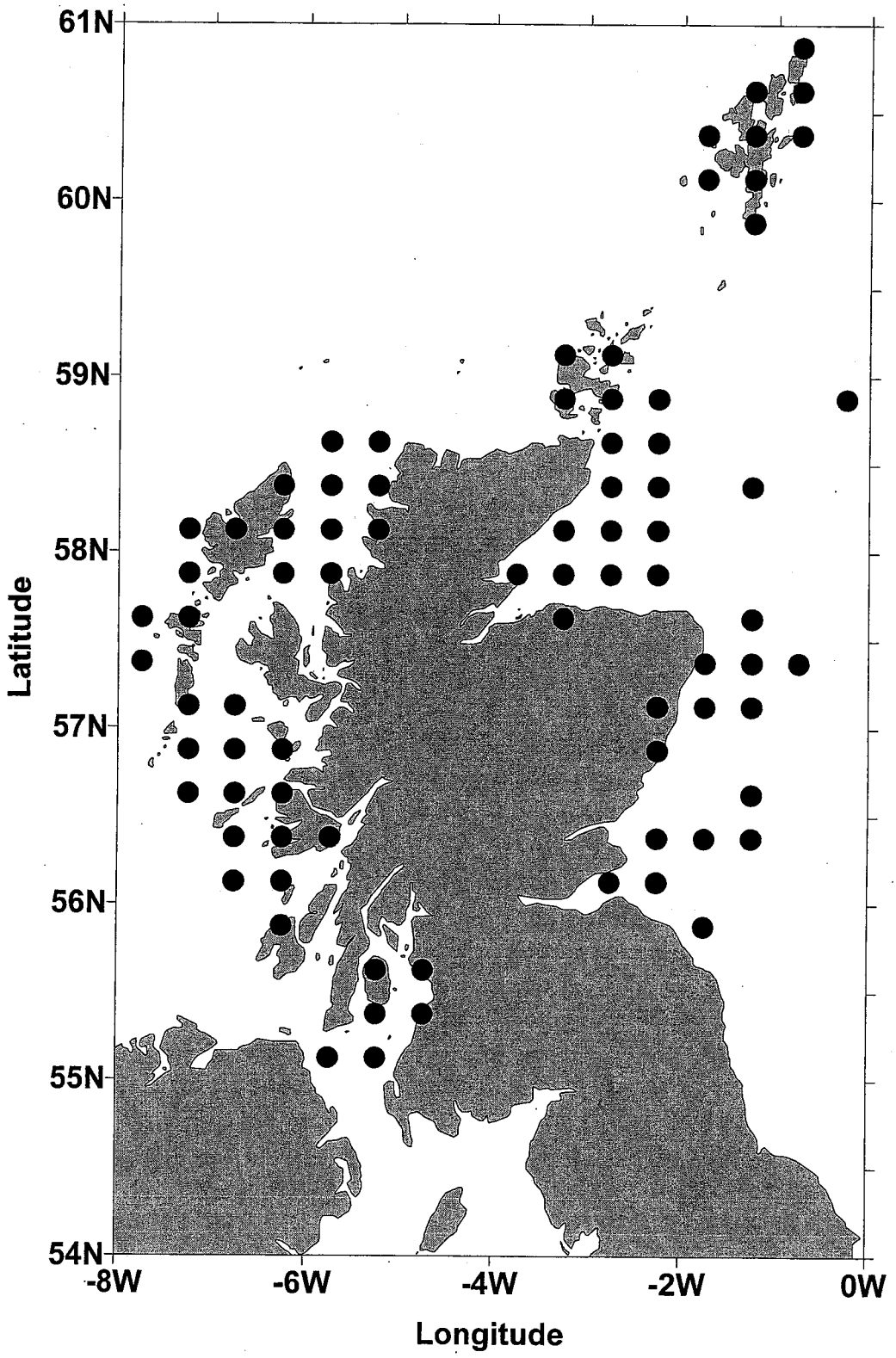


TABLE 3.1

Phytoplankton species and associated toxins monitored through the phytoplankton monitoring programme during 1 April 2003 – 31 March 2004.

Species	Toxin
Alexandrium spp.	PST (paralytic shellfish toxin)
Dinophysis acuminata	DST (diarrhetic shellfish toxin)
D. acuta	DST (diarrhetic shellfish toxin)
D. norvegica	DST (diarrhetic shellfish toxin)
D. dens	DST (diarrhetic shellfish toxin)
D. rotundata	DST (diarrhetic shellfish toxin)
Prorocentrum lima	DST (diarrhetic shellfish toxin)
Lingulodinium polyedrum	Yessotoxin (YTX)
Protoceratium reticulatum	Yessotoxin (YTX)
Pseudo-nitzschia spp.	Amnesic shellfish toxin (AST)
Protoperidinium spp.	Potential Azaspiracid (AZA) producers

4. RESULTS

4.1 Sample Return

The number of samples requested from the 23 coastal sites (which include two in Loch Ewe) varied depending on whether the site was following the more traditional method of reduced sampling during winter or alternatively was part of a more comprehensive ecosystem monitoring programme, in which case the objective was to obtain weekly samples throughout the year. In this context 35 samples were requested from 12 sites and 52 samples were requested from 6 sites. Of the remaining 5 sites, two could only be sampled monthly throughout the year due to the limited availability of collectors while three entered the programme in the summer months. However, both these sites had an excellent return rate with only one sample missing out of a possible 24 (see Loch Ryan and Dhoon, Table 4.1). The return from the ecosystem monitoring sites was also generally good with greater return than 90% for the sites at Scapa Bay, Isle of Ewe (A and B, both 100%) and Stonehaven. The return rate for Scalloway and Loch Maddy was 83% and 77% respectively. The average return from the ecosystem sites was 92.0% (Range = 77-100%; Standard Deviation (population) =7.5; n = 6). In contrast, the average return for the sites from which 35 samples were requested was 39.7% (Range =3-97%; Standard Deviation (population) =27.6; Range = 12). This would suggest that where the sites are part of a wider programme, the sample return is considerably better.

Ultimately a total of 506 samples, from a requested 812, were received from the coastal sites during 2003/04 (Table 4.1).

A total of 79 offshore sites were sampled (Table 4.2). Only one sample was received from thirty four (34) of the sites, a site being a standard box currently utilised as part of the offshore biotoxin monitoring programme. The average number of samples for the remaining 45 sites was 4.4 (Range 2–17; Standard Deviation (population) = 3.1; n = 45; Median = 4). Fifty (50; 21.6% of the 232 offshore samples) of the samples collected were collected from around Orkney, including 17 from O19. Forty two (42; 18.1%) of the samples were collected from the South Minches while thirty one (31; 13.4%) samples were collected from both the North Minches and Moray areas. Less than thirty samples were collected from each of the remaining 5 areas (east Scotland, Shetland, Clyde, Hebrides and Jura).

Overall, a total of 738 samples (506 coastal, 232 offshore) were received and analysed during the period covered by this report.

TABLE 4.1

Sample information for water samples from coastal sites received 1 April 2003 - 31 March 2004.

Site	Samples requested	Samples received	% return	Collector
St Abbs	35	2	6	EHO
Dornoch Firth	35	1	3	Highland Council
Loch Laxford	35	13	37	Shellfish Farmer
Loch Roag	35	34	97	Shellfish Farmer
Loch Scridain	35	19	54	Shellfish Farmer
Loch Eishort	35	20	57	Shellfish Farmer
Loch Etive	35	20	57	Shellfish Farmer
Loch Leven	12	7	58	Shellfish Farmer
Loch Fyne	35	16	46	Shellfish Farmer
Loch Striven	35	1	3	Shellfish Farmer
West Loch Tarbert	35	19	54	Shellfish Farmer
Sandsound	35	18	51	Shellfish Farmer
Busta Voe	35	4	11	Shellfish Farmer
Vaila Sound	27	20	74	Shellfish Farmer
Basta Voe	17	2	12	Shellfish Farmer
Scalloway	52	43	83	North Atlantic Fishery College
Scapa Bay	52	50	96	Orkney Council
Isle of Ewe A	52	52	100	FRS
Isle of Ewe B	52	52	100	FRS
Stonehaven	52	50	96	FRS
Loch Maddy	52	40	77	Volunteer (Comman na Mara)
Loch Ryan	12	11	91	EHO
Dhoon	12	12	100	EHO
Total	**812**	**506**		

EHO - Environmental Health Officer; FRS – Fisheries Research Services

TABLE 4.2

Sample information for water samples from offshore sites received 1 April 2003 – 31 March 2004. All samples were collected by FSA Charter Vessels.

Site East Coast	No of Samples Received	Site West Coast	No of Samples Received
E1	6	C3	1
E2	1	C4	1
E3	3	C5	2
E5	3	C6	1
E6	5	C7	1
E7	2	C8	1
E10	1	H5	4
E17	1	H6	1
E21	2	H8	3
E22	1	H9	2
E23	1	H10	1
E26	1	H11	1
E27	1	J1	5
E33	1	J2	4
M2	4	J3	2
M3	2	J4	1
M5	1	J5	4
M9	5	J8	1
M10	7	NM5	2
M11	2	NM6	2
M16	1	NM9	6
M17	2	NM10	2
M18	4	NM11	2
M19	1	NM12	4
M25	1	NM13	10
M29	1	NM14	1
O10	5	NM16	1
O11	8	NM17	1
O18	13	SM5	1
O19	17	SM6	7
O20	2	SM9	5
O24	1	SM10	6
O27	2	SM11	7
O28	2	SM13	1
S3	1	SM14	7
S6	2	SM15	8
S7	1		
S9	1		
S10	2		
S11	2		
S13	1		
S14	2		
S16	1		

E – east Scotland; M – Moray; O – Orkney; S – Shetland; C – Clyde; H – Hebrides; J – Jura; NM – North Minches; SM – South Minches

4.2 Light Microscope Analysis

4.21 Coastal sites

Light, nutrients and temperature all control phytoplankton growth. Phytoplankton attain higher cell densities from spring – autumn when day length is longer and sea temperatures are generally warmer. The maximum values of *Alexandrium* spp., *Dinophysis* spp., *Pseudo-nitzschia* spp., *P. lima*, *P. reticulatum*, *L. polyedrum* and *Protoperidinium* spp. recorded from each of the coastal sites from 1 April 2003 to 31 March 2004 are summarised in Table 4.3. The bubble plots in Figures 4.1-4.7 show the number of cells observed and also when no samples were received. The complete results for these sites are given in Appendix I.

The results show *Alexandrium* spp. to occur in the coastal areas during the spring and summer months with maximum values observed in June and July 2003. High levels of *Dinophysis* spp. were detected from June to September. Two distinct blooms of *Pseudo-nitzschia* spp. were observed. The first occurred in April 2003 and comprised mainly of *Pseudo-nitzchia* spp. cells with a cell diameter less than 5 µm. A second bloom, comprising mainly of individuals with a diameter greater than 5 µm, was observed in the late summer and autumn. *Protoperidinium* spp. was observed in the water column in low numbers throughout the year while *Prorocentrum reticulatum* and *Lingulodinium polyedrum* were observed infrequently.

4.22 Offshore sites

A summary of the toxin producing phytoplankton numbers observed in water samples taken at offshore sites is shown in Table 4.4. Full details of the results are given in Appendix II. The lack of frequent samples from these sites prevents any detailed examination of the dynamics of toxic phytoplankton species in offshore sites.

TABLE 4.3

Maximum numbers of target species (cells.l^{-1}) measured at coastal sites from 1 April 2003 – 31 March 2004

Site	*Alexandrium* spp. Date observed	*Dinophysis* spp. Date observed	*Pseudo-nitzschia* spp. Date observed	*P. Lima* Date observed	*L. polyedrum* Date observed	*P. reticulatum* Date observed	*Protoperidinium* spp. Date observed
South East							
St Abbs	Nd 10 Jun 03	200 10 Jun 03	2,180 10 Jun 03	20 10 Jun 03	nd	nd	20 10 Jun 03
Stonehaven	140 16 Apr 03	2,200 23 Jun 03	307,480 8 Jul 03	20 23 Feb 04	20 25 Aug 03	20 16 Apr 03	7,020 16 Jun 03
North East							
Dornoch Firth	nd	nd	nd	nd	nd	nd	40 23 Jun 03
Orkney and Shetland							
Scapa	800 23 Apr 03	400 4 Jul 03	682,460 17 Apr 03	800 30 May 03	nd	20 23 Apr 03	260 17 Apr 03
Scalloway	4,340 14 Jul 03	1,640 18 Jul 03	390,680 4 Jul 03	20 8 Aug 03	40 25 Jul 03	40 25 Jul 03	720 30 May 03 18 July 03
Sandsound	18,860 16 Jul 03	2,340 16 Jul 03	126,620 18 Jun 03	80 16 Jul 03	nd	100 16 Jul 03	1,000 5 Jun 03
Busta Voe	300 30 Jun 03	1,440 30 Jun 03	53,200 30 Jun 03	20 14 Oct 03	20 30 Jun 03	20 30 Jun 03	1,080 30 Jun 03
Vaila Sound	920 21 Jul 03	1,660 21 Jul 03	189,500 4 Jul 03	20 11 Aug 03	nd	40 21 Jul 03	2,700 5 Jun 03
Basta Voe	nd	nd	4,880 16 Oct 03	nd	nd	nd	nd

nd: samples collected but phytoplankton species not detected. Limit of detection = 20 cells.l^{-1}

Site	*Alexandrium* spp. Date observed	*Dinophysis* spp. Date observed	*Pseudo-nitzchia* spp. Date observed	*P. lima* Date observed	*L. polyedrum* Date observed	*P. reticulatum* Date observed	*Protoperidinium* spp. Date observed
North West							
Loch Laxford	400 28 May 03	2,380 27 Jun 03	5,800 28 May 03	20 14 Jul 03	nd	nd	280 9 Jun 03
Outer Hebrides							
Loch Maddy	60 22 Jul	640 3 Jul 03	251,960 6 Aug 03	nd	40 16 Jul	nd	360 22 Jul 03
Loch Roag	5,700 3 Jun 03	140 1 Sep 03	95,840 4 Aug 03	20 4 Sep 03	20 18 Aug 03	nd	1,160 20 May 03
Central West							
Isle of Ewe Site A	100 12 May 03	4,960 23 Jun 03	47,760 23 May 03	nd	40 9 Jun 03	20 21 Jul 03	640 8 Sept 03
Isle of Ewe Site B	160 28 April 03	2,120 23 Jun 03	103,180 16 Sep 03	20 6 Oct 03	20 8 Sep 03	80 30 Jun 03	100 26 May 03
Loch Eishort	360 20 May 03	360 7 Jul 03	78,720 18 Aug 03	nd	nd	20 21 Apr 03	140 21 Apr 03
South West							
Loch Scridain	60 14 Apr 03	760 16 Jun 03	143,760 29 Sep 03	20 23 Jun 03	nd	nd	2,560 16 Jun 03
Loch Etive	20 21 Jun 03	60 12 May 03	5,180 21 Jun 03	20 23 Jun 03	nd	nd	360 14 Apr 03
Loch Leven	20 15 Mar 04	nd	180 18 Nov 03	nd	nd	nd	20 18 Nov 03
West Loch Tarbert	40 25 Aug 03	180 1 Jul 03	9,060 4 Nov 03	60 14 Oct 03	nd	20 22 Apr 03	280 7 Apr 03

nd: samples collected but phytoplankton species not detected. Limit of detection = 20 cells.l^{-1}

Site	*Alexandrium* spp. Date observed	*Dinophysis* spp. Date observed	*Pseudo-nitzchia* spp. Date observed	*P. lima* Date observed	*L. polyedrum* Date observed	*P. reticulatum* Date observed	*Protoperidinium* spp. Date observed
Clyde							
Loch Fyne	60 24 Apr 03	600 1 May 03	52,546 10 Sep 03	nd	nd	nd	3,740 19 May 03
Loch Striven	1,420 5 May 03	220 5 May 03	5,640 5 May 03	nd	nd	nd	nd
Loch Ryan	60 3 Jun 03	100 3 Jun 03	520 15 Mar 04	500 26 Aug 03	nd	nd	1,620 3 Jun 03
Solway							
Dhoon	nd	nd	240 6 May 03	nd	nd	nd	nd

nd: samples collected but phytoplankton species not detected. Limit of detection = 20 cells.l^{-1}

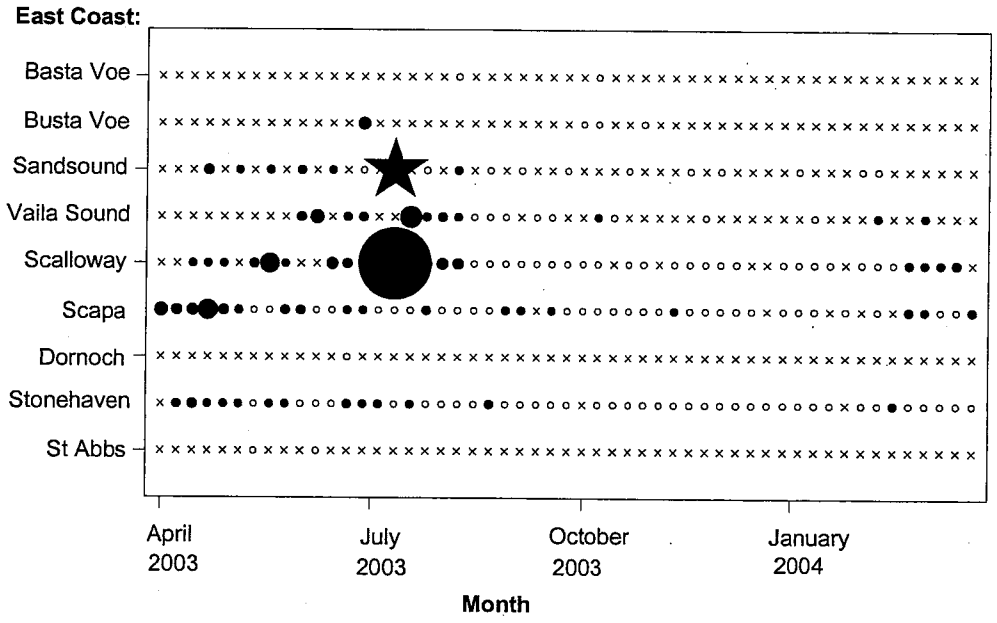
TABLE 4.4

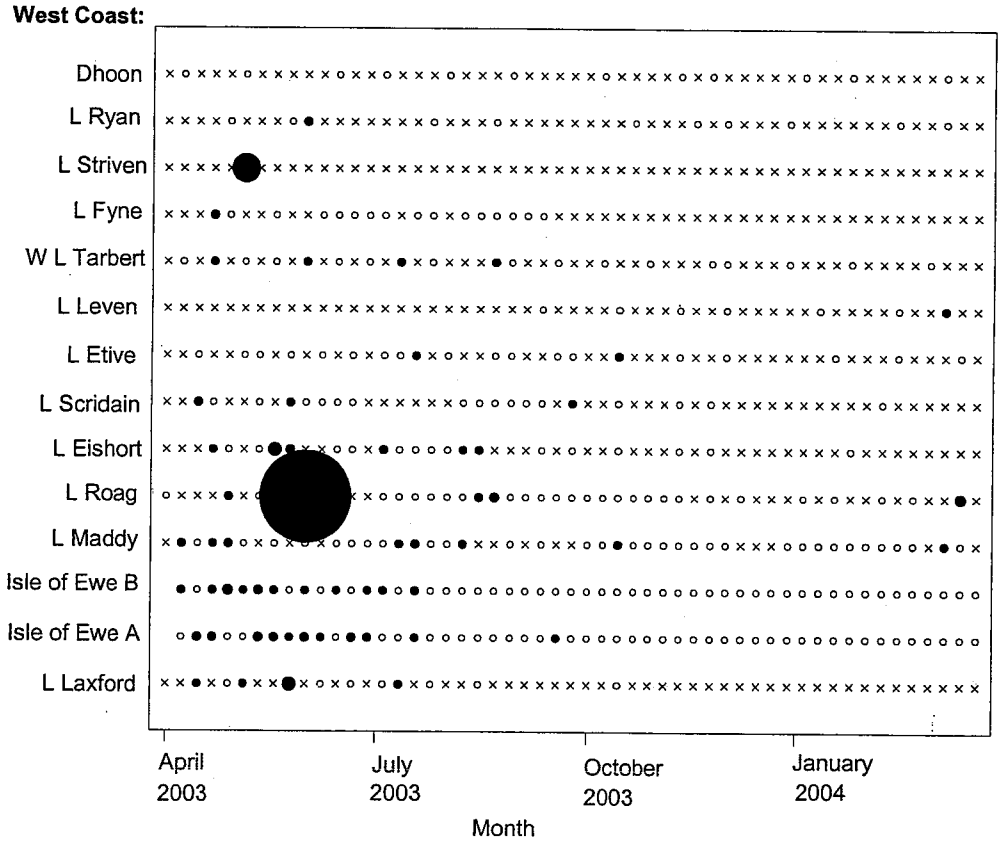
Maximum numbers of target species (cells $l.^{-1}$) measured in offshore samples from 1 April 2003 – 31 March 2004

Site	*Alexandrium* spp. Date observed	*Dinophysis* spp. Date observed	*Pseudo-nitzchia* spp. Date observed	*P. lima* Date observed	*L. polyedrum* Date observed	*P. reticulatum* Date observed	*Protoperidinium* spp. Date observed
E boxes (East Coast)	180 4 May 03	500 14 Jun 03	77,140 12 Jul 03	nd	20 14 Jun 03	nd	1,320 14 Jun 03
M boxes (Moray)	2,260 23 Apr 03	1,380 8 Aug 03	1,489,440 23 Apr 03	nd	20 3 Jun 03	nd	1,060 23 Apr 03
O boxes (Orkney)	260 15 Jun 03	300 15 Jun 03	41,880 16 Aug 03	nd	nd	nd	360 13 May 03
S boxes (Shetland)	180 13 May 03	40 11 Jun 03	8,660 12 Apr 03	20 11 Aug 03	nd	nd	660 25 May 03
NM boxes (Nth Minch)	100 29 Apr 03	200 23 Jun 03	139,020 23 Jun 03	nd	nd	nd	680 29 Apr 03
SM boxes (Sth Minch)	100 25 May 03	1,500 30 Jun 03	430,300 30 Jun 03	nd	nd	nd	360 15 and 25 Jun 03
H boxes (Hebrides)	60 24 Aug 03	20 25 Aug 03	58,380 6 Aug 03	nd	20 8 Sep 03	nd	240 14 Apr 03
J Boxes (Jura)	20 9 Sep 03	40 21 Jun 03	160,980 9 Sep 03	nd	nd	nd	180 26 Jul 03
C boxes (Clyde)	60 29 Mar 04	nd	22,720 27 Mar 04	nd	nd	nd	100 29 Mar 04

nd: samples collected but phytoplankton species not detected. Limit of detection = 20 cells.l^{-1}

Figure 4.1 ***Alexandrium*** **spp. cells observed from 1 April 2003 – 31 March 2004. Note the exceptional bloom in Sandsound in July 2003.**





★ *Alexandrium* spp. observed at 18,860 cells.l^{-1}

o No *Alexandrium* spp. cells observed

× No sample received

Linear scale:

● 5,000 cells.l^{-1}

• 20 cells.l^{-1}

Figure 4.2 ***Dinophysis*** **spp. cells observed from 1 April 2003 – 31 March 2004**

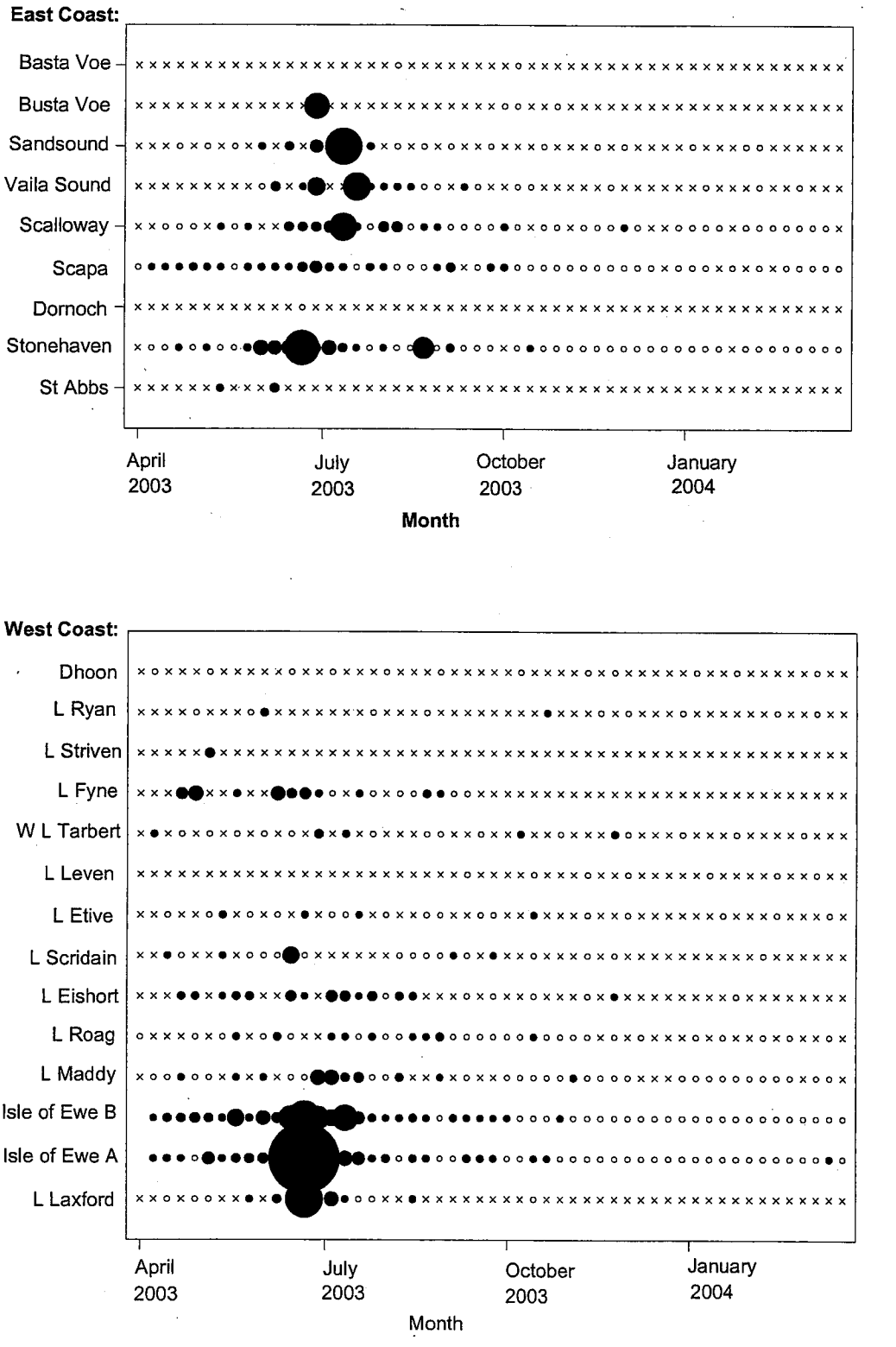


Figure 4.3 ***Pseudo-nitzchia*** **spp. cells observed from 1 April 2003 – 31 March 2004**

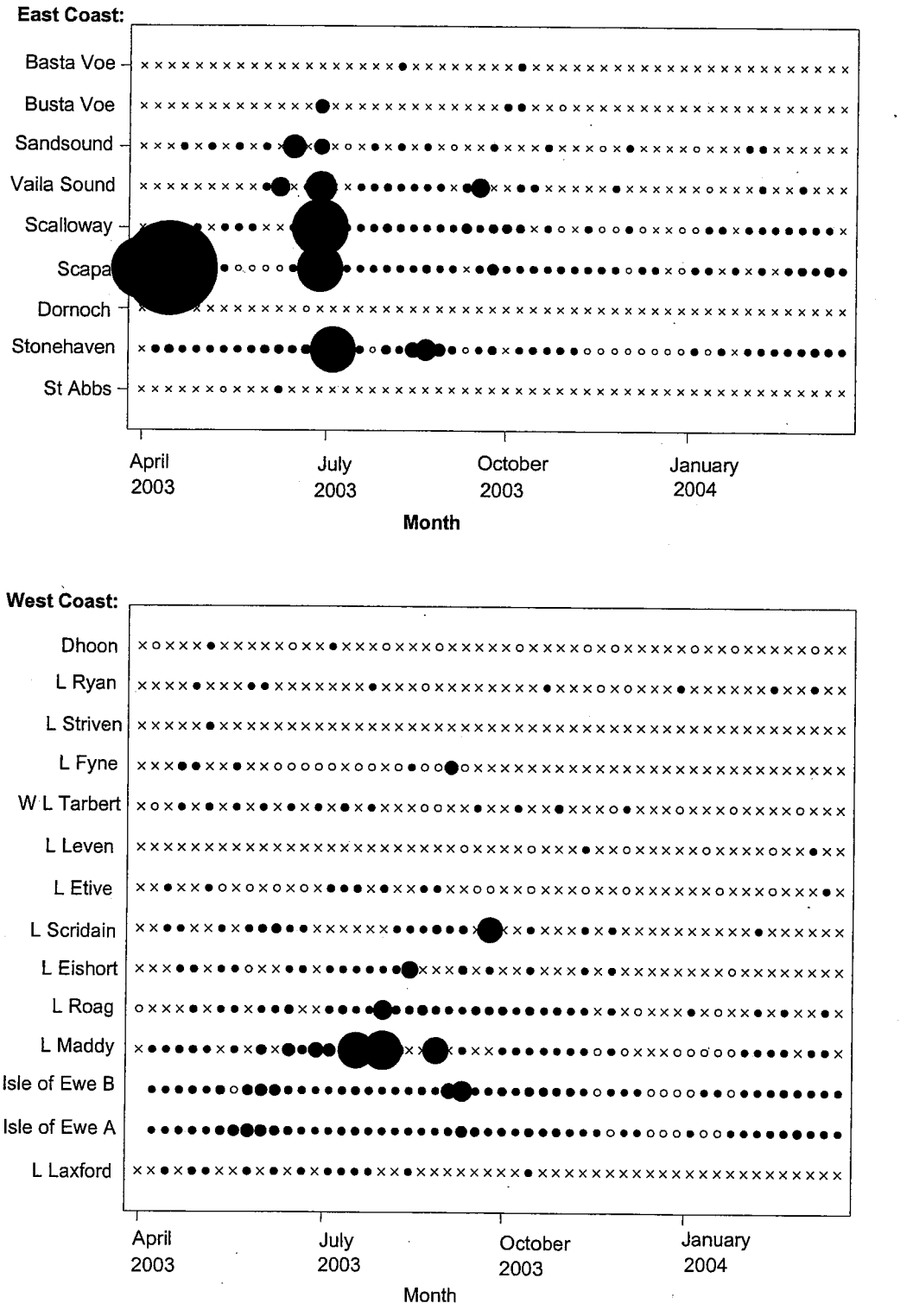


Figure 4.4 ***Prorocentrum lima*** **cells observed from 1 April 2003 – 31 March 2004**

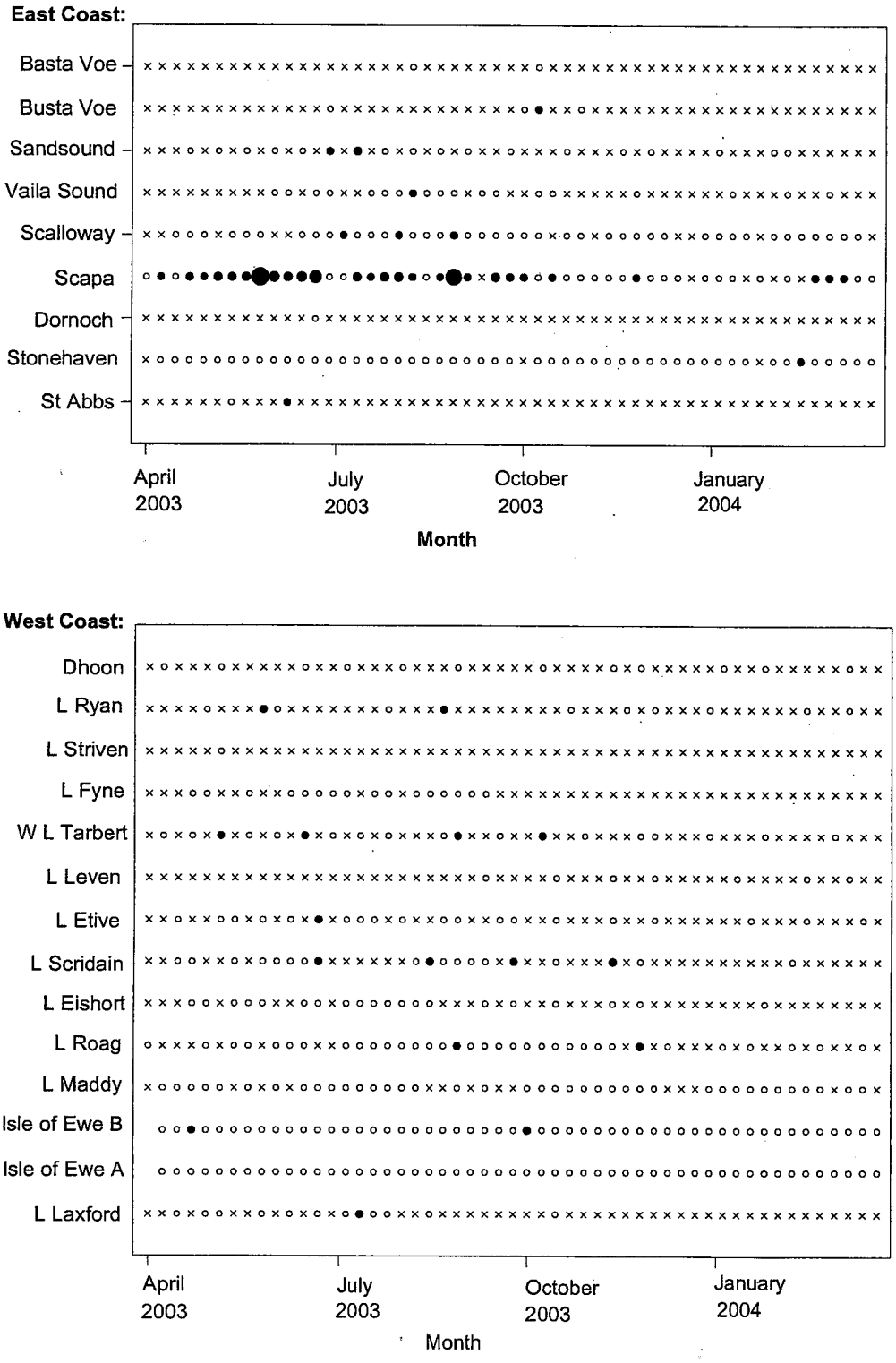


Figure 4.5 ***Lingulodinium polyedrum*** **cells observed from 1 April 2003 – 31 March 2004**

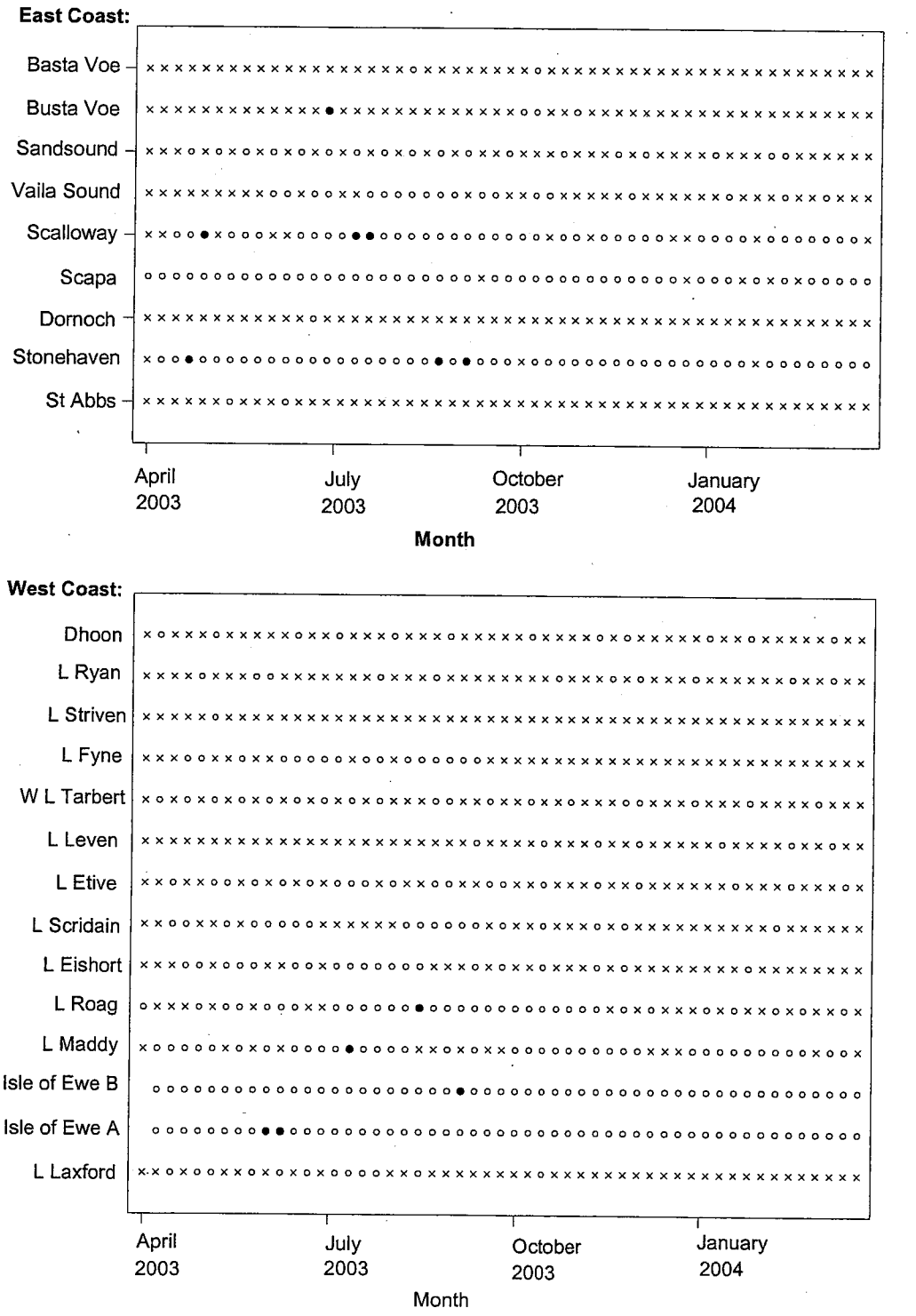


Figure 4.6 ***Prorocentrum reticulatum*** **cells observed from 1 April 2003 – 31 March 2004**

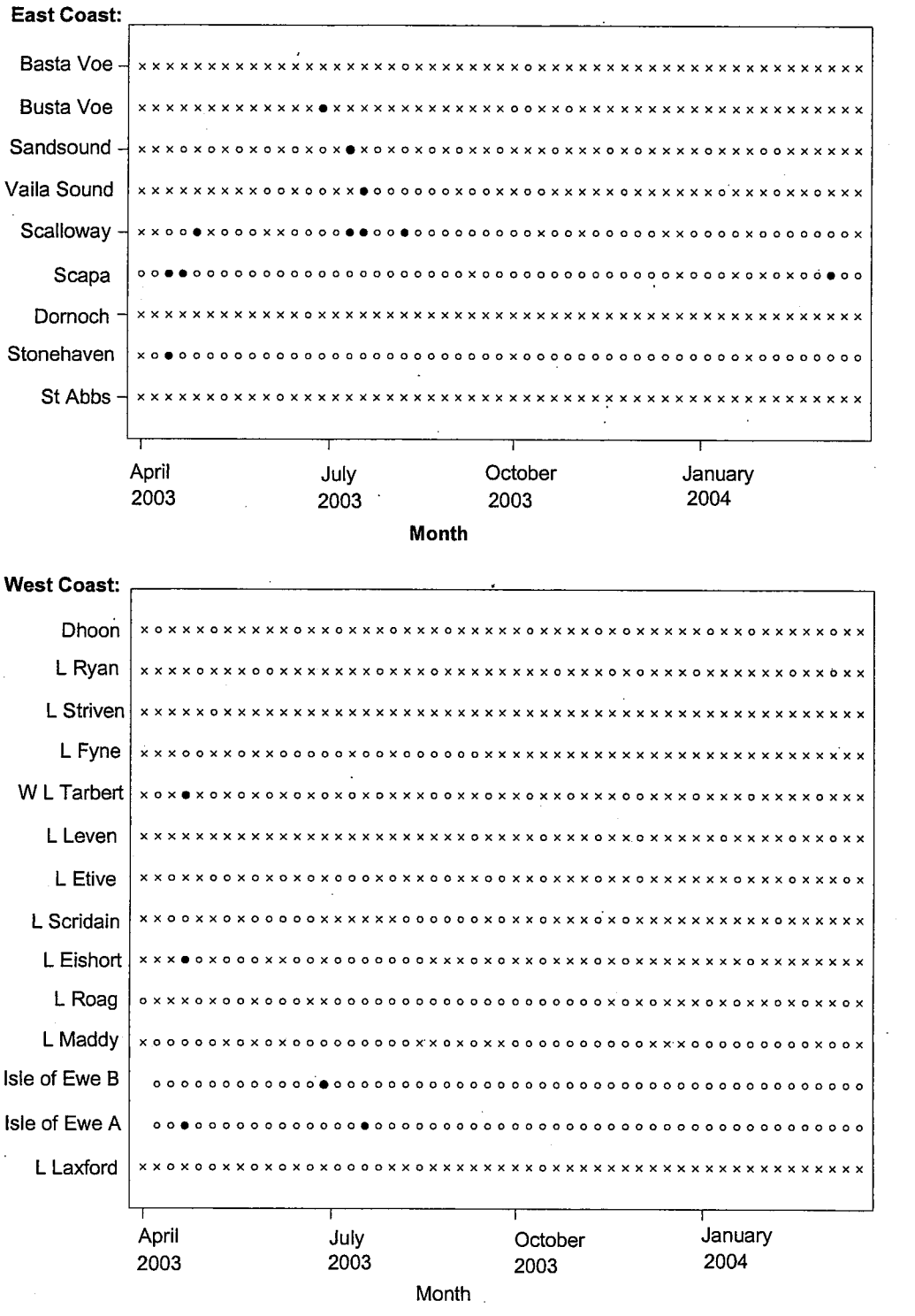
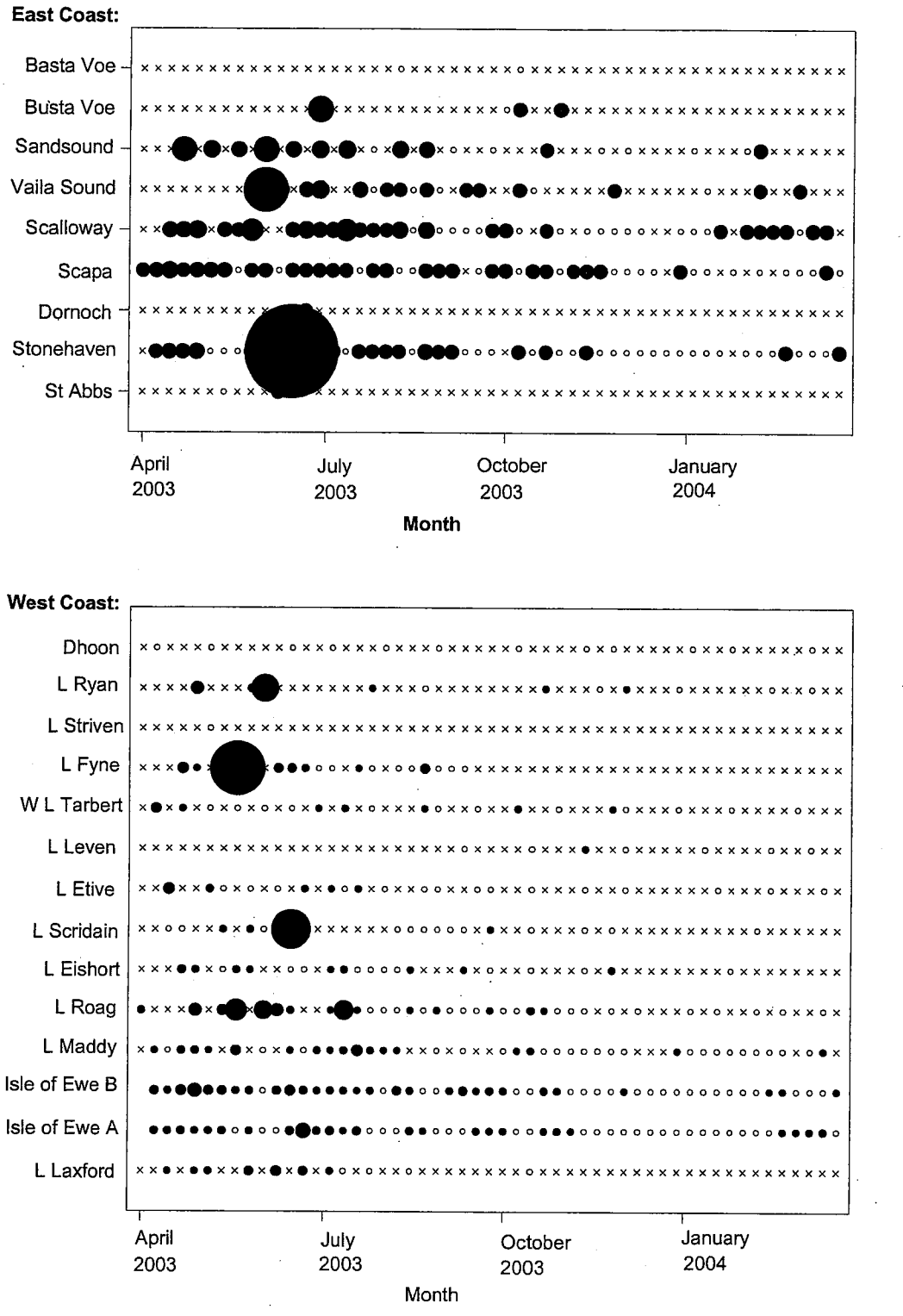


Figure 4.7 ***Protoperidinium*** **spp. cells observed from 1 April 2003 – 31 March 2004**



4.2 TEM Results

The results of the TEM analysis are given in Table 4.5. Six different *Pseudo-nitzschia* species were identified. *P. australis, P.* cf. *delicatissima*, *P.* cf. *heimii, P.* cf. *pseudodelicatissima, P. pungens, P* cf. *seriata*. With the exception of *P.* cf. *heimii* all other species are potential AST producers.

TABLE 4.5

Pseudo-nitzchia species detected using Transmission Electron Microscopy. The location uses the same box codes detailed for Table 4.2.

Sample Number / Location	Sample Date	Number of *Pseudo-nitzschia* (cells l^{-1}) determined by Light Microscopy	Species Present
03/277 SM7	30/03/04	846,100	*P.* cf. *delicatissima*
03/480 Stonehaven	08/07/03	307,480	*P. australis* *P. pungens*
03/492 E2	12/07/03	76,320	*P. australis* *P.* cf. *seriata*
03/499 Scapa	04/07/03	310,400	*P. australis*
03/657 SM10	01/09/03	22,440	*P. australis* *P.* cf. *pseudodelicatissima*
03/675 H5	09/09/03	29,360	*P. australis* *P. pungens*
03/679 J2	09/09/03	133,440	*P. australis* *P. cf. Heimii* *P. pungens* *P.* cf. *pseudodelicatissima*
03/678 J1	09/09/03	160,980	*P. australis* *P. pungens* *P.* cf. *pseudodelicatissima*
03/681 Loch Fyne	15/09/03	52,540	*P. pungens*
03/702 Loch Scridain	16/09/03	8,580	*P. australis* *P.* cf. *heimii* *P. pungens* *P.* cf. *pseudodelicatissima*

5. DISCUSSION

The primary purpose of the toxin producing phytoplankton monitoring programme is to monitor the coastal waters around Scotland for the presence of toxin producing phytoplankton cells. This monitoring programme can support the shellfish flesh monitoring programme by providing an early warning for the potential occurrence of shellfish toxin events. A recent study funded by the Food Standards Agency UK has highlighted the relationship between toxin producing phytoplankton in the water column and toxin levels in shellfish flesh (Bresnan *et al.,* 2004). This study highlighted how phytoplankton cell numbers can show great temporal variation over a time scale as short as a few days and that routine fortnightly sampling frequency can provide insufficient information to warn of potential toxin events in shellfish flesh. Thus the ability of any phytoplankton monitoring programme to sufficiently monitor the presence of toxin producing cells will therefore be a function of its temporal and spatial spread. The overall worth of the 2003/04 exercise was compromised by the low sample return from some sites. While six sites achieved a sample return of >95%, a third of the coastal sampling sites targeted had a sample return of <50%. Sites which were a component of another FRS programme provided a significantly greater sample return rate. An improved sample return will be required if phytoplankton monitoring is to be used to accurately assess the presence of toxic phytoplankton species in the water column or to act as a trigger to initiate shellfish flesh testing.

Alexandrium spp. numbers were particularly high during 2003. *Alexandrium spp.* have a complex life cycle strategy involving formation of temporary and overwintering resting cysts. The controls that govern these processes in Scottish species have yet to be elucidated. The spring and summer of 2003 were exceptionally warm and calm and it is possible that this may have had an influence in promoting the development of these blooms during the year. The *Alexandrium* spp. bloom observed in May in Loch Striven was associated with PSP levels in mussels greater than the closure limit of 80 µg STX eq $100g^{-1}$. No shellfish samples were returned from Sandsound during the exceptional bloom in July 2003.

Dinophysis spp. cells were observed at most sites that returned a regular supply of samples during the year. This is a complex dinoflagellate and very little is known about its life cycle, mainly due to the inability of this cell to be successfully grown in laboratory culture. Cell numbers were lower this year then in previous years. The highest number observed this year were at Isle of Ewe Site A where 4,960 cells.l^{-1} were recorded on 23 June 2003. No shellfish samples were collected from this site during this period.

Blooms of the two *Pseudo-nitzschia* spp. morphotypes measured by LM in the monitoring programme (*P. delicatissima* 'type', diameter <5 µm, and *P. seriata* 'type', diameter >5 µm) were observed during the year. High numbers of *P. delicatissima* 'type' cells were observed at both M10 and Scapa during April 2004 while high numbers of the *P. seriata* 'type' were observed in Loch Maddy during August 2003. TEM analysis of 10 samples from around the Scottish coast once more highlighted the complexity of *Pseudo-nitzschia* spp. populations. Six different species were identified with up to four species co-occurring in the same population at the same time. Further study is needed to determine if all of these species actually produce ASTs in laboratory culture.

The highest number of *Prorocentrum lima* was observed at Scapa where 800 cells.l^{-1} were observed in May 2003. This species is benthic, i.e. it lives on the seabed sediment surface. The site at Scapa is particularly shallow and the samples frequently contained suspended sediment. Although *P. lima* cells may be more easily resuspended from the benthos at this site, the number of cells in a 10 m integrated hose sample may underrepresent the true population size of this species.

This was the second year in which the two yessotoxin-producing species, *Lingulodinium polyedrum* and *Protoceratium reticulatum*, have been reported. As in 2002-2003 both species were observed infrequently and at low concentrations, maximum levels being 40 cells l^{-1} and 100 cells l^{-1}. Scottish shellfish samples are not routinely monitored by chemical methods for the presence of PTXs, or YTXs.

Protoperidinium spp. has been implicated in azaspiracid poisoning and all *Protoperidinium* species present in phytoplankton samples are enumerated. *Protoperidinium* is a common member of the dinoflagellate flora around the Scottish coast and is frequently present in low numbers during the summer and autumn. A range of *Protoperidinium* species, including *P. bipes, P. oblongum, P. depressum* and *P. conicum,* was observed over the year. *P. crassipes,* tentatively associated with the production of AZA was infrequently observed.

The degree of temporal spread was particularly poor in the offshore samples making it very difficult to make any significant comments about the dynamics of potential toxic phytoplankton species in Scottish offshore waters. The very high *Pseudonitzchia* spp. cell numbers observed in M10 indicate that blooms of this diatom can occur in these offshore areas.

The poor rate of return from coastal sites and the limited temporal spread from offshore sites significantly compromise the usefulness of the toxin producing phytoplankton monitoring programme. The collection of coastal samples might be improved by a combination of better communication with potential collectors and encouragement to co-operate. But collection of samples from the offshore area raises more significant logistical and therefore economic issues. Thus it is recommended that a weekly sample be collected from a smaller number of offshore sites in order to gauge the temporal variability in the dynamics of toxic phytoplankton species in offshore areas around the Scottish coast. It is further recommended that consideration be given to greater utilisation of multifunctional sites that can support weekly sampling.

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		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
13-May-03	St. Abbs	0	60	0	0	0	0	0
10-Jun-03	St. Abbs	0	200	2180	20	0	0	20

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
8-Apr-03	Stonehaven	60	0	5720	0	0	0	20
16-Apr-03	Stonehaven	140	0	11580	0	0	20	120
23-Apr-03	Stonehaven	20	20	180	0	20	0	80
28-Apr-03	Stonehaven	20	0	1120	0	0	0	160
6-May-03	Stonehaven	20	20	100	0	0	0	0
12-May-03	Stonehaven	0	0	360	0	0	0	0
19-May-03	Stonehaven	20	0	420	0	0	0	0
26-May-03	Stonehaven	20	100	3920	0	0	0	40
2-Jun-03	Stonehaven	0	620	9620	0	0	0	80
9-Jun-03	Stonehaven	0	540	12680	0	0	0	20
16-Jun-03	Stonehaven	0	540	5440	0	0	0	7020
23-Jun-03	Stonehaven	60	2200	16360	0	0	0	520
30-Jun-03	Stonehaven	20	280	13160	0	0	0	220
8-Jul-03	Stonehaven	20	600	307480	0	0	0	240
15-Jul-03	Stonehaven	0	180	5640	0	0	0	0
21-Jul-03	Stonehaven	20	20	6620	0	0	0	20
28-Jul-03	Stonehaven	0	0	0	0	0	0	20
4-Aug-03	Stonehaven	0	20	16060	0	0	0	20
11-Aug-03	Stonehaven	0	0	3680	0	0	0	20
20-Aug-03	Stonehaven	0	0	62900	0	0	0	0
25-Aug-03	Stonehaven	60	1160	111600	0	20	0	140
1-Sep-03	Stonehaven	0	0	43920	0	0	0	20
8-Sep-03	Stonehaven	0	140	8040	0	20	0	40
15-Sep-03	Stonehaven	0	0	0	0	0	0	0
24-Sep-03	Stonehaven	0	0	80	0	0	0	0
29-Sep-03	Stonehaven	0	0	10820	0	0	0	0
16-Oct-03	Stonehaven	0	0	900	0	0	0	20
21-Oct-03	Stonehaven	0	20	1120	0	0	0	0
27-Oct-03	Stonehaven	0	0	320	0	0	0	20
3-Nov-03	Stonehaven	0	0	260	0	0	0	0
13-Nov-03	Stonehaven	0	0	160	0	0	0	0
17-Nov-03	Stonehaven	0	0	0	0	0	0	20
24-Nov-03	Stonehaven	0	0	0	0	0	0	0
1-Dec-03	Stonehaven	0	0	0	0	0	0	0
8-Dec-03	Stonehaven	0	0	0	0	0	0	0
18-Dec-03	Stonehaven	0	0	0	0	0	0	0
23-Dec-03	Stonehaven	0	0	0	0	0	0	0
29-Dec-03	Stonehaven	0	0	0	0	0	0	0
5-Jan-04	Stonehaven	0	0	0	0	0	0	0
12-Jan-04	Stonehaven	0	0	80	0	0	0	0
19-Jan-04	Stonehaven	0	0	0	0	0	0	0
26-Jan-04	Stonehaven	0	0	80	0	0	0	0
9-Feb-04	Stonehaven	0	0	240	0	0	0	0
16-Feb-04	Stonehaven	0	0	140	0	0	0	0
23-Feb-04	Stonehaven	40	0	520	20	0	0	0
1-Mar-04	Stonehaven	0	0	1900	0	0	0	20
8-Mar-04	Stonehaven	0	0	1860	0	0	0	0
20-Mar-04	Stonehaven	0	0	9780	0	0	0	0
22-Mar-04	Stonehaven	0	0	5000	0	0	0	0
29-Mar-04	Stonehaven	0	0	880	0	0	0	40

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
23-Jun-03	Dornoch Firth	0	0	0	0	0	0	40

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
3-Apr-03	Scapa	380	0	429920	0	0	0	20
11-Apr-03	Scapa	180	20	450632	20	0	0	80
17-Apr-03	Scapa	240	20	682460	0	0	20	260
23-Apr-03	Scapa	800	20	101929	60	0	20	20
30-Apr-03	Scapa	180	80	242820	20	0	0	100
9-May-03	Scapa	60	40	1100	120	0	0	120
14-May-03	Scapa	0	20	600	100	0	0	80
21-May-03	Scapa	0	0	0	120	0	0	0
30-May-03	Scapa	100	60	0	800	0	0	20
5-Jun-03	Scapa	80	40	0	240	0	0	20
11-Jun-03	Scapa	0	60	0	140	0	0	0
17-Jun-03	Scapa	0	20	1300	220	0	0	40
24-Jun-03	Scapa	20	220	8800	400	0	0	20
4-Jul-03	Scapa	20	400	310400	0	0	0	20
9-Jul-03	Scapa	0	120	14300	0	0	0	20
17-Jul-03	Scapa	0	60	120	120	0	0	20
24-Jul-03	Scapa	0	0	0	20	0	0	0
26-Jul-03	Scapa	0	0	160	0	0	0	0
31-Jul-03	Scapa	60	80	860	140	0	0	20
8-Aug-03	Scapa	0	40	1720	140	0	0	40
13-Aug-03	Scapa	0	0	1480	20	0	0	0
21-Aug-03	Scapa	0	0	800	0	0	0	0
27-Aug-03	Scapa	0	0	10700	20	0	0	60
4-Sep-03	Scapa	40	20	1220	660	0	0	20
10-Sep-03	Scapa	20	40	2840	40	0	0	20
11-Sep-03	Scapa	0	200	1120	0	0	0	40
26-Sep-03	Scapa	20	0	6180	120	0	0	0
1-Oct-03	Scapa	0	80	31180	80	0	0	20
9-Oct-03	Scapa	0	40	620	40	0	0	40
15-Oct-03	Scapa	0	0	1140	0	0	0	0
22-Oct-03	Scapa	0	0	1120	20	0	0	20
28-Oct-03	Scapa	0	0	500	0	0	0	20
6-Nov-03	Scapa	0	0	140	0	0	0	0
13-Nov-03	Scapa	0	0	640	0	0	0	20
20-Nov-03	Scapa	20	0	80	0	0	0	20
26-Nov-03	Scapa	0	0	80	0	0	0	20
4-Dec-03	Scapa	0	0	40	20	0	0	0
11-Dec-03	Scapa	0	0	0	0	0	0	0
16-Dec-03	Scapa	0	0	100	0	0	0	0
23-Dec-03	Scapa	0	0	280	0	0	0	0
6-Jan-04	Scapa	0	0	0	0	0	0	20
15-Jan-04	Scapa	0	0	260	0	0	0	0
20-Jan-04	Scapa	0	0	340	0	0	0	0
5-Feb-04	Scapa	0	0	160	0	0	0	0
18-Feb-04	Scapa	0	0	2160	0	0	0	0
1-Mar-04	Scapa	60	0	2440	40	0	0	0
10-Mar-04	Scapa	20	0	8860	20	0	0	0
16-Mar-04	Scapa	0	0	2920	20	0	20	0
22-Mar-04	Scapa	0	0	18900	0	0	0	20
29-Mar-04	Scapa	60	0	3140	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
18-Apr-03	Scalloway	40	0	3160	0	0	0	160
25-Apr-03	Scalloway	40	0	2240	0	0	0	180
2-May-03	Scalloway	20	0	1060	0	20	40	320
17-May-03	Scalloway	120	20	180	0	0	0	80
23-May-03	Scalloway	780	0	80	0	0	0	20
30-May-03	Scalloway	20	20	1040	0	0	0	720
20-Jun-03	Scalloway	260	200	1820	0	0	0	100
27-Jun-03	Scalloway	120	200	21320	0	0	0	280
4-Jul-03	Scalloway	140	220	390680	0	0	0	140
11-Jul-03	Scalloway	1640	380	0	20	0	0	160
14-Jul-03	Scalloway	4340	1160	120	0	20	40	40
18-Jul-03	Scalloway	3460	1640	0	0	20	0	720
25-Jul-03	Scalloway	200	120	1160	0	40	40	60
1-Aug-03	Scalloway	40	0	4080	0	0	0	20
8-Aug-03	Scalloway	240	300	11940	20	0	0	20
15-Aug-03	Scalloway	200	300	4820	0	0	20	260
22-Aug-03	Scalloway	0	0	1820	0	0	0	0
29-Aug-03	Scalloway	0	20	1800	0	0	0	240
5-Sep-03	Scalloway	0	20	4920	20	0	0	0
12-Sep-03	Scalloway	0	0	520	0	0	0	0
19-Sep-03	Scalloway	0	0	21560	0	0	0	0
26-Sep-03	Scalloway	0	0	2740	0	0	0	0
4-Oct-03	Scalloway	0	0	13920	0	0	0	20
10-Oct-03	Scalloway	0	40	16020	0	0	0	40
18-Oct-03	Scalloway	0	0	11480	0	0	0	0
31-Oct-03	Scalloway	0	0	1020	0	0	0	20
7-Nov-03	Scalloway	0	0	0	0	0	0	0
21-Nov-03	Scalloway	0	0	40	0	0	0	0
29-Nov-03	Scalloway	0	0	0	0	0	0	0
5-Dec-03	Scalloway	0	0	0	0	0	0	0
12-Dec-03	Scalloway	0	20	40	0	0	0	0
19-Dec-03	Scalloway	0	0	0	0	0	0	0
9-Jan-04	Scalloway	0	0	0	0	0	0	0
16-Jan-04	Scalloway	0	0	0	0	0	0	0
23-Jan-04	Scalloway	0	0	80	0	0	0	0
6-Feb-04	Scalloway	0	0	460	0	0	0	20
13-Feb-04	Scalloway	0	0	400	0	0	0	40
20-Feb-04	Scalloway	0	0	320	0	0	0	20
27-Feb-04	Scalloway	0	0	160	0	0	0	20
5-Mar-04	Scalloway	40	0	1420	0	0	0	40
12-Mar-04	Scalloway	20	0	800	0	0	0	0
19-Mar-04	Scalloway	20	0	1440	0	0	0	60
25-Mar-04	Scalloway	80	0	480	0	0	0	40

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
25-Apr-03	Sandsound	160	0	1220	0	0	0	940
7-May-03	Sandsound	20	0	420	0	0	0	280
23-May-03	Sandsound	40	0	460	0	0	0	160
5-Jun-03	Sandsound	40	40	460	0	0	0	1000
18-Jun-03	Sandsound	20	140	126620	0	0	0	180
30-Jun-03	Sandsound	0	460	66220	0	0	0	320
16-Jul-03	Sandsound	18860	2340	0	0	100	100	340
1-Aug-03	Sandsound	0	40	80	0	0	0	0
15-Aug-03	Sandsound	20	0	260	0	0	0	280
27-Aug-03	Sandsound	0	0	120	0	0	0	180
11-Sep-03	Sandsound	0	0	0	0	0	0	0
29-Sep-03	Sandsound	0	0	280	0	0	0	0
29-Oct-03	Sandsound	0	0	1440	0	0	0	20
27-Nov-03	Sandsound	0	0	0	0	0	0	0
8-Dec-03	Sandsound	0	0	220	0	0	0	0
12-Jan-04	Sandsound	0	0	0	0	0	0	0
9-Feb-04	Sandsound	0	0	820	0	0	0	0
16-Feb-04	Sandsound	0	0	740	0	0	0	60

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
30-Jun-03	Busta Voe	300	1440	53200	0	20	40	1080
7-Oct-03	Busta Voe	0	0	2760	0	0	0	0
14-Oct-03	Busta Voe	0	0	3700	20	0	0	20
4-Nov-03	Busta Voe	0	0	0	0	0	0	20

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
5-Jun-03	Vaila Sound	100	0	3740	0	0	0	2700
12-Jun-03	Vaila Sound	400	220	93080	0	0	0	460
24-Jun-03	Vaila Sound	40	20	3200	0	0	0	120
30-Jun-03	Vaila Sound	100	860	6600	0	0	0	360
4-Jul-03	Vaila Sound	100	340	189500	0	0	0	220
21-Jul-03	Vaila Sound	920	1660	200	0	0	40	140
30-Jul-03	Vaila Sound	40	40	1900	0	0	0	0
4-Aug-03	Vaila Sound	100	40	5320	0	0	0	20
11-Aug-03	Vaila Sound	20	40	1940	20	0	0	20
19-Aug-03	Vaila Sound	0	20	460	0	0	0	0
25-Aug-03	Vaila Sound	0	0	620	0	0	0	40
1-Sep-03	Vaila Sound	0	0	3000	0	0	0	0
16-Sep-03	Vaila Sound	0	20	14580	0	0	0	40
25-Sep-03	Vaila Sound	0	0	90200	0	0	0	20
14-Oct-03	Vaila Sound	20	0	4580	0	0	0	20
20-Oct-03	Vaila Sound	0	0	1040	0	0	0	0
2-Dec-03	Vaila Sound	0	0	60	0	0	0	20
20-Jan-04	Vaila Sound	0	0	0	0	0	0	0
16-Feb-04	Vaila Sound	20	0	360	0	0	0	20
11-Mar-04	Vaila Sound	20	0	1120	20	0	40	20

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
11-Aug-03	Basta Voe	0	0	3560	0	0	0	0
16-Oct-03	Basta Voe	0	0	4880	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
16-Apr-03	Loch Laxford	20	0	3320	0	0	0	20
28-Apr-03	Loch Laxford	0	0	5040	0	0	0	20
5-May-03	Loch Laxford	20	0	200	0	0	0	60
28-May-03	Loch Laxford	400	20	5800	0	0	0	200
9-Jun-03	Loch Laxford	0	160	2940	0	0	0	280
23-Jun-03	Loch Laxford	0	20	1020	0	0	0	0
27-Jun-03	Loch Laxford	0	2380	1920	0	0	0	180
9-Jul-03	Loch Laxford	0	580	820	0	0	0	60
14-Jul-03	Loch Laxford	20	80	1840	20	0	0	0
25-Jul-03	Loch Laxford	0	0	480	0	0	0	0
1-Aug-03	Loch Laxford	0	0	1180	0	0	0	0
19-Aug-03	Loch Laxford	0	60	1120	0	0	0	0
20-Oct-03	Loch Laxford	0	0	540	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
7-Apr-03	Isle EweA	0	40	420	0	0	0	100
14-Apr-03	Isle EweA	80	60	1140	0	0	0	100
21-Apr-03	Isle EweA	60	20	5440	0	0	20	120
25-Apr-03	Isle EweA	0	0	6440	0	0	0	40
5-May-03	Isle EweA	0	440	2580	0	0	0	80
12-May-03	Isle EweA	100	60	14880	0	0	0	100
19-May-03	Isle EweA	60	180	31520	0	0	0	0
26-May-03	Isle EweA	20	220	47760	0	0	0	60
2-Jun-03	Isle EweA	80	280	34960	0	20	0	0
9-Jun-03	Isle EweA	20	400	20420	0	40	0	0
16-Jun-03	Isle EweA	0	620	12900	0	0	0	180
23-Jun-03	Isle EweA	80	4960	1880	0	0	0	640
30-Jun-03	Isle EweA	60	860	520	0	0	0	120
7-Jul-03	Isle EweA	0	600	360	0	0	0	160
14-Jul-03	Isle EweA	0	620	6740	0	0	0	20
21-Jul-03	Isle EweA	20	480	7960	0	0	20	160
28-Jul-03	Isle EweA	0	60	4280	0	0	0	0
4-Aug-03	Isle EweA	0	140	4080	0	0	0	0
11-Aug-03	Isle EweA	0	0	980	0	0	0	0
18-Aug-03	Isle EweA	0	100	2580	0	0	0	120
25-Aug-03	Isle EweA	0	60	1520	0	0	0	20
1-Sep-03	Isle EweA	0	0	960	0	0	0	0
8-Sep-03	Isle EweA	0	0	7980	0	0	0	0
16-Sep-03	Isle EweA	0	120	34040	0	0	0	0
22-Sep-03	Isle EweA	20	60	15520	0	0	0	60
29-Sep-03	Isle EweA	0	40	4860	0	0	0	40
6-Oct-03	Isle EweA	0	0	7140	0	0	0	40
13-Oct-03	Isle EweA	0	0	80	0	0	0	0
20-Oct-03	Isle EweA	0	20	12340	0	0	0	0
27-Oct-03	Isle EweA	0	20	4660	0	0	0	40
3-Nov-03	Isle EweA	0	0	10020	0	0	0	60
10-Nov-03	Isle EweA	0	0	1300	0	0	0	20
17-Nov-03	Isle EweA	0	0	280	0	0	0	0
24-Nov-03	Isle EweA	0	0	540	0	0	0	0
1-Dec-03	Isle EweA	0	0	0	0	0	0	0
8-Dec-03	Isle EweA	0	0	80	0	0	0	0
15-Dec-03	Isle EweA	0	0	60	0	0	0	0
22-Dec-03	Isle EweA	0	0	0	0	0	0	0
29-Dec-03	Isle EweA	0	0	0	0	0	0	0
5-Jan-04	Isle EweA	0	0	0	0	0	0	0
12-Jan-04	Isle EweA	0	0	80	0	0	0	0
19-Jan-04	Isle EweA	0	0	0	0	0	0	0
26-Jan-04	Isle EweA	0	0	0	0	0	0	0
2-Feb-04	Isle EweA	0	0	120	0	0	0	0
9-Feb-04	Isle EweA	0	0	120	0	0	0	0
16-Feb-04	Isle EweA	0	0	120	0	0	0	0
23-Feb-04	Isle EweA	0	0	1260	0	0	0	0
1-Mar-04	Isle EweA	0	0	4420	0	0	0	20
8-Mar-04	Isle EweA	0	0	13700	0	0	0	20
15-Mar-04	Isle EweA	0	0	2100	0	0	0	40
22-Mar-04	Isle EweA	0	20	2080	0	0	0	80
29-Mar-04	Isle EweA	0	0	140	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
7-Apr-03	Isle EweB	20	20	200	0	0	0	180
14-Apr-03	Isle EweB	0	140	280	0	0	0	80
21-Apr-03	Isle EweB	40	160	5740	20	0	0	280
28-Apr-03	Isle EweB	160	280	5360	0	0	0	540
5-May-03	Isle EweB	20	180	2040	0	0	0	220
12-May-03	Isle EweB	100	60	15000	0	0	0	180
19-May-03	Isle EweB	20	800	0	0	0	0	60
26-May-03	Isle EweB	0	60	25800	0	0	0	100
2-Jun-03	Isle EweB	20	560	36940	0	0	0	0
9-Jun-03	Isle EweB	0	280	31320	0	0	0	160
16-Jun-03	Isle EweB	20	1340	8700	0	0	0	300
23-Jun-03	Isle EweB	0	2120	3520	0	0	0	120
30-Jun-03	Isle EweB	20	1300	160	0	0	80	60
7-Jul-03	Isle EweB	20	740	460	0	0	0	80
14-Jul-03	Isle EweB	0	1480	6760	0	0	0	60
21-Jul-03	Isle EweB	40	440	10320	0	0	0	20
28-Jul-03	Isle EweB	0	100	5320	0	0	0	60
4-Aug-03	Isle EweB	0	20	2500	0	0	0	0
11-Aug-03	Isle EweB	0	40	1440	0	0	0	200
18-Aug-03	Isle EweB	0	120	2020	0	0	0	80
25-Aug-03	Isle EweB	0	20	6320	0	0	0	0
1-Sep-03	Isle EweB	0	0	540	0	0	0	0
8-Sep-03	Isle EweB	0	80	64080	0	20	0	60
16-Sep-03	Isle EweB	0	40	103180	0	0	0	200
22-Sep-03	Isle EweB	0	20	4420	0	0	0	40
29-Sep-03	Isle EweB	0	20	3980	0	0	0	100
6-Oct-03	Isle EweB	0	20	11500	20	0	0	60
13-Oct-03	Isle EweB	0	0	3480	0	0	0	0
20-Oct-03	Isle EweB	0	0	15080	0	0	0	0
27-Oct-03	Isle EweB	0	0	11120	0	0	0	100
3-Nov-03	Isle EweB	0	20	8980	0	0	0	60
10-Nov-03	Isle EweB	0	0	7620	0	0	0	0
17-Nov-03	Isle EweB	0	0	640	0	0	0	0
24-Nov-03	Isle EweB	0	0	0	0	0	0	0
1-Dec-03	Isle EweB	0	0	60	0	0	0	0
8-Dec-03	Isle EweB	0	0	80	0	0	0	20
15-Dec-03	Isle EweB	0	0	40	0	0	0	0
22-Dec-03	Isle EweB	0	0	0	0	0	0	0
29-Dec-03	Isle EweB	0	0	0	0	0	0	0
5-Jan-04	Isle EweB	0	0	0	0	0	0	0
12-Jan-04	Isle EweB	0	0	0	0	0	0	0
19-Jan-04	Isle EweB	0	0	40	0	0	0	0
26-Jan-04	Isle EweB	0	0	40	0	0	0	0
2-Feb-04	Isle EweB	0	0	0	0	0	0	0
9-Feb-04	Isle EweB	0	0	200	0	0	0	0
16-Feb-04	Isle EweB	0	0	320	0	0	0	0
23-Feb-04	Isle EweB	0	0	1000	0	0	0	20
1-Mar-04	Isle EweB	0	0	4780	0	0	0	20
8-Mar-04	Isle EweB	0	0	3520	0	0	0	0
15-Mar-04	Isle EweB	0	0	2000	0	0	0	0
22-Mar-04	Isle EweB	0	0	100	0	0	0	0
29-Mar-04	Isle EweB	0	0	80	0	0	0	20

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
6-Apr-03	Loch Maddy	20	0	1480	0	0	0	20
9-Apr-03	Loch Maddy	0	0	300	0	0	0	0
18-Apr-03	Loch Maddy	0	0	960	0	0	0	0
23-Apr-03	Loch Maddy	20	20	6540	0	0	0	100
2-May-03	Loch Maddy	40	0	5060	0	0	0	100
10-May-03	Loch Maddy	0	0	840	0	0	0	20
19-May-03	Loch Maddy	0	20	3780	0	0	0	260
4-Jun-03	Loch Maddy	0	20	21980	0	0	0	0
16-Jun-03	Loch Maddy	0	0	45260	0	0	0	40
24-Jun-03	Loch Maddy	0	0	15000	0	0	0	0
3-Jul-03	Loch Maddy	0	640	63376	0	0	0	60
8-Jul-03	Loch Maddy	0	620	44740	0	0	0	20
16-Jul-03	Loch Maddy	20	160	12240	0	40	0	80
22-Jul-03	Loch Maddy	60	280	227520	0	0	0	360
29-Jul-03	Loch Maddy	0	0	29140	0	0	0	60
6-Aug-03	Loch Maddy	0	0	251960	0	0	0	20
14-Aug-03	Loch Maddy	40	100	67700	0	0	0	20
2-Sep-03	Loch Maddy	0	20	152360	0	0	0	0
16-Sep-03	Loch Maddy	0	0	2200	0	0	0	0
11-Oct-03	Loch Maddy	0	0	40	0	0	0	0
16-Oct-03	Loch Maddy	0	0	3320	0	0	0	20
23-Oct-03	Loch Maddy	20	0	840	0	0	0	0
28-Oct-03	Loch Maddy	0	0	300	0	0	0	0
6-Nov-03	Loch Maddy	0	0	140	0	0	0	0
12-Nov-03	Loch Maddy	0	40	60	0	0	0	0
20-Nov-03	Loch Maddy	0	0	80	0	0	0	0
29-Nov-03	Loch Maddy	0	0	0	0	0	0	0
5-Dec-03	Loch Maddy	0	0	80	0	0	0	20
10-Dec-03	Loch Maddy	0	0	0	0	0	0	0
9-Jan-04	Loch Maddy	0	0	0	0	0	0	0
17-Jan-04	Loch Maddy	0	0	0	0	0	0	0
23-Jan-04	Loch Maddy	0	0	0	0	0	0	0
30-Jan-04	Loch Maddy	0	0	0	0	0	0	0
4-Feb-04	Loch Maddy	0	0	0	0	0	0	0
11-Feb-04	Loch Maddy	0	0	80	0	0	0	0
18-Feb-04	Loch Maddy	0	0	40	0	0	0	0
27-Feb-04	Loch Maddy	0	0	280	0	0	0	0
2-Mar-04	Loch Maddy	0	0	360	0	0	0	20
17-Mar-04	Loch Maddy	20	0	760	0	0	0	20
24-Mar-04	Loch Maddy	0	0	1480	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
1-Apr-03	Loch Roag	0	0	0	0	0	0	100
29-Apr-03	Loch Roag	40	0	2720	0	0	0	460
13-May-03	Loch Roag	0	0	580	0	0	0	300
20-May-03	Loch Roag	20	40	700	0	0	0	1160
3-Jun-03	Loch Roag	5700	0	1420	0	0	0	900
10-Jun-03	Loch Roag	380	100	4900	0	0	0	460
17-Jun-03	Loch Roag	960	0	14300	0	0	0	100
7-Jul-03	Loch Roag	0	20	6620	0	0	0	20
14-Jul-03	Loch Roag	0	20	12460	0	0	0	1000
21-Jul-03	Loch Roag	0	0	2620	0	0	0	20
28-Jul-03	Loch Roag	0	40	4800	0	0	0	0
4-Aug-03	Loch Roag	0	0	95840	0	0	0	0
11-Aug-03	Loch Roag	0	0	12160	0	0	0	0
18-Aug-03	Loch Roag	40	20	9300	0	20	0	20
25-Aug-03	Loch Roag	100	20	24160	0	0	0	0
1-Sep-03	Loch Roag	0	140	8540	20	0	0	60
8-Sep-03	Loch Roag	0	0	6180	0	0	0	0
15-Sep-03	Loch Roag	0	0	520	0	0	0	0
22-Sep-03	Loch Roag	0	0	12320	0	0	0	0
29-Sep-03	Loch Roag	0	0	11340	0	0	0	20
7-Oct-03	Loch Roag	0	0	10480	0	0	0	0
13-Oct-03	Loch Roag	0	0	660	0	0	0	0
20-Oct-03	Loch Roag	0	20	9880	0	0	0	80
27-Oct-03	Loch Roag	0	0	2700	0	0	0	20
3-Nov-03	Loch Roag	0	0	6120	0	0	0	0
10-Nov-03	Loch Roag	0	0	720	0	0	0	0
17-Nov-03	Loch Roag	0	0	320	0	0	0	0
1-Dec-03	Loch Roag	0	0	80	20	0	0	0
15-Dec-03	Loch Roag	0	0	0	0	0	0	0
12-Jan-04	Loch Roag	0	0	60	0	0	0	0
26-Jan-04	Loch Roag	0	0	0	0	0	0	0
16-Feb-04	Loch Roag	0	0	40	0	0	0	0
2-Mar-04	Loch Roag	0	0	160	0	0	0	0
23-Mar-04	Loch Roag	180	0	560	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
21-Apr-03	Loch Eishort	20	80	3260	0	0	20	140
28-Apr-03	Loch Eishort	0	80	2520	0	0	0	60
12-May-03	Loch Eishort	0	20	60	0	0	0	0
20-May-03	Loch Eishort	360	120	160	0	0	0	60
27-May-03	Loch Eishort	100	120	0	0	0	0	20
16-Jun-03	Loch Eishort	0	300	320	0	0	0	0
23-Jun-03	Loch Eishort	0	20	2300	0	0	0	0
7-Jul-03	Loch Eishort	40	360	720	0	0	0	20
14-Jul-03	Loch Eishort	0	280	1380	0	0	0	60
21-Jul-03	Loch Eishort	0	20	1140	0	0	0	0
28-Jul-03	Loch Eishort	0	220	2440	0	0	0	0
4-Aug-03	Loch Eishort	0	0	1340	0	0	0	0
11-Aug-03	Loch Eishort	20	120	8180	0	0	0	0
18-Aug-03	Loch Eishort	20	100	78720	0	0	0	40
15-Sep-03	Loch Eishort	0	0	12400	0	0	0	20
29-Sep-03	Loch Eishort	0	0	3400	0	0	0	0
20-Oct-03	Loch Eishort	0	0	1780	0	0	0	0
17-Nov-03	Loch Eishort	0	0	120	0	0	0	0
1-Dec-03	Loch Eishort	0	20	160	0	0	0	60
2-Feb-04	Loch Eishort	0	0	0	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
14-Apr-03	Loch Scridain	60	20	260	0	0	0	0
22-Apr-03	Loch Scridain	0	0	600	0	0	0	0
13-May-03	Loch Scridain	0	20	40	0	0	0	40
27-May-03	Loch Scridain	40	0	4180	0	0	0	60
3-Jun-03	Loch Scridain	0	0	6400	0	0	0	0
10-Jun-03	Loch Scridain	0	0	20620	0	0	0	60
16-Jun-03	Loch Scridain	0	760	1120	0	0	0	2560
23-Jun-03	Loch Scridain	0	0	1040	20	0	0	0
11-Aug-03	Loch Scridain	0	0	960	0	0	0	0
19-Aug-03	Loch Scridain	0	0	1360	20	0	0	0
26-Aug-03	Loch Scridain	0	0	880	0	0	0	0
2-Sep-03	Loch Scridain	0	0	14180	0	0	0	0
10-Sep-03	Loch Scridain	0	20	4260	0	0	0	0
16-Sep-03	Loch Scridain	0	0	8580	0	0	0	0
29-Sep-03	Loch Scridain	20	20	143760	20	0	0	20
21-Oct-03	Loch Scridain	0	0	200	0	0	0	0
18-Nov-03	Loch Scridain	0	0	460	20	0	0	0
2-Dec-03	Loch Scridain	0	0	80	0	0	0	0
17-Feb-04	Loch Scridain	0	0	80	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
14-Apr-03	Loch Etive	0	0	380	0	0	0	360
5-May-03	Loch Etive	0	0	160	0	0	0	100
12-May-03	Loch Etive	0	60	0	0	0	0	0
27-May-03	Loch Etive	0	0	0	0	0	0	0
9-Jun-03	Loch Etive	0	0	0	0	0	0	0
23-Jun-03	Loch Etive	0	40	0	20	0	0	40
7-Jul-03	Loch Etive	0	0	4420	0	0	0	20
14-Jul-03	Loch Etive	0	0	760	0	0	0	0
21-Jul-03	Loch Etive	20	20	5180	0	0	0	40
4-Aug-03	Loch Etive	0	0	4520	0	0	0	0
25-Aug-03	Loch Etive	0	0	80	0	0	0	0
1-Sep-03	Loch Etive	0	0	60	0	0	0	0
23-Sep-03	Loch Etive	0	0	0	0	0	0	0
30-Sep-03	Loch Etive	0	0	0	0	0	0	0
21-Oct-03	Loch Etive	20	20	0	0	0	0	0
18-Nov-03	Loch Etive	0	0	0	0	0	0	0
9-Dec-03	Loch Etive	0	0	0	0	0	0	0
27-Jan-04	Loch Etive	0	0	0	0	0	0	0
23-Feb-04	Loch Etive	0	0	0	0	0	0	0
22-Mar-04	Loch Etive	0	0	600	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
15-Sep-03	Loch Leven	0	0	0	0	0	0	0
21-Oct-03	Loch Leven	0	0	0	0	0	0	0
18-Nov-03	Loch Leven	0	0	180	0	0	0	20
9-Dec-03	Loch Leven	0	0	0	0	0	0	0
20-Jan-04	Loch Leven	0	0	0	0	0	0	0
23-Feb-04	Loch Leven	0	0	0	0	0	0	0
15-Mar-04	Loch Leven	20	0	160	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
7-Apr-03	W L Tarbert	0	40	0	0	0	0	280
22-Apr-03	W L Tarbert	20	0	80	0	0	40	20
6-May-03	W L Tarbert	0	0	3480	20	0	0	0
19-May-03	W L Tarbert	0	0	960	0	0	0	0
3-Jun-03	W L Tarbert	20	0	140	0	0	0	0
16-Jun-03	W L Tarbert	0	0	40	80	0	0	0
1-Jul-03	W L Tarbert	0	180	760	0	0	0	20
15-Jul-03	W L Tarbert	20	60	6840	0	0	0	40
29-Jul-03	W L Tarbert	0	0	360	0	0	0	0
25-Aug-03	W L Tarbert	40	0	0	0	0	0	20
5-Sep-03	W L Tarbert	0	0	0	20	0	0	0
23-Sep-03	W L Tarbert	0	0	80	0	0	0	0
14-Oct-03	W L Tarbert	0	40	1020	60	0	0	60
4-Nov-03	W L Tarbert	0	0	9060	0	0	0	0
3-Dec-03	W L Tarbert	0	60	0	0	0	0	20
9-Dec-03	W L Tarbert	0	0	40	0	0	0	0
9-Jan-04	W L Tarbert	0	0	0	0	0	0	0
2-Feb-04	W L Tarbert	0	0	0	0	0	0	0
9-Mar-04	W L Tarbert	0	0	0	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
24-Apr-03	Loch Fyne	60	360	9560	0	0	0	320
1-May-03	Loch Fyne	0	600	4860	0	0	0	20
19-May-03	Loch Fyne	0	60	4500	0	0	0	3740
10-Jun-03	Loch Fyne	0	560	0	0	0	0	200
16-Jun-03	Loch Fyne	0	240	0	0	0	0	200
23-Jun-03	Loch Fyne	0	360	0	0	0	0	80
4-Jul-03	Loch Fyne	0	60	0	0	0	0	0
10-Jul-03	Loch Fyne	0	0	0	0	0	0	0
21-Jul-03	Loch Fyne	0	60	0	0	0	0	20
30-Jul-03	Loch Fyne	0	0	0	0	0	0	0
12-Aug-03	Loch Fyne	0	0	0	0	0	0	0
18-Aug-03	Loch Fyne	0	0	80	0	0	0	0
26-Aug-03	Loch Fyne	0	120	0	0	0	0	240
3-Sep-03	Loch Fyne	0	40	0	0	0	0	0
10-Sep-03	Loch Fyne	0	0	52546	0	0	0	0
18-Sep-03	Loch Fyne	0	0	0	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
5-May-03	Loch Striven	1420	220	5640	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
29-Apr-03	Loch Ryan	0	0	80	0	0	0	460
27-May-03	Loch Ryan	0	0	280	20	0	0	100
3-Jun-03	Loch Ryan	60	100	80	0	0	0	1620
29-Jul-03	Loch Ryan	0	0	40	0	0	0	20
26-Aug-03	Loch Ryan	0	0	0	500	0	0	0
27-Oct-03	Loch Ryan	0	20	80	0	0	0	40
26-Nov-03	Loch Ryan	0	0	0	0	0	0	0
8-Dec-03	Loch Ryan	0	0	0	0	0	0	20
6-Jan-04	Loch Ryan	0	0	40	0	0	0	0
24-Feb-04	Loch Ryan	0	0	80	0	0	0	0
16-Mar-04	Loch Ryan	0	0	520	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
7-Apr-03	Dhoon Bay	0	0	0	0	0	0	0
6-May-03	Dhoon Bay	0	0	240	0	0	0	0
18-Jun-03	Dhoon Bay	0	0	0	0	0	0	0
7-Jul-03	Dhoon Bay	0	0	120	0	0	0	0
4-Aug-03	Dhoon Bay	0	0	0	0	0	0	0
2-Sep-03	Dhoon Bay	0	0	0	0	0	0	0
13-Oct-03	Dhoon Bay	0	0	0	0	0	0	0
17-Nov-03	Dhoon Bay	0	0	0	0	0	0	0
1-Dec-03	Dhoon Bay	0	0	0	0	0	0	0
12-Jan-04	Dhoon Bay	0	0	0	0	0	0	0
3-Feb-04	Dhoon Bay	0	0	0	0	0	0	0
15-Mar-04	Dhoon Bay	0	0	0	0	0	0	0

		Alexandrium spp. (cells.l^{-1})	*Dinophysis* spp. (cells.l^{-1})	*Pseudonitzchia* spp. (cells.l^{-1})	*P.lima* (cells.l^{-1})	*L.polyedrum* (cells.l^{-1})	*P.reticulatum* (cells.l^{-1})	*Protoperidinium* spp. (cells.l^{-1})
29-Mar-04	C3	60	0	11760	0	0	0	100
28-Mar-04	C4	40	0	2140	0	0	0	0
23-Feb-04	C5	0	0	260	0	0	0	0
27-Mar-04	C5	20	0	22720	0	0	0	60
28-Mar-04	C6	20	0	1000	0	0	0	20
23-Feb-04	C7	0	0	120	0	0	0	20
23-Feb-04	C8	0	0	240	0	0	0	0
13-May-03	E01	0	0	240	0	0	0	40
13-May-03	E01	0	0	1120	0	0	0	0
12-Jul-03	E01	0	120	30520	0	0	0	120
10-Aug-03	E01	0	0	10280	0	0	0	0
31-Aug-03	E01	0	20	3560	0	0	0	0
27-Sep-03	E01	0	0	100	0	0	0	0
12-Jul-03	E02	0	80	76326	0	0	0	140
19-Apr-03	E03	0	20	120	0	0	0	0
10-Aug-03	E03	0	0	3220	0	0	0	0
28-Sep-03	E03	0	0	6300	0	0	0	0
13-May-03	E05	0	0	260	0	0	0	40
12-Jul-03	E05	0	320	20380	0	0	0	120
15-Feb-04	E05	0	0	400	0	0	0	0
4-May-03	E06	180	0	1180	0	0	0	60
19-May-03	E06	20	40	3660	0	0	0	100
2-Jun-03	E06	20	20	15780	0	0	0	120
12-Jul-03	E06	0	40	77140	0	0	0	0
11-Aug-03	E06	0	0	3000	0	0	0	0
11-Aug-03	E07	0	0	6400	0	0	0	0
28-Sep-03	E07	0	0	14660	0	0	0	0
15-Feb-04	E10	0	0	480	0	0	0	0
15-Jun-03	E17	20	100	960	0	0	0	80
13-May-03	E21	0	0	1380	0	0	0	40
13-May-03	E21	0	0	1600	0	0	0	120
14-Jun-03	E22	0	500	12340	0	0	0	1320
14-Jun-03	E23	40	240	140	0	20	0	0
1-May-03	E26	0	20	440	0	0	0	100
12-May-03	E27	0	20	980	0	0	0	60
12-May-03	E33	0	20	1200	0	0	0	20
9-Jun-03	H05	0	0	11240	0	0	0	0
6-Aug-03	H05	0	0	58380	0	0	0	0
9-Sep-03	H05	60	20	29724	0	0	0	100
22-Sep-03	H05	0	20	38640	0	0	0	0
10-Jun-03	H06	0	0	9500	0	0	0	0
26-Aug-03	H08	0	0	2940	0	0	0	0
8-Sep-03	H08	20	0	9260	0	20	0	20
22-Sep-03	H08	0	20	19940	0	0	0	0
14-Apr-03	H09	0	0	6780	0	0	0	240
25-Aug-03	H09	0	20	10740	0	0	0	0
25-Aug-03	H10	0	0	540	0	0	0	0
24-Aug-03	H11	60	20	1720	0	0	0	40
25-May-03	J01	0	0	10320	0	0	0	40
26-Jul-03	J01	0	40	63480	0	0	0	180
25-Aug-03	J01	0	0	0	0	0	0	0
9-Sep-03	J01	20	0	160980	0	0	0	0
21-Sep-03	J01	0	0	1280	0	0	0	0
26-Jul-03	J02	0	0	14720	0	0	0	20
26-Aug-03	J02	0	0	120	0	0	0	0
9-Sep-03	J02	20	0	133440	0	0	0	0
22-Sep-03	J02	0	0	1880	0	0	0	0
21-Jun-03	J03	0	0	2860	0	0	0	0
27-Aug-03	J03	0	0	100	0	0	0	0
26-Jul-03	J04	0	0	1520	0	0	0	0
27-Jul-03	J05	0	0	15680	0	0	0	100
26-Aug-03	J05	0	0	440	0	0	0	20
10-Sep-03	J05	0	0	0	0	0	0	0
22-Sep-03	J05	0	0	1240	0	0	0	0
21-Jun-03	J08	0	40	18600	0	0	0	20
27-Jul-03	M02	0	0	1640	0	0	0	0
30-Aug-03	M02	0	0	3360	0	0	0	20
15-Feb-04	M02	0	0	0	0	0	0	0
15-Oct-03	M02	0	0	580	0	0	0	20
1-Sep-03	M03	0	0	17420	0	0	0	0
28-Sep-03	M03	0	0	0	0	0	0	0
12-Apr-03	M05	60	0	6880	0	0	0	80
5-Jul-03	M09	20	520	16700	0	0	0	60
10-Aug-03	M09	0	0	9560	0	0	0	20
31-Aug-03	M09	0	100	19120	0	0	0	20
27-Sep-03	M09	0	0	1040	0	0	0	0
9-Feb-04	M09	0	0	0	0	0	0	0
23-Apr-03	M10	2260	80	1489440	0	0	0	1060
3-Jun-03	M10	360	260	420	0	20	0	200
6-Jul-03	M10	40	1140	34720	0	0	0	100
28-Jul-03	M10	0	0	3640	0	0	0	0
28-Jul-03	M10	60	0	4680	0	0	0	80
11-Aug-03	M10	0	0	24600	0	0	0	80
16-Feb-04	M10	0	0	160	0	0	0	0
11-Aug-03	M11	0	0	33760	0	0	0	0
16-Feb-04	M11	0	0	0	0	0	0	0
09-Mar-04	M16	20	0	3980	0	0	0	20
9-Feb-04	M17	0	0	140	0	0	0	0

09-Mar-04	M17	20	0	3880	0	0	0	40
6-Jul-03	M18	0	60	80	0	0	0	40
14-Sep-03	M18	0	0	0	0	0	0	0
28-Sep-03	M18	0	0	40	0	0	0	0
08-Mar-04	M18	0	0	80	0	0	0	0
11-Aug-03	M19	0	0	30760	0	0	0	40
15-May-03	M25	0	60	1300	0	0	0	40
8-Jun-03	M29	100	1380	300	0	0	0	400
4-Aug-03	NM05	0	0	5320	0	0	0	60
5-Oct-03	NM05	0	0	480	0	0	0	0
4-Aug-03	NM06	20	100	13860	0	0	0	100
5-Oct-03	NM06	0	0	720	0	0	0	0
3-Jul-03	NM09	0	60	12100	0	0	0	60
16-Aug-03	NM09	20	160	97560	0	0	0	60
24-Sep-03	NM09	0	0	0	0	0	0	0
21-Oct-03	NM09	0	0	220	0	0	0	0
23-Nov-03	NM09	0	0	0	0	0	0	0
15-Dec-03	NM09	0	0	0	0	0	0	0
5-Aug-03	NM10	0	160	8500	0	0	0	100
8-Sep-03	NM10	20	0	1020	0	0	0	0
7-Sep-03	NM11	0	0	840	0	0	0	0
01-Mar-04	NM11	0	0	60	0	0	0	0
18-Aug-03	NM12	0	40	9820	0	0	0	0
23-Sep-03	NM12	0	0	240	0	0	0	0
19-Oct-03	NM12	0	0	260	0	0	0	0
23-Nov-03	NM12	0	0	0	0	0	0	0
9-Jun-03	NM13	60	280	4020	0	0	0	320
23-Jun-03	NM13	0	200	139020	0	0	0	280
20-Jul-03	NM13	0	80	9020	0	0	0	20
21-Jul-03	NM13	0	0	4060	0	0	0	0
5-Aug-03	NM13	0	0	240	0	0	0	0
17-Aug-03	NM13	0	140	340	0	0	0	0
23-Sep-03	NM13	0	0	140	0	0	0	0
20-Oct-03	NM13	0	0	360	0	0	0	0
15-Dec-03	NM13	0	0	0	0	0	0	0
02-Mar-04	NM13	0	0	5580	0	0	0	0
02-Mar-04	NM14	60	0	3040	0	0	0	0
14-May-03	NM16	0	0	0	0	0	0	0
29-Apr-03	NM17	100	0	18500	0	0	0	680
5-Apr-03	O10	0	0	6140	0	0	0	0
13-Jul-03	O10	0	20	15320	0	0	0	60
31-Aug-03	O10	0	0	3080	0	0	0	20
14-Sep-03	O10	0	0	80	0	0	0	0
11-Jan-04	O10	0	0	160	0	0	0	0
12-May-03	O11	80	0	8660	0	0	0	0
25-May-03	O11	20	0	480	0	0	0	360
15-Jun-03	O11	260	300	16540	0	0	0	360
13-Jul-03	O11	0	0	1120	0	0	0	20
31-Aug-03	O11	0	0	5260	0	0	0	0
14-Sep-03	O11	0	0	80	0	0	0	0
10-Nov-03	O11	0	0	880	0	0	0	60
11-Jan-04	O11	0	0	340	0	0	0	0
15-May-03	O18	0	60	1500	0	0	0	100
14-Jun-03	O18	0	180	2320	0	0	0	60
12-Jul-03	O18	20	100	2720	0	0	0	0
26-Jul-03	O18	0	0	560	0	0	0	0
26-Jul-03	O18	0	0	520	0	0	0	0
16-Aug-03	O18	0	40	41880	0	0	0	40
13-Sep-03	O18	0	0	440	0	0	0	0
23-Oct-03	O18	0	0	1160	0	0	0	0
8-Nov-03	O18	0	0	140	0	0	0	0
23-Nov-03	O18	0	0	0	0	0	0	0
29-Nov-03	O18	0	0	40	0	0	0	0
6-Dec-03	O18	0	0	0	0	0	0	0
3-Feb-04	O18	0	0	1820	0	0	0	0
12-Jul-03	O19	0	80	400	0	0	0	0
16-Aug-03	O19	20	0	7660	0	0	0	20
30-Aug-03	O19	0	0	1760	0	0	0	0
13-Sep-03	O19	0	0	1560	0	0	0	0
29-Sep-03	O19	0	0	1720	0	0	0	0
29-Sep-03	O19	0	0	10880	0	0	0	0
15-Oct-03	O19	0	0	260	0	0	0	0
25-Oct-03	O19	0	0	820	0	0	0	200
8-Nov-03	O19	0	0	240	0	0	0	40
23-Nov-03	O19	0	0	40	0	0	0	0
29-Nov-03	O19	0	0	0	0	0	0	0
6-Dec-03	O19	0	0	60	0	0	0	0
6-Jan-04	O19	0	0	120	0	0	0	0
17-Jan-04	O19	0	0	80	0	0	0	0
24-Jan-04	O19	0	0	0	0	0	0	0
2-Feb-04	O19	20	0	380	0	0	0	0
07-Mar-04	O19	20	0	21380	0	0	0	0
26-Jul-03	O20	20	0	2020	0	0	0	20
22-Feb-04	O20	0	0	340	0	0	0	0
24-May-03	O24	60	180	1300	0	0	0	100
26-Jul-03	O27	180	20	13200	0	0	0	60
23-Feb-04	O27	0	0	0	0	0	0	0
26-Jul-03	O28	0	0	1960	0	0	0	0
23-Feb-04	O28	0	0	560	0	0	0	0
20-Mar-04	S03	0	0	280	0	0	0	20

11-Aug-03	S06	0	40	3820	20	20	0	0
16-Feb-04	S06	0	0	0	0	0	0	0
14-Feb-04	S07	0	0	80	0	0	0	0
13-May-03	S09	180	0	4160	0	0	0	660
12-May-03	S10	140	0	4640	0	0	0	0
22-Feb-04	S10	0	0	160	0	0	0	0
16-Feb-04	S11	0	0	300	0	0	0	20
23-Feb-04	S11	0	0	320	0	0	0	0
12-Apr-03	S13	40	0	8660	0	0	20	60
11-May-03	S14	0	0	360	0	0	0	0
21-Mar-04	S14	0	0	1500	0	0	0	60
22-Mar-04	S18	0	0	1260	0	0	0	40
27-May-03	SM05	0	0	300	0	0	0	0
28-May-03	SM06	80	140	28400	0	0	0	280
17-Jul-03	SM06	0	20	8700	0	0	0	20
18-Aug-03	SM06	0	0	11560	0	0	0	0
1-Sep-03	SM06	0	0	5560	0	0	0	0
16-Sep-03	SM06	0	0	3560	0	0	0	0
21-Oct-03	SM06	0	0	0	0	0	0	20
15-Nov-03	SM06	0	0	40	0	0	0	0
19-Aug-03	SM09	0	20	24140	0	0	0	40
22-Sep-03	SM09	0	0	1880	0	0	0	0
7-Oct-03	SM09	0	0	80	0	0	0	20
20-Oct-03	SM09	0	0	80	0	0	0	0
16-Nov-03	SM09	0	0	60	0	0	0	0
17-Jul-03	SM10	40	0	4040	0	0	0	20
19-Aug-03	SM10	0	0	9480	0	20	0	0
1-Sep-03	SM10	0	0	22440	0	0	0	60
15-Sep-03	SM10	0	0	1060	0	0	0	0
16-Nov-03	SM10	0	0	200	0	0	0	20
7-Dec-03	SM10	0	0	0	0	0	0	0
18-Jul-03	SM11	0	80	10660	0	0	0	0
18-Aug-03	SM11	0	20	29380	0	0	0	20
2-Sep-03	SM11	0	0	7920	0	0	0	0
15-Sep-03	SM11	0	0	153660	0	0	0	20
23-Sep-03	SM11	0	0	9040	0	0	0	0
22-Oct-03	SM11	0	0	560	0	0	0	0
17-Nov-03	SM11	0	0	160	0	0	0	20
21-Jun-03	SM13	20	60	7580	0	0	0	100
21-Jun-03	SM14	0	40	5740	0	0	0	80
30-Jun-03	SM14	60	1500	430300	0	0	20	600
20-Jul-03	SM14	20	20	13000	0	0	0	20
19-Aug-03	SM14	0	0	0	0	0	0	0
19-Aug-03	SM14	20	0	300	0	0	0	0
2-Sep-03	SM14	0	0	13980	0	0	0	0
16-Sep-03	SM14	0	0	1360	0	0	0	0
25-May-03	SM15	100	80	200	0	0	0	100
22-Jun-03	SM15	0	40	7320	0	0	0	40
1-Jul-03	SM15	20	620	15940	0	0	0	180
20-Jul-03	SM15	0	0	3660	0	0	0	0
20-Aug-03	SM15	0	0	260	0	0	0	0
3-Sep-03	SM15	0	20	15520	0	0	0	20
16-Sep-03	SM15	0	0	19160	0	0	0	0
6-Dec-03	SM15	0	0	80	0	0	0	0