

**ENVIRONMENT AGENCY**

**MICROALGAL MONITORING  
IN COASTAL WATERS  
1993 - 1995**

**NATIONAL CENTRE  
ECOTOXICOLOGY AND HAZARDOUS SUBSTANCES**

**NUTRIENTS SECTION**

**November 1998**

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## 1. INTRODUCTION

- 1.1 The Environment Agency has a responsibility to protect coastal water quality (for three nautical miles offshore), to monitor bathing water quality and assess the aesthetic quality of beaches. The quality of the coastal environment may be influenced by the presence of an excessive biomass of microalgae, or phytoplankton.
- 1.2 The impact of an excessive algal biomass or bloom can manifest itself in the marine and coastal environment as an aesthetic nuisance in the form of foams, scums and discolouration of water. In addition, the ecology of the area can be affected by localised deoxygenation or direct toxicity caused by some algal species. Certain microalgae can pose a human/animal health risk through the bioaccumulation of algal toxins in shellfish which can cause poisoning on subsequent consumption by humans and animals.
- 1.3 In 1991 the Environment Agency's predecessor, the National Rivers Authority (NRA), instigated a monitoring programme for algal blooms at sites sampled for the EC Bathing Waters Directive at the request of the Department of the Environment (DoE, now known as the Department of the Environment, Transport and the Regions, DETR). Incidents of exceptional algal blooms were initially reported to the DoE.
- 1.4 Subsequently, the Ministry of Agriculture, Fisheries and Food (MAFF) has implemented the Shellfish Hygiene Directive (91/492/EC) which requires algal monitoring in shellfish production areas. Results of Agency monitoring can provide valuable additional information for MAFF with regard to potentially toxic algal species. Since 1995 close contact has been established, and a regular exchange of information now takes place. However, at present, there is no formal coordination of MAFF and Agency monitoring programmes.
- 1.5 The results from the marine algal monitoring programme between 1991 to 1993 were collated in Welsh Region. A summary report was produced describing the distribution of algal blooms around the coast of England and Wales in 1991 and 1992 (NRA, 1993). In 1994 responsibility for data collation was passed to the National Centre for Toxic and Persistent Substances (TAPS) in Anglian Region. (This responsibility was passed again in 1998 to the National Centre for Ecotoxicology and Hazardous Substances [EHS] based in Thames Region). A Questionnaire was issued from 1994 onwards in order to gain more detailed information on marine algae in each Region. The questionnaire for 1995 is reproduced in Appendix 1 for information.
- 1.6 This report presents the results from the microalgal monitoring programme in the coastal environment for 1993, 1994 and 1995. Information on the sites monitored and the occurrence of species is described for the individual years and a comparison made between the years. Details of the Agency and MAFF monitoring programmes are presented, together with an overview of the impact of marine microalgal blooms in England and Wales.
- 1.7 Since 1993 a number of the Regions have undergone mergers and subsequent name changes. All the data and information presented in this report are for the seven maritime Agency Regions, (excluding Midlands Region) formed in 1996.

## **2. THE IMPACT OF NUISANCE MICROALGAE**

### **2.1 Introduction**

2.1.1 Under ideal physical and chemical conditions the growth rate of microalgae is rapid. Fluctuations in population size are influenced by many factors such as grazing, nutrient limitation, light, and structure of the water column. If the ecological balance is disturbed, a large biomass of phytoplankton can accumulate to form blooms of nuisance microalgae. Such blooms can affect the marine environment in three main ways:

### **2.2 Discoloured Water. Scums and Deoxygenation**

2.2.1 When concentrated by growth or water movement, microalgae can discolour the water to form "red tides". These are often spectacular and can be widespread, occurring in a range of colours such as green, orange or red. Blooms of some species, such as *Noctiluca scintillans*, can bioluminesce at night when disturbed. Species such as *Phaeocystis pouchetii* can form foams or scums due to the production of extracellular material. Such foams may be present on the water surface and/or be deposited on beaches and can result in offensive smells as the algal material decays. These events can be mistaken for pollution, such as sewage pollution, and result in the Agency receiving enquiries and complaints from the public. Members of the Bacillariophyceae or diatoms, such as *Asterionella*, *Attheya* and *Chaetoceros* can also cause discolouration of the water.

2.2.2 These incidents are harmless if the species involved are non-toxic but deoxygenation can occur if the algal material decays in a poorly flushed area.

### **2.3 Toxicity Through the Food Chain**

2.3.1 A number of marine microalgal species are known to be toxin producers. Incidents may not be obvious as they do not need to be in numbers sufficient to discolour the water. Toxins can be accumulated and passed through the food chain, most notable are shellfish toxins which can be a serious hazard to humans. There are several types of shellfish poisoning: paralytic shellfish poisoning (PSP) caused by, for example, *Alexandrium* species and *Gymnodinium catenatum*; diarrhetic shellfish poisoning (DSP) caused by, for example, *Dinophysis* species and *Prorocentrum lima*; and amnesic shellfish poisoning (ASP) caused by, for example, *Pseudo-nitzschia* species.

2.3.2 The protection of public health from shellfish toxins is the responsibility of MAFF.

### **2.4 Direct Toxicity and Physical Damage**

2.4.1 Some species can have a direct toxicity effect on marine organisms. *Gyrodinium aureolum* and *Chrysochromulina polylepis*, for example, can cause fish kills.

Other species such as *Chaetoceros* have spines which can physically clog and damage fish gills.

### **3. MARINE MICROALGAL MONITORING PROCEDURES**

#### **3.1 Environment Agency Marine Microalgal Monitoring Programme**

- 3.1.1 In England and Wales, marine microalgal blooms most commonly cause aesthetic nuisance in bathing waters and on beaches when large accumulations, foams or scums are washed in shore. This can result in offensive smells as the algal material decays. The common public perception is that they are some sort of pollution incident, resulting in the Agency receiving reports and enquiries about such events.
- 3.1.2 In 1991 the DoE (now DETR), via the Marine Pollution Monitoring Management Group (MPMMG) requested the Agency's predecessor, the NRA, to implement monitoring of algal blooms in coastal waters. This was in response to the increasing international concern over the effects of eutrophication of coastal waters and the apparent increase in incidents of algal blooms around the UK coastline. It was proposed that the Marine Algal Monitoring Programme might be built on to the existing Bathing Waters Monitoring Programme as an opportunistic and cost-effective means of obtaining this information at most relevant sites. Instances of exceptional blooms were initially reported to the DoE.
- 3.1.3 A phased programme of monitoring marine algal blooms in the coastal environment was introduced which has allowed for increased effort as resources and skills became available, and in the light of experience within particular Regions and their possible need for further, more detailed monitoring. The programme consists of two levels of monitoring:
- A "Minimum Effort" programme which is incorporated within the Bathing Waters Monitoring Programme in all Agency maritime Regions. A sample is taken for algal analysis when a bloom is evident.
  - A "Best Endeavours" programme to provide more information than the minimum effort programme but within the time and sampling constraints of the Bathing Waters Monitoring Programme. A sample is taken for algal analysis each time a site is visited.
- 3.1.4 Depending on the extent of marine algal problems in the Region, and the available resources, Regions implement the "Minimum Effort" programme as a basic requirement, and the "Best Endeavours" programme where appropriate. Regions with recognised microalgal problems have implemented the "Best Endeavours" programme. Regions also react to *ad hoc* requests for sampling at non-EC bathing waters, using the same sampling and analysis methods. The detailed methodology for these programmes appears in Appendix 2.

- 3.1.5 When potentially toxic algal blooms of the species listed in Table 1 are identified from the marine algal monitoring programme, this information was passed to TAPS (now superseded by EHS), by completing a Toxic Algal Bloom Report form. This is included in Appendix 2 for information.
- 3.1.6 On receipt of a Toxic Algal Bloom Report from a Region, TAPS contacted the Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft Laboratory, to alert them to the potential problem. In an exchange of information, CEFAS alerted the Agency via TAPS to any potential toxic marine algal problems identified through their sampling programme. (This arrangement now continues with EHS).

Table 1. Notifiable Toxic Marine Microalgal Species

Class	Species	Toxic Effect
Bacillariophyceae	<i>Pseudo-nitzschia</i> spp.	Amnesic shellfish poisoning (ASP)
Dinophyceae	<i>Alexandrium</i> spp. <i>Gymnodinium catenatum</i>	Paralytic shellfish poisoning (PSP) PSP
	<i>Dinophysis acuminata</i> <i>D. acuta</i> <i>D. norvegica</i> <i>Prorocentrum lima</i>	Diarrhetic shellfish poisoning (DSP) DSP DSP DSP
	<i>Amphidinium carterae</i> <i>Gyrodinium aureolum</i>	Ichthyotoxic (Kills fish) Ichthyotoxic
Haptophyceae	<i>Chrysochromulina polylepis</i> <i>Prymnesium parvum</i>	Ichthyotoxic Ichthyotoxic
Raphidophyceae	<i>Fibrocapsa japonica</i> <i>Heterosigma akashiwo</i>	Ichthyotoxic Ichthyotoxic
Cyanophyceae	<i>Nodularia spumigena</i>	Hepatotoxic

## **3.2 Monitoring Procedures of MAFF**

- 3.2.1 Under the Shellfish Hygiene Directive (91/492/EC) EC Member States are required to have monitoring programmes covering commercial shellfish production areas in order to "check the possible presence of toxin producing plankton in production and relaying waters, and biotoxins in live bivalve molluscs". In England and Wales this is the responsibility of MAFF.
- 3.2.2 In 1968, 78 people were hospitalised as a result of ingesting contaminated mussels from the north-east coast of Britain. Since that time MAFF has carried out regular shellfish monitoring in high risk areas of England and Wales for paralytic shellfish toxins. The programme is based on the collection and testing of shellfish and there has been no recorded incidence of paralytic shellfish poisoning (PSP) in England and Wales since it began. More recently the programme was expanded to include testing for diarrhetic shellfish toxins using the same sample site and collection methods. Again this programme has been successful as there has been no recorded incidence of diarrhetic shellfish poisoning (DSP) in England and Wales.
- 3.2.3 The Shellfish Hygiene Directive required that water monitoring should also be carried out for potentially toxic algal species in all shellfish harvesting areas. In response to this an algal monitoring programme was begun in 1992. This was run in parallel with the shellfish flesh sampling programme. Algal sampling is carried out in all the main shellfish production areas. From 1993 seventeen sampling sites were used, and in 1994 a further offshore site was added, off Blyth Northumberland, making eighteen in total.
- 3.2.4 Water samples are taken mainly by the Environmental Health departments of local authorities and sent to CEFAS, Lowestoft Laboratory for analysis. Sampling frequency in any of the areas is increased if defined levels of potentially toxic algal species are recorded there. The same levels also trigger additional sampling at other sites within the main production area. Further details can be found in Environment Agency (1997).
- 3.2.5 Closure of shellfish harvesting areas is determined by trigger levels of toxins in shellfish flesh. Closure measures involve, in the first instance, voluntary cessation of shellfish marketing and secondarily, a temporary prohibition order (TPO) under the Food Safety (Live Bivalve Molluscs and Other Shellfish) Regulations 1992, or an order under the Food and Environmental Protection Act 1985 (FEPA). Additionally, Environmental Health Officers (EHOs) are recommended to erect warning notices to inform any casual gatherers. Enforcement of such measures is the responsibility of EHOs, MAFF Fisheries Inspectorate and Harbour Authorities.

## **4. REVIEW OF THE AGENCY MARINE MICROALGAL MONITORING PROGRAMME**

### **4.1 Monitoring in 1993**

- 4.1.1 In 1993 all Regions except Welsh Region implemented the Minimum Effort Monitoring Programme for the period May to September. Welsh Region implemented the Best Endeavours Programme. Table 2 summarises the number of bathing water sites and other sites affected by nuisance blooms of microalgae for this year. North East and Thames Regions did not record the presence of any blooms during the monitoring period.
- 4.1.2 A complete list of the sites sampled including the species present, cell counts and notes on any problems caused by the bloom is presented in Appendix 3.

### **4.2 Monitoring in 1994**

- 4.2.1 In 1994 Welsh Region again implemented the Best Endeavours Programme, other Regions implemented the Minimum Effort Monitoring Programme from May to September, except North West Region which had a reactive programme. Table 3 summarises the number of sites affected by nuisance blooms of microalgae in 1994. North East and Thames Regions did not record the presence of any blooms during the monitoring period.
- 4.2.2 In Welsh Region, 21 bathing water sites in the Northern Area were included in the Best Endeavours Programme between May and the end of July, and then Minimum Effort was carried out from August to September. The Minimum Effort Programme was carried out at 25 sites in the South Western Area of Welsh Region throughout the season.
- 4.2.3 North West Region carried out a reactive programme where if a bloom was reported a sample was either sent to Marine Biological and Chemical Consultants (MBCC) at Bangor as part of their Bloomwatch programme or examined in-house (Agency).
- 4.2.4 One Area in North East Region reported that problems in communication meant that no blooms were notified. At other sites in the Region no samples were necessary at bathing water sites and so the Region did not record the presence of any blooms during the monitoring period.
- 4.2.5 Southern Region identified its monitoring programme as Minimum Effort but in practise it was more than this. The bathing water bacteriological samples were analysed by the same staff responsible for the marine microalgal analysis. All samples were analysed if there was any algae visible in the bottle. Consequently, some blooms may have been identified which were not obviously apparent to the sampler in the field.
- 4.2.6 The Eastern Area of Anglian Region commented that fifteen bathing water sites, from Wells to Felixstowe, experienced blooms of *Phaeocystis* during May and

June. However, no samples were examined locally as the analysis was undertaken by the Public Health Laboratory Service (PHLS).

- 4.2.7 A complete list of the sites sampled including the species present, cell counts and notes on any problems caused by the bloom is presented in Appendix 4.

### 4.3 Monitoring in 1995

- 4.3.1 In 1995 Welsh Region again implemented the Best Endeavours Programme, other Regions implemented the Minimum Effort Monitoring Programme except South West Region which had a reactive programme. The period covered was from May to September, except for North East and Thames Regions which covered May to October, Welsh Region covered April to September and South West Region covered February to October.
- 4.3.2 North West Region commented that reports of algal blooms were only recorded from the North Area. The other Areas acknowledged the presence of blooms but no samples were collected.
- 4.3.3 As in 1994, Southern Region identified its monitoring programme as more than the Minimum Effort Programme. The bathing water bacteriological samples were analysed by the same staff responsible for the marine microalgal analysis and samples were analysed if there was any algae visible in the bottle.
- 4.3.4 South West Region carried out a reactive programme in 1995 which resulted in 12 sites being monitored.
- 4.3.5 Table 4 summarises the number of sites affected by nuisance blooms of microalgae in 1995. A complete list of the sites sampled including the species present, cell counts and notes on any problems caused by the bloom is presented in Appendix 5.

**Table 2. Regional Summary of the 1993 Monitoring Programme**

Region	Monitoring Strategy	Number of Sites Monitored	Number of Designated Bathing Water Sites	Number of Designated Bathing Water Sites with Blooms	Number of Other Sites with Blooms	Total Number of Sites with Blooms	Total Number of Bloom Occurrences	Period of Blooms	Number of Potentially Toxic Blooms
Anglian	M.E.	54	33	10	4	14	14	May - Sep	0
North East	M.E.	62	56	0	0	0	0	-	-
North West	M.E.	33	33	1	4	5	5	May - Sep	0
Southern	M.E.	113	67	26	14	40	48	May - August	0
South West	M.E.	156	176	11	6	17	18	May - Sep	1
Thames	M.E.	8	3	0	0	0	0	-	-
Welsh	B.E.	70	51	28	13	41	58	May - August	0
All Regions	-	496	419	76	41	117	143	-	1

Table 3. Regional Summary of the 1994 Monitoring Programme

Region	Monitoring Strategy	Number of Sites Monitored	Number of Designated Bathing Water Sites	Number of Designated Bathing Water Sites with Blooms	Number of Other Sites with Blooms	Number of Sites with Blooms	Total Number of Bloom Occurrences	Period of Blooms	Number of Potentially Toxic Blooms
Anglian	M.E.	33	33	18	4	22	22	May - Sep	1
North East	M.E.	12	56	0	0	0	0	-	-
North West	Reactive	-	33	0	3	3	3	June - Sep	1
Southern	M.E.	93	67	50	12	62	62	May - August	0
South West	M.E.	87	176	29	24	53	57	May - Sep	3
Thames	M.E.	8	3	0	0	0	0	-	-
Welsh	B.E. (and M.E.)	46	51	12	4	16	18	May - Oct	3
All Regions	-	279	419	109	47	156	162	-	8

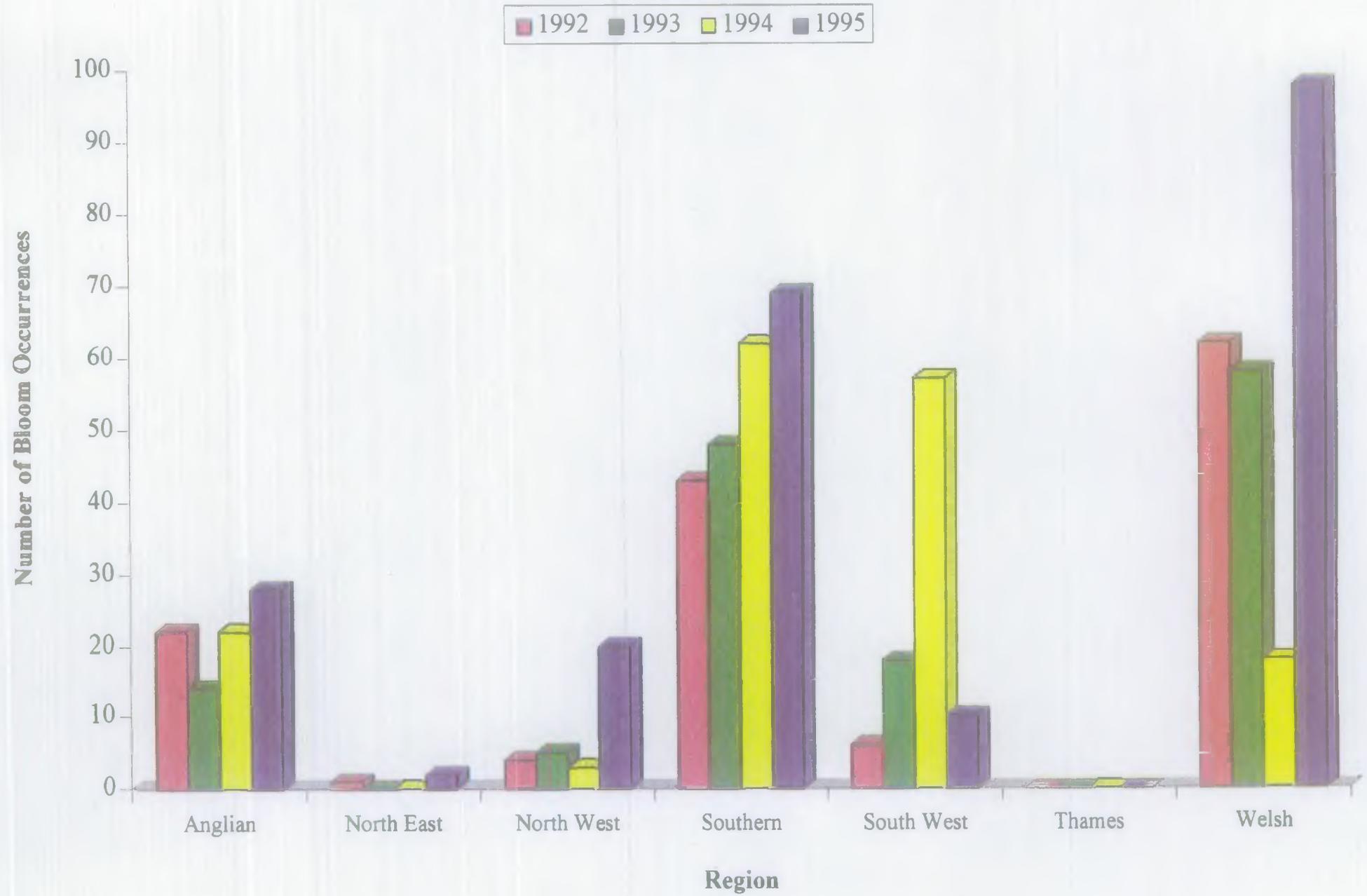
Table 4. Regional Summary of the 1995 Monitoring Programme

Region	Monitoring Strategy	Number of Sites Monitored	Number of Designated Bathing Water Sites	Number of Designated Bathing Water Sites with Blooms	Number of Other Sites with Blooms	Number of Sites with Blooms	Total number of Bloom Occurrences	Period of Blooms	Number of Potentially Toxic Blooms
Anglian	M.E.	34	34	18	5	23	28	May - August	1
North East	M.E.	53	56	0	2	2	2	March - May	0
North West	M.E.	31	33	9	2	11	20	June - July	1
Southern	M.E.	93	67	44	19	63	69	May - Sep	0
South West	Reactive	12	176	2	7	9	10	May - August	5
Thames	M.E.	8	3	0	0	0	0	-	-
Welsh	B.E.	53	56	43	24	67	98	April - Sep	8
All Regions	-	284	425	116	59	175	227	-	15

#### 4.4 Discussion of the Monitoring Programme from 1992 to 1995

- 4.4.1 The aim of this section is to review the marine microalgal monitoring data up to 1995. This includes data from 1992 presented in NRA (1993) to enable a longer term trend to be examined.
- 4.4.2 Figure 1 demonstrates the Regional differences in the number of marine microalgal blooms which occurred from 1992 to 1995. The numbers presented are the total number of bloom occurrences, which includes those sites which had more than one bloom during a year. In Welsh Region in 1995, for example, Pembrey had a bloom of *Phaeocystis* in May, *Asterionella* in June and *Chaetoceros* in July.
- 4.4.3 North East and Thames Regions had few or no blooms from 1992 to 1995. Thames Region monitors just eight sites in any year compared to North East Region which has monitored a maximum of 62 sites (1993).
- 4.4.4 The number of blooms in North West Region has varied in the different years, but this is more likely to be due to sampling effort rather than the real extent of problems. In 1994 for example, the full Minimum Effort Programme was not carried out but samples were taken reactively as a result of external enquiries. In 1995 blooms were only reported from the North Area, other Areas commented on the presence of blooms although no samples were taken. Therefore, the extent of blooms in North West Region is likely to be underestimated.
- 4.4.5 In South West Region the number of bloom occurrences again reflects the sampling effort. In 1994 a total of 57 blooms were recorded but this dropped to 10 in 1995 when a reactive monitoring programme was adopted as opposed to the Minimum Effort Programme.
- 4.4.6 In 1992, 1993 and 1995 Welsh Region experienced the highest number of bloom occurrences of all the Regions, with 62, 58, and 98 blooms, respectively. In comparison there were 18 bloom occurrences in 1994. It was noted that in 1995, monitoring began earlier which resulted in more samples being taken.
- 4.4.7 In Anglian Region the number of blooms has varied from 1992 to 1995, from 14 to 28 blooms. In Southern Region the number of bloom occurrences has steadily increased from 1993 to 1995. Southern Region may have identified more blooms due to the nature of the sample analysis.
- 4.4.8 On examining the Regional differences in the occurrence of marine microalgal blooms, it is difficult to draw any conclusions about the incidence of marine microalgae over the years in different Regions. Some of the differences can be largely accounted for by the type of monitoring programme implemented. For example, in 1994 North West Region, and in 1995 South West Region, employed a reactive monitoring programme, as opposed to the Minimum Effort Programme which resulted in very few samples being taken. It is apparent that Welsh,

Figure 1. Regional Comparison of the Total Number of Marine Microalgal Bloom Occurrences from 1992 to 1995



Southern, Anglian and South West Regions have a higher incidence of blooms than North East, North West and Thames Regions.

- 4.4.9 In the questionnaire, the Regions were asked to comment on the extent of marine microalgal blooms in comparison to previous years. It was generally felt that there was not enough information historically, or the data were too infrequent to make any such observations.
- 4.4.10 Figure 2a summarises the incidence of marine microalgal blooms for all Regions. The graph shows the number of sites monitored, the total number of sites with blooms, the total number of bloom occurrences and the number of potentially toxic blooms from 1992 to 1995. This illustrates that while the number of sites monitored has decreased, the number of sites with blooms and the number of bloom occurrences has increased between 1992 to 1995. Therefore there appears to be an overall trend for the incidence of marine microalgal blooms to be increasing.
- 4.4.11 This trend can be seen further by examining the percentage of sites monitored with blooms as shown in Figure 2b. Whilst recognising that the number of sites monitored has decreased from 615 in 1992 to 284 in 1995 (Figure 2a), the percentage of sites monitored with blooms has increased from 16% in 1992 to 62% in 1995. The percentage of sites monitored with potentially toxic blooms has varied between 1% in 1992, 0% in 1993, 3% in 1994 and 5% in 1995.
- 4.4.12 There are a number of hypotheses as to why this increasing trend in bloom incidence may be occurring:
- Eutrophication - there may be an upward trend in the incidence of blooms caused by coastal eutrophication.
  - Increased awareness of microalgae - the public are more aware of the phenomenon of nuisance microalgae and are reporting their occurrence more.
  - The public is also more aware of environmental pollution and is increasingly reporting washed up decaying foams of *Phaeocystis* as sewage pollution.
  - Weather conditions may have been more conducive to bloom formation in the years where the incidence of blooms was highest.
  - The exchange of information with MAFF was formalised in 1995 resulting in an increased Agency awareness of microalgae and potential toxicity problems.
- 4.4.13 It is likely that a combination of any of these factors influences the number of blooms that the Agency identifies, in addition to differences in the monitoring programmes. Subsequent years data are important for any trend to be examined further.

Figure 2a. Incidence of Marine Microalgal Blooms from 1992 to 1995

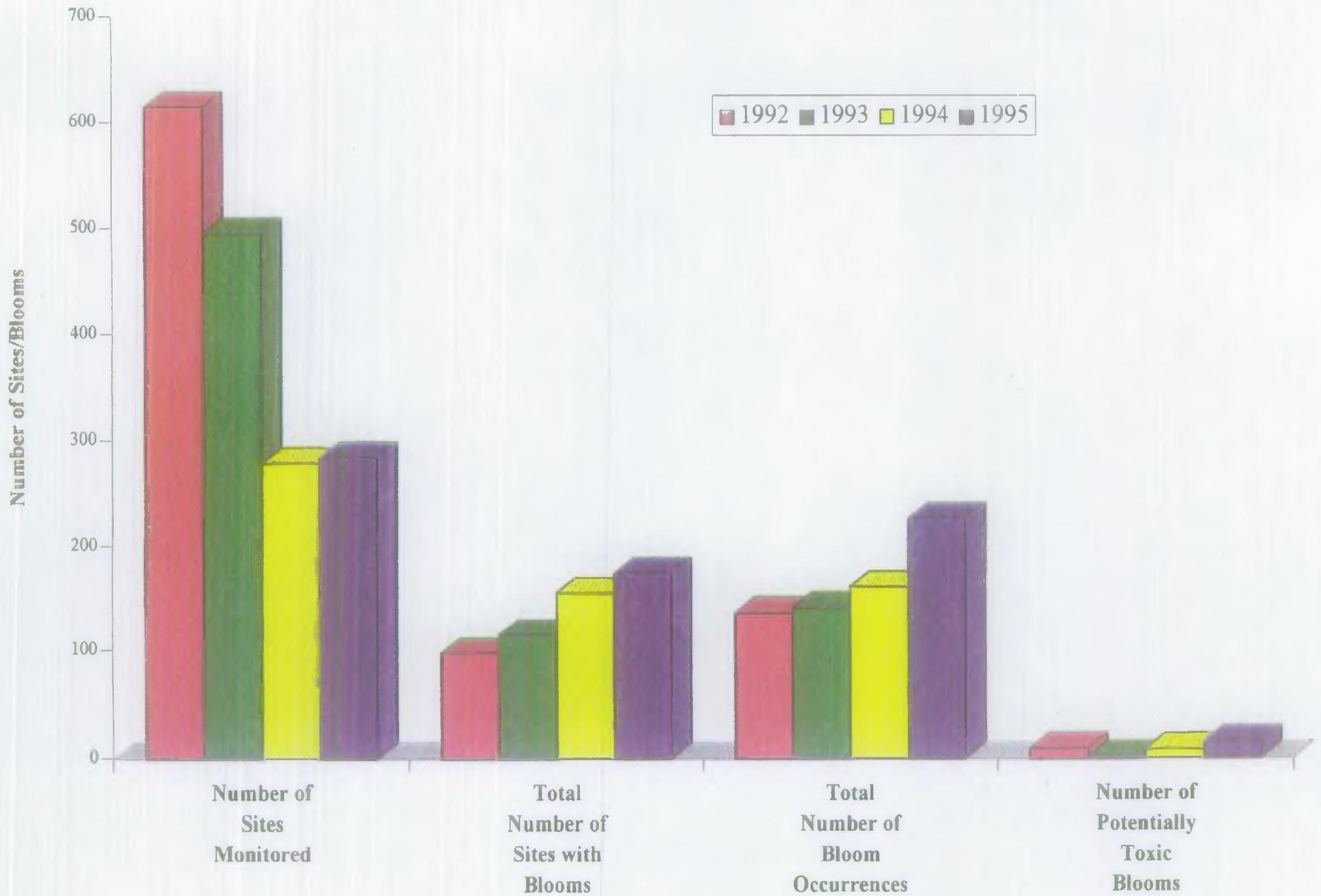
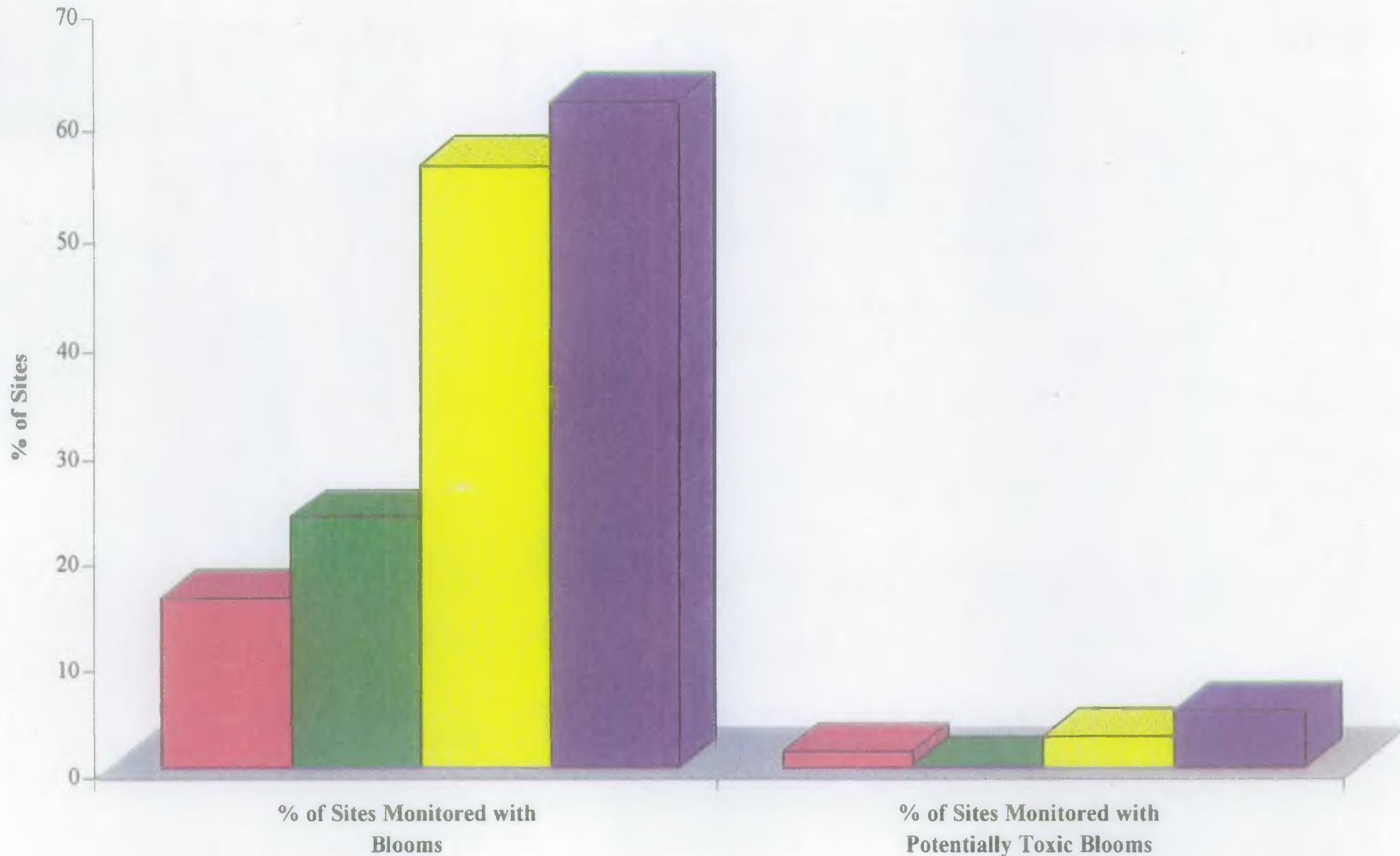


Figure 2b. Percentage of Sites with Marine Microalgal Blooms from 1992 to 1995

1992 1993 1994 1995



## 5. OCCURRENCE AND DISTRIBUTION OF NUISANCE MARINE MICROALGAE

The occurrence and distribution of particular nuisance marine microalgal species has been examined further by the use of maps to illustrate where species occur around the coast of England and Wales. This section has been divided into those species which cause discoloured water, scums and deoxygenation, and those which are potentially toxic.

### DISCOLOURED WATER, SCUMS AND DEOXYGENATION

#### 5.1 *Phaeocystis* species

- 5.1.1 *Phaeocystis* can form foams or scums due to the production of extracellular material, this material may be present on the water surface and/or be deposited on beaches resulting in offensive smells as the algal material decays. These events can be mistaken for pollution and result in the Agency receiving enquiries and complaints from the public.
- 5.1.2 Figure 3 shows the incidence of reported *Phaeocystis* blooms around the coastline of England and Wales. Many of these blooms were associated with shoreline foams and scums. The figure demonstrates that Anglian, Southern and Welsh Regions have had blooms annually from 1993 to 1995. North West Region has had few or no *Phaeocystis* blooms until 1995, while South West Region has had a few blooms in 1993 and 1995, and many in 1994, although a decreased sampling effort in 1995 may account for the lack of problems. North East Region had one confirmed *Phaeocystis* bloom in 1995.
- 5.1.3 When the occurrence of *Phaeocystis* in 1993 to 1995 is plotted onto one map (Figure 3d) the distribution of the species can be reviewed. *Phaeocystis* has been reported as occurring mainly along the coast of Anglian Region, Southern Region and Welsh Region, with parts of North West Region and South West Region affected. *Phaeocystis* has rarely been reported as occurring north of the Wash along the North East coast, North and South Wessex, and Cornwall.

#### Regional Observations

- 5.1.4 In 1994 Anglian Region, Eastern Area reported that concern was expressed over foaming at Sizewell Beach during June. This coincided with the *Phaeocystis* bloom down the Suffolk coast. Foaming occurred in the River Deben mouth in June which was shown to be algal related. The Area commented that *Phaeocystis* blooms were recorded from Wells to Felixstowe but that no samples were analysed as they were passed directly to the Public Health Laboratory Service for bacterial analysis.
- 5.1.5 Southern Region reported that in 1994 a widespread *Phaeocystis* bloom affected most of the English Channel coastline during late May, Hampshire and the Isle of Wight were significantly affected.

Figure 3. Distribution of Reported *Phaeocystis* sp. Blooms

a. 1993



b. 1994



c. 1995



d. 1993 to 1995



- 5.1.6 In late May/early June 1994, Welsh Region received a number of reports and enquiries in the Northern Area about brown foams and marine algal blooms which were identified as *Phaeocystis*.
- 5.1.7 In 1995 in Anglian Region a student undertook a project in Eastern Area to study, amongst other things, the algal blooms off the Norfolk, Suffolk and Essex coastline. *Phaeocystis* occurred along the Norfolk and Suffolk coastline but was absent along the Essex coastline. When sampling began in May, the *Phaeocystis* bloom event was already well underway. North West Region commented that *Phaeocystis* blooms are often not reported now as they are recognised.
- 5.1.8 Southern Region experienced a widespread *Phaeocystis* bloom which affected most of the Kent and Sussex coastline during May and early June 1995. Unlike the previous year, Hampshire and the Isle of Wight were not significantly affected.
- 5.1.9 Welsh Region commented that a number of public complaints were received during May and June 1995 concerning foaming and scums which were identified as *Phaeocystis*. It was perceived that blooms were more intensive in 1995 than in 1994, but similar to those in 1993 and previous years. The *Phaeocystis* bloom continued for a period of thirteen weeks, which was longer than in previous years, although the start of the sampling period was brought forward in 1995 to detect the beginning of the bloom.

## 5.2 *Noctiluca scintillans*

- 5.2.1 The dinoflagellate *Noctiluca scintillans* is a species which can cause spectacular discoloured water events, sometimes described as "tomato soup". Blooms can be bioluminescent when the cells are physically disturbed, for example, in the wake of a boat or where waves break. Figure 4 shows the occurrence of reported *N. scintillans* blooms around the coast of England and Wales from 1993 to 1995.
- 5.2.2 The distribution of *Noctiluca* has varied from Region to Region in the three years. In 1993 the species occurred off the coast of North West Region, Cornwall in South West Region, Kent in Southern Region and the north and south coasts of Welsh Region. In 1994 the distribution was limited to the north coast of Welsh Region extending into North West Region, and the Deben Estuary, Anglian Region. In 1995 the species was reported from the northerly coast of North West Region, Suffolk in Anglian Region and Kent in Southern Region.
- 5.2.3 When the occurrence of *Noctiluca* for each year is plotted onto one graph as in Figure 4d, a more general distribution for the species can be outlined. There are three main areas where the species has been reported, the north coast of Welsh Region and the coast of North West Region; the Suffolk coast of Anglian Region and Kent in Southern Region; and the north and south coasts of Cornwall in South West Region and the south coast of Welsh Region.

Figure 4. Distribution of Reported *Noctiluca scintillans* Blooms

a. 1993



b. 1994



c. 1995



d. 1993 to 1995



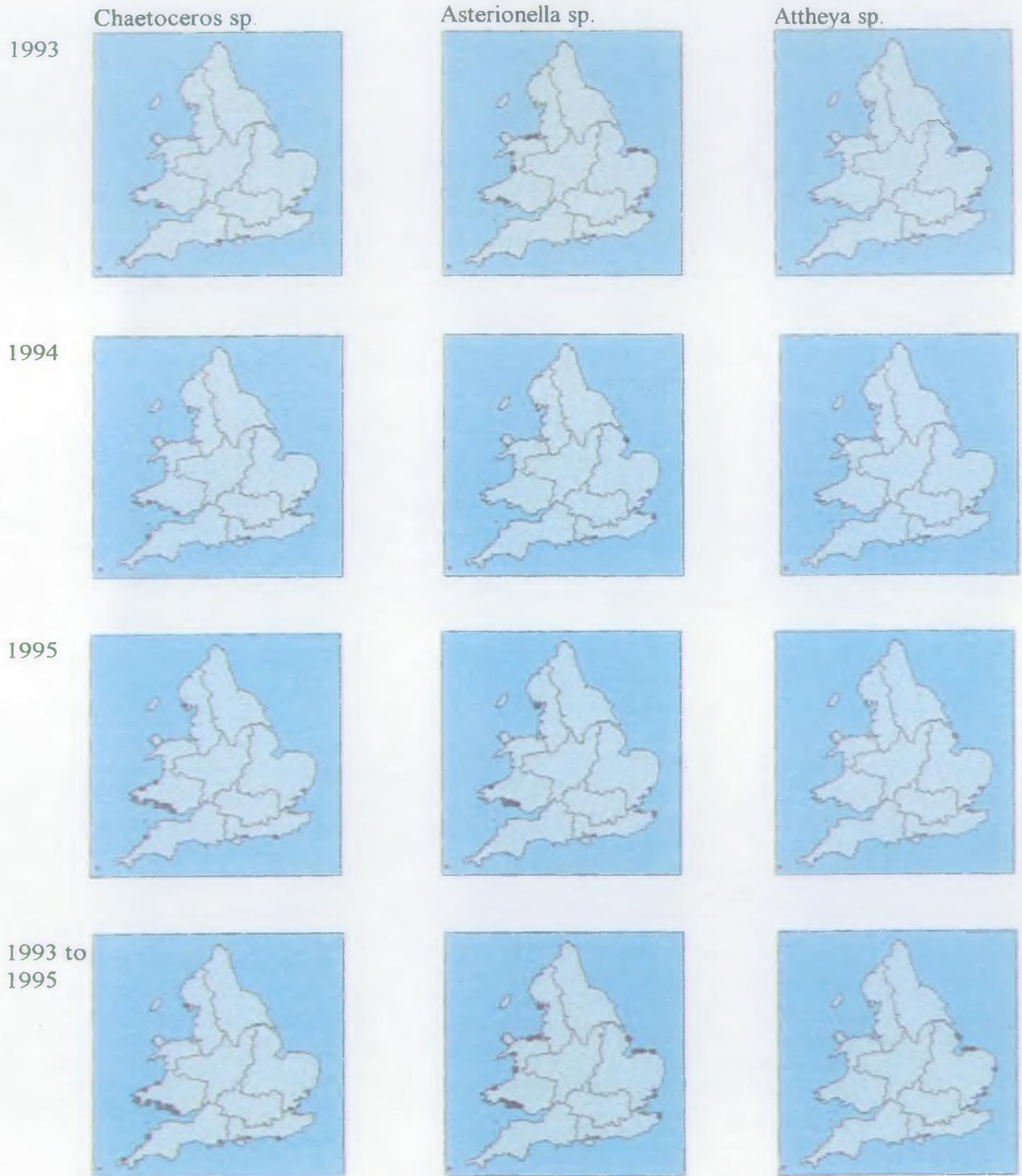
## Regional Observations

- 5.2.4 In Anglian Region in July 1994 reports were received of discoloured water at Ramsholt Quay, Deben Estuary. This was shown to be caused by a dense bloom of *Noctiluca*.
- 5.2.5 In Welsh Region in 1994, an orange/pink scum, confirmed as a *Noctiluca* bloom, was reported in June from Colwyn Bay to Prestatyn. In July a coastguard reported orange patches occurring from Colwyn Bay to Holyhead, which was also identified as *Noctiluca*.
- 5.2.6 In North West Region a sample of foam was taken from Grange-over-Sands in 1994 in response to public complaints and an MP's letter about sewage on the shore at the site. The sample was found to contain large numbers of diatoms and *Noctiluca*. The latter identification was confirmed by Marine Biological and Chemical Consultants (MBCC) at Bangor as part of their Bloomwatch programme.
- 5.2.7 In 1995 in North West Region enquiries were received about "glowing" blooms of *Noctiluca*, especially in the vicinity of Sellafield Nuclear Power Station causing concern about radiation leaks.

## 5.3 Bacillariophyceae: *Chaetoceros*, *Asterionella* and *Attheya* species

- 5.3.1 Members of the Bacillariophyceae (diatoms), such as *Chaetoceros*, *Asterionella* and *Attheya* can cause discoloured water events resulting in enquiries from the public. Species such as *Chaetoceros* have spines which can physically clog and damage fish gills, although no reports were received of such effects from 1993 to 1995.
- 5.3.2 Figure 5 is a series of graphs showing the distribution of *Chaetoceros*, *Asterionella* and *Attheya* from 1993 to 1995.
- 5.3.3 For *Chaetoceros*, a few sites in Welsh and South West Regions had blooms in 1993 and 1994. In 1995, isolated blooms were reported in North West, Southern and South West Regions, while a number of blooms occurred along the east and south coast of Welsh Region. The distribution from 1993 to 1995 demonstrates that *Chaetoceros* has been reported to occur along the south and west coasts of England and Wales.
- 5.3.4 In 1993, *Asterionella* was reported off the coast of Welsh Region and Anglian Region with one bloom occurring off Southern Region. In 1994, there were isolated occurrences off the Anglian and Southern coasts, and in 1995 Southern Region again had isolated incidents, together with North West Region, and Welsh Region had a number of blooms. On combining the occurrence for 1993 to 1995, it is apparent that *Asterionella* has been reported along the east and west coasts of England and Wales.

Figure 5. Distribution of Reported Bacilleroiophyceae Blooms:  
Chaetoceros, Asterionella and Attheya spp



- 5.3.5 The occurrence of *Attheya* has been limited to Anglian Region. There were a number of reported blooms in 1993 and 1995.

#### Regional Observations

- 5.3.6 In September 1993, a bloom of *Asterionella glacialis* and *Attheya* sp. at Holland Beach in Anglian Region caused a brown scum at the strandline with a resulting minor aesthetic impact on the beach. At Mablethorpe, a foaming brown stain of *Attheya* was present in June.
- 5.3.7 In August 1994 a bloom of *A. glacialis* at Sandwich Bay in Southern Region caused a beach slime and discoloured water. Similarly, in 1995 two large *Asterionella japonica* blooms occurred in the Pegwell Bay area at Ramsgate and Sandwich Bay in early July and early August. At Sandwich Bay a black slime was reported on the beach.
- 5.3.8 In May 1994, a bloom of *A. japonica* caused foaming on the shoreline at Huttoft in Anglian Region. In August 1995 *Attheya* caused a brown scum on the beach at Huttoft and Mablethorpe in the Region.

#### POTENTIALLY TOXIC SPECIES

##### 5.4 *Alexandrium tamarense*

- 5.4.1 The dinoflagellate *Alexandrium tamarense* can cause a type of shellfish poisoning called paralytic shellfish poisoning (PSP). The toxins can be accumulated and passed through the food chain resulting in a serious hazard to humans and animals. Blooms of *Alexandrium* can cause red tides, but a toxic threat can be present even when numbers are insufficient to discolour the water.
- 5.4.2 The distribution of *A. tamarense* around the coast of England and Wales from 1993 to 1995 is shown in Figure 6. No occurrences of the species were reported in 1993. In 1994 one occurrence was recorded at Weymouth Harbour, South West Region. In 1995 the reported incidence of the species increased with South West Region describing the occurrence at three sites and Welsh Region at one site. Few recordings of *A. tamarense* have been made from 1993 to 1995, but those reported have been on the south west coast of England and south coast of Wales.
- 5.4.3 1995 was the first year that MAFF recorded the presence of PSP toxins on the south coast of England. At the River Teign, PSP toxins were recorded in the flesh of shellfish samples but no potentially toxic algal species were present in the water samples taken at the same time. Similarly, no *Alexandrium* was recorded in any of the water samples taken by MAFF on the north-east coast of England but PSP toxins were found in some shellfish flesh samples.

Figure 6. Distribution of Reported *Alexandrium tamarense* Blooms

a. 1993



b. 1994



c. 1995



d. 1993 to 1995



## Regional Observations

- 5.4.4 On 25 July 1994 a local fisherman informed South West Region that the water at Weymouth Inner Harbour had turned a reddish/brown colour, and that sand eels which were being kept in containers over the side of boats for live baiting were dying. The "red tide" was identified as *A. tamarensis*. Liaisons were set up between the NRA, the Chief Port Health Officer (CPHO), and MAFF. A monitoring programme was carried out to investigate the bloom location and movement in the Weymouth Harbour area. Information on this was regularly reported to the CPHO. The intensity of the MAFF water and shellfish monitoring programme was increased at the time of the bloom and revealed that none of the shellfish samples taken in the Weymouth area contained PSP toxins.
- 5.4.5 A contingency plan was established to monitor the Weymouth Harbour water for bloom formation in subsequent years. In 1995 Environmental Health Officers (EHOs) at Weymouth visually inspected the harbour area from May/June. When a bloom was observed, samples were taken and examined microscopically to confirm whether *Alexandrium* cells were present. EHOs then contacted MAFF to enable water and shellfish samples to be taken. In June 1995 a red tide again occurred in Weymouth Harbour, a month earlier than the previous year. Shellfish flesh samples were again negative for PSP toxins.
- 5.4.6 In 1995 *A. tamarensis* was recorded for the first time at two other sites in South West Region, the Fal Estuary and Helford Estuary. The Region first noted its occurrence and informed MAFF, the Port Health Authority and EHO. MAFF confirmed the identification and took additional water and flesh samples from the Fal which revealed the presence of PSP toxins in the shellfish flesh samples.
- 5.4.7 In 1995 Welsh Region also experienced a bloom of *Alexandrium*, possibly for the first time, at Milford Haven. A "red tide" was first noted in the upper reaches by the Port Health Authority. The Region confirmed the presence of the species, and sampling of shellfish flesh by MAFF revealed the presence of PSP toxins.

## 5.5 *Gymnodinium* species

- 5.5.1 Different species of the dinoflagellate *Gymnodinium* can cause different types of toxic effects. For example, *G. catenatum* can cause paralytic shellfish poisoning (although it is yet to be identified off the UK coast it occurs elsewhere in Europe and may potentially be found in the future), and *G. veneficum* has been shown to be toxic to fish and invertebrates in laboratory experiments. None of the reports of *Gymnodinium* recorded by the Regions were identified to species level but no problems were associated with any of the occurrences.
- 5.5.2 Figure 7 shows the reported distribution of *Gymnodinium* species around England and Wales. In 1993 one occurrence was reported in South West Region. In 1994 the incidence of *Gymnodinium* increased with four recordings on the west coast, in South West, Welsh and North West Regions. In 1995 there was a single recorded occurrence, in Welsh Region. All the reported occurrences of

Figure 7. Distribution of Reported *Gymnodinium* sp. Blooms

a. 1993



b. 1994



c. 1995



d. 1993 to 1995



*Gymnodinium* have been along the west coast of England and Wales between 1993 to 1995.

#### Regional Observations

- 5.5.3 In August 1993, a bloom of *Gymnodinium* sp. caused discoloured water at Dinas Cove, Padstow, South West Region.
- 5.5.4 In 1994, there were occurrences of *Gymnodinium* species at four sites along the west coast of England and Wales. At Marine Lake, New Brighton, Wirral the bloom prevented windsurfing and canoeing activities in June, North West Region. In South West Region, a *Gymnodinium* species occurred off Carbin Bay and off Tolcarne, Newquay and in Welsh Region, Pembroke Mill Pond had a bloom with no associated problems.
- 5.5.5 In 1995, Nolton Haven in Welsh Region had a bloom in July with no reported problems.

#### 5.6 *Gyrodinium aureolum*

- 5.6.1 The dinoflagellate *Gyrodinium aureolum* is a species which can have a direct toxic effect on marine organisms, including fish. Mortalities have been caused in some cases by oxygen depletion, and in others by toxicity, reported as being due to polyunsaturated fatty acids. Figure 8 shows the reported occurrence of *G. aureolum* blooms around the coast of England and Wales.
- 5.6.2 In 1993 no blooms of *G. aureolum* were reported. In 1994, a bloom occurred off Pembrokeshire, Welsh Region, this occurred again in the same but wider area in 1995 together with a bloom at two sites in Cornwall. In the two years where the species has been recorded, it has occurred off the south west coast of England and Wales.

#### Regional Observations

- 5.6.3 On 22 August 1994, Welsh Region became aware of a large fish mortality in the St. Brides Bay area off Pembrokeshire. More than 1000 fish were washed up on the shore at Littlehaven and Broadhaven beaches. This coincided with a bloom of *G. aureolum*. Samples of fish tissue were analysed for toxins at the MAFF Torry Research Laboratory, Aberdeen, but proved negative. Aerial surveys were carried out to determine the extent of the bloom. EHOs and MAFF were informed of events.
- 5.6.4 In South West Region a bloom of *G. aureolum* was identified at two sites in Cornwall, Gunwalloe and the Lizard, in 1995. No problems were reported associated with this bloom.

Figure 8. Distribution of Reported Gyrodinium aureolum Blooms

a. 1993



b. 1994



c. 1995



d. 1993 to 1995



## 5.7 *Nodularia* species

- 5.7.1 Blue-green algae (cyanobacteria) most commonly cause problems in the freshwater environment where many species can produce mammalian toxins affecting humans, pets and livestock, but species can also occur in the brackish and marine environment.
- 5.7.2 In Anglian Region in 1994, incidents occurred at a brackish lagoon, Shepherd's Port Lake, at Snettisham, Norfolk, where a toxic scum of *Nodularia* was present, containing the hepatotoxin nodularin.
- 5.7.3 In July a fish mortality occurred, probably caused by low dissolved oxygen levels. It later became apparent that a man had swum in an associated lake and failed to see the erected warning notices until he left the water. He then probably panicked and hyperventilated, resulting in pins and needles in his arms and legs. He reported this to his doctor thinking that he had been affected by the algae. This is not considered to be a symptom of blue-green algal poisoning and the swimmer recovered within the same day. In 1995 low levels of *Nodularia* were again identified at the lake but with no associated problems.

## 5.8 *Prymnesium parvum*

- 5.8.1 The species *Prymnesium parvum* can occur in brackish waters, releasing toxins which kill fish. Toxin formation is influenced by a range of factors and the amount of toxin produced is largely independent of the number of cells present. In May 1995, Anglian Region experienced fish kills at Hickling Broad due to a bloom of *P. parvum*. Pumping from underground water supplies was instigated to alleviate the problems.

## 6. LIAISON AND COMMUNICATION

### 6.1 Introduction

- 6.1.1 Nuisance marine microalgal blooms, by their very nature, attract public attention resulting in the Agency receiving enquiries about them, as they are mistaken for some sort of pollution incident.
- 6.1.2 As the Agency is not responsible for matters relating to public health, liaison with Environmental Health Departments of local Councils and MAFF takes place when an algal bloom or species presents a potential threat to health.
- 6.1.3 Regional comments on liaison and communication are presented for 1994 and 1995 when the questionnaire was issued to gather more information about the monitoring programme.

## 6.2 Regional Comments - 1994

- 6.2.1 In Anglian Region a number of complaints and queries were received from the public in Eastern Area. Foaming at Sizewell Beach caused concern during June, this coincided with the *Phaeocystis* bloom along the Suffolk coast. Foaming in the River Deben mouth was shown to be algal related in June. In July reports were received of discoloured water at Ramsholt Quay, Deben Estuary. This was shown to be caused by a dense bloom of *N. scintillans*.
- 6.2.2 North East Region reported that two enquiries were received in one Area concerning algal blooms and their potential health effects.
- 6.2.3 In North West Region a disintegrating bloom of *N. scintillans* led to an unsightly shoreline scum at Grange Over Sands. This resulted in complaints to the Region and samples were taken.
- 6.2.4 Southern Region commented that in 1994 there was general public concern about blooms of *Phaeocystis* as they were mistaken for sewage pollution.
- 6.2.5 The South Wessex Area of South Western Region commented that liaison between the NRA and Weymouth Port Health Authority and MAFF worked well. No complaints were received and enquiries were dealt with promptly. The *Alexandrium* bloom at Weymouth was contained in the inner harbour and did not affect the bathing water at Weymouth Bay. Fishermen were the only people who noticed the reddish discolouration of the seawater and were kept informed of the situation by the Chief Port Health Officer. At the Fleet near Portland, a complaint was received of reddish brown discolouration due to benthic diatomaceous breakdown. Devon Area commented that there were about a dozen telephone calls concerned with foaming/scum and discolouration due to spring blooms of *Phaeocystis*.
- 6.2.6 Thames Region stated that three general enquiries were received in 1994. The Region monitors few sites for marine microalgae and receives few enquiries.
- 6.2.7 In Welsh Region, Northern Area commented that a number of reports and queries were received from the end of May to July 1994 concerning *Phaeocystis* and *Noctiluca*. In the South West Area many external calls were received but no details were taken. One bloom at Morfa Bychan was reported by the EHO and investigations identified it as *Eutreptiella*. At the time of the *Gyrodinium* bloom and fish kill in St Brides Bay, liaison with MAFF and EHOs took place. It was generally commented that there is an acceptance in many parts of Wales that *Phaeocystis* blooms are a natural annual event.

## 6.3 Regional Comments - 1995

- 6.3.1 The Eastern Area of Anglian Region reported that a district council rang to confirm that algae were the cause of sea water discolouration. A number of queries were received during the year concerned with foaming on beaches, and

Agency staff working at a beach at Ingoldmells were frequently challenged about the foaming and scums. It was commented that the public do not accept that it is a natural phenomenon.

- 6.3.2 North East Region commented that the only response was from walkers observing foaming and complaining to the Agency that nothing was being done about the "pollution incident". Generally, few enquiries were made.
- 6.3.3 In North West Region most reactions were from water users in response to the bioluminescent *N. scintillans*, especially in the vicinity of Sellafield nuclear power station, leading to fears about radiation leaks.
- 6.3.4 Southern Region stated that in 1995 generally, there was public concern about blooms of *Phaeocystis* as they were mistaken for sewage pollution.
- 6.3.5 South West Region received a number of queries regarding the bloom of *A. tamarensis* in Weymouth Harbour. Enquiries were from EHOs, Chief Port Health Officer (Weymouth), MAFF, local fishermen and fish market owners, and marine algal researchers. Most of the contact with EHOs concerned the liaison between themselves and the Agency in monitoring and managing the bloom. It was commented that some water users understood the phenomenon when explained to them but others do not believe what they are told. Some fishermen and members of the public at Weymouth Harbour believed that the reddish discolouring of the harbour water was due to a pesticide that the council spray onto the water to eradicate mosquitos. Other fishermen want to be involved by notifying the Agency when a bloom is sighted, and agreeing to keep their live bait in other water. Boat owners have enquired about the red plumes surrounding their boats while they work on them.
- 6.3.6 Elsewhere in South West Region, a number of queries were received from the public about foams and scums of *Phaeocystis*, together with enquiries from EHOs, Southern Sea Fisheries, Agency water quality staff and owners of seaside entertainment centres such as Sea Life Centres. One Area reported that a District Council complained that there was, apparently, no set procedure for notification in the event of a bloom and a lack of guidelines for their monitoring.
- 6.3.7 Thames Region monitors few sites for marine microalgae and received very few enquiries.
- 6.3.8 Welsh Region received a number of public complaints from May to July concerning foaming and scums. All were due to blooms of *Phaeocystis*.

## **7. PUBLICITY**

### **7.1 Introduction**

- 7.1.1 Many of the enquiries which the Agency receives are of a general nature asking for further information on beach foams and scums. In 1994 a national public information leaflet on marine algae was produced to answer the most commonly asked questions about nuisance and toxic marine microalgae.
- 7.1.2 Regional comments on publicity are presented for 1994 and 1995 when the questionnaire was issued to gather more information about the monitoring programme.

### **7.2 Regional Comments - 1994**

- 7.2.1 Anglian and Thames Regions stated that the marine algae leaflet was distributed on request to enquirers. Southern Region did not issue any proactive publicity and used data to respond to public enquiries.
- 7.2.2 South West Region circulated the marine algae leaflet and issued a press release in May 1994, which is thought to have had a good effect. Similarly, Welsh Region sent out the marine algae leaflet in response to queries and issued a proactive press release at the beginning of the bloom season to forewarn of likely events.

### **7.3 Regional Comments - 1995**

- 7.3.1 Anglian Region used the leaflet in 1995 and commented that care is required not to overstate the issue and cause unnecessary concern. It was suggested that posters, leaflets, television, radio and school visits could be used to increase publicity.
- 7.3.2 North East Region reported that no external publicity was issued and that Agency samplers were informed of the monitoring situation in May. The apparently low occurrence of blooms in the Region has kept the programme low profile. Southern Region did not issue any proactive publicity and used data to respond to public enquiries.
- 7.3.3 South West Region reported that some publicity is used to tell the public about *Phaeocystis*, but this usually occurs too late in the season to be effective. It was suggested that a press release could be made early in the season or possibly a weekly piece in the local newspaper describing where any problems are being experienced.
- 7.3.4 Welsh Region issued a press release on the local television news and newspapers such as the "Evening Post". It was noted that this may have had the desired effect in that there appeared to be a reduction in the number of complaints about *Phaeocystis* blooms, particularly in the South West Area.

## **8. RESEARCH AND DEVELOPMENT (R&D)**

### **8.1 Introduction**

8.1.1 The Agency and its predecessor, the NRA, has carried out a comprehensive R&D programme for potentially toxic freshwater blue-green algae (cyanobacteria). MAFF is the responsible authority for public health matters relating to shellfish poisoning caused by toxic marine algae, therefore, MAFF has pursued a number of R&D projects concerning the issue, as opposed to the Agency/NRA.

8.1.2 Regional comments on Agency/NRA R&D and projects are presented for 1994 and 1995 when the questionnaire was issued to gather more information about the monitoring programme.

### **8.2 Agency R&D Projects and Project Proposals**

8.2.1 For 1994, Northern Area of Anglian Region commented that phase one of the project to develop a Marine Algal Database (M.A.D) was complete. MAFF have expressed an interest in developing it further. Eastern Area had put forward an R&D proposal to study the effect of algal resuspension/turbidity on chlorophyll levels in the River Deben Estuary.

8.2.2 In 1994 Welsh Region proposed that aerial and satellite images, ground drift surveys and nutrient monitoring may provide more evidence on the cause and effect of nuisance blooms. It was recognised that such surveys would need to be extensive and intensive to be successful.

8.2.3 In 1995 Anglian Region, Northern Area undertook a study of the Nene & Witham estuaries for the Urban Waste Water Treatment Directive (UWWTD). It was commented that this would be extended in 1996 and a more structured algal sampling programme will be undertaken including chlorophyll-*a* analysis for the UWWTD and for a general operational requirement.

### **8.3 Non-Agency R&D Projects**

8.3.1 MAFF has been involved in a number of R&D projects related to algal toxins and shellfish food hygiene.

8.3.2 Dr Judith Taylor has been working on a MAFF funded project at IFE Windermere, on the immunodetection of toxic dinoflagellates. This method will enable the rapid identification of species. The technique involves using antibodies raised against algal cells, and presenting them to potentially similar algal strains and detecting any recognition by the use of methods such as fluorescence microscopy and continuous flow cytometry. In 1994 samples of *A. tamarense* from Weymouth Harbour, South West Region were sent to Dr Taylor for the work.

- 8.3.3 The University of Westminster has been contracted to carry out a study of *Alexandrium* cysts off the east coast of Britain. The aim of the work was to determine the distribution of cysts, identify any possible seed areas and the species involved, and the toxicity and impact of the cysts on shellfish.
- 8.3.4 The Scottish Office Agriculture, Environment and Fisheries Department has been contracted by MAFF to investigate the production of sodium channel blocking toxins (paralytic shellfish poisons) by bacteria. This work stems from the fact that bacteria isolated from seawater during a PSP outbreak have been shown to produce sodium channel blocking toxins. The mechanisms involved in PSP outbreaks were not fully understood and the work aims to investigate the role of bacteria in such outbreaks.
- 8.3.5 MAFF has also funded a number of projects to develop alternative techniques to the mouse bioassay for the detection of PSP and DSP toxins in shellfish. Such methods include HPLC, tissue culture assay, biochemical assay and an ELISA test kit.
- 8.3.6 At the University of Wales, Swansea, Dr Flynn has studied the role of nutrient ecophysiology in affecting dinoflagellate toxicity.
- 8.3.7 A project reported from the Environmental Research Newsletter in 1994 was "Modelling *Phaeocystis* Blooms, their Causes and Consequences". This project was developed jointly with a number of European countries including Belgium, France, Denmark, Germany, Netherlands and UK (Cranfield University). The aim of the project was to develop a framework to address eutrophication in the continental coastal waters of the North Sea, as characterised by blooms of *Phaeocystis*.
- 8.3.8 As part of the NRA funded R&D project "The Occurrence and Fate of Blue-Green Algal Toxins in Freshwaters" Dundee University has investigated the extraction and analysis of the toxin nodularin from the brackish blue-green algal species *Nodularia*.

## 9. DISCUSSION AND CONCLUSIONS

- 9.1 Marine microalgae can impact on the coastal environment by causing an aesthetic nuisance by the presence of foams, scums and discolouration, and the ecology of the area can be affected by deoxygenation problems and direct toxicity caused by some species. Certain microalgae can cause a human health risk by the bioaccumulation of toxins in shellfish which can cause shellfish poisoning on consumption by humans/animals. This phenomenon can result in the Agency receiving enquiries from the public as they perceive algal blooms to be pollution, and in an overlap with the monitoring programmes of MAFF as they fulfil their requirements under the Shellfish Hygiene Directive.
- 9.2 In response to the increasing international concern over the effects of eutrophication of coastal waters, the Agency's predecessor, the NRA, implemented monitoring of algal

blooms in coastal waters at the request of the DoE (now known as the DETR). The Marine Algal Monitoring Programme was built on to the existing Bathing Waters Monitoring Programme as an opportunistic and cost-effective means of obtaining information at most relevant sites. The programme has two levels of monitoring, Minimum Effort where a sample is taken for algal analysis when a bloom is evident, and Best Endeavours where a sample is taken for algal analysis each time a site is visited.

- 9.3 Under the Shellfish Hygiene Directive (91/492/EC), MAFF undertakes algal monitoring in shellfish production areas. In 1995 an exchange of information between MAFF and the Agency was established and this continues to work well ensuring that each organisation is aware of the results of each others algal monitoring.
- 9.4 A review of the Agency's Marine Microalgal Monitoring Programmes carried out in 1993, 1994 and 1995 has shown that the majority of Regions have implemented the Minimum Effort Programme and Welsh Region has implemented the Best Endeavours Programme. Other Regions, notably North East and South West, had a varied programme over the period reported.
- 9.5 On summarising the monitoring data since 1992, an upwards trend in the incidence of marine microalgal blooms is apparent. The number of designated bathing water sites and other sites with marine microalgal blooms has increased from 98 in 1992, to 117 in 1993, to 156 in 1994 and to 175 in 1995. A number of sites had more than one bloom in any year resulting in the number of bloom occurrences increasing from 138 blooms in 1992, to 143 in 1993, to 162 in 1994 and to 227 in 1995. The number of potentially toxic blooms has varied from nine in 1992, to one in 1993, five in 1994 and 15 in 1995.
- 9.6 In addition to differences in monitoring programmes over the years and between Regions, this apparent increase in the incidence of blooms from 1992 to 1995 may be explained by a combination of factors:
- Eutrophication - there may be an upward trend in the incidence of blooms caused by coastal eutrophication.
  - Increased awareness of microalgae - the public are more aware of the phenomenon of nuisance microalgae and are reporting their occurrence more.
  - The public is also more aware of environmental pollution and is increasingly reporting washed up decaying foams of *Phaeocystis* as sewage pollution.
  - Weather conditions may have been more conducive to bloom formation in the years where the incidence of blooms was highest.
  - The exchange of information with MAFF was formalised in 1995 resulting in an increased Agency awareness of microalgae and potential toxicity problems.
- Subsequent years data are important for any trend to be examined further.
- 9.7 The occurrence and distribution of particular nuisance marine microalgal species has been examined further by the use of maps to illustrate where species occur around the coast of England and Wales. *Phaeocystis pouchetii* can form foams or scums which may be present on the water surface and/or be deposited on beaches resulting in offensive smells as the algal material decays. These events can be mistaken for pollution incidents and result in the Agency receiving enquiries and complaints from the public. *Phaeocystis* has been reported as occurring mainly along the coast of Anglian Region, Southern Region and

Welsh Region, with parts of North West Region and South West Region affected. *Phaeocystis* has rarely been reported as occurring north of the Wash along the North East coast, North and South Wessex, and Cornwall.

- 9.8 The dinoflagellate *Noctiluca scintillans* can cause spectacular discoloured water events, blooms can be bioluminescent when the cells are disturbed. This species has been reported in three main areas, the north coast of Welsh Region and the coast of North West Region; the Suffolk coast of Anglian Region and Kent in Southern Region; and the north and south coasts of Cornwall in South West Region and the south coast of Welsh Region.
- 9.9 The Bacillariophyceae (diatoms), such as *Asterionella*, *Attheya* and *Chaetoceros* can cause discoloured water events resulting in public enquiries. Species such as *Chaetoceros* have spines which can physically clog and damage fish gills, although no reports were received of such effects from 1993 to 1995. *Chaetoceros* has been reported to occur along the south and west coasts of England and Wales, *Asterionella* has been reported along the east and west coasts of England and Wales. The occurrence of *Attheya* has been limited to Anglian Region.
- 9.10 The dinoflagellate *Alexandrium tamarense* can cause paralytic shellfish poisoning (PSP). The toxins can be accumulated and passed through the food chain resulting in a serious hazard to humans. Blooms of *Alexandrium* can cause "red tides", but a toxic threat can be presented even when cells are in numbers insufficient to discolour the water. Few recordings of *A. tamarense* have been made from 1993 to 1995, but those reported have been on the south west coast of England and south coast of Wales. MAFF recorded the presence of PSP toxins on the south coast of England for the first time in 1995. At one site, the River Teign, PSP toxins were recorded in the flesh of shellfish samples but no potentially toxic algal species were present in the water samples taken at the same time. Similarly, no *Alexandrium* was recorded in any of the water samples taken by MAFF on the north-east coast of England but PSP toxins were found in some shellfish flesh samples. MAFF has been involved in R&D to investigate this phenomenon further.
- 9.11 Different species of the dinoflagellate *Gymnodinium* can cause different types of toxic effects. None of the reports of *Gymnodinium* recorded by the Regions were identified to species level but no problems were associated with any of the occurrences. *Gymnodinium* sp. has been reported along the west coast of England and Wales.
- 9.12 *Gyrodinium aureolum* can have a direct toxic effect on marine organisms, including fish. Mortalities have been caused in some cases by oxygen depletion, and in others by toxicity. This species has occurred off the south west coast of England and Wales.
- 9.13 Other algal species can cause problems in brackish waters, Anglian Region has experienced problems with the species *Prymnesium parvum* and the blue-green alga *Nodularia*.
- 9.14 Where an algal bloom or species presents a potential threat to health, the Agency liaises with Environmental Health Departments of local Councils and MAFF. Regions have reported that where liaison has taken place this has worked well.

- 9.15 Algal blooms and discoloured water events results in the Agency receiving enquiries and complaints from the public as they perceive it to be some sort of pollution incident. Regions have distributed the marine algae leaflet to enquirers and issued press releases to local newspapers, TV and radio to raise awareness about specific incidents as and when required. It is deemed that this is the most appropriate level of response and should continue.
- 9.16 MAFF is the responsible authority for public health matters relating to shellfish poisoning caused by toxic marine algae and has therefore pursued a number of R&D projects concerning the issue. It is important that the results from this work are reviewed to improve our understanding of toxic marine microalgae.
- 9.17 This report has shown that marine microalgae can impact on the Agency's responsibilities in coastal waters. With the apparent increase in the number of sites affected by algal blooms from 1993 to 1995, it is important that the Agency continues to implement its marine microalgal monitoring programme to enable longer term trends in algal occurrence and distribution to be determined.

## 10. REFERENCES

Environment Agency (1997). Nuisance Microalgae in Tidal Waters. Report of the Toxic Algae Task Group. Dr Jane Lewis, University of Westminster.

NRA, Welsh Region (1993). National Marine Algal Monitoring Programme, Summary Report for 1992. Report No. EAE/93/3.

### Report Author:

Alison Frogley, Water Quality Officer  
Anglian Region, Kingfisher House, Orton Goldhay, Peterborough, PE2 5ZR

### Report Available From:

EHS National Centre  
Nutrients Section, Evenlode House, Howbery Park, Wallingford, Oxon, OX10 8BD

## APPENDIX 1

### MARINE ALGAE QUESTIONNAIRE 1995

#### INTRODUCTION

Since 1991, information from the marine algal monitoring programme has been collated and produced into an annual report describing the distribution of algal blooms around the coast of England and Wales.

The 1995 Marine Algae Questionnaire has the same format as that introduced in 1994, with questions designed to gain more detailed information on marine algae in each Region. In addition to gathering data from the sampling programme, the questionnaire includes questions on any incidents caused by nuisance or toxic blooms of marine algae, any liaison with bodies external to the NRA and information on publicity and R&D.

Please complete all questions and table 1 as fully and clearly as possible, and indicate where a question is not applicable. If you require more space to answer a question or to complete the table, please use a continuation sheet.

Completed questionnaires should be returned to Alison Frogley at the National Centre for Toxic and Persistent Substances, Peterborough in Anglian Region by 5 July 1996.

#### 1995 MARINE ALGAL MONITORING

##### 1. 1995 Monitoring Programme

Please outline the marine algal monitoring programme carried out in 1995:-

What period was covered by the monitoring?

How many Bathing Water sites did your Region include in the sampling programme?

What level of monitoring was carried out, the Minimum Effort (ME) or Best Endeavours (BE) programme?

##### 2. Bathing Waters Sampled in 1995

Please complete table 1 for all Bathing Waters which were sampled for marine algae during 1995. Indicate in the appropriate column whether any of the waters sampled were reported as a "Toxic Algae Bloom".

3. **Nuisance and Toxic Algae Bloom Reports**

Please provide details on the outcome of reporting any Nuisance or Toxic Algae Blooms. For example, what procedure was followed to notify EHOs/MAFF of the potential problem? Did the reporting procedure result in any samples being taken for toxicity assessment, and if so, who carried out the analysis and what are the results of this?

4. **Incidents due to Toxicity**

Did you receive any reports or hear of any illnesses or fatalities caused to invertebrates, fish, animals or humans, associated with toxic marine algae this year in your Region? If this was investigated, please provide details of the local MAFF office so that this can be examined further, and/or provide copies of any reports produced.

5. **The Extent of Blooms in 1995 Compared to Previous Years**

Is there any evidence to suggest that blooms of marine algae were either more or less frequent, intensive or extensive this year than in previous years? Have you enough information on the historical occurrence of marine algal blooms in your Region to draw such conclusions?

6. **Liaison with MAFF, EHO's and CCD's Concerning the NRA'S Approach to Dealing with Marine Algae**

Did you receive any complaints or queries from MAFF Regional Offices, Environmental Health Officers (EHO), Consultants in Communicable Disease (CCD) or other sources concerning the NRA's approach to dealing with marine algae? Please give details:-

7. **Reactions from Water Users**

Do you have any idea of the water users reactions when an area had been identified as containing large populations of potentially toxic or nuisance species of marine algae? Please provide details, for example, press cuttings reports:-

8. **Reports or Queries Received from Sources External to the NRA**

Can you estimate how many queries you have received, from sources outside of the NRA, concerning marine algal problems? For example, reporting unsightly shoreline scums, blooms, unpleasant odours etc. Please give details:-

9. **Publicity**

What methods of publicity were used in your Region and did it have the desired effect? Have you any suggestions for increasing public awareness of the potential problems caused by marine algae?

10. **NRA R&D Projects and Project Proposals**

Do you have any R&D projects currently running, or any R&D proposals, for marine algae and/or their toxins? Please give details:-

11. **Non-NRA R&D Projects**

Are you aware of any non-NRA organisations including Universities etc, that are carrying out investigative work concerning marine algae and toxicity? If so please give details:-

**Table 1. Bathing Waters Sampled for Marine Algae in 1995**

Location	Grid Reference	Duration of Bloom <sup>1</sup>		Dominant Taxa	Cell Count if Available <sup>2</sup>	Toxic Algae Bloom (Y/N)	Any Problems Caused by Blooms
		From	To				

<sup>1</sup> If more than one bloom occurred at a site during the season, record each one separately.  
<sup>2</sup> Cell count = cells/ml or colonies if stated.

## APPENDIX 2. MARINE MICROALGAL MONITORING PROGRAMME

### **Minimum Effort Programme**

On all routine sampling visits to an EC designated bathing water, the following procedure must be adopted in each maritime Region:

- Observe the strandline within 50m of the sampling transect, and also observe along the sampling transect, and record presence or absence of any evidence of a bloom deposited by the previous high tide, such as slime, scum, gelatinous sludge, localised dark patches on sand, or sulphurous smell;
- Observe the sea water at the water's edge for any evidence of a microalgal bloom - excessive foaming, colour change, smell, etc. Presence or absence of microalgal blooms must be recorded;
- Observe sea offshore for signs of any slicks, windrows, or foaming indicative of microalgal blooms and record presence or absence;
- Any positive observations under 1 or 2 above should be supported by a 100ml (minimum volume) sample for laboratory examination in order to confirm the bloom, and identify and enumerate, if possible, the dominant species. Samples must be kept cool and in the dark until returned to the laboratory;
- Record water temperature, local wind direction at water's edge (compass points), speed (Beaufort Scale) and sea state (Beaufort Scale). This information is valuable to Pollution Control staff in dealing with public complaints and in assessing the likely movement and impact of blooms.
- At the laboratory the sample should either:
  - be examined immediately, and the phytoplankton identified and enumerated; or
  - be fixed immediately with Lugol's Iodine and stored in the dark for future examination on a batch basis, (in-house or external contract).

### **Best Endeavours Programme**

The monitoring protocol for the "Best Endeavours" Programme is based on the "Minimum Effort" protocol, with the following additions:

- On every occasion that routine EC bathing waters monitoring samples are taken, a separate sample for microalgal examination must be obtained, at the same location as the bathing waters samples;
- Whenever bloom deposits are found on a beach, or accumulations of floating scum, etc. are evident in bathing waters within a safe sampling distance of the water's edge, a sample must be taken for laboratory examination, i.e., there must always be a sample associated with bathing waters samples, and an additional sample(s) of the bloom manifestation, when present. The routine sample will always be examined to identify and enumerate algae present. Bloom samples will normally be examined, unless the nature and extent of the bloom is so extensive or uniform as to render the examination unnecessary;
- On receipt at the laboratory, samples should ideally be identified and enumerated fresh. Failing that, they should be fixed on receipt (Lugol's Iodine), and stored in the dark for examination within one week.

MARINE MICROALGAL MONITORING PROGRAMME

TOXIC ALGAL BLOOM REPORT



REGION: BLOOM REPORT NO:  
DIVISION/AREA: BLOOM REPORT DATE:  
LOCATION:  
GRID REF: SAMPLE POINT NO:

DATE BLOOM FIRST RECORDED:

BLOOM CONTINUING? YES  NO

DATE SAMPLE TAKEN: STORED  ANALYSED

IF SAMPLE ANALYSED, LIST DOMINANT TAXA:

TAXA	ABUNDANCE	TAXA	ABUNDANCE

DESCRIBE APPEARANCE OF BLOOM:

EVIDENCE OF AESTHETIC IMPACT ON BEACH? YES  NO

EVIDENCE OF TOXIC EFFECT: YES  NO

IF YES, LIST ORGANISMS AFFECTED:

COMMENTS:

CONTACT NAME: TEL. NO:

SEE GUIDANCE NOTES OVERLEAF

## GUIDANCE NOTES ON COMPLETION OF TOXIC ALGAL BLOOM REPORT

1. The report form is to be used for communicating information **only when actual/or potentially toxic microalgal blooms are present, not for reporting of all algal monitoring data.** Once a bloom has been notified for a location, it should not be reported again unless there is evidence that the dominant alga or nature of the bloom has changed significantly (eg. it may become toxic).
2. All completed forms should be sent to the Toxic Algae Scientist, National Centre for Toxic and Persistent Substances, Environment Agency, Peterborough for collation and forwarding to the national network on toxic algae. If *Alexandrium*, *Dinophysis* or *Pseudo-nitzschia* are present at the action levels in Table 2, the report should be faxed (01733 464685) and the TAPS Centre will inform MAFF.
3. Reports should be made as soon as possible after a bloom is recorded and should be as complete as possible. At this stage it is not anticipated that duration of the bloom will be reported, but some indication of whether or not the bloom is persisting should be given under "Bloom Continuing?".
4. The location should include the official bathing water name and the town (if different from beach name) and county.
5. The bloom report number should begin with the year, followed by the number of the report, to be allocated consecutively on a Regional basis (eg. 96/1...96/n). The Bloom Report date is the date the report is completed.
6. Description of the bloom should include information on such factors as appearance, colour, smell, foaming, etc.
7. The taxonomic level to be reported will depend on the expertise and experience of the analysts, but species' names should only be used where there is a degree of certainty about the identification. Abundance should be recorded as unit/cell counts per ml.
8. Aesthetic impact: although somewhat subjective, an aesthetic impact will generally give rise to public complaint.
9. Toxic algae: care should be taken, whenever possible, to differentiate between the direct toxic effects of an algal bloom and the indirect effects of bloom material coming ashore (eg. smothering of intertidal fauna by decaying algal material). The latter type of event should **not be notified using this procedure.**

**APPENDIX 3**  
**Sites Sampled for Marine Microalgae in 1993**

REGION	LOCATION	NOR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Anglian	Brancaster	TF771452	05/05/1993		Gonioceros sp.	5,742		
					Asterionella glacialis	3,984		
					Phaeocystis pouchetii	6 cols		
Anglian	Cromer	TG219425	11/05/1993		Asterionella glacialis	5,743		
					Phaeocystis pouchetii	7 cols		
Anglian	Frinton	TM237194	07/09/1993		Odontella sp.	6,144		
					Asterionella glacialis	947		
Anglian	Gorleston	TG532031	16/05/1993		Phaeocystis pouchetii	9 cols		
Anglian	Holland Beach	TM224176	07/09/1993		Asterionella glacialis	18,432		Brown scum at strandline, minor aesthetic impact on beach
					Gonioceros sp.	12,288		
					Odontella sp.	4,160		
Anglian	Holme Next Sea	TF694440	05/05/1993	18/05/1993	Asterionella glacialis	23,500		Brown, turbid water with some floating creamy froth
					Gonioceros sp.	30,000		
					Phaeocystis pouchetii	10 cols		
Anglian	Hopton	TM536997	16/05/1993		Phaeocystis pouchetii	13 cols		
Anglian	Kessingland	TM536867	16/05/1993		Phaeocystis pouchetii	14 cols		
Anglian	Lowestoft North	TM553950	16/05/1993		Phaeocystis pouchetii	9 cols		
Anglian	Lowestoft South	TM545917	16/05/1993		Phaeocystis pouchetii	14 cols		
Anglian	Mablethorpe	TM503870	10/06/1993		Gonioceros sp.	Very abundant		Foaming, brown stain
Anglian	Sheringham	TG162436	11/05/1993		Asterionella glacialis	6,528		
					Phaeocystis pouchetii	5 cols		
Anglian	Southwold	TM508754	16/05/1993		Phaeocystis pouchetii	11 cols		
Anglian	Wells	TM914456	05/05/1993		Asterionella glacialis	12,964		
					Gonioceros sp.	6,520		
					Phaeocystis pouchetii	6 cols		
North West	Blackpool South	SD300330	07/06/1993		Phaeocystis sp.			
North West	Canada Dock, Liverpool Bay	SJ335937	23/06/1993		Noctiluca scintillans	740		Bioluminescence
North West	Grange O' Sands	SD405770	06/09/1993		Noctiluca scintillans	970		Foaming on shoreline
North West	North Wirral	SJ287937	26/05/1993		Phaeocystis sp.			

**APPENDIX 3**  
**Sites Sampled for Marine Microalgae in 1993**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
North West	Ribble Estuary	SD430270	02/06/1993		Phaeocystis sp.			Fouling of nets
South West	Bude (Crooklets)	SS203072	14/06/1993		Noctiluca scintillans	14,000		
South West	Bude (Sandymouth)	SS202099	14/06/1993		Noctiluca scintillans	500		
South West	Bude (Summerleaze)	SS204066	14/06/1993		Noctiluca scintillans	10,000		
South West	Charlestown	SX042516	08/06/1993		Diatoms (non centric)	79,000		
South West	Croyder Bay	SS434393	11/05/1993		Phaeocystis sp.	119,000		Scum
South West	Dinas Cove, Padstow	SW923745	22/08/1993		Gymnodinium sp.	25,000	Yes	Discolouration
South West	Gwithian Towans	SW522402	05/08/1993		Chaetoceros armature	100,000		Discolouration
South West	Gyllyngvase	SW809316	10/06/1993		Noctiluca scintillans	5,000		
South West	Instow	SS472304	10/05/1993		Phaeocystis sp.	126,000		Scum
South West	Mothecombe	SX610473	07/05/1993		Phaeocystis sp.	362,000		Sewage like scum
South West	Newquay (Fistral)	SW794623	18/05/1993		Phaeocystis sp.	122,000		Scum
South West	Poole Harbour	SY995895	02/07/1993		Thalassiosira sp.	870		
South West	Poole Harbour	SY995895	17/06/1993		Chaetoceros spp.	684		
South West	Saunton Sands	SS446376	11/05/1993		Phaeocystis sp.	160,000		Scum
South West	Sea off Penzance	SW467294	10/05/1993		Phaeocystis sp.	103,000		Scum
South West	The Fleet	SY592825	12/11/1993		Navicula			
					Procentrum micans			
South West	Truro R. Maplas	SW839442	05/09/1993		Nitzschia sp.			Discolouration
South West	Westward Ho!	SS432294	10/05/1993		Phaeocystis sp.	181,000		Scum
Southern	Bexhill	TQ737068	10/06/1993		Phaeocystis sp.			
Southern	Botany Bay	TR391712	07/07/1993		Flagellates	Abundant		Excessive Foam
Southern	Broadstairs	TR401688	26/05/1993		Phaeocystis sp.			Excessive Foam
Southern	Bulverhythe	TQ748086	27/05/1993	10/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Camber	TQ973184	08/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Christchurch Bay	SZ239928	15/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Cuckmere Haven	TU520975	03/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Deal	TR387527	01/06/1993	08/06/1993	Phaeocystis sp.			Foam Offshore
Southern	Dover	TR321412	25/05/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Dumpton Gap	TR397667	26/05/1993		Phaeocystis sp.			Excessive Foam
Southern	Dymchurch	TR128319	01/06/1993	08/06/1993	Phaeocystis sp.			
Southern	Eastbourne	TU625998	10/06/1993		Phaeocystis sp.			Excessive Foam

**APPENDIX 3**  
**Sites Sampled for Marine Microalgae in 1993**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Southern	Folkestone	TR248376	25/05/1993	08/06/1993	Phaeocystis sp.			Foam Offshore
					Noctiluca			Foam Offshore
Southern	Greatstone	TR082229	25/05/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Greatstone	TR082229	31/08/1993		Gyrosigma sp.			Discoloured sand/foam
Southern	Hampton Pier	TR158684	12/05/1993		Diatoms			Scum
Southern	Hastings	TQ819092	27/05/1993	10/06/1993	Phaeocystis sp.			Scum on beach
Southern	Highcliffe	SZ216931	15/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Hythe	TR160340	01/06/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Kingsdown	TR308485	01/06/1993	08/06/1993	Phaeocystis sp.			
Southern	Littlestone	TR084239	25/05/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Margate	TR347708	17/07/1993		Flagellates, diatoms			Excessive Foam
Southern	Margate	TR347708	19/05/1993	16/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Milford on Sea	SZ283915	15/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Minnis Bay	TR286697	21/07/1993		Dunaliella sp.			Excessive Foam
Southern	Minnis Bay	TR286697	23/06/1993		Phaeocystis sp.			Foam offshore
Southern	Newhaven	TU449988	03/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Normans Bay	TQ682053	27/05/1993	10/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Palm Bay	TR373714	07/07/1993		Flagellates	Abundant		Excessive Foam
Southern	Palm Bay	TR373714	16/06/1993	23/06/1993	Phaeocystis sp.			
Southern	Pevensy Bay	TQ657037	03/06/1993		Phaeocystis sp.			Excessive Foam
Southern	Ramsgate Sands	TR387649	01/06/1993		Phaeocystis sp.			
Southern	Recalver	TR226694	21/07/1993		Dunaliella sp.			Excessive Foam
Southern	Sandgate	TR188348	25/05/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Sandgate	TR203351	25/05/1993	08/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Sandwich	TR358590	01/06/1993		Phaeocystis sp.			
Southern	Sandwich	TR358590	07/06/1993		Asterionella sp.			
Southern	St Leonards	TQ797087	03/06/1993	10/06/1993	Phaeocystis sp.			
Southern	St Margarets Bay	TR368440	01/06/1993		Phaeocystis sp.			Excessive Foam
Southern	St Marys Bay	TR093277	01/06/1993	15/06/1993	Phaeocystis sp.			Scum on beach
Southern	St Mildreds Bay	TR328705	02/06/1993	23/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Walpole Bay	TR365715	07/07/1993		Abundant flagellates			Excessive Foam
Southern	Walpole Bay	TR365715	19/05/1993	23/06/1993	Phaeocystis sp.			Excessive Foam

**APPENDIX 3**  
**Sites Sampled for Marine Microalgae in 1993**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Southern	West Beach	TR098660	12/05/1993	26/05/1993	Diatoms			Excessive Foam
Southern	Westbrook	TR341706	02/06/1993	23/06/1993	Phaeocystis sp.			Excessive Foam
Southern	Westbrook	TR341706	21/07/1993		Dunaliella	Abundant		Excessive Foam
Southern	Westgate	TR320720	16/06/1993	23/06/1993	Phaeocystis sp.			Foam Offshore
Southern	Winchelsea	TQ912156	01/06/1993		Phaeocystis sp.			Excessive Foam
Welsh	Aberdyfi	SN606958	17/05/1993		Asterionella sp.	887		
Welsh	Aberdyfi	SN606958	21/06/1993		Phaeocystis sp.	5 cols		
Welsh	Aberdyfi	SN606958	28/06/1993		Asterionella sp.	526		
Welsh	Aberdyfi	SN606958	29/07/1993		Asterionella sp.	500+		
Welsh	Aberystwyth N.	SN583822	02/06/1993		Phaeocystis sp.	10 cols		
Welsh	Amroth Central	SN167680	17/05/1993	24/05/1993	Phaeocystis sp.	40 cols		
Welsh	Benllech	SH566812	02/06/1993	14/06/1993	Phaeocystis sp.	94 cols		Brown Discolouration
Welsh	Benllech	SH566812	19/05/1993		Phaeocystis sp.	12 cols		
Welsh	Borth	SN606901	03/08/1993	11/08/1993	Asterionella sp.	800 cols		
Welsh	Borth	SN606901	05/05/1993	26/05/1993	Phaeocystis sp.	10 cols		
Welsh	Borth	SN606901	20/05/1993	23/05/1993	Asterionella sp.	920 cols		
Welsh	Bracelet	SS630871	07/06/1993		Phaeocystis sp.	14 cols		
Welsh	Carreg Wen	SH560371	29/06/1993		Asterionella sp.	560		
Welsh	Caswell	SS591874	11/05/1993		Phaeocystis sp.	10 cols		
Welsh	Cemaes Bay	SH373936	09/06/1993		Phaeocystis sp.	6 cols		
Welsh	Colwyn Bay Rhos	SH845805	18/05/1993	14/06/1993	Phaeocystis sp.	54 cols		
Welsh	Colwyn Bay Cayley	SH849796	18/05/1993	24/06/1993	Phaeocystis sp.	80 cols		
Welsh	Colwyn Bay R'Way	SH843810	18/05/1993	24/06/1993	Phaeocystis sp.	147 cols		Brown Discolouration
Welsh	Conwy Morfa	SH757788	18/05/1993	24/06/1993	Phaeocystis sp.	143 cols		
Welsh	Deganwy	SH775794	18/05/1993	14/06/1993	Phaeocystis sp.	26 cols		
Welsh	Fairbourne	SH610140	25/05/1993		Phaeocystis sp.	9 cols		
Welsh	Langland	SS606871	11/05/1993		Phaeocystis sp.	10 cols		
Welsh	Limeslade	SS625870	07/06/1993		Phaeocystis sp.	50+ cols		
Welsh	Llandanwg	SH567028	21/06/1993		Phaeocystis sp.			
Welsh	Llanddona	SH531823	02/06/1993	14/06/1993	Phaeocystis sp.	79 cols		
Welsh	Llanddona	SH566812	18/05/1993		Phaeocystis sp.	39 cols		Brown Discolouration
Welsh	Llanddwyn	SH403631	27/05/1993		Phaeocystis sp.	7 cols		

**APPENDIX 3**  
**Sites Sampled for Marine Microalgae in 1993**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Welsh	Llandudno N.	SH784829	18/05/1993	14/06/1993	Phaeocystis sp.	27 cols		
Welsh	Llandudno W.	SH769822	11/05/1993	14/06/1993	Phaeocystis sp.	26 cols		
Welsh	Llanfairfechan	SH680758	18/05/1993	14/06/1993	Phaeocystis sp.	143 cols		Brown Discolouration
Welsh	New Quay South	SN398587	20/05/1993		Phaeocystis sp.	6 cols		
Welsh	Newport Sands	SN053407	29/07/1993		Chaetoceros sp.	77		
Welsh	Oxwich	SS507862	11/05/1993		Phaeocystis sp.	20 cols		
Welsh	Pembrey	SS400998	10/05/1993	15/05/1993	Phaeocystis sp.	20 cols		
Welsh	Pembrey	SS400998	15/06/1993		Phaeocystis sp.	760		
Welsh	Pembrey	SS400998	26/07/1993		Asterionella sp.	1,070		
Welsh	Pendine	SN238074	17/05/1993	24/05/1993	Phaeocystis sp.	10 cols		
					Asterionella sp.	930		
Welsh	Penmaenmawr	SH718769	18/05/1993	14/06/1993	Phaeocystis sp.	101 cols		Brown Discolouration
Welsh	Penrhyn Bay	SH831816	14/05/1993	08/06/1993	Phaeocystis sp.	49 cols		
Welsh	Prestatyn	SJ050833	04/06/1993	14/06/1993	Phaeocystis sp.	120 cols		Brown Discolouration
Welsh	Prestatyn	SJ050833	05/06/1993		Asterionella sp.	167		
Welsh	Prestatyn	SJ050833	18/05/1993		Phaeocystis sp.	8 cols		
Welsh	Rest Bay	SS800779	10/08/1993		Noctiluca scintillans	10		
Welsh	Rhossilli	SS414900	10/05/1993	25/05/1993	Phaeocystis sp.	30 cols		
Welsh	Rhossilli	SS414900	15/06/1993		Chaetoceros sp.	1,800		
Welsh	Rhossilli	SS414900	19/07/1993	27/07/1993	Chaetoceros sp.	3,200		
Welsh	Rhyl High St.	SJ000810	06/05/1993	11/05/1993	Asterionella sp.	3000+		
Welsh	Rhyl High St.	SJ000810	16/05/1993	24/06/1993	Phaeocystis sp.	249 cols		Brown Discolouration
Welsh	Sandy Cove	SH970798	11/05/1993		Asterionella sp.	550		
Welsh	Sandy Cove	SH970798	18/05/1993	15/06/1993	Phaeocystis sp.	89 cols		Brown Discolouration
Welsh	Saundersfoot	SN141047	10/05/1993	24/05/1993	Phaeocystis sp.	30 cols		
Welsh	Southern-down	SS884729	08/06/1993		Phaeocystis sp.	6 cols		
Welsh	Tenby North	SN135008	10/05/1993	17/05/1993	Phaeocystis sp.	10 cols		
Welsh	Tenby South	SS133998	10/05/1993	17/05/1993	Phaeocystis sp.	30 cols		
Welsh	Tywyn	SH543120	21/06/1993		Phaeocystis sp.	8 cols		
Welsh	West Kirby	SJ210860	06/05/1993		Asterionella sp.	647		
Welsh	West Kirby	SJ210860	07/07/1993		Noctiluca scintillans	3		
Welsh	West Kirby	SJ210860	19/05/1993	22/06/1993	Phaeocystis sp.	94 cols		

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### Sites Sampled for Marine Microalgae in 1994

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Anglian	Barton on Humber	TA020210	03/08/1994		<i>Prymnesium</i> sp.	180,000	Yes	
Anglian	Caister Point	TG530120	May		<i>Phaeocystis</i>			
Anglian	Chapel St Leonards	TF560720	10/08/1994		Mixed diatoms			Sampled in response to reports of skin burns and sores. No known toxin producers identified.
Anglian	Cromer	TG219425	May		<i>Phaeocystis</i>			
Anglian	Deben Estuary, Ramsholt Quay	TM310400	01/07/1994		<i>Noctiluca scintillans</i>			
Anglian	Felixstowe North	TM305343	May		<i>Phaeocystis</i>			
Anglian	Felixstowe South	TM297337	May		<i>Phaeocystis</i>			
Anglian	Gorleston Beach	TG532031	May		<i>Phaeocystis</i>			
Anglian	Great Yarmouth North	TG535105	May		<i>Phaeocystis</i>			
Anglian	Great Yarmouth Pier	TG533074	May		<i>Phaeocystis</i>			
Anglian	Great Yarmouth South	TG533064	May		<i>Phaeocystis</i>			
Anglian	Hemsby	TG509174	May		<i>Phaeocystis</i>			
Anglian	Huttoft	TF550776	17/05/1994		<i>Asterionella japonica</i>			Foaming on shoreline
					Pennate diatoms			Foaming on shoreline
Anglian	Lowestoft North	TM553950	May		<i>Phaeocystis</i>			
Anglian	Lowestoft South	TM545917	May		<i>Phaeocystis</i>			
Anglian	Mablethorpe	TF508854	06/09/1994		Mixed diatoms			Foaming on shoreline
Anglian	Mundesley	TG317366	May		<i>Phaeocystis</i>			
Anglian	Sheringham	TG162436	May		<i>Phaeocystis</i>			
Anglian	Southwold The Denes	TM508754	May		<i>Phaeocystis</i>			
Anglian	Sutton Bridge	TF470210	04/07/1994		<i>Biddulphia</i> sp.			No Cyanophyta
Anglian	Sutton on Sea	TF522821	04/07/1994		<i>Asterionella japonica</i>			
					<i>Nitzschia</i> sp.			
					<i>Skeletonacma</i> sp.			
Anglian	Wells	TF914456	May		<i>Phaeocystis</i>			
North West	Grange-Over-Sands	SD410780	08/09/1994		<i>Noctiluca</i>			Sampled in response to public complaints and an MP letter about "sewage" on the shore.
North West	Great Meols, New Brighton, Wirral	SJ250920	08/07/1994		<i>Noctiluca</i>			Thick gelatinous bloom coating ropes and nets

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### Sites Sampled for Marine Microalgae in 1994

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
North West	Marine Lake, New Brighton, Wirral	SJ300940	14/06/1994		Gymnodinium	1.68 x 10 <sup>6</sup>	Yes	Prevented windsurfing and canoeing activities, notified to Brian Eyan at Bloom Watch.
South West	Axe Estuary	SY25608970	18/05/1994		Phaeocystis sp.	13 cols		
South West	Bantham	SX66234380	05/05/1994		Phaeocystis sp.	Abundant		Foaming
South West	Beesands	SX82054050	23/05/1994		Phaeocystis sp.	4 cols		Foaming
South West	Blackpool Sands	SX85504785	06/05/1994		Phaeocystis sp.	2 cols		Foaming
South West	Broadsands	SX89705745	04/05/1994		Phaeocystis sp.	13 cols		Foaming
South West	Budleigh Salterton	SY06958190	18/05/1994		Phaeocystis sp.	15 cols		
South West	Churston/Fishermans Cove	SX91915700	04/05/1994		Phaeocystis sp.	2 cols		Foaming
South West	Combe Martin	SS57724732	17/05/1994		Phaeocystis sp.	3 cols		
South West	Croyde	SS43473930	17/05/1994		Phaeocystis sp.	1 col		
South West	Dart Estuary Mouth	SX886505	06/05/1994		Phaeocystis sp.	1 col		Foaming
South West	Dartmouth Castle	SX88655020	27/05/1994		Phaeocystis sp.	4 cols		
South West	Dawlish (Rockstone)	SX96117606	18/05/1994		Phaeocystis sp.	30 cols		Foaming
South West	Dawlish Town	SX96557680	12/05/1994		Phaeocystis sp.			Foaming
South West	Elbruy Cove	SX90305700	04/05/1994		Phaeocystis sp.	4 cols		Foaming
South West	Exmouth Beach	SY00987995	01/05/1994		Phaeocystis sp.	7 cols		Foaming
South West	Exmouth Beach	SY00987995	24/05/1994		Phaeocystis sp.	34 cols		Foaming
South West	Exmouth Beach	SY00987995	18/05/1994		Phaeocystis sp.	3 cols		
South West	Exmouth Beach	SY00987995	11/05/1994		Phaeocystis sp.	3 cols		Foaming
South West	Goodrington	SX89355940	04/05/1994		Phaeocystis sp.	14 cols		Foaming
South West	Helebay	SS53554792	17/05/1994		Phaeocystis sp.	4 cols		
South West	Hope Cove	SX67553975	14/05/1994		Phaeocystis sp.	4 cols		
South West	Mouthwell Sands	SX67554014	05/05/1994		Phaeocystis sp.	Abundant		Foaming
South West	Mouthwell Sands	SX67554014	14/05/1994		Phaeocystis sp.	8 cols		
South West	Off Carbin Bay	SW54003850	03/08/1994		Gymnodinium sp.	765	Yes	
South West	Off Sidmouth	SY1290860	05/05/1994		Phaeocystis sp.	Abundant		Foaming
South West	Off Tolcarne, Newquay	SW81806215	03/08/1994		Gymnodinium sp.	2,460	Yes	
South West	Paignton Sands	SX89496063	04/05/1994		Phaeocystis sp.	18 cols		Foaming
South West	Paignton, Preston Sands	SX89646177	06/05/1994		Phaeocystis sp.	5 cols		Foaming
South West	Portledge Beach	SS38602464	16/05/1994		Phaeocystis sp.	4 cols		Foaming

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### Sites Sampled for Marine Microalgae in 1994

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
South West	Preston Sands	SX89646177	04/05/1994		Phaeocystis sp.	3 cols		Foaming
South West	River Camel, Wadebridge	SW98497318	15/07/1994		Nitzschia, Closterium			
South West	Sandy Bay	SS44553760	26/05/1994		Phaeocystis sp.	19 cols		
South West	Saunton Sands	SY03357980	18/05/1994		Phaeocystis sp.	5 cols		
South West	Seaton	SY24508985	18/05/1994		Phaeocystis sp.	18 cols		
South West	Shaldon Beach	SX93507230	12/05/1994		Phaeocystis sp.			Foaming
South West	Shipload Bay	SS24802740	31/05/1994		Phaeocystis sp.	23 cols		
South West	Shoalstone	SX93205662	04/05/1994		Phaeocystis sp.	2 cols		Foaming
South West	Sidmouth	SY12708720	18/05/1994		Phaeocystis sp.	14 cols		
South West	Sidmouth Town	SY12708720	11/05/1994		Phaeocystis sp.	7 cols		Foaming
South West	Sidmouth, Jacobs Ladder	SY11908695	01/05/1994		Phaeocystis sp.	12 cols		Foaming
South West	Sidmouth, Jacobs Ladder	SY11908695	17/05/1994		Phaeocystis sp.	11 cols		
South West	Slapton Monument	SX82954430	23/05/1994		Phaeocystis sp.	12 cols		Foaming
South West	Slapton Torcross	SX82354195	23/05/1994		Phaeocystis sp.	22 cols		Foaming
South West	St Marys Bay	SX93205510	04/05/1994		Phaeocystis sp.	10 cols		Foaming
South West	Stretgate	SX83054550	23/05/1994		Phaeocystis sp.	7 cols		Foaming
South West	Sutton Harbour	SX485543	06/05/1994		Phaeocystis sp.	Abundant		Foaming
South West	Swanpool, Falmouth	SW80303130	08/09/1994	11/09/1994	heterotrophic dinoflagellates	11,212		Invertebrate Deaths . (By Oxygen Sag)
South West	Teign Estuary	SX936727	06/05/1994		Phaeocystis sp.	Abundant		Foaming
South West	Teignmouth	SX94307285	19/05/1994		Phaeocystis sp.	15 cols		Foaming
South West	Topsham, Theretreat	SX956887	21/08/1994		Nitzschia cf	350,000		
					Nitzschia seriata			
					Naviculoid spp.	424,000		
South West	Meadfoot	SX93056305	06/05/1994		Phaeocystis sp.	2 cols		Foaming
South West	Broadsands	SX89705745	06/05/1994		Phaeocystis sp.	4 col		Foaming
South West	Goodrington	SX89355940	06/05/1994		Phaeocystis sp.	5 cols		Foaming
South West	Hollicombe	SX89806215	06/05/1994		Phaeocystis sp.	4 cols		Foaming
South West	Torre Abbey	SX90956351	06/05/1994		Phaeocystis sp.	3 cols		Foaming
South West	Westward Ho!	SS43252940	16/05/1994		Phaeocystis sp.	3 cols		Foaming

**APPENDIX 4**  
**Sites Sampled for Marine Microalgae in 1994**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
South West	Weymouth Bay (Harbour End)	SY683789	29/07/1994	03/08/1994	Alexandrium tamarense	2-120	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
South West	Weymouth Ferrylink span	SY683787	03/08/1994		Alexandrium tamarense	>2000	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
South West	Weymouth, Harbour Mouth	SY686788	29/07/1994	03/08/1994	Alexandrium tamarense	10-.500	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
South West	Weymouth, Municipal Building	SY677787	25/07/1994	03/08/1994	Alexandrium tamarense	30->10000	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
South West	Weymouth Inner Harbour, Town Bridge	SY683799	25/07/1994	03/08/1994	Alexandrium tamarense	50-5000	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
South West	Weymouth Inner Harbour, Westwey House	SY676788	29/07/1994		Alexandrium tamarense	>30000	Yes	Potentially toxic but did not produce toxins, some dissolved oxygen problems which were overcome.
Southern	Bexhill	TQ737068	19/05/1994		Phaeocystis sp.	27 cols		Abnormal colour
Southern	Bognor Regis	SZ923985	26/05/1994		Phaeocystis sp.	2 cols		Foam
Southern	Botany Bay	TR391712	25/05/1994	01/06/1994	Phaeocystis sp.	5 cols		Foam
Southern	Brachlesham Bay	SZ805963	26/05/1994	02/06/1994	Phaeocystis sp.	30 cols		Foam
Southern	Broadstairs (E. Cliff)	TR401688	25/05/1994	01/06/1994	Phaeocystis sp.	8 cols		
Southern	Broadstairs (Viking Bay)	TR398677	25/05/1994		Phaeocystis sp.	2 cols		
Southern	Brighton	TQ323034	19/05/1994		Phaeocystis sp.	23 cols		Abnormal colour
Southern	Calshot	SU481012	31/05/1994	07/06/1994	Phaeocystis sp.	7 cols		Foam
Southern	Camber	TQ973184	17/05/1994		Phaeocystis sp.	28 cols		Abnormal colour
Southern	Christchurch Bay	SZ239928	31/05/1994	07/06/1994	Phaeocystis sp.	54 cols		Foam
Southern	Colwell Bay	SZ328879	25/05/1994	01/06/1994	Phaeocystis sp.	11 cols		Foam and abnormal colour
Southern	Compton Bay	SZ377841	25/05/1994	01/06/1994	Phaeocystis sp.	92 cols		Foam
Southern	Cowes	SZ488967	25/05/1994		Phaeocystis sp.	0.5 col		Foam and abnormal colour
Southern	Cuckmere Haven	TQ381018	19/05/1994		Phaeocystis sp.	15 cols		Abnormal colour
Southern	Dumpton Gap		25/05/1994	01/06/1994	Phaeocystis sp.	30 cols		
Southern	East Selsey	SZ868937	26/05/1994		Phaeocystis sp.	3.5 cols		Foam
Southern	Eastbourne	TV614982	19/05/1994		Phaeocystis sp.	28 cols		Abnormal colour
Southern	Eastney	SZ675988	02/05/1994	31/05/1994	Phaeocystis sp.	1 col		Foam

**APPENDIX 4**  
**Sites Sampled for Marine Microalgae in 1994**

REGION	LOCATION	NOR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Southern	Gurnard	SZ477959	25/05/1994	01/06/1994	Phaeocystis sp.	1 col		Foam and abnormal colour
Southern	Hastings	TQ819092	19/05/1994		Phaeocystis sp.	26 cols		Abnormal colour
Southern	Herne Bay	TR186686	28/06/1994		Phaeocystis sp.	1 col		
Southern	Highcliffe	SZ216931	31/05/1994	07/06/1994	Phaeocystis sp.	214 cols		Foam
Southern	Hillhead	SU540022	31/05/1994		Phaeocystis sp.	2 cols		Foam
Southern	Joss Bay	TR399702	25/05/1994	01/06/1994	Phaeocystis sp.	55 cols		Foam and abnormal colour
Southern	Lee on Solent	SU562005	02/05/1994		Phaeocystis sp.			Foam
Southern	Lepe	SZ456985	31/05/1994	07/06/1994	Phaeocystis sp.	1 col		Foam
Southern	Margate (Fulsam Rock)	TR356715	25/05/1994	01/06/1994	Phaeocystis sp.	24 cols		Foam and abnormal colour
Southern	Margate (The Bay)	TR347708	01/06/1994		Phaeocystis sp.	42 cols		Foam and abnormal colour
Southern	Middleton on Sea	SZ985999	26/05/1994		Phaeocystis sp.	2.5 cols		Foam
Southern	Milford on Sea	SZ283915	31/05/1994	31/05/1994	Phaeocystis sp.	96 cols		Foam
Southern	Minnis Bay	TR286697	01/06/1994		Phaeocystis sp.	3 cols		Foam
Southern	Newhaven	TV488982	19/05/1994		Phaeocystis sp.	7 cols		
Southern	Normans Bay	TQ682053	19/05/1994		Phaeocystis sp.	10 cols		Abnormal colour
Southern	Pagham	SZ892972	26/05/1994	02/06/1994	Phaeocystis sp.	9 cols		Foam
Southern	Palm Bay	TR373714	25/05/1994	01/06/1994	Phaeocystis sp.	26 cols		Foam and abnormal colour
Southern	Pevensy Bay	TQ657037	19/05/1994		Phaeocystis sp.	43 cols		Abnormal colour
Southern	Portsmouth (Victoria Pier)	SZ631992	02/05/1994	31/05/1994	Phaeocystis sp.	2 cols		
Southern	Ramsgate Sands	TR387649	25/05/1994	01/06/1994	Phaeocystis sp.	19 cols		Abnormal colour
Southern	Ryde	SZ601927	03/05/1994	25/05/1994	Phaeocystis sp.	3 cols		Foam not observed on 10/5 or 17/5
Southern	Saltdean	TQ381018	19/05/1994		Phaeocystis sp.	40 cols		Abnormal colour
Southern	Sandown	SZ601843	25/05/1994	01/06/1994	Phaeocystis sp.	8.5 cols		Foam
Southern	Sandwich Bay	TR358590	10/08/1994		Asterionella glacialis	269,900		Beach slime and abnormally coloured water
Southern	Seaford	TV488982	19/05/1994		Phaeocystis sp.	22 cols		Abnormal colour
Southern	Seagrove	SZ632912	25/05/1994	01/06/1994	Phaeocystis sp.	2 cols		Foam
Southern	Shanklin	SZ585811	25/05/1994	01/06/1994	Phaeocystis sp.	10 cols		Foam
Southern	Shanklin (Welcome)	SZ589827	03/05/1994	01/06/1994	Phaeocystis sp.	11 cols		Foam not observed on 10/5 and 17/5
Southern	Sheerness	TQ925750	28/06/1994		Phaeocystis sp.	3 cols		Visible rafts and abnormal colour
Southern	Southsea	SZ653982	02/05/1994	31/05/1994	Phaeocystis sp.	1 col		Foam and scum on strandline
Southern	Springvale		03/05/1994	25/05/1994	Phaeocystis sp.	2 cols		Foam not observed on 10/5 and 17/5
Southern	St Mildreds Bay	TR328705	01/06/1994		Phaeocystis sp.	7 cols		Foam

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**Sites Sampled for Marine Microalgae in 1994**

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Southern	Stokes Bay	SZ600979	02/05/1994		Phaeocystis sp.			Foam
Southern	Totland Bay	SZ322871	25/05/1994	01/06/1994	Phaeocystis sp.	6 cols		Foam and abnormal colour
Southern	Ventnor	SZ562773	25/05/1994	01/06/1994	Phaeocystis sp.	8 cols		Foam
Southern	Walpole Bay	TR365715	25/05/1994	01/06/1994	Phaeocystis sp.	5 cols		Foam
Southern	West Beach	TR098660	28/06/1994		Phaeocystis sp.	1 col		
Southern	West Hayling	SZ705987	02/05/1994	31/05/1994	Phaeocystis sp.	9 cols		Foam and scum on strandline
Southern	West of Eastoke	SZ729984	02/05/1994		Phaeocystis sp.			Foam
Southern	West Wittering	SZ768980	26/05/1994	02/06/1994	Phaeocystis sp.	13.5 cols		Foam
Southern	Westbrook Bay	TR341706	01/06/1994		Phaeocystis sp.	41 cols		Foam and abnormal colour
Southern	Westgate Bay	TR320702	01/06/1994		Phaeocystis sp.	38 cols		Foam and abnormal colour
Southern	Whitecliff Bay	SZ641862	03/05/1994	01/06/1994	Phaeocystis sp.	2 cols		Foam not observed on 10/5 and 17/5
Southern	Winchelsea	TQ912154	17/05/1994		Phaeocystis sp.	20 cols		Abnormal colour
Welsh	Amroth	SS172072	17/08/1994		Chaetoceros	10,000		
Welsh	Bendlech	SH566812	30/05/1994	26/06/1994	Phaeocystis sp.	10-80 cols		
Welsh	Broadhaven	SM859135	22/08/1994	02/09/1994	Gyrodinium	>10000	Yes	
Welsh	Colwyn Bay	SH860790	12/07/1994		Noctiluca			Orangy/pink scum
Welsh	Colwyn Bay	SH843810	16/05/1994	12/06/1994	Phaeocystis sp.	6-16 cols		Foaming scums and smells
Welsh	Holyhead	SH250835	14/07/1994		Noctiluca			Coastguard reported orange patches
Welsh	Llandudno North	SH784890	16/05/1994	12/06/1994	Phaeocystis sp.	6-8 cols		
Welsh	Llandudno West	SH769822	23/05/1994	29/05/1994	Phaeocystis sp.	7 cols		
Welsh	Newgale	SM848220	23/08/1994		Gyrodinium	155	Yes	Associated with fish mortality in St Brides Bay
Welsh	Pembroke Mill Pond	SN984016	14/07/1994	02/08/1994	Gymnodinium	1400-1800	Yes	
Welsh	Prestatyn	SJ050833	12/07/1994		Noctiluca			Orangy/pink scum
Welsh	Prestatyn	SJ050833	09/05/1994	15/05/1994	Phaeocystis sp.	20 cols		Foaming scums and smells
Welsh	Rhyl High St.	SJ000810	02/05/1994	05/06/1994	Phaeocystis sp.	5-18 cols		Foaming scums and smells
Welsh	Sandy Cove	SH970798	09/05/1994	12/06/1994	Phaeocystis sp.	7-35 cols		Foaming scums and smells
Welsh	Saundersfoot	SS138045	09/08/1994		Chaetoceros	10,000		
Welsh	Southerndown	SS884736	26/07/1994		Chaetoceros	>1000		
Welsh	Tywyn	SH543120	30/05/1994	05/06/1994	Phaeocystis sp.	30 cols		
Welsh	Wisemans Bridge (offshore)	SS145060	25/10/1994		Chaetoceros	>5000		

## APPENDIX 5

### Sites Sampled for Marine Microalgae in 1995

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Anglian	Caister	TG530120	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Cromer	TG219425	08/05/1995	14/06/1995	Phaeocystis	Present		
Anglian	Felixstowe North	TM305343	21/05/1995	31/05/1995	Phaeocystis	Present		
Anglian	Felixstowe North	TM305343	11/06/1995		Noctiluca spp	Present		
Anglian	Felixstowe South	TM297337	09/05/1995	31/05/1995	Phaeocystis	Present		
Anglian	Felixstowe South	TM297337	11/06/1995		Noctiluca spp	Present		
Anglian	Gorleston	TG532031	02/05/1995	05/07/1995	Phaeocystis	Present		
Anglian	Great Yarmouth North	TG535105	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Great Yarmouth Pier	TG533074	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Great Yarmouth South	TG533064	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Heacham North, Ouse Estuary	TF663375	25/06/1995		Biddulphia			Scum at sea not seen on beaches
Anglian	Hemsby	TG509174	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Hopton-on-Sea	TM520290	09/05/1995	05/07/1995	Phaeocystis	Present		
Anglian	Huttoft	TF550776	21/08/1995		Attheya armatus			Brown scum on beach
Anglian	Lowestoft North	TM553950	09/05/1995	25/06/1995	Phaeocystis	Present		
Anglian	Lowestoft South	TM545917	09/05/1995	11/06/1995	Phaeocystis	Present		
Anglian	Mablethorpe	TF508854	02/06/1995		Phaeocystis sp.			Foaming
					Pseudo-nitzschia seriata		Yes	
Anglian	Mablethorpe	TF508854	21/08/1995		Attheya armatus			Brown scum on beach
Anglian	Mundesley	TG317366	08/05/1995	14/06/1995	Phaeocystis	Present		
Anglian	Old Hunstanton	TF676422	25/06/1995		Biddulphia			Scum at sea not seen on beaches
Anglian	Scratby	TG510160	06/05/1995	20/06/1995	Phaeocystis	Present		
Anglian	Sheringham	TG162436	08/05/1995	14/06/1995	Phaeocystis	Present		
Anglian	Skegness	TF572634	12/07/1995					Brown scum on shore - sample too turbid to analyse
Anglian	Southwold South Denes	TM508754	09/05/1995	31/05/1995	Phaeocystis	Present		
Anglian	Southwold South Denes	TM508754	19/06/1995	05/07/1995	Phaeocystis	Present		
Anglian	Southwold South Denes	TM508754	11/06/1995		Noctiluca spp	Present		
Anglian	Sutton on Sea	TF522821	21/08/1995					Brown scum on shore - sample too turbid to analyse

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REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Anglian	Wells	TF914456	08/05/1995	14/06/1995	Phaeocystis	Present		
North East	Berwick, Lower Tweed Estuary	NU262188	17/05/1995		Pennate diatoms	1,000		Slight foaming, brown colouration
					Phaeocystis sp.	10,000		
North East	Cullerose Point	NU001520	09/03/1995					Brown heavy foaming - photos taken by the public
North West	Askam-in-Furness	SD209782	26/06/1995		Phaeocystis	2,000		
North West	Greenodd	SD315824	16/06/1995		Phaeocystis unicells	2.4 x 10 <sup>6</sup>		Sample of foam also present, Biddulphia granulata and Cuinoralia
					Noctiluca scintillans	6 x 10 <sup>6</sup>		
North West	Kirkstanton	SD128797	26/06/1995		Phaeocystis	Abundant		Decaying, semi intact colonies. Strong sulphurous smell
					Noctiluca scintillans	950		
					Rhizosolenia shrubsolei	<104 cells		
North West	Newbiggin	SD273694	26/06/1995		Phaeocystis unicells	4 x 10 <sup>5</sup>		
					Asterionella glacialis	1.26 x 10 <sup>5</sup>		
					Asterionella kariana	10,000		
					Navicula spp.	8,000		
					Nitzschia closterium	2,000		
					Pseudo-nitzschia seriata	2,000	Yes	
					Thalassiorera fallax	8,000		
North West	Roan Head	SD198758	27/06/1995		Phaeocystis	6000 cols		
					Guinardia flaccidia	62,000		
					Rhizosolenia shrubsolei	62,000		
					Unidentified Dinoflagellates	low conc		
North West	Seascale	NY037008	23/06/1995		Phaeocystis	>40 x 10 <sup>3</sup>		Colonies Decaying, complaint of foul smelling scum/foam along the shore. Numerous dead jelly fish washed up along the shore
North West	Seascale	NY037008	26/06/1995		Phaeocystis	42000 cols		
North West	Seascale	NY037008	27/06/1995		Phaeocystis	25000 cols		

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					Noctiluca scintillans	3,000		
North West	Silecroft	SD120812	26/06/1995		Phaeocystis	14000 cols		
North West	Silecroft	SD120812	27/06/1995		Phaeocystis	13000 cols		
					Chaetoceros	low abundance		
North West	St Bees	NX963117	23/06/1995		Phaeocystis unicells	1.24 x 10 <sup>7</sup>		Cryptomads also present
North West	St Bees	NX963117	26/06/1995		Phaeocystis	5000 cols		
					Guinardia flaccida	2,000		
					Rhizosolenia shrubsolei	2,000		
					Rhizosolenia stolerfohitii	2,000		
					Miniscula bipes	800		
North West	St Bees	NX959117	27/06/1995		Phaeocystis	27000 cols		
North West	St Bees	NX957115	05/07/1995		Noctiluca scintillans	735,000		Orange slick on shore. Sample taken from rock pool at low tide. Noctiluca cells disintegrating.
North West	Walney Island, Biggar Bank	SD178673	26/06/1995		Phaeocystis	36000 cols		
North West	Walney Island, Biggar Bank	SD178673	27/06/1995		Phaeocystis	9000 cols		
North West	Walney Island, Sandy Gap	SD175681	26/06/1995		Phaeocystis	28000 cols		
North West	Walney Island, Sandy Gap	SD175681	27/06/1995		Phaeocystis	11000 cols		
North West	Walney Island, West Shore	SD170700	26/06/1995		Phaeocystis	38000 cols		
North West	Walney Island, West Shore	SD170700	27/06/1995		Phaeocystis	9000 cols		
South West	Fal Estuary	SW830340	01/07/1995		Alexandrium tamarense		Yes	
South West	Gunwalloe	SW650220	01/07/1995		Gyrodinium aureolum		Yes	

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South West	Helford Estuary	SW750260	01/07/1995		Alexandrium tamarens		Yes	
South West	Jennycliffe		18/05/1995		Phaeocystis sp.			
South West	Lizard Point	SW700120	01/07/1995		Gyrodinium aureolum		Yes	
South West	Plymouth Hoe West	SX500520	18/05/1995		Unidentified flagellate	2,500		
South West	Preston Beach	SY685820	02/06/1995		Phaeocystis sp.	2		Lots of small broken fragments which blocked the gills of aquarium fish at Preston Beach.
South West	Sandbanks		03/08/1995		Diatoms			
South West	Weymouth Bay	SY683789	17/05/1995	01/06/1995	Phaeocystis sp.	20		Lots of small broken fragments which blocked the gills of aquarium fish at Preston Beach.
South West	Weymouth Bay	SY683789	19/06/1995	06/07/1995	Alexandrium tamarens	2	Yes	
			30/06/1995		Alexandrium tamarens	25	Yes	
Southern	Ramsgate (W. Undercliffe)	TR37206400	04/08/1995		Asterionella japonica	153,000		
Southern	Ramsgate (W. Undercliffe)	TR37206400	10/05/1995	24/05/1995	Phaeocystis sp.	64 cols		Foam at the waters edge, windrows offshore.
Southern	Bexhill	TQ73700680	04/05/1995	11/05/1995	Phaeocystis sp.	11 cols		
Southern	Birling Gap	TV55209600	11/05/1995	01/06/1995	Phaeocystis sp.	25 cols		
Southern	Botany Bay	TR39107120	03/05/1995	24/05/1995	Phaeocystis sp.	130 cols		
Southern	Brighton	TQ32300340	04/05/1995	11/05/1995	Phaeocystis sp.	6 cols		
Southern	Broadstairs (E Cliff)	TR40106880	10/05/1995		Phaeocystis sp.	51 cols		
Southern	Broadstairs (Viking Bay)	TR39806770	03/05/1995	10/05/1995	Phaeocystis sp.	35 cols		
Southern	Calshot (Activity centre)	SU47800230	09/05/1995		Navicula sp			Slime at strandline
Southern	Camber	TQ97301840	09/05/1995	16/05/1995	Phaeocystis sp.	85 cols		Abnormal colour at the waters edge and foam offshore
Southern	Christchurch Bay	SZ23909280	08/06/1995		Euglenoids, diatoms			
Southern	Compton Bay	SZ37708410	14/06/1995		Phaeocystis sp.	2 cols		
Southern	Deal Castle	TR37805270	10/05/1995		Phaeocystis sp.	30 cols		
Southern	Dover Harbour	TR32104120	10/05/1995		Phaeocystis sp.	7 cols		
Southern	Dumpton Gap	TR39706670	10/05/1995		Phaeocystis sp.	65 cols		Abnormal colour at the waters edge
Southern	Dymchurch	TR11303040	09/05/1995	16/05/1995	Phaeocystis sp.	13 cols		

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Southern	Eastbourne (EC)	TV61409820	04/05/1995	01/06/1995	Phaeocystis sp.	10 cols		
Southern	Eastbourne (yacht club)	TV62509980	11/05/1995	01/06/1995	Phaeocystis sp.	13 cols		
Southern	Folkestone (EC)	TR23703630	09/05/1995	16/05/1995	Phaeocystis sp.	10 cols		
Southern	Folkestone (The Warren)	TR48003760	09/05/1995	16/05/1995	Phaeocystis sp.	33 cols		
Southern	Hampton Pier	TR15806840	16/05/1995		Phaeocystis sp.	46 cols		
Southern	Hastings	TQ81900920	11/05/1995		Phaeocystis sp.	28 cols		
Southern	Herne Bay	TR18606860	16/05/1995		Phaeocystis sp.	50 cols		
Southern	Hillhead	SU54000220	30/05/1995		Euglenoids, diatoms			Foam at waters edge and slime at strandline
Southern	Hove	TQ28800430	25/05/1995	08/06/1995	Phaeocystis sp.	110 cols		Abnormal colour offshore
Southern	Hythe	TR16003400	09/05/1995	16/05/1995	Phaeocystis sp.	14 cols		Abnormal colour at waters edge
Southern	Joss Bay	TR39907020	10/05/1995		Phaeocystis sp.	58 cols		
Southern	Kingsdown Beach	TR38004850	10/05/1995		Phaeocystis sp.	10 cols		
Southern	Lee-on-Solent	SU56200050	30/05/1995	06/06/1995	Euglenoids, diatoms			Foam at waters edge
Southern	Lepe	SZ45609850	06/06/1995		Euglenoids, diatoms			
Southern	Lepe	SZ45609850	15/08/1995		Navicula			Foam at waters edge
Southern	Leysdown	TR03407080	09/05/1995	16/05/1995	Phaeocystis sp.	10 cols		
Southern	Littlehampton	TQ04000130	25/05/1995		Phaeocystis sp.	250 cols		Abnormal colour offshore
Southern	Littlestone	TR08402390	09/05/1995	16/05/1995	Phaeocystis sp.	11 cols		
Southern	Margate (Fulsam Rock)	TR35607150	03/05/1995	10/05/1995	Phaeocystis sp.	84 cols		
Southern	Margate (The Bay)	TR34707080	03/05/1995	10/05/1995	Phaeocystis sp.	93 cols		
Southern	Milford on Sea	SZ28309150	08/06/1995		Euglenoids, diatoms			
Southern	Minnis Bay	TR28606970	10/05/1995		Phaeocystis sp.	12 cols		Foam on the waters edge
Southern	Newhaven (West Quay)	TV44709990	04/05/1995		Phaeocystis sp.	10 cols		
Southern	Palm Bay	TR37307140	03/05/1995	10/05/1995	Phaeocystis sp.	44 cols		
Southern	Pevensey Bay	TQ65700370	04/05/1995	11/05/1995	Phaeocystis sp.	18 cols		
Southern	Ramsgate Sands	TR38706490	03/05/1995	10/05/1995	Phaeocystis sp.	64 cols		
Southern	Ryde (West)	SZ58809300	31/05/1995		Euglenoids, diatoms			
Southern	Saltdean	TQ38100180	11/05/1995	01/06/1995	Phaeocystis sp.	1 col		
Southern	Saltdean	TQ38100180	24/05/1995		Dinaliella	>20000		

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Southern	Sandgate	TR18803480	09/05/1995	23/05/1995	Phaeocystis sp.	6 cols		Abnormal colour at waters edge
Southern	Sandown (Yaverland)	SZ61109210	31/05/1995		Phaeocystis sp.	10 cols		
Southern	Sandwich Bay	TR35805900	03/05/1995	10/05/1995	Phaeocystis sp.	96 cols		
Southern	Sandwich Bay	TR35805900	31/05/1995	03/07/1995	Asterionella japonica	3,300,000		Black slime on beach
Southern	Seaford (Dawe Rd)	TV47829895	11/05/1995	01/06/1995	Phaeocystis sp.	94 cols		
Southern	Seaford (EC)	TV48809820	04/05/1995	01/06/1995	Phaeocystis sp.	150 cols		Discoloured water complaint
					Chaetoceros			
Southern	Sheerness	TQ92507500	09/05/1995	16/05/1995	Phaeocystis sp.	19 cols		
Southern	South Lancing	TQ18300360	25/05/1995	08/06/1995	Phaeocystis sp.	1 col		Abnormal colour offshore
Southern	Southwick	TQ24200480	25/05/1995	08/06/1995	Phaeocystis sp.	52 cols		Abnormal colour offshore
Southern	St Helens	SZ83708920	03/05/1995		Pennate diatoms	abundant		Abnormal colour at waters edge
Southern	St Leonards	TQ79700870	04/05/1995	11/05/1995	Phaeocystis sp.	27 cols		
Southern	St Margarets Bay	TR3804440	10/05/1995		Phaeocystis sp.	6 cols		
Southern	St Marys Bay	TR09302770	09/05/1995		Phaeocystis sp.	38 cols		
Southern	St Mildreds Bay	TR32807050	03/05/1995	10/05/1995	Phaeocystis sp.	49 cols		
Southern	Tankerton	TR12706740	09/05/1995	16/05/1995	Phaeocystis sp.	63 cols		
Southern	Walpole Bay	TR36507150	10/05/1995		Phaeocystis sp.	56 cols		
Southern	West Beach	TR09806600	09/05/1995	16/05/1995	Phaeocystis sp.	35 cols		
Southern	Westbrook Bay	TR34107060	03/05/1995	10/05/1995	Phaeocystis sp.	62 cols		
Southern	Westgate Bay	TR32007020	10/05/1995		Phaeocystis sp.	15 cols		
Southern	Westgate Bay	TR32007020	31/05/1995		Noctiluca	3		Foam on the waters edge
Southern	Winchelsea	TQ91201540	09/05/1995	16/05/1995	Phaeocystis sp.	19 cols		Smell at the waters edge
Southern	Wormans Bay	TQ68200530	13/05/1995		Phaeocystis sp.	13 cols		Foam offshore
Southern	Worthing	TQ13900210	25/05/1995	15/06/1995	Phaeocystis sp.	180 cols		Abnormal colour offshore
Welsh	Aberdyfi	SN60609580	05/05/1995	23/05/1995	Phaeocystis sp.	14 cols		
Welsh	Aberfan at slip	SS739896	03/06/1995		Asterionella	4,460		
Welsh	Aberfan at slip	SS739896	05/09/1995	12/09/1995	Chaetoceros	91,050		
Welsh	Aberfan at slip	SS739896	06/06/1995		Phaeocystis sp.	10 cols		
Welsh	Aberfan at slip	SS739896	10/05/1995	23/05/1995	Phaeocystis sp.	110 cols		
Welsh	Aberfan at slip	SS739896	15/07/1995	27/07/1995	Chaetoceros	2,800		

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Welsh	Aberfan at slip	SS739896	21/08/1995		Chaetoceros	2,140		
Welsh	Aberporth	SN258517	01/05/1995		Phaeocystis sp.	20 cols		
Welsh	Aberporth	SN258517	06/07/1995		Phaeocystis sp.	60 cols		
Welsh	Aberporth	SN258517	16/05/1995	24/05/1995	Phaeocystis sp.	140 cols		
Welsh	Aberporth	SN258517	21/06/1995		Phaeocystis sp.	20 cols		
Welsh	Abersoch	SH31802830	09/05/1995		Phaeocystis sp.	25 cols		
Welsh	Aberystwyth Harbour	SN570820	04/08/1995		Melosira			
Welsh	Aberystwyth North	SN583822	16/05/1995	05/06/1995	Phaeocystis sp.	210 cols		
Welsh	Aberystwyth South	SN579814	16/05/1995	01/06/1995	Phaeocystis sp.	300 cols		
Welsh	Amroth	SN167068	02/05/1995	05/06/1995	Phaeocystis sp.	290 cols		
Welsh	Amroth	SN167068	13/07/1995		Chaetoceros	680 cols		
Welsh	Amroth	SN167068	25/07/1995		Chaetoceros	18430 cols		
Welsh	Barmouth	SH60301720	08/05/1995	23/05/1995	Phaeocystis sp.	17 cols		
Welsh	Benllech	SH56608121	29/05/1995	27/06/1995	Phaeocystis sp.	>50 cols		
Welsh	Borth	SN606901	01/05/1995	24/05/1995	Phaeocystis sp.	110 cols		
Welsh	Bracelet Bay	SS630871	10/09/1995		Chaetoceros	790 cols		
Welsh	Bracelet Bay	SS630871	17/05/1995		Phaeocystis sp.	60 cols		
Welsh	Broadhaven	SM861138	05/05/1995		Melosira			
					Chaetoceros			
Welsh	Broadhaven	SM861138	23/05/1995		Phaeocystis sp.	60 cols		
Welsh	Carew Oyster Beds	SN040030	30/06/1995		Gyrodinium		Yes	
Welsh	Caswell Bay	SS591874	17/05/1995		Phaeocystis sp.	90 cols		
Welsh	Colwyn Bay	SH84308100	24/05/1995	21/06/1995	Phaeocystis sp.	262 cols		
Welsh	Cricieth	SH50203790	09/05/1995		Phaeocystis sp.	9 cols		
Welsh	Fairborne	SH61001400	19/04/1995	23/05/1995	Phaeocystis sp.	21 cols		
Welsh	Harlech	SH56303260	05/05/1995		Phaeocystis sp.	8 cols		
Welsh	Langland Bay	SS606871	08/05/1995	17/05/1995	Phaeocystis sp.	130 cols		
Welsh	Limeslade Bay	SS625870	17/05/1995		Phaeocystis sp.	30 cols		
Welsh	Littlehaven	SM850120	17/08/1995		Gyrodinium aureolum		Yes	
Welsh	Llondonog	SH56702860	26/04/1995	08/06/1995	Phaeocystis sp.	7 cols		

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Welsh	Llandudno North	SH78408900	24/05/1995	12/06/1995	Phaeocystis sp.	52 cols		
Welsh	Llandudno West	SH76908220	12/06/1995		Phaeocystis sp.	8 cols		
Welsh	Loughor at Loughor Road Bridge	SS560980	03/08/1995		Asterionella			
Welsh	Milford Haven, Burton	SM910050	29/06/1995		Glenodinium			
Welsh	Milford Haven, Hakin Point	SM890050	29/06/1995		Glenodinium			
Welsh	Milford Haven, Hook	SM900050	20/06/1995		Gyrodinium		Yes	
Welsh	Milford Haven, Sprinkle Pill	SM910050	27/06/1995		Alexandrium		Yes	
Welsh	Morfa Bychan	SH52203740	01/06/1995		Phaeocystis sp.	7 cols		
Welsh	Newgale	SM846217	10/05/1995	19/05/1995	Phaeocystis sp.	70 cols		
Welsh	Newgale Beach	SM850220	10/08/1995		Gyrodinium aureolum		Yes	
Welsh	Newport Beach	SN053407	30/05/1995		Chaetoceros			
					Asterionella			
Welsh	Newport Sands North	SN053407	06/06/1995		Phaeocystis sp.	30 cols		
Welsh	Newport Sands North	SN053407	23/05/1995		Phaeocystis sp.	400 cols		
Welsh	Newport Sands South	SN053407	18/05/1995		Phaeocystis sp.			
Welsh	Newquay	SN398579	24/05/1995		Phaeocystis sp.			
Welsh	Nolion Haven	SM860180	12/07/1995		Gymnodinium		Yes	
Welsh	Ogmore Mouth, Bridgend	SS860750	19/07/1995		Chaetoceros			
Welsh	Oxwich Bay	SS507862	02/05/1995	17/05/1995	Phaeocystis sp.	170 cols		
Welsh	Pembrey	SS400998	03/05/1995	06/06/1995	Phaeocystis sp.	310 cols		
Welsh	Pembrey	SS400998	16/06/1995		Asterionella	2,550		
Welsh	Pembrey	SS400998	20/07/1995	27/07/1995	Chaetoceros	2,200		
Welsh	Pendine	SN235074	02/05/1995	23/05/1995	Phaeocystis sp.	300 cols		
Welsh	Penmaenmawr	SH71807693	29/05/1995	27/06/1995	Phaeocystis sp.	21 cols		
Welsh	Pwllheli	SH38603430	09/05/1995	18/05/1995	Phaeocystis sp.	9 cols		

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Welsh	Point of Ayr	SJ12108590	16/05/1995	26/06/1995	Phaeocystis sp.	50 cols		
Welsh	Port Eynon	SS472848	02/05/1995	17/05/1995	Phaeocystis sp.	280 cols		
Welsh	Port Eynon	SS472848	31/05/1995		Phaeocystis sp.	20 cols		
Welsh	Prestatyn	SJ05008830	24/05/1995	05/06/1995	Phaeocystis sp.	104 cols		
Welsh	Rest Bay	SS800779	15/07/1995		Chaetoceros	8,500		
Welsh	Rest Bay	SS800779	17/08/1995	21/08/1995	Chaetoceros	2,240		
Welsh	Rest Bay	SS800779	18/05/1995	23/05/1995	Phaeocystis sp.	30 cols		
Welsh	Rest Bay	SS800779	27/07/1995		Chaetoceros	17,750		
Welsh	Rhossilli at Hillend	SS414900	02/05/1995		Asterionella	7,030		
Welsh	Rhossilli at Hillend	SS414900	08/05/1995	31/05/1995	Phaeocystis sp.	280 cols		
Welsh	Rhossilli at Hillend	SS414900	14/07/1995	19/07/1995	Chaetoceros	3,720		
Welsh	Rhossilli at Hillend	SS414900	20/08/1995	10/09/1995	Chaetoceros	9,300		
Welsh	Rhyl	SJ00008100	24/05/1995	01/06/1995	Phaeocystis sp.	150 cols		
Welsh	Sandy Bay	SS824765	18/05/1995	23/05/1995	Phaeocystis sp.	20 cols		
Welsh	Sandy Bay	SS824765	21/08/1995		Chaetoceros	3,760		
Welsh	Sandy Bay	SS824765	27/07/1995		Chaetoceros	17,750		
Welsh	Sandy Cove	SH97007980	24/05/1995	05/06/1995	Phaeocystis sp.	105 cols		
Welsh	Saundersfoot	SN141047	08/05/1995	05/06/1995	Phaeocystis sp.	260 cols		
Welsh	Southerndown	SS884729	18/05/1995	23/05/1995	Phaeocystis sp.	30 cols		
Welsh	St. Brides Haven	SM785100	04/08/1995		Gyrodinium		Yes	
Welsh	Swansea Bay at Mumbles	SS610870	31/05/1995		Diatoms			
Welsh	Swansea Bay at Slip	SS644921	08/05/1995	25/05/1995	Phaeocystis sp.	150 cols		
Welsh	Swansea Bay at Slip	SS644921	20/08/1995		Chaetoceros	1,770		
Welsh	Swansea Boat Club	SS650920	03/08/1995		Asterionella			
Welsh	Tal-y-bont	SH57752110	16/05/1995	23/05/1995	Phaeocystis sp.	16 cols		
Welsh	Teifi Estuary	SN170475	11/07/1995		Gyrodinium		Yes	
Welsh	Tenby Beach	SS110990	29/04/1995		Melosira			
Welsh	Tenby North	SN134008	23/04/1995		Chaetoceros			
Welsh	Tenby North	SN134008	08/05/1995	31/05/1995	Phaeocystis sp.	220 cols		

## APPENDIX 5

### Sites Sampled for Marine Microalgae in 1995

REGION	LOCATION	NGR	DATE FROM	DATE TO	SPECIES	CELL COUNT	TOXIC BLOOM	COMMENTS/PROBLEMS
Welsh	Tenby South	SS132998	23/04/1995	30/06/1995	Chaetoceros			
Welsh	Tenby South	SS132998	08/05/1995	25/05/1995	Phaeocystis sp.	100 cols		
Welsh	Traeth Gwyn	SN398597	01/05/1995		Phaeocystis sp.	10 cols		
Welsh	Traeth Gwyn	SN398597	06/07/1995		Phaeocystis sp.	40 cols		
Welsh	Traeth Gwyn	SN398597	16/05/1995	24/05/1995	Phaeocystis sp.	250 cols		
Welsh	Traeth Gwyn	SN398597	30/07/1995		Chaetoceros	6,000		
Welsh	Trecco Bay	SS831763	18/05/1995	23/05/1995	Phaeocystis sp.	50 cols		
Welsh	Tresaith	SN278517	06/07/1995		Phaeocystis sp.	90 cols		
Welsh	Tresaith	SN278517	09/05/1995	24/05/1995	Phaeocystis sp.	110 cols		
Welsh	Tywyn stn	SA54301200	26/04/1995	23/05/1995	Phaeocystis sp.	33 cols		