

**REPORT OF THE  
ICES-IOC WORKING GROUP ON HARMFUL ALGAL  
BLOOM DYNAMICS**

**Jena, Germany  
16–20 March 1999**

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## 1 WELCOME AND OPENING OF THE MEETING

The ICES-IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD) was convened at Friedrich Schiller Universität in Jena, Germany (16–20 March 1999). The meeting was organized by Prof. Berndt Luckas and was chaired by Patrick Gentien (France). 21 scientists from 10 countries took part: they are listed in Annex I.

In plenary session of the WGHABD, individual participants introduced themselves and their institute and gave a concise description of their major field of research. A forum was organized to allow presentation of new results from research. 13 presentations were made. Different working group members added an extra term of discussion to the agenda, following requests; it concerns the future of WGHABD in light of the development of GEOHAB.

## 2 NOMINATION OF A NEW CHAIRPERSON

Due to the nomination of P. Gentien as chair of the scientific steering committee of the IOC-SCOR GEOHAB programme, the chairman resigned and nominations for a new chairman were done. Dr Kaisa Kononen was nominated (9 out of 16). On this basis, the appointment of Dr Kaisa Kononen as chairperson of the WGHABD is submitted by the WGHABD for approval by ICES council.

## 3 TERMS OF REFERENCE

At the 86 Th ICES Annual Science Conference in Cascais (Portugal), the council resolved (C. Res. 1998/2: 13) that:

The ICES-IOC Working Group on Harmful Algal Blooms Dynamics (Chairman: P. Gentien, France) will meet in Jena (16–20 March 1999) to:

- ToR 1:** collate and assess National Reports and update the mapping of HABs;
- ToR 2:** review the work of the ad hoc group set up to establish the ICES-IOC Harmful Algal Bloom Event Database (HAEDAT);
- ToR 3:** continue preparation of a review document on the population scenarios for the different harmful algae species;
- ToR 4:** continue the examination of the population dynamics and assess the role of harmful benthic microalgae in benthic and pelagic food web
- ToR 5:** identify and summarize existing knowledge on sources of "founding" populations for HABs such as overwintering of vegetative cells, cyst germination, hydrographic transfer, transfer through biological or human activities;
- ToR 6:** examine with the help of invited experts and in collaboration with the Working Group on Shelf Seas Oceanography recent developments and inherent assumptions in physical coastal modelling;
- ToR 7:** formulate a final statement for the Kristineberg workshop on *in situ* growth rate
- ToR 8:** report and discuss new findings

## 4 SUMMARY OF THE CONCLUSIONS

### Future of the WGHABD

*(this item is not discussed any further in the report but it should be discussed in the 1999 ASC in the context of GEOHAB presentation)*

The group discussed the form, objectives and functioning of the group in light of the forthcoming international programme in Harmful Blooms under the name of GEOHAB. It was noted that this WG is special in that it brings biologists and physicists together although there is never a very large contingent of physicists and/or modelers.

Techniques for analysis and prediction of the population dynamics of Harmful Algae are not well developed. Measurements of species-specific growth rates and mortality rates are very difficult. There has been a rapid improvement in coastal modelling and some coupled bio/physical models in the last few years. It was suggested the WG should consider a broader range of models than those based on combined biological and hydrodynamic formalisms.

Monitoring is an important aspect of the HAB problem and the WG needs to interact with the monitoring program design and the data interpretation. For example, more environmental data is often needed, and the sampling should be rationalized with the local hydrography such as mixed layer depth, circulation patterns, frontal dynamics, etc. Historical data and time series from sediment and from climate studies should be examined to look for historical occurrence of HAB's (e.g., cyanobacteria in the Baltic for the past 8000 years). It was noted that some HAB problems have decreased

in the past years. The WG needs to consider decreases in population size (or even disappearance) as well as increases in occurrence or number of Harmful Algae.

The importance of the WG approach and focus on the population dynamics of the specific species of interest and not on phytoplankton ecology in general (which too often implies the only fluxes approach) was emphasized. In fact, flux studies are now finding it necessary to track species specific differences to incorporate their different contributions to flux rates.

It was also noted that the WG is the only place where the national reports are collated and presented in a consistent manner.

The WG has provided distinct leadership on the problems of HABs and it would be unfortunate to lose the continuity while the larger international programme begins.

**It was concluded that the WG should continue with the focus on Population Dynamics of the specific species.** Further meetings with the Working Group on Shelf Seas Oceanography should be pursued, especially given the recent emphasis in that WG on ecological modelling and monitoring. As well, the WGHABD should take an active rôle in the analysis of historical and monitoring data as well as the design of monitoring programmes. Monitoring and modelling must be brought together in a format that allows the monitoring data to be input to models directly. Inversely, the models offer the opportunity to expand the utility and information from the monitoring data. WGHABD should extend its membership to non-ICES countries participating in GEOHAB.

**Term of reference 1:** collate and assess National Reports and update the mapping of HABs.

Country members presented in plenary session a summary of their respective national reports for 1998. It should be stressed that national reporting greatly improved, due to recommendations of the ICES council to national delegates.

This annual exercise is highly valuable:

The maps of Harmful Algal Events have already been used extensively. Given the interest in the general public, IOC and ICES should make these maps available on their respective Web sites.

**Term of reference 2:** review the work of the *ad hoc* group set up to establish the ICES-IOC Harmful Algal Bloom Event Database ( HAEDAT );

According to schedule, National Reports since 1987 have been entered into the database. However, only those from 1993 onwards (n = 427) have been completed and reviewed.

Data entry from previous National Reports will be completed by May 1999. Concurrently, the database will be presented on the IOC and ICES WWW servers. This database will be available for a 4 month testing period prior to being introduced globally.

The HAEDAT will be operated, maintained and funded by the IOC-IEO Science and Communication Centre (HAEDAT Adm), Vigo, at least until the end of 2001. Annual National reports should be submitted directly to the HAEDAT WWW-site at least 1 month prior to the annual WGHABD meetings in the format in this Annex. National focal points will be reminded by the HAEDAT Adm. Input on single events, and complementary information on previously recorded events, to the HAEDAT WWW site will be possible at any time. Data submitted to the HAEDAT WWW site will not go directly to the HAEDAT but will be controlled and monitored by the HAEDAT Adm. The IOC HAEDAT WWW site will be linked to the WGHABD decadal HAE maps and the IOC-ICES MONDAT database on HAB monitoring systems worldwide.

In order to avoid misinterpretation and misuse of the sensitive information on the maps and in the database, a warning and a disclaimer should be included when information is extracted. As an example, a quick glance could lead to avoid importing shellfish from a given coastline while the number and size of the icons reveal simply that shellfish from this area are probably safer than elsewhere, due to the intensive monitoring effort. A general disclaimer formulation is proposed.

## RECOMMENDATIONS:

The ICES-IOC WGHABD recommends that the completed HAEDAT, covering the period 1987–1998, be made available on the ICES and IOC WWW sites. It further recommends that the HAEDAT format for national reports, as specified in Annex 1 hereto, is adopted as the new format for all national reports on HAE collated by the WGHABD.

The ICES-IOC WGHABD recommends that a disclaimer be included in the presentation text of the decadal maps and of the HAEDAT database.

The ICES-IOC WGHABD recommends that each decadal map be published with a warning.

**Term of Reference 3:** continue preparation of a review document on the population scenarios for the different harmful algae species;

Some difficulties associated with the IOC Website occurred. Therefore, the questionnaire was not easily accessible during the past year. This may explain that there were only a few more contributions relatively to the ones summarized in last year report. It was decided to attempt at a better yield of answers during the coming year before synthesising the results.

It is however possible to foresee some of the interests of that exercise.

There is clearly two groups of documents; one is poorly documented in hydrological climate and more or less documented in biology and toxins and the other one, usually coming from teams who have been working on the subject for quite a while, which are quite well documented.

The first group will allow to focus on problems regions where expertise is needed and the second group should help in defining an implementation plan for more detailed studies.

Another point of importance is the number of cases involving coastal lagoons with a large impact on human health.

This survey will be of value when defining the implementation plan of GEOHAB.

**Term of Reference 4:** continue the examination of the population dynamics and assess the role of harmful benthic microalgae in benthic and pelagic food web

Relatively little attention has been directed to the study of population dynamics of harmful benthic microalgae. Nevertheless, there are several valid reasons why population dynamic studies of harmful benthic are worthy of consideration by the ICES-IOC WGHABD.

Benthic dinoflagellates are known to be responsible for ciguatera poisoning in tropical regions and affect a large number of seafood consumers. To the knowledge of the WGHABD there are no monitoring programs for known- or potentially harmful benthic species anywhere in the world. Use of such a "*Dinophysis* index" derived from phytoplankton monitoring data was found to be totally unworkable to forecast DSP toxicity or to explain historical toxicity patterns in Nova Scotia (eastern Canada).

To date there have been few detailed biogeographical or seasonal studies on the population dynamics of harmful benthic microalgae, and little information is available on the residence time of cells in the water column. Critical studies are essential to evaluating the potential for suspension of harmful benthic microalgae from the sediments to the upper water column and the mobilization of such cells due to advection and storm events.

Further case studies in a diversity of environments are required to confirm if DSP toxicity caused by benthic microalgae is a widespread phenomenon or is limited to special circumstances. It is therefore, recommended that each working group member investigate this possible source of contamination and report on this subject at the next WG meeting.

**Term of Reference 5:** identify and summarize existing knowledge on sources of "founding" populations for HABs such as over-wintering of vegetative cells, cyst germination, hydrographic transfer, transfer through biological or human activities;

Most coastal phytoplankton species which include HAB species are meroplanktonic as they only have a short bloom period during their life cycles. When absent from plankton, they are either present as physiological resting stage forms, which are morphologically non differentiated compared to vegetative cells, or morphologically different cysts. Mechanisms for formation and fate of physiological resting stages (as present in the domoic acid producer *Pseudo-nitzschia*) are even less understood than those for resting cysts. Most algae responsible for HABs belong to the dinoflagellates, a group known to produce both temporary and long term resting cysts. It is therefore also important to evaluate the contribution of resting cysts to the development and decline of HABs.

The WGHABD identified some critical processes deserving specific studies:

- Investigation of the physiological resting stages for HAB species not known to produce resting cysts.
- Determination of the cyst distributions of major HAB species in order to identify areas prone to HAB development.
- Assessment of the potential for predation and parasitism on natural cyst populations.
- Determination of the influence of environmental factors (e.g., temperature, light etc.) and internal biological clocks on cyst germinations.
- Investigation of the relationship between cyst germination and timing and amplitude of HAB blooms.

It will become necessary to develop coupled biological-physical models for different HAB species. These models will aid in estimating the importance of location, transport, timing and size of initial inocula on the development of HABs.

**Term of Reference 6:** examine with the help of invited experts and in collaboration with the Working group on Shelf Seas Oceanography recent developments and inherent assumptions in physical coastal modelling;

Due to the commitments of different scientists and probably problems encountered in funding two ICES meetings, only one physicist not attending usually this group was present. He presented the physical-phytoplankton biomass model of the Baltic developed in the Institut für Ostseeforschung, Warnemuende.

Dr T. Neumann presented its results : the spring bloom is adequately reproduced as it progresses from the Kategatt to the Arkona Basin and then to the Baltic Proper. The succession of phytoplankton, starting with diatoms then flagellates and finally cyanobacteria, is reproduced by the calculations. These results arise with just nitrogen and phosphorus nutrient pools and fluxes, without using silica limitation. A traditional formulation of the shift between diatoms and flagellates involves limitation by silica as the trigger. Some models use a threshold in silica concentrations under which the set of physiological processes changes parametrization despite the evidence that the two types of population often coexist at significant silica concentrations. Even if these two model formulations approximate time series in an acceptable manner, it is likely that only one is pertinent; this raises the problem of defining the more simple and more realistic formulation of phytoplankton growth. This discussion however, extends beyond the scope of WGHABD and could be discussed in a more appropriate forum like WGPE.

Much discussion ensued about the details of the biological models and their applicability to species-specific predictions. It was felt that a model of the type presented could describe the likelihood of a flagellate bloom but would probably not forecast the specific harmful species. However, it might be possible to examine the sensitivity of the oceanic setting to different species due to their detailed population dynamics. It may also be necessary to include a species-specific model into a biomass model of phytoplankton.

**Term of Reference 7:** formulate a final statement for the Kristineberg workshop on *in situ* growth rate – (*this item is not discussed any further in the report*)

The ICES/IOC Workshop on the Intercomparison of the *in situ* growth rate measurements (Dinoflagellates) was held at Kristineberg Marine Research Station, Sweden from 9–15 September 1996.

Due to the perfect organization and the well-prepared logistics by Odd Lindahl, the local organizer, some individual contributions turned out to be of good scientific quality. However, after examination of the available results, the WG could only conclude that the results were not comparable and that a synthesis was not possible. A shortage of the Workshop certainly was that some techniques were not yet established and were used for the first time. This induces risks which might be reduced with a more careful choice of available techniques and a better preparation of the methodologies. These risks could be reduced if a strong steering committee is involved since the beginning.



Rather than proposing the edition by ICES of a Cooperative Research Report, participants are encouraged to publish their findings either in groups or separately. The results have already been circulated among the Working Group members.

**Term of Reference 8:** report and discuss new findings

The suggestion that the group should take the opportunity to present new results and concepts related to the dynamics of harmful algal blooms was well received. Ten contributions were presented.

## 5 DETAILED DISCUSSION OF THE TERMS OF REFERENCE

### Term of Reference 1: collate the National Reports in the usual form

The compiled national reports are appended in Annex III. Country members presented in plenary session a summary of their respective national reports for 1998. It should be stressed that national reporting greatly improved, due to recommendations of the ICES council to national delegates.

#### CANADA

##### West Coast

Canada's Pacific coast experiences annual occurrences of PSP shellfish toxicity from the majority of its shellfish harvesting areas due to blooms of *A. catenella*. 1988 was no exception. In addition, mortalities of pilchards (carnivorous fish) were observed and initially *Pseudo-nitzschia* spp. and domoic acid were suspected to be responsible. Further studies indicated an absence of *Pseudo-nitzschia* spp. in the water and fish guts appeared to be empty. The cause of death has since been suggested to be starvation. Mortalities in salmon aquaculture operations occurred as a result of *Heterosigma* blooms.

##### East Coast

Areas of the Atlantic coast that experienced HAB events are divided into three geographic locations - the St. Lawrence Estuary, the Bay of Fundy, and southern Nova Scotia. The St. Lawrence Estuary and Bay of Fundy experience annual closures of shellfish harvesting areas due to unacceptable levels of PSP toxins. This occurred again in 1998 with concentrations of *A. tamarensis* exceeding  $10^6$  cells.l<sup>-1</sup> resulting in discolouration of the water in the St. Lawrence Estuary and illness and hospitalisation of 2 people documented. Shellfish areas were also closed to harvesting in the Bay of Fundy but for a short period of time and maximum *A. fundyensis* concentrations observed were  $8 \times 10^3$  cells.l<sup>-1</sup> - lower than during most years. From Nova Scotia, 6 people became ill from consumption of Halifax Harbour shellfish - an area closed year-round to harvesting due to fecal coliform contamination.

Although there were no shellfish area closures due to unsafe levels of domoic acid, trace levels were detected in scallops from the Magdalen Islands, Gulf of St. Lawrence. There were also 20 persons who became ill from the Magdalen Islands with DSP symptoms although only trace levels of DTX1 were detected.

The southwest Bay of Fundy also experienced mortalities of salmon from aquaculture operations due to oxygen depletion as a result of a red tide of *Mesodinium rubrum*.

#### DENMARK

Relatively low phytoplankton biomasses and concentrations were registered in the spring and summer period in Danish waters. The biomasses were dominated by diatoms (e.g., *Skeletonema costatum*) and dinoflagellates (e.g., *Prorocentrum minimum*). A bloom of raphidophycean flagellates from the genus *Chatonella* was observed in the spring in the northern part of Kattegat, the Limfjord and Ringkjøbing Fjord. Minor fishkills (*Belone belone*) were observed. A minor bloom of *Gyrodinium aureolum* was observed in the Limfjord, no fish kills or kills of benthic invertebrates were observed in relation to the bloom. No algal toxins were observed in Danish shellfish in 1998.

#### ENGLAND AND WALES

There were no unusual occurrences of toxic algae blooms in England and Wales in 1998. *Alexandrium tamarensis* occurred at 4 sites, at higher concentrations than in 1997. It also persisted longer, from May to the end of September at 3 sites. *Dinophysis* spp. occurred at concentrations above the action limit at 3 sites, but at lower concentrations than in 1997. It was recorded from the Fal estuary (Cornwall) for the first time since monitoring in this area began (1993), where it was present from April to September.

#### ESTONIA

In 1998 as well as in 1996, the intensive bloom of *Heterocapsa triquetra* (Dinophyta) was the most striking feature in the Gulf of Finland and adjacent areas. *H. triquetra* became dominant in the middle July. In Finnish coastal waters, *Heterocapsa*-bloom was observed until the end of August, while in Estonian coastal areas and the western Gulf the

short-time maximum was recorded in the end of July/ beginning of August (cf. annex). However, the dinoflagellate *H. triquetra* disappeared eastward of 25° 30' E in the southern Gulf of Finland, i.e., by salinity < 5 psu.

Due to cold and windy weather conditions no large surface accumulations of blue-green algae were observed. The maximum concentrations of *Aphanizomenon flos-aquae* (blue-green algae) were recorded in the mid of July ( $6.5 \times 10^5$  filaments per litre). Mostly straight filaments of potentially toxic cyanobacteria *Nodularia spumigena* have been observed during July and August in relatively low numbers -  $\sim 10^4$  filaments per litre, which is an order smaller than in July 1997. The one more potentially toxic species *Anabaena lemmermannii* has been occasional in the phytoplankton of the Gulf of Finland in 1998.

## FINLAND

Summer 1998 was exceptionally cold and windy in the northern Europe and the Baltic Sea area. In the Gulf of Finland, cyanobacterial filaments (*Aphanizomenon flos-aquae*, *Anabaena* spp., *Nodularia spumigena*) were present in low numbers in the surface layer throughout the summer and relatively high concentrations of  $\text{PO}_4$  (ca.  $0.1 \mu\text{M}$ ) compared to the situation in early 1990s were measured in July-August. However, blooms of cyanobacteria did not develop due to the low water temperature compared to long-term means and strong mixing. Instead, a bloom of *Heterocapsa triquetra* ( $1-2 \times 10^6$  cells.l<sup>-1</sup>) developed in July-August. The situation was very similar as observed in July 1996, when the weather conditions were similar.

## FRANCE

Ten sites along the French coast were affected by DSP toxins and two sites by PSP toxins in 1998. In addition, this was the first time that *Alexandrium tamarense* was linked to PSP toxins in shellfish.

### DSP episodes

As in previous years, DSP toxins were detected in shellfish from Normandy, southern Brittany and the western Mediterranean in 1998. DSP toxicity was also detected in shellfish, although concentrations of *Dinophysis* spp. were very low.

### PSP episodes

A bloom of *Alexandrium minutum* in the Rance estuary (Northern Brittany) was associated with PSP toxins in shellfish at levels less than 800  $\mu\text{g}$  per 100 g meat. Prior to 1996, *A. minutum* was not observed and PSP toxins were not detected at this location.

Northern Brittany has been the only region since 1988 where *Alexandrium minutum* has reached high concentrations. PSP shellfish toxicity occurs annually in Morlaix Bay, and rarely in the Abers - sites located in Northwestern Brittany.

In addition, *Alexandrium minutum* has been observed during several years in many regions, especially along the Atlantic and Mediterranean coasts, but at low concentrations (below 5000 cells.l<sup>-1</sup>)

*Alexandrium tamarense* was associated with a PSP event for the first time in 1998. The bloom occurred in Thau lagoon, on the western Mediterranean coast. This species was first observed in this lagoon in 1995 at concentrations of 20 000 cells per liter, but PSP toxins were not detected.

The 1998 episode began in late October with a maximum observed concentration of 90 000 cells per liter and PSP mouse-test results reaching 850  $\mu\text{g}$  per 100 g in mussels. The lagoon was closed to harvesting for all shellfish. During mid-November, concentrations of *A. tamarense* began to decrease in water, even when *Dinophysis* spp. was observed at a concentration of 800 cells per liter. PSP toxins lingered in mussels and clams (*Ruditapes decussatus*), but were not detected in oysters. During the same period, DSP mouse tests conducted at Ifremer were negative for all shellfish. (Since 1996 the extraction using dichloromethane has been used instead of acetone). In late November, with PSP results still negative for oysters, the area was re-opened (for oysters only). PSP toxins subsequently depurated from mussels and clams resulting in a complete opening in late December.

Chemical analyses performed by HPLC and mass spectrometry showed the presence of GTX1, 2, 3, 4 and STX, in both phytoplankton and shellfish. *A. tamarense* was identified by Nezan (Ifremer) and confirmed by Fukuyo, who thinks there are two different species present - *A. tamarense* and *A. catenella*, depending on the presence or absence of a ventral pore.

A problem occurred as a result of the decision made by the European Reference Laboratory (ERL) for phycotoxins (Vigo) for DSP mouse bioassays. Following numerous unexplained toxic episodes during the years 1992–96 in France, Ifremer chose not to use the acetone extraction method recommended by the ERL for the DSP mouse-test, but to use the dichloromethane extraction which is more specific for DSP toxins (OA, DTX, but also YTX, PTX and azaspiracid). Ifremer is responsible for monitoring shellfish in water, but the mandate for marketed shellfish is with Veterinary Services. Since the French National Reference Laboratory (CNEVA) follows the ERL procedures, they recommended that the Veterinary Services use the acetone extraction.

The consequences of using the two different methods were important in this particular case, because of interference of PSP toxins in acetone. In addition, the acetone extraction is performed on digestive glands which results in high concentrations of PSP toxins. Traces of toxins even below the detection limit of the AOAC PSP mouse-test (about 40 µg) can lead to positive results with the acetone test. This happened with oysters where they did not contain DSP toxins (negative dichloromethane test), but contained very low levels of PSP toxins, not harmful for consumers (always below 80 µg, and often below 40 µg), which led to positive acetone tests. If the procedure as recommended by the ERL had been used, the re-opening of the area for all shellfish would have delayed several weeks.

In conclusion, a decision was made with Veterinary Services to apply an experimental procedure which consists of performing both extractions (acetone and dichloromethane) on all shellfish samples in 1999. Following a trial one year period, results will be analysed and sent to the ERL.

Monitoring of ASP toxins will begin in 1999 in France. Quantification of toxins will be made according to the Lawrence HPLC method, following the commitment by the European Directive 97/61. For the first time in France, a number of toxic *Pseudo-nitzschia* species (*P. pseudodelicatissima*) were observed along the Northern coast of Brittany last summer. Very low concentrations of ASP toxins were detected.

Following the different events of these last years, procedures for monitoring are as follows for year 1999 :

- as soon as *Dinophysis* spp. are detected, DSP mouse-tests are performed on shellfish from the affected area; both acetone and dichloromethane extractions are performed.
- when *Alexandrium minutum* concentrations exceed 10 000 cells per liter, PSP mouse-tests are performed,
- as soon as *Alexandrium tamarense* is observed, PSP mouse-tests are performed
- when *Pseudo-nitzschia* spp. concentrations exceed 100 000 cells per liter, ASP testing is performed, according to the HPLC Lawrence method, validated by AOAC.

## GERMANY

### North Sea : German Bight

In coastal waters of Niedersachsen and Schleswig-Holstein (Southern German Bight) the obligate heterotrophic and potential toxic dinoflagellate *Noctiluca scintillans* formed red water discolourations as early as end of April, beginning of May (up to 1 000 cells l<sup>-1</sup>). Strong winds distributed the cells thereafter in the water column and only in late August/early September *Noctiluca* caused again water discolouration. Adverse effects have not been reported.

The potentially foam-forming prymnesiophyte *Phaeocystis globosa* started to form a bloom in late April/early May together with *Noctiluca*, but due to strong winds *Phaeocystis* did not reach high cell and colony densities. In May - like in Norway, Sweden and Denmark - the raphidiophyte *Chattonella* cf. *verruculosa* was found in the German Bight in coastal waters of Schleswig-Holstein and around Helgoland. Fish kills or other adverse effects have not been observed.

In the middle of August, *Dinophysis acuminata* reached cell densities of about 1 000 cells l<sup>-1</sup> at the west coast of Schleswig-Holstein between the islands of Amrum and Sylt. In this region, blue mussels harvested at the 23rd of August, contained up to 800 µg okadaic acid kg<sup>-1</sup> mussel hepatopancreas (reference level for Germany: 400 µg OA kg<sup>-1</sup>). Mussel harvesting was stopped for 3 weeks, causing an economic loss of about 200 000 EURO.

The raphidiophytes *Heterosigma akashiwo* and *Fibrocapsa japonica* were found repeatedly in the southern German Bight but no adverse effects have been reported.

## Baltic Sea : Coast of Schleswig-Holstein and Mecklenburg-Vorpommern

Cyanobacteria dominated the biomass of the phytoplankton during long periods from spring to autumn. These were the potentially toxic taxa *Anabaena* cf. *flos aquae*, *Aphanizomenon* cf. *baltica*, *Limnithrix redeckei*, *Microcystis aeruginosa*, and *Nodularia spumigena*. *Anabaena* cf. *flos aquae* reached biomass densities up to 36 mg $\cdot$ l<sup>-1</sup>. Toxicity was not measured, adverse effects have not been reported. The dinoflagellate *Prorocentrum minimum* reached cell densities up to 2.5 million cells per liter during late August to October. *Dinophysis acuminata* reached cell densities of 3 000 cells $\cdot$ l<sup>-1</sup>. Again, adverse effects were not recorded.

## IRELAND

The newly detected toxin, azaspiracid persisted in mussels during most of the winter 1997–1998 along the northwest coast. *Dinophysis* distribution was similar the previous years. *Gymnodinium mikimotoi* was responsible for abalone mortalities on the west coast in September

## NETHERLANDS

In 1998 there were no toxic events measured in The Netherlands. There was, however, a small bloom of the raphidophycean *Fibrocapsa japonica* in August along the Dutch coast with maximum cell concentrations of 2 10<sup>4</sup> cell $\cdot$ l<sup>-1</sup>. No *Fibrocapsa* toxins or related events (NSP) were measured although there was concern that the poor condition of common seals in the Wadden Sea was due to this bloom.

## NORWAY

The problems related to harmful algal blooms along the Norwegian coast in 1998 were about as normal concerning recordings of shellfish toxins (diarrhetic and paralytic). A bloom of *Chattonella* aff. *verruculosa* in early May caused, however, a loss of 350 tonnes of Atlantic salmon in fish farms located at the south-west coast of Norway. No toxicity were found according to mice bio-assays. The fish mortality may have been due to mechanical clogging of the fish gills. This is the first report of *Chattonella* aff. *verruculosa* blooming in European waters.

## PORTUGAL

This year the most relevant problem was the occurrence of DSP all over the country coast and mainly at Algarve, where littoral bivalve fisheries had to be closed for long periods. ASP reached twice values over 20 $\mu$ g/g (Minho Estuary and Aveiro Lagoon), which only had happened before once, in *Callista chione* at Setubal area on 1995.

## SCOTLAND

A toxic phytoplankton monitoring programme was introduced in Scotland in 1995 and is undertaken by the Marine Laboratory, Aberdeen (MLA) on behalf of the Scottish Office Agriculture and Fisheries Department (SOAEFD). This programme runs in conjunction with an intensive toxin monitoring programme in shellfish flesh. Thirty-one sites around the coast of Scotland were monitored for the presence of potentially toxic phytoplankton in 1998. All sites were selected on the basis of their importance as shellfish growing or harvesting areas and in order to maximise coverage of the entire Scottish coastline.

The main toxic species of concern to shellfish in Scottish waters are:

*Alexandrium* spp. which is considered to be the main source of PSP, *Dinophysis* spp. and *Prorocentrum lima* which are potential producers of DSP and *Pseudo-nitzschia* spp. which have been associated with the production of ASP.

Depth integrated water samples (0–10 m) are collected weekly, fortnightly or monthly, depending on the site and/or time of year. The samples are examined for potentially toxic species. In addition, all of the first 100 cells in each sample are identified and counted in order to quantify the overall composition of the sample.

In 1997, a threshold level of 150,000 cells $\cdot$ l<sup>-1</sup> of *Pseudo-nitzschia* spp. was set for ASP testing (i.e., if the concentration of this genus exceeded this level, samples of shellfish were tested for ASP toxins). This level was reduced to 50,000 cells $\cdot$ l<sup>-1</sup> in 1998 when it became apparent that toxicity in shellfish could be detected below the original threshold level.

MLA recognised the need for a dedicated relational database to handle the large volumes of diverse data collected through its monitoring programmes. A Phytoplankton & Shellfish Monitoring Paradox Database was designed, tested and implemented for use in our monitoring programmes in 1996. This system is an efficient way of handling the data collected and allows the different data types e.g., environmental data, shellfish toxin results and species data, collected to be archived. The database also produces comprehensive reports and allows the user to export the data in a suitable form for further analysis. All results collected to date have been archived in this database.

As in past years, *Alexandrium* spp. were recorded in low to moderate concentrations over a wide area of the Scottish coast and were observed at 26 of the 31 regular monitoring sites and in 23 % of all samples. These potentially toxic species were first detected on the 27 January in a sample from Stonehaven near Aberdeen at a concentration of 100 cells.l<sup>-1</sup>. The highest concentration observed in 1998 was 5,000 cells.l<sup>-1</sup> which occurred in a sample from String, Orkney on the 18 May. This also represents the highest concentration recorded in the monitoring programme since it began in 1996.

PSP toxins were detected in several areas with the most prolonged period of high toxicity occurring in Scapa Flow, Orkney as has been the case over recent years (May to Dec). The highest level recorded in this area was 1695µg STX eq./100 g in mussels (*Mytilus edulis*).

*Dinophysis* spp. were observed at 25 sites during 1998. Four different species were identified, *D. acuminata*, *D. acuta*, *D. norvegica* and *D. rotundata*. *Dinophysis* spp. were present in 37 % of all samples analysed. The first *Dinophysis* spp. detected was in a sample from St. Abbs on the 13 th of January at a concentration of 20 cells.l<sup>-1</sup>. The highest concentration was recorded at Ullapool on the 3rd of August at a concentration of 2,600 cells.l<sup>-1</sup>.

Another potential producer of DSP toxins, *Prorocentrum lima* proved to be comparatively rare in Scottish waters in 1998. This species was recorded at 6 sites and in 9 samples (1.8 %). *P. lima* was observed at concentrations of 100 cells.l<sup>-1</sup> in all samples where it was present. DSP toxins were found in 8 areas with prolonged outbreaks in the Dornoch Firth and Fairlie in the Clyde. Shorter outbreaks occurred in other areas of the West coast.

*Pseudo-nitzschia* spp. were recorded at all 31 sites and in 71 % of samples, with a maximum concentration of 3.1 cells.l<sup>-1</sup>, recorded in a sample from Scapa Bay, Orkney on the 16 July.

Domoic acid levels exceeded the closure value in Scapa Flow, Orkney, Scalpay off Skye and from scallop grounds off the east coast (Stonehaven and Orkney) in July and August.

## SPAIN

**Cataluña:** The most outstanding episode was the blooming of *Alexandrium catenella* (first recorded in the region in 1996), in the coasts of Tarragona (May-June) and Barcelona (July-August), reaching maximum concentrations of 8 x 10<sup>7</sup> cell<sup>-1</sup> and toxicity values up to 983 µg equiv. STX 100 g<sup>-1</sup> meat. For the first time, the usual occurrence of *Dinophysis sacculus* in the winter, that reached very high numbers in 1998 (19 x 10<sup>3</sup> cell<sup>-1</sup>) was associated to detection of DSP toxins in bivalves. Blooms of *Gyrodinium corsicum* in the winter caused mussel mortality.

**Galicia:** Moderate ASP toxicity associated with *Pseudo-nitzschia* spp was reported in a northern and in a southern ría in the autumn. There was a very localized PSP outbreak in Ría de Vigo associated to *Alexandrium minutum*. DSP toxicity associated with proliferations of *Dinophysis acuminata* appeared in the Southern Rías in different pulses in early summer and in the autumn.

**Andalucía:** DSP toxicity was detected in Cadiz Bay during proliferations of *D. acuminata* in February, and ASP toxicity in the Alboran Sea connected to high levels of *Pseudo-nitzschia* spp in June. A bloom of *Prorocentrum minimum* in the Bay of Cádiz in February was not associated with any harmful effect.

**Baleares Islands:** Dense blooms of *Alexandrium minutum* and *Alexandrium taylori* in summer cause water discoloration in beaches in Mallorca, preventing recreational swimming and causing important damage to the tourist industry.

## SWEDEN

1998 was a relatively "calm" year in Swedish waters. The only major bloom was the *Chattonella* bloom in the Skagerrak area in April-May. The bloom was first observed just north of Jutland and developed then to cover the whole Skagerrak and most of the Kattegat. In mid May, it culminated west of Denmark. In Swedish waters the maximum cell

densities were about 6 million cells per liter. There were several reports of mortality among wild fish, e.g., garfish, herring, mackerel. This species, *Chattonella* cf. *verruculosa* has not been observed in these waters earlier.

In mid July, there was a sudden increase in Okadaic acid content in blue mussels along the Swedish Skagerrak coast. Concentrations of up to 2 500 µg/kg mussel meat were found from July through December. *Dinophysis* spp. were common, but not unusually abundant.

In the northern Baltic Sea, there was an intense bloom of *Heterocapsa triquetra* between July and September. Especially along the coasts and in bays, the water was coloured red by the accumulation of this species. This was the most intense bloom of *Heterocapsa* that has been observed in northeast Baltic (Askö area). Cell densities of up to 23 million cells per liter was reported.

The bluegreen blooms, that are characteristic for the summer in the Baltic Sea were rare in 1998, due to unusual bad weather. Only a few surface accumulations of *Nodularia/Aphanizomenon/Anabaena* were observed.

#### U. S. A.

With two exceptions, it was a "normal" year for HABs in the U.S. As it happens most years, PSP was recorded in the New England states as well as California, Washington and Alaska on the west coast. Brown tides were observed in Long Island and Texas but at much reduced cell concentrations from the recent past. The Florida red tide recurred as well, along the west coast of Florida.

The two unusual or noteworthy events were:

1. Extremely high domoic acid levels in the state of Washington where DA reached 295 ppm in razor clams. Since razor clams take at least 9 months and probably longer to depurate domoic acid, the toxicity from 1998 will likely keep the shellfishery closed in 1999.
2. Several outbreaks were linked to *Pfiesteria*-like organisms. There was one outbreak with massive fish kills in the Neuse River, NC and one in the St. Lucie River, Florida, where no fish kills occurred, but where many fish with lesions were reported. There is no definitive link yet established between lesions and dinoflagellates, but some think the St. Lucie problems may have involved *Cryptoperidiniopsis*.

#### DECADAL MAPS (ANNEX IV)

The purpose of plotting events on maps is to obtain a global and visual overview of harmful events for the preceding ten years. Information which is plotted on the maps includes indication of regular monitoring sites (phytoplankton and / or phycotoxins), and indication of the frequency of harmful events during the last ten years. Each map represents one type of event, and the different types of events are: DSP, PSP, ASP, NSP, CFP, animal and plant mortality, and cyanobacteria toxicity. The information plotted is the presence of toxins, or observations of mortality. Blooms of potentially toxic species with non detectable levels of toxicity do not appear on maps.

For this third year, maps are updated for the period 1988–1997. These new maps will be included in the IOC and ICES Web pages, as soon as possible.

**Term of Reference 2:** review the work of the ad hoc group set up to establish the ICES-IOC Harmful Algal Bloom Event Database ( HAEDAT);

#### DEVELOPMENT OF A COMPUTER DATA-BASE ON HARMFUL ALGAL OCURRENCES WORLDWIDE: "HABDAT"

At the 1998 meeting of the ICES/IOC Working Group on HAB Dynamics, the development of an IOC-ICES database on harmful algal events (HAEDAT) and the format of the new questionnaire for the National Reports were approved. An updated analysis of the information, which has been entered into the database to date, was presented.

#### Report analysis:

Although most National Reports since 1987 have been entered into the database, only those from 1993 onwards (n = 427) have been completed and reviewed. The composition of the different fields of HAEDAT has also been modified to simplify the presentation. Table I summarizes the information provided in the reports when the different fields of the database were completed. Main conclusions were:

- 30 % of the reports summarized more than one event. Whenever possible, the reports were divided into individual events to facilitate future use.
- Although most of the reported events were associated with a specific location, exact dates were only given for approximately 75 % of the events.
- Provision of environmental information (except for temperature and salinity) was scarce.
- More than 95 % of the event reports have identified the causative species, but only 55 % showed quantitative data. There is little information concerning cyst presence, and pigment analysis.
- Data concerning toxins is qualitative for more than 80 % of the reported events. Once toxicity was detected or intoxication occurred, management decisions and additional information on harmful effects was provided for more than the 90 % of the events.

#### **Future steps:**

- New format for the National Reports- The present structure does not have the appropriate questions to complete the different database fields. The new format is presented in Annex I as of 1999 the new questionnaire should be used and it is up each countries responsibility to complete reports from previous years.
- Data entry from previous National Reports will be completed by May 1999. Concurrently, the database will be presented on the IOC and ICES WWW servers. This database will be available for a 4 month testing period prior to being introduced globally.
- The annual National Reports can be reported via the WWW directly to the IOC-IEO Scientific Communication Center located in Vigo. More details on the operation of the database are given in Annex I.
- Participation in HAEDAT will open to global contributions following the trial period.



TABLE I: Statistical analysis from the National Reports entered into the HAEDAT from 1993–1997. Number of total events reported was 427. The percentages summarize the number of completed fields.

Location and Date		Microalgae Information	
Detailed location	70 %	Causative species	95 %
Approximate location	30 %	Unknown species	5 %
Coordinates	15 %	Cell concentration	55 %
Graphical information	15 %	Additional species	0.3 %
Description of location	2 %	Pigments/Cysts	5 %
Approximate date	75 %		
Accurate date	20 %		
Precise day	5 %		
		Harmful effects	
Environment		Toxicity vector	87 %
Weather/water column	7 %	Unexplained toxicity	3 %
Temperature/salinity	54 %	Toxin identification	4 %
Turbidity/Oxygen cont., etc.	4 %	Toxin quantification	12 %
Nutrients	2 %	Effects/Management	91 %
Advected/In situ bloom	65 %	Economic losses	0.1 %

## **Operation of the HAEDAT**

1. The HAEDAT will be operated, maintained and funded by the IOC-IEO Science and Communication Centre (HAEDAT Adm), Vigo, at least until the end of 2001;
2. Annual National reports should be submitted directly to the HAEDAT WWW-site at least 1 month prior to the annual WGHABD meetings in the format in this Annex. National focal points will be reminded by the HAEDAT Adm;
3. Input on single events, and complementary information on previously recorded events, to the HAEDAT WWW site will be possible at any time;
4. Data submitted to the HAEDAT WWW site will not go directly to the HAEDAT but will be controlled and monitored by the HAEDAT Adm;
5. The IOC HAEDAT WWW site will be linked to the WGHABD decadal HAE maps and the IOC-ICES MONDAT database on HAB monitoring systems worldwide.

## **Disclaimer - Warning**

In order to avoid misinterpretation and misuse of the sensitive information on the maps and in the database, a warning and a disclaimer should be included when information is extracted. As an example, a quick glance could lead to avoid importing shellfish from a given coastline while the number and size of the icons reveal simply that shellfish from this area are probably safer than elsewhere, due to the intensive monitoring effort.

### **HAEDAT Disclaimer - Warning**

"This database contains information on harmful algal events from 1987–1998. The information is based on yearly national reports by ICES member states. The available information on individual events varies greatly from event to event or country to country. Monitoring intensity, number of monitoring stations, number of samplings, stations, etc. also varies greatly and therefore there is not a direct proportionality between recorded events and actual occurrences of e.g., toxicity in a given region. Furthermore, areas with numerous recorded occurrences of HAE's, but with an efficient monitoring and management programmes, may have very few problems and a low risk of intoxications, whereas rare HAE's in other areas may cause severe problems and represent significant health risks.

Therefore, HAEDAT maps should thus be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries.

The IOC and ICES are not liable for the possible misuse of this information."

### **DECADAL Maps of Toxin presence - Warning**

#### **"DISCLAIMER – WARNING"**

HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries.

The IOC and ICES are not liable for possible misuse of this information."

### **Recommendation:**

The ICES-IOC WGHABD recommends that the completed HAEDAT, covering the period 1987–1998, be made available on the ICES and IOC WWW sites. It further recommends that the HAEDAT format for national reports, as specified in Annex 1 hereto, is adopted as the new format for all national reports on HAE collated by the WGHABD.

The ICES-IOC WGHABD recommends that a disclaimer be included in the presentation text of the decadal maps and of the HAEDAT database.

The ICES-IOC WGHABD recommends that each decadal map a warning sidebar (*vide supra*)

**Term of Reference 3:** prepare a review document on the population scenarios for the different harmful algae species;

( *vide supra*: summary of the discussion on this item)

**Term of Reference 4:** continue the examination of the population dynamics and assess the role of harmful benthic microalgae in benthic and pelagic food web

Relatively little attention has been directed to the study of population dynamics of harmful benthic microalgae, even in descriptive terms. Most research on harmful benthic species has focussed on classification of new taxa, semi-quantitative surveys of species abundance in a limited number of environments, toxin analysis of cultured isolates, and general descriptions of benthic habitats. The paucity of information is related to the fact that phycotoxin syndromes clearly linked to benthic/epiphytic species, e.g., ciguatera fish poisoning (CFP), are considered to be primarily sub-tropical or tropical phenomena, usually occurring in areas with underdeveloped scientific infrastructures. Nevertheless, there are several valid reasons why population dynamic studies of harmful benthic are worthy of consideration by the ICES WGHABD: 1) certain ICES member countries have territories or dependencies in tropical/sub-tropical environments afflicted by ciguatera, notably the United States (Virgin Islands, Puerto Rico, Hawaii, Guam) and France (certain Caribbean areas, French Polynesia); 2) increased tourism and business travel from ICES countries to ciguateric areas has led to a dramatic rise in human cases of intoxication in citizens returning home; and 3) increased consumption of imported seafood from ciguateric areas requires monitoring vigilance by ICES member states.

**Development of rational and statistically representative sampling protocols for potentially toxic benthic microalgae is clearly an important consideration.** Certain problems of representative sampling inherent in monitoring harmful planktonic algal bloom, i.e., spatial "patchiness" may actually be magnified for benthic/epiphytic species given their tendency to grow in clumps. The ICES WG recognizes that truly representative sampling will require many replicates, with proper care needed so as not to lose weakly attached cells to the water column. However, once the appropriate spatial scale has been defined, the relatively static distribution of the population may confer some advantages in conducting time-series measurements, such as the determination of *in situ* growth rates and life cycle observations.

Studies on grazing processes can also be more readily conducted on substrate-attached species than on their pelagic counterparts. Zooplankton, including harpacticoid copepods and ciliates, have been observed to graze on epiphytic microalgae attached to macroalgal and cyanobacterial mats. **This surface grazing upon toxic species could be an important mechanism for the transfer of toxins within marine food webs, including the plankton.**

Since many epibenthic species grow readily on nutrient-rich solid substrates, e.g., marine agar plates, this ability can be exploited to conduct experiments on allelopathic or chemotactic interactions, exo-enzyme or toxin production, multidimensional responses to nutrient gradients and genetic studies. Bacterial-algal interactions should be a particular focus of such research activities. Time-series experiments using artificial substrates placed *in situ* in the water column or the benthos would be valuable to evaluate rates of colonization and mobilization of harmful microalgae.

Mechanisms of dispersal and geographical spreading may be rather different for benthic microalgal species than for phytoplankton. In addition to their ability to roam within the water column, due to their usually rather limited swimming behaviour, the former species can often exploit a wide variety of ecological niches and substrates, including the hulls of vessels, docks and pilings, floating and attached macroalgae, marine fauna, coral reefs, sediments, inter- and sub-tidal sand deposits, aquaculture installations, etc. Such "benthic" species are frequently found attached to macroalgal and cyanobacterial mats, and rafting in this manner is a plausible dispersal mechanism. Indeed it is perhaps most accurate to describe many of these substrate-preferring species as facultatively benthic, as they often occur in the plankton and some (e.g., *Prorocentrum lima*) were first described from the water column.

**To the knowledge of the WGHABD there are no monitoring programs for known- or potentially harmful benthic species anywhere in the world.** This is in spite of the fact that historical and current incidents of human illness unequivocally associated with benthic microalgae, specifically CFP linked to the occurrence of *Gambierdiscus toxicus*, outnumber those assigned to toxic phytoplankton. Toxin dynamics of CFP are often described as the "ciguatera complex" – a poorly differentiated group of toxins that may be derived from multiple benthic species (of *Gambierdiscus*, *Ostreopsis*, *Coolia*, etc.). This syndrome may even include toxins from DSP toxin-producing species such as certain *Prorocentrum* found in the mixed benthic assemblage in ciguateric areas. The population dynamics of the individual species in these assemblages clearly deserve further scrutiny.

Within the possible exception of CFP, the role of epi-benthic species in other toxin syndromes is definitely under-appreciated. In ICES countries, such as France, Norway, Spain, Portugal, and Canada, where benthic species known to produce DSP toxins (such as *P. lima*) are typically found at concentrations of only a few cells per litre in water column monitoring, their contribution to toxicity has often been dismissed as negligible. In most areas of the world where DSP

toxicity is endemic, the primary causative organism has been identified as one or more species of *Dinophysis*. Therefore, the harmful phytoplankton monitoring programs in many countries employ cell concentrations or "standing stock" of *Dinophysis* spp. as an early warning of potential DSP toxicity in shellfish species. In some countries, an arbitrary threshold of a few hundred to a few thousand cells per litre in surface waters is used to guide or impose closures to shellfish harvesting. Use of such a "*Dinophysis* index" derived from phytoplankton monitoring data was found to be totally unworkable to forecast DSP toxicity or to explain historical toxicity patterns in Nova Scotia (eastern Canada). It has been repeatedly confirmed that *Dinophysis* populations in this area are consistently non-toxic. Anecdotal speculations on unexplained DSP toxicity in molluscs in New Zealand, Iberia and France have suggested the possibility of that toxic benthic species might be involved, but until the recent study in eastern Canada (see theme sub-report below) this had not been substantiated. For example, in Brittany, France, the direct association between observed *Dinophysis* blooms and DSP toxicity is not always evident. Such lack of correlation is usually explained as due to inadequate phytoplankton sampling and to spatio-temporal patchiness in plankton distribution. Indeed this explanation is likely to be valid under most circumstances. **Nevertheless, further case studies in a diversity of environments are required to confirm if DSP toxicity caused by benthic microalgae is a widespread phenomenon or is limited to special circumstances.**

Much remains to be determined regarding the effects of aquaculture installations on the population dynamics of epi-benthic species, changes in microalgal community structure, and their respective contributions to net toxicity. Introduction of floating rafts, longlines, or cages to the water column effectively provides an "artificial reef" substrate oriented on a vertical axis, with the opportunity for colonization in the upper water column where light levels may be favourable to the rapid growth of harmful phototrophic species. Furthermore, liquid and solid excreta of aquaculture species contribute to organic enrichment, thereby promoting selective growth of epi-benthic species capable of heterotrophic nutrition. Toxin transfer may be very complex under such circumstances, including secondary accumulation of toxins by predatory macrofauna, such as carnivorous gastropods and crustaceans, which may prey upon toxic suspension-feeding shellfish in dense aggregations.

*To date there have been few detailed biogeographical or seasonal studies on the population dynamics of harmful benthic microalgae, and little information is available on the residence time of cells in the water column. Critical studies are essential to evaluating the potential for suspension of harmful benthic microalgae from the sediments to the upper water column and the mobilization of such cells due to advection and storm events.*

**Term of Reference 5:** identify and summarize existing knowledge on sources of "founding" populations for HABs such as over-wintering of vegetative cells, cyst germination, hydrographic transfer, transfer through biological or human activities;

Most coastal phytoplankton species which include HAB species are meroplanktonic as they only have a short bloom period during their life cycles. When absent from plankton, they are either present as physiological resting stage forms, which are morphologically non differentiated compared to vegetative cells, or morphologically different cysts. Mechanisms for formation and fate of physiological resting stages (as present in the domoic acid producer *Pseudo-nitzschia*) are even less understood than those for resting cysts. Most algae responsible for HABs belong to the dinoflagellates, a group known to produce both temporary and long term resting cysts. It is therefore also important to evaluate the contribution of resting cysts to the development and decline of HABs.

### **Resting cyst stages in harmful algae**

Resting stages are not found in all taxa. So far, no harmful diatoms have been shown to produce resting cysts. However, prymnesiophytes, raphidophytes and blue-greens produce cysts. Given the limited amount of information available on cyst dynamics for these three last groups, the discussion focused exclusively on dinoflagellates. However, concepts and recommendations may be applied to all resting stages, which form HABs.

### **Temporary cysts in dinoflagellates**

Dinoflagellates produce both temporary and long-term over-wintering cysts. Temporary cysts have been observed at several locations in the natural environment, generally following adverse conditions such as increased turbulence. Temporary cysts may therefore allow dinoflagellates to extend their growth periods. These cysts may be formed quite rapidly (minutes to hours) and persist for a few days returning to vegetative cells in a matter of hours. Cysts may also allow dinoflagellates to resist digestion by shellfish; e.g., when *Alexandrium minutum* cells go through the oyster digestive track, the cell wall rapidly loses its permeability. The cell wall regains its permeability following the excretion of the cell and becomes viable in 3–4 hours. Furthermore, this provides an example of where temporary cysts can allow the reseedling of a population, extending its growth period. Translocation of shellfish from a contaminated site to a toxin-free area may also represent a high risk for introduction of HAB species.

## Resting cysts in dinoflagellates

### Cysts in the water column

Resting cyst formation seems to be triggered by unfavorable environmental conditions such as strong winds, mixing and nutrient limitations. Although encystment may represent an obvious cause for bloom termination, we are not aware of reports of increased concentrations of cysts in the water column associated with the collapse of a harmful dinoflagellate bloom in nature. This may be because of high sinking rates of cysts. Considerable variability has been reported in the cyst/vegetative cell ratio during natural blooms. This ratio seems to vary from species to species, as well as inter-regionally for similar and closely related species. This inter-regional variability has been observed between *Alexandrium tamarense* in the St. Lawrence where cysts are rarely seen in the water column even when observed concentrations were greater than  $1 \text{ million cells} \cdot \text{L}^{-1}$  and *A. fundyense* in the Bay of Fundy where cysts were observed when peak bloom concentrations exceeded  $20,000 \text{ cells} \cdot \text{L}^{-1}$ . Causes for this variability are unknown, but may reflect a different life cycle hydrodynamic strategy. Measurements of change in the percentage of cysts with respect to vegetative cells during the different phases of blooms should provide useful information on the physiological status of the algae.

Recently excysted cells may exhibit particular physiological features allowing their identification. In the Bay of Fundy, newly excysted *Alexandrium fundyense* cells are significantly smaller than the usual healthy vegetative cells and have less free space between the theca and the cell contents when preserved with FAA. This may be a very convenient way to determine bloom initiation location and timing. If these small cells are meiospores, four daughter cells may be rapidly produced in less than one day. This may result in a rapid increase in initial inoculum.

### Cysts in the sediment

Cysts have been recorded at varying depths, from shallow waters to depths greater than 100 m where they tend to accumulate with fine sand and silt. The fate of cysts deposited in deep waters is unknown. Cysts of HAB species may be found in areas where they are known to thrive. Mapping of cyst distributions could provide valuable information about areas prone to toxic outbreaks. There is no apparent correlation between abundance of cysts in sediments and the bloom amplitude. It is not known whether there is a minimum threshold cyst concentration necessary to perpetuate a population in a given hydrodynamic system. Sinking cysts may be advected by local currents before they reach the sediment. Once on bottom, be relocated by bottom currents to more suitable depositional areas. Cysts may subsequently be observed far from their area of formation.

### Cyst maturation and germination

Most cysts have to go through a mandatory dormancy period before germination. The length of the dormancy period ranges from 12 h to several weeks or months and seems to be under physiological control. Duration periods for cyst dormancy have been suggested to be either temperature dependant (i.e., lower temperature = longer maturation time) or controlled by depletion of internal storage products. Once cysts mature, their germination may be triggered by various environmental factors such as temperature, salinity and light. However, it is clear that anoxia prevents germination in the majority of cyst species. The germination of cysts in deeper anoxic sediments may be triggered by resuspension events such as storms or dredging. Factors governing the length of dormancy periods and resulting excystment are not well understood for most species and should be investigated due to their critical role in bloom initiation.

Empty *Gymnodinium catenatum* cysts without a typical archeopyle and with one or two round openings in their outer walls have been observed in Portuguese coastal waters during 1998. Parasitism and predation have been suggested as possible causes for this phenomenon. Although this observation needs to be confirmed, it represents a potentially new mechanism which may control the initiation of HABs. Coincidentally, *G. catenatum* blooms have not occurred in Portugal since 1996. The apparent relationship between the decline in bloom intensity and these abnormal cysts is speculative. Given its potential direct impact on bloom initiation, this new phenomena should be considered for future studies.

## Recommendations

- Investigate the physiological resting stages for HAB species not known to produce resting cysts.
- Determine the cyst distributions of major HAB species in order to identify areas prone to HAB development.
- Investigate the potential for predation and parasitism on natural cyst populations.
- Determine the influence of environmental factors (e.g., temperature, light etc.) and internal biological clocks on cyst germinations.

- Investigate the relationship between cyst germination and timing and amplitude of HAB blooms.

Develop coupled biological-physical models for different HAB species. These models will aid in estimating the importance of location, transport, timing and size of initial inocula for HAB distributions.

**Term of Reference 6:** examine with the help of invited experts and in collaboration with the Working group on Shelf Seas Oceanography recent developments and inherent assumptions in physical coastal modelling;

Model results from the Baltic were presented and discussed in detail. The coupled physical and biological models from the Institut für Ostseeforschung, Warnemuende combine the MOMs (Modular Ocean Model) with two different biological models. While the objective of this work is to document the nitrogen flux in the Baltic Sea, the results presented by Dr. T. Neumann give insight into some of the processes which are of interest for HAB work, specifically the spring bloom is reproduced as it progresses from the Kattegatt to the Arkona Basin and then to the Baltic Proper. The succession of phytoplankton, starting with diatoms then flagellates and finally cyanobacteria, is reproduced by the calculations. This results arise with just nitrogen and phosphorous nutrient pools and without using silica limitation.

The three algae groups have different dependencies on temperature. Diatoms don't depend on temperature. Flagellates (or more precisely, algae using the recycling capabilities of the microbial loop in summer) have a weak dependence on temperature, whereas the cyanobacteria are strongly coupled to temperature. This assumption is in accordance with observations. Data shows that cyano blooms occur only when temperature exceed 16–17 °C. The diatom group have a sinking velocity, flagellates don't sink. Cyanobacteria have the capability to adjust their buoyancy. The groups have a different sensitivity to nutrient concentration as well as they have different maximum growth rates. We assume, that during winter the nutrient concentration is restored to high values. The diatoms with the highest maximum growth rate and no dependence on temperature grow up very fast in spring if the light is sufficient. If nutrients become depleted, flagellates have an advantage. They are more adapted to deal with low concentrations. In the model, this is realised with a smaller half saturation constant in the Michaelis-Menten kinetics. Cyanobacteria have the highest value for the half saturation constant but they depend only on phosphorus. In the model as well as in general in the Baltic we have a surplus of phosphorus. If, in the course of the summer, the nutrients and in particular nitrogen are further depleted, cyanos are advantaged. They are not limited by nitrogen (by phosphorus only). All these properties together, temperature, sinking velocities and nutrient limitation cause the succession of the phytoplankton groups.

Much discussion ensued about the details of the biological models and their applicability to species-specific predictions. It was felt that a model of the type presented could describe the likelihood of a flagellate bloom but would probably not forecast the specific harmful species. However, it might be possible to examine the sensitivity of the oceanic setting to different species due to their detailed population dynamics. This hypothesis needs testing, which can be accomplished by detailed calculations over a range of parameterizations for the biological interactions. Different nutrient uptake formulations can be used to test different hypotheses about the population dynamics. For example, the proclivity of cyanobacteria to bloom is associated with their ability to use atmospheric nitrogen. However, the use of nitrate and ammonia by cyanobacteria could hasten their bloom in two ways. First, it would limit the flagellates by removing their nutrient source and second there would be more cyanobacteria in the water when the dissolved nitrogen limitation suppressed the other phytoplankton. These two effects would serve to move the cyanobacteria bloom forward in time and increase its amplitude.

Modelling will need to account for advances in understanding of HAB population dynamics that will come from improved sampling systems. Measurements have shown that planktonic populations are frequently concentrated into relatively thin layers. These thin layers mean that the plankton dynamics are not based on average concentrations. The relative spatial positioning of predators and prey are unmeasured and hence there is a major gap in our ability to model the mortality/loss rates. Also, the advection of harmful algae and their interactions with target species (usually shellfish) will be strongly affected by their vertical distributions in relation to the velocity profile in the water.

Much work is needed on modelling HABs as was seen from examples presented at the meeting. The *Alexandrium* bloom in the Gulf of St Lawrence is a good candidate for modelling. Excystment from the seed bed, retention of the algae in order to start the bloom, and the advection of the bloom in the coastal current were strongly affected by physical processes and the hydrodynamics. Work is underway to couple a biological model to a hydrodynamic model to study the particular *Alexandrium* bloom.

Another general problem which can be studied with modelling is the question of the relative importance of nutrient input to the recycled nutrients available in the system. Nutrient input can arise from oceanic sources (presumably natural), from riverine input (both natural and anthropogenic sources), from atmospheric input (natural, anthropogenic, and conversion by cyanobacteria), and from benthic sources.

Models must be designed to study specific questions, for example:

- 1) flux of nutrients
- 2) prediction of the spring bloom/ timing and amplitude
- 3) species succession
- 4) test hypotheses about parameterizations of rates etc.
- 5) Biomass production

The modelling approach changes from one problem to the next. Sometimes one will model the spatial distribution but at other times the total number (the total integral on the number concentration) is sufficient. Many specific HAB events have small dimensions relative to the spatial resolution of the models available and in addition thin layer considerations will force special model developments.

## **6 FORUM ON NEW RESULTS**

The suggestion that the group should take the opportunity to present new results and concepts related to the dynamics of harmful algal blooms was well received. Ten contributions were presented.

### **TOXICITY TESTING PROCEDURES (C. Belin)**

During the *Alexandrium tamarense* episode in Thau lagoon (vide supra French National Report), a problem occurred as a result of the procedure chosen for the DSP mouse-test by the European Reference Laboratory (ERL) for phycotoxins (Vigo). Due to the simultaneous presence of DSP and PSP in the mussels, the recommended procedure for DSP extraction (acetone extraction) led to biased toxin estimates.

The consequences of using the two different methods were important in this particular case, because of the co-extraction with acetone of PSP toxins. In addition, the acetone extraction is performed on digestive glands only, resulting in high concentrations of PSP toxins. Traces of toxins even below the detection threshold of the AOAC PSP mouse-test (about 40 µg) can lead to positive results with the acetone test. This happened with oysters even when they did not contain DSP toxins (negative dichloromethane test), but contained traces of PSP toxins, at levels which are not considered harmful for consumers (always below 80 µg, often below 40 µg). This procedure led to positive acetone tests, even in the absence of DSP toxins.

Following numerous unexplained toxic episodes during the years 1992–96 in France, IFREMER chose not to use the acetone extraction method recommended by the ERL for the DSP mouse-test, but to use the dichloromethane extraction which is more specific for DSP toxins (OA, DTX, but also YTX, PTX and azaspiracid).

IFREMER is responsible for monitoring shellfish in water, but the mandate for marketed shellfish is with Veterinary Services. Since the French National Reference Laboratory (CNEVA) follows ERL procedures which recommend an acetone extraction. If the procedure recommended by the ERL had been applied, the re-opening of the area for all shellfish would have been delayed for several weeks.

In agreement with Veterinary Services, it has been decided to perform both extractions (acetone and dichloromethane) on all shellfish samples in 1999. Following the trial one-year period, results of this experience will be analysed and discussed with the ERL.

### **PROROCENTRUM LIMA AND DINOPHYSIS (A. Cembella)**

This topic was presented by Allan Cembella in the discussion of TOR4.

### **CONTROL OF GERMINATION OF ALEXANDRIUM TAMARENSE CYSTS FROM THE LOWER ST. LAWRENCE ESTUARY (CANADA)**

M. Levasseur, S. Roy, C. Castell Perez, D. Anderson

Cysts of the toxic dinoflagellate *Alexandrium tamarense* (Lebour) Balech 1992 from the lower St. Lawrence estuary were used in a test of the following hypotheses: (a) cyst germination is triggered by a change in temperature, and (b) germination rate varies throughout the year and is controlled by a circannual internal biological clock. Results show that cyst germination was not affected significantly by temperature of incubation over the range 1–16°C and light showed no significant stimulation of germination. This is supported by the lack of effect of cyst incubation conditions during evaluation of the seasonal changes in germination rate (two temperatures: 4 and 15°C, and two light conditions:

darkness and  $150 \mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ). Direct environmental control through short-term increases in temperature and exposure to light thus has no effect on the germination of the cysts tested. The rate of germination, observed monthly over a 16-month period, showed low germination ( $< 20\%$ ) over most of the period tested, except for a maximum reaching more than  $50\%$  germination in August to October of the second year of the experiment. This pattern was observed for cysts from both monthly field-collections and from laboratory-stored cysts kept under constant environmental conditions ( $4^{\circ}\text{C}$ , in the dark). The peak in germination observed under constant environmental conditions (in the laboratory), the almost coincidental increase in cyst germination observed for the field-collected cysts and the absence of effects of temperature and light during incubation could be explained either by a temperature-controlled cyst maturation period (the time-temperature hypothesis of Huber and Nipkow, 1923) or by the presence of an internal biological clock. However, the large decline in the rate of germination 2 months after the maximum provides strong support for the biological clock hypothesis. The *ca* 12 month maturation (dormancy) period observed for the laboratory-stored cysts is the longest reported for this species to our knowledge; this may be related to the low storage temperature ( $4^{\circ}\text{C}$ ) which is close to bottom temperatures generally encountered in this environment ( $0$  to  $6^{\circ}\text{C}$ ). Similar field and laboratory storage temperatures could explain the coincidental increase in germination rate in the fall of the second year if cyst maturation is controlled by temperature. A fraction of the laboratory-stored cysts did not follow a rhythmic pattern: a rather constant germination rate of about  $20\%$  was observed throughout the year. This continuous germination of likely mature cysts may supplement the local blooms of this toxic dinoflagellate, since these often occur earlier than peak germination observed in late summer. It seems that two cyst germination strategies are present in the St. Lawrence: continuous germination after cyst maturation, with temperature controlling the length of the maturation period, and germination controlled by a circannual internal rhythm.

#### DEEP CHLOROPHYLL MAXIMUM (K. Kononen)

Kaisa Kononen presented results obtained during a R/V Aranda cruise at the entrance to the Gulf of Finland in July 1998. The case study was carried out during extremely dynamic weather conditions, and an intense blooming of *Heterocapsa triquetra* was observed throughout the northern Baltic Proper and the Gulf. Nitrate was completely exhausted from the surface layer down to a sharp nitracline at the depth of  $27\text{--}35$  m. The steepest gradients of nitrate was up to  $0.23 \mu\text{M}$  in  $10$  cm. The fluorescence mappings made with a towed undulating device carrying CTD+fluorometer (Estonian Marine Institute) revealed the existence of a maximum layer of Chl *a* fluorescence in the lower part of the chlorophyll-containing layer. The positioning of the fluorescence maximum coincided always with the nitracline and its thickness varied between  $0.5$  and  $2$  m. The Chl *a* concentration of the DCM layer was  $1\text{--}8 \text{ mg m}^{-3}$ , in most prominent cases the value was in the same level as in the surface layer. According to the microscopical examination the DCM layer was formed solely by the dinoflagellate species *Heterocapsa triquetra* Ehrenberg. There was a good correlation between Chl *a* and the abundance of *H. triquetra*. In some cases the vertical positioning of the DCM coincided with a small gradient of salinity, but this was not a rule. In every case the DCM coincided with the sharpest part of the nitracline. It was proven by  $^{14}\text{C}$  primary production measurements that the *Heterocapsa*-population found in the DCM was living and able start photosynthesis as soon as exposed to illuminated conditions.

This observation of the DCM was similar as found in the same area, in similar weather conditions in July 1996. The analysis of the hydrographical situation during the 1996 case study showed that the DCM was created by lateral transport of *Heterocapsa* from a patch formed as a result of eddy activity.

#### GYMNODINIUM CATENATUM CYSTS ON THE PORTUGUESE COAST (M. A. Sampaio)

Between 1994 and 1996 *G. catenatum* cysts accounted for at least  $70\%$  of all cysts found in sediment beds on the Portuguese coast. Of the total number of *G. catenatum* cysts recorded in 1998,  $98\%$  were empty and less than  $2\%$  of these cysts had a typical archeopyle. The remainder had 1 or 2 round openings and it has been proposed that the cell contents were either destroyed by parasites or predators. The relative percentage of *G. catenatum* cysts has been steadily declining in recent years, and at the moment account for less than  $30\%$  of the total recorded cysts (Amorim *et al.*, pers. comm.). The high percentage of non-germinated empty cysts may account for the *G. catenatum* population decline observed on the Portuguese coast, where PSP events have not been detected since 1996.

#### IN SITU GROWTH RATE MEASUREMENTS during the 1998 Alexandrium tamarense red tide in the St. Lawrence estuary, Canada

M. Levasseur, R. Gagnon, J. Fauchot

The St. Lawrence estuary on the Canadian east coast is one of the most toxic locations in the world for PSP. The causative organisms are *Alexandrium tamarense*, and, occasionally, *A. ostenfeldii*. Each year, shellfish from hundreds of kilometers along the coast become toxic for several weeks. Usually, concentrations remain below  $50,000 \text{ cell l}^{-1}$ , with shellfish becoming toxic ( $> 80 \mu\text{g STX}/100 \text{ g meat}$ ) when cell concentrations reach  $1,000 \text{ cells l}^{-1}$ . In July 1998, a red tide ( $100 \text{ km}$  long by  $1 \text{ km}$  wide with discolored water) developed along the south shore with cell concentrations



reaching 2 million cells l<sup>-1</sup>. Incubation experiments were conducted during the bloom in order to determine variations in growth rates. Preliminary analysis of the data shows that growth rates varied from ca. 0.55 div. d<sup>-1</sup> to undetectable during the bloom. Addition of nitrate and phosphate during two *in situ* growth experiments had no significant effect on both growth rate and biomass production.

#### **MICROALGAL POLYUNSATURATED FATTY ACIDS: Effect of temperature and light on their biosynthesis**

G. Bodennec (presented by P. Gentien)

Lipids are one of the most important organic compounds in the phytoplankton cells, mainly serving as structural components of membranes and for storage of metabolic energy. There has been an increasing interest in the analysis of these compounds in marine microalgae, particularly omega-3 polyunsaturated fatty acids (PUFA) and their derivatives on account of their interesting bioactive properties. The beneficial effects on human health as well in fish nutrition of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are widely documented (e.g., Tucker & *al.*, 1997; Ackman 1995). By contrast, the same or similar PUFA have also been shown to be haemolytic and to adversely affect growth in several species, in particular C18 fatty acids with four or five double bonds (e.g., Lawrence & *al.*, 1994; Arzul & *al.*, 1995) and to be implicated in the ecological impact of harmful *Gymnodinium* blooms (e.g., Yasumoto & *al.*, 1990). The noxious activity of octadecapentaenoic acid (18:5w3) and other related PUFA present in *Gymnodinium* species were recently tested (Fossat & *al.*, *in press*) in isolated trout hepatocytes. The addition of 18:5w3 to the medium induced, in particular, a decrease of intracellular pH and Na,K ATPase inhibition, parameters involved in cellular homeostasis. This may at first seem contradictory, but the stimulatory and cytotoxic effects of PUFA or their oxidation products are generally concentration-dependent (Bégin, 1987).

Lipidic metabolism in microalgae is strongly influenced by environmental factors and by the physiological state of the cell. The effect of temperature and light on the lipid biosynthesis was studied with a French *Gymnodinium mikimotoi* strain, with the expectation that cultures grown at a lower temperature would have more PUFA. *G. mikimotoi* is a local toxic bloom-forming dinoflagellate closely related to the species *G. nagasakiense* and *Gyrodinium aureolum*, commonly encountered in the North Atlantic coastal waters and around Japan. These species are thought to cause fish and shellfish mortalities by producing PUFA in the free form or esterified in a glycolipid structure. Glycolipids can be described as lipophilic compounds in which one or two sugar residues [galactosyl (MGDG or DGDG) or sulphoquinovosyl (SQDG)] are linked to a glycerol chain containing one or two fatty acid moieties. They are major components of membrane and chloroplasts where they play an important role in the thermoadaptative regulation of membrane fluidity (Adlerstein *et al.*, 1997).

The distribution of these two haemolytic lipid classes in the cellular extract was determined by Chromarod thin-layer chromatography (TLC/FID) over a time course sampling. Free fatty acids (FFA) were minor components in *G. mikimotoi* cells grown at 13 or 18°C under a relatively high light level with an averaged proportion of 4 % of total lipids in the two cultures. This proportion increased up to 14 % under attenuated light. The main intracellular lipid class, glycolipid (GL), was averaged around 50 % of total lipids in the tested culture conditions. The highest GL content was observed in the cells grown at 13°C. This may be a stress response as temperatures close to 18°C are optimal for the growth of this strain.

Fatty acids analysed by gas chromatography at the end of the exponential phase revealed, besides the usual algal acids, a high amount of 18:5w3 in all the particular extracts, particularly in cultures at the lower light level. It was much more present in cells grown at 13 or 18°C (during the exponential and stationary phases) than at 20°C. Lower growth rates induced by sub-optimal temperatures and light levels appeared favourable to the synthesis of this fatty acid involving an increase of the allelopathic activity. Maximum concentrations observed at 18°C near the maximum cell densities were followed by a rapid decrease during the senescence phase, especially at the highest light level. This fatty acid accounted for up to 34 % of the fatty acids under conditions of comparatively high temperature (18°C) and low light. However, the amount of PUFA in the culture medium was very low suggesting that if cell lysis is the source of most dissolved lipids, the great reactivity of free PUFA and derivatives does not permit their accumulation in the surrounding water.

Toxic fatty acids can occur in the free (unesterified) form, but most are esterified in a glycolipid structure 18:5w3 appeared as the major PUFA in MGDG (30 %) and in DGDG (19 %), it was less represented in the other lipid classes. 16:4w3 was prominent only in MGDG and DGDG while 22:6w3 was the major PUFA in SQDG and in the phospholipids. The others PUFA (18:4w3, 20:5w3, 22:5w3) were minor components in all the lipid classes.

Considering its restricted distribution to Prymnesiophytes and photosynthetic dinoflagellates, 18:5w3 has been proposed to be a biomarker of toxic algae (Joseph, 1993; Okuyama *et al.*, 1993) or of animals grazing on such algae (Mayzaud *et al.*, 1976). 18:5w3/18:4w3 may be characteristic of *G. mikimotoi* with a ratio in the range 20–113, depending on environmental conditions cf. 3.0+/-2.6 in 18 species of microalgae including 14 dinoflagellates. 18:5w3/16:4w3 ratio

appeared also relatively constant in *G. mikimotoi* cells grown under various culture conditions with an average value of  $3.0 \pm 0.7$  ( $n = 53$ ). In relation to algal taxonomy, these ratios may be useful as a link between the usual microscopic observations and a more sophisticated genetic method of species identification.

This study showed the marked effect of light intensity on the synthesis of acyl lipids containing 18:5w3 suggesting a possible imbalance in polyunsaturated fatty acid metabolism at low irradiance. The importance of environmental conditions on the production of 18:5w3 by *G. mikimotoi* may explain the large variability observed in the toxicity of this bloom-forming dinoflagellate.

#### **DETECTION AND DISCRIMINATION OF DINOFLAGELLATES BY FLOW CYTOMETRY, *In-situ* Hybridization and Neural Networks**

J. Brenner, G. Gerdt, Chr. Hummert, G. Donner, N. Simon, Chr. Schütt, B. Luckas, M. Elbrächter, L. K. Medlin, H.-D. Görtz

During several cruises with the research vessel HEINCKE (BAH/AWI, Helgoland, Germany) we were able to detect different species of dinoflagellates - causing algal blooms - by flow cytometry. In August 1996 we found an algal bloom of *Gymnodinium mikimotoi* at the Orkney Islands (Scotland). A distinct population was found in multiparametric dot-plots, where cell volume, side-scatter and fluorescence at two different wavelengths of living cells were measured after concentration of planktonic cells by reverse filtration.

During two further cruises in May 1997 and May 1998 we found toxic algal blooms at the eastcoast of Scotland and at the Orkney Islands. These blooms were caused by a saxitoxin producing species of *Alexandrium tamarense*. We detected these dinoflagellates in water samples by *in-situ* hybridization of 18SrRNA and 28SrRNA and flow cytometry. The population of *Alexandrium tamarense* in multiparametric dot-plots can be correlated with the saxitoxin concentration measured by HPLC. We were also able to show a correlation between cell concentration measured by flow cytometry and the cell concentration determined by the microscopic method of Utermöhl.

The flow cytometric data (list-mode) were also analysed automatically by a trained neural network (backpropagation) and compared with results from conventional gating, corresponding populations in 2D-dot-plots. Our measurements and results of different dinoflagellates from algal blooms clearly show that it is possible to detect specific algae species and subspecies by *in-situ* hybridization with specific oligonucleotide probes and to quantify it in a flow cytometer. In combination with the automatic recognition of the dinoflagellates by a neural network this system is a further step towards automated plankton monitoring.

This study was supported by the German BMBF, TEPS-Project

#### **BLOOMING OF *CHATTONELLA* AFF. *VERRUCULOSA* IN THE SKAGERRAK/NORTH SEA**

Einar Dahl

In April-May 1998 *Chattonella* aff. *verruculosa* bloomed in the Skagerrak/North Sea. Mortality among both farmed and wild fish were associated with the bloom. This was the first recorded bloom of this species in European waters. There is more information on the bloom in the national report from Norway.

#### **FIRST REPORT OF PARASITISM ON THE TOXIC DINOFLAGELLATE *ALEXANDRIUM MINUTUM* HALIM**

E. Erard-Le Denn, M.J. Chrétiennot-Dinet and I. Probert (presented by P. Gentien)

Blooms of the toxic red tide phytoplankton *Alexandrium minutum* Halim (Dinophyceae) have frequently occurred during recent years in the estuaries of northern Brittany, France. Some months after a bloom in the Penzé river in 1997, many *Alexandrium* cells in samples kept in the dark at 14°C were observed to be infected by the sporocysts of an unknown parasite, which, upon exposure to increased light intensity and temperature, ejected many small biflagellate zoospores. The parasite was found to infect laboratory cultures of several other dinoflagellate species, and estimates of parasite-induced mortality indicate that this parasite is capable of removing a significant fraction of dinoflagellate biomass in a short time, raising the possibility of its use as a biological control agent of toxic dinoflagellate blooms. The effect of this parasite on natural *A. minutum* populations remains, however, to be estimated. This paper presents video images used in preliminary identification and life cycle elucidation of the parasite, which may be affiliated with the Apicomplexan complex.

## A NEW PARASITE OF THE TOXIC DINOFLAGELLATE *ALEXANDRIUM CATENELLA* FROM THE MEDITERRANEAN SEA

M. Elbrächter, G. Donner, M. Schweikert.

From Dr M. Delgado, Barcelona, Spain, we got a culture of *Alexandrium catenella*, isolated from the waters off Barcelona, which was parasitized by an unknown organism. The light- and scanning electron microscopy data provided by Dr Delgado did not allow an affiliation to a special group except it has zoospores with the heterocont type of flagellation. The parasite had also been tested for species specificity and seems to be fairly species-specific, not infecting, for instance, *Alexandrium affine*. This made further infection experiments and it did not infect *A. tamarense* and *A. fundyense*. The parasite does feed on particulate material, therefore the possible affiliation to any group of „fungi“ can be excluded. Transmission electron microscopy investigations are ongoing; so far no further affiliation to any subgroup of the heterocont flagellates cannot be given.

Due to the species-specificity of the parasite, it is unlikely that this parasite is identical to that found by French scientist at the Atlantic coast, attacking *Alexandrium minutum* and a wide variety of other flagellates.

### PIV AND HOLOGRAPHY INSTRUMENTATION AND MEASUREMENTS (T. Osborn)

Measurements from a bottom mounted Particle Image Velocimetry were shown and discussed. The system measures turbulence and the velocity profile in the bottom boundary layer. Such measurements are useful for studies of cyst transport, burial, and remobilization. Vertical resolution is on the order of 6 mm. Results from data collected off the New Jersey coast in June 1998 spanned elevations between 10 cm and 138 cm from the bottom, in 15 m deep water. Spectra were calculated from composite vector maps generated using two minutes of data (130 vector maps collected at 1 Hz).

The spectra showed:

- Anisotropy of the velocity field at all scales.  $E_{uu} \gg E_{ww}$  even at dissipation scales while isotropy would predict  $E_{ww} = (4/3)E_{uu}$ . Both  $E_{ww}$  and  $E_{uu}$  show an inertial subrange and can be fit to the universal spectral shape to estimate  $\epsilon$ . However, due to the anisotropy, the dissipation estimates from the downstream spectra are over 50 % larger than from the cross stream spectra.
- Decrease of  $E_{ww}$  as the seabed is approached.
- The 2D spatial data allow the "direct" computation of 6 terms of the dissipation tensor. ( $\epsilon = -2 \sum S_{ij} S_{ij}$ ). The remaining six terms can be estimated based on the measured terms, assuming that all the cross derivative terms are of comparable magnitudes ("weak" isotropy assumption). This is a weaker assumption than the isotropy requirement involved in using a  $k-5/3$  line fit to estimate dissipation.
- Spectra cover 3 decades in wavenumber with little noise contamination at the high wavenumber

### HOLOGRAPHY (T. Osborn)

Three-dimensional, oceanic holography samples were demonstrated to show the capability to sample a volume of the ocean (12-cm diameter by 40-cm length) down to scales of 5 microns. The hologram can be expanded in the laboratory and examined with a microscopic lens on a video camera in order to determine the three dimensional distribution of all particles larger than 5 microns. Double exposures of the hologram (rather than with a single flash of the laser) enables PIV calculations to get the three-dimensional flow field in conjunction with the particle velocities for the predators and prey particles. Such a system offers the capability to measure the local, in-situ distribution of harmful algae. This information is fundamental to understanding the in-situ life cycle and distribution which are needed to understand the population dynamics of the algae.

## 7 PROPOSED TERMS OF REFERENCE FOR THE 2000 WGHABD MEETING

The WGHABD should meet in Barcelona, and will be hosted by the Institut de Ciències del Mar from the 14 to the 18.3.2000 (or 21–25.3. 2000) to:

- 1) collate and assess national reports, update the mapping of HABs and evaluate the development of the harmful algae event database (HAEDAT);
- 2) prepare a retrospective and critical analysis of the work performed by WGHABD in the course of its existence;
- 3) examine the possible ways of analysing historical data and fossil records with the help of an invited specialist ;
- 4) following the 1999 WGHABD report on implications of benthic species in toxic events, examine the information provided by the WGHABD participants on the possible implication of benthic species in toxic events and report on induced problems on monitoring procedures;

1. 5) compare model parameterizations for growth rates, nutrient uptake rates, nutrient limitation, predation rates, remineralization rates and the physics of the turbulent fluxes and stresses ;
- 5) Review scenarios of toxic events developments ;
- 6) Report and discuss on new findings.

#### **Justification for ToR § 1**

Besides their collation, the assessment of national reports should take into account the possible use of data (numbers) from algal monitoring for management purposes from different countries.

The table produced in the IOC report on monitoring should be updated because much experience has been gained the last few years. The review could reveal if the action limits in different member countries are scientific sound in the light of today's knowledge of toxicity and growth dynamics of toxic algae, and it could be a good way of demonstrating for the outside society how data from algal monitoring may be used for practical management of seafood toxicity due to algae.

#### **Justification for ToR § 2**

During its existence the WGHABD has tackled several scientific questions of crucial importance in HAB dynamics. In most of the cases the WG was able to produce a satisfactory overview of the 'state of the art' and/or to identify needs for research. In some cases the expertise of the WG was not sufficient to tackle the question. Given the fact that during the ongoing decade much research has been done, new information on the HABs has been produced, and the composition of the WG has changed, some questions may need reconsideration. A retrospective and critical analysis of the work performed by WGHABD is needed for the discussion and definition of the future role of WGHABD.

#### **Justification for ToR § 3**

The occurrence of HABs has frequently been associated with human impact on the marine environment. Recent reports on fossil pigment records from the Baltic Sea and Arabian Sea, however, reveal relatively stable phytoplankton community structure in the time scale of  $> 10^3$  years. Many HAB species form highly resistant resting stages, which can be identified from sediment layers. It would be useful to consider and examine the possible ways of analysing historical data and fossil records in the HAB context. As the expertise of WGHABD will not be sufficient for this ToR, invitation of a specialist may be necessary.

#### **Justification for ToR § 4**

In the Canadian case presented, benthic harmful microalgae are an important source of phycotoxins transferred through benthic and pelagic food webs. Most of the WGHABD have not previously addressed this issue, since studies on HAB dynamics usually focus on events and processes in the pelagic domain, where stratification can contribute to bloom aggregation. Members have agreed to collect information and assess the possible role of benthic species in toxic events.

Biomass and growth rate estimates for toxigenic benthic species (e.g., *Prorocentrum* spp., responsible for some D.S.P. outbreaks) are often considered difficult to ascertain because growth is spatially heterogeneous (in "patches"). Nevertheless, the fact that these populations are relatively stationary may yield advantages to studying growth rates, nutrient dynamics, and susceptibility to grazing, allelopathic interactions and microscale processes. Thus, whilst benthic harmful microalgae warrant special attention, the results may prove highly relevant for interpreting similar mechanisms for pelagic blooms.

Since this would have important consequences on monitoring procedures, it was felt that, despite the little information available, the WGHABD should address this question with more information.

#### **Justification for ToR § 5**

In order to compare model parameterizations for growth rates, nutrient uptake rates, nutrient limitation, predation rates, remineralization rates and the physics of the turbulent fluxes and stresses, it was felt necessary that a joint session of the WGHABD and WGSSO be held. On the basis of case examples such as the Baltic, the Gulf of Maine, the estuary of Saint Lawrence, the Bay of Biscay, etc., it should be possible to compare and discuss implications of the different biological processes formulations.

Recent developments and the status of physical models for coastal circulation will be reviewed to understand the inherent accuracy, resolution, assumptions and parameterisations, etc. This understanding and interaction is necessary to appropriately incorporate the details of the population dynamics (bloom initiation, growth, and mortality) to provide meaningful calculations of the population development.

During this joint meeting, physicists could also provide advices to some biologists regarding design of oceanographic investigations.

#### **Justification for ToR §6**

The objective is to produce descriptions of the population life histories for each specific region and species of interest in their oceanographic context. This information will be used as the basis of communication between physical oceanographers and the physiological ecologists for modelling work. While physicists are trained to simplify problems by neglecting details in order to make models that explain the features of the system, biologists must examine and identify the details that separate species. A joint description of the basic systems will form a common base for discussion and modelling.

These case descriptions will include details of algal life histories, physical processes, and interactions with other organisms. These scenarios should identify the salient features of the population history to enable modelling of bloom initiation, the effects of growth, grazing, behaviour, advection as well as environmental fluctuations on seasonal cycles as well as random events. To be compiled by P. Gentien and T. Osborn during the intersessional period from contributions of identified experts.

#### **Justification for ToR §7**

The working group annual meeting is seen by the members as a unique opportunity to exchange ideas and discuss their new results. It was, of course, done previously but given the willingness of members to share their new findings and the time required in this rapidly evolving topic, it was felt necessary to formalise this as a term of reference.

### **8 RECOMMENDATIONS**

The ICES-IOC WGHABD recommends that:

- given the need for further coordination in research on this topic and the recent international developments, the group be continued under the new Oceanography Committee.
- ICES takes an active role in promoting actions under the GEOHAB programme.

The ICES-IOC WGHABD recommends that:

- the completed HAEDAT, covering the period 1987–1998, be made available on the ICES and IOC WWW sites. It further recommends that the HAEDAT format for national reports, as specified in Annex 1 hereto, is adopted as the new format for all national reports on HAE collated by the WGHABD.
- IOC and ICES make these maps available on their respective Web sites.
- a disclaimer be included in the presentation text of the decadal maps and of the HAEDAT database.
- each decadal map be published with a warning.

Each member country representative is strongly encouraged to provide all necessary support for the presence of a physicist and a phytoplankton specialist at the next Working Group meeting in order to present either examples of integrated case studies or situations where integrated studies should be promoted.

Regarding intersessional work, it is recommended that each working group member

- investigate this possible role of benthic algae in shellfish contamination and report on this subject at the next WG meeting.
- document the physiological resting stages for HAB species not known to produce resting cysts.
- determine the cyst distributions of major HAB species in order to identify areas prone to HAB development.
- Investigate the potential for predation and parasitism on natural cyst populations.
- Determine the influence of environmental factors (e.g., temperature, light etc.) and internal biological clocks on cyst germinations.
- Investigate the relationship between cyst germination and timing and amplitude of HAB blooms.

- Develop coupled biological-physical models for different HAB species. These models will aid in estimating the importance of location, transport, timing and size of initial inocula for HAB distributions.

## ANNEX I - LIST OF PARTICIPANTS TO THE 1999 - WGHABD

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## ANNEX II – REPORTING FORMAT FOR IOC-HAEDAT DATA BASE

ONE report should be associated with ONE event and additional information can be included as ADDITIONAL DATA. In addition, all other information such as graphs, maps, pictures, tables and weblinks are also welcome.

**EVENT NUMBER:** ex:CA-98-001 (Country-Year-number) **EVENT DURATION** **COUNTRY**

Has this event occurred before in this area? YES/NO

### LOCATION

Region Area Code: (assigned on a national basis)

Event extent: (Km<sup>2</sup>, mile<sup>2</sup>)

Detailed location: (name of bay, city)

### DATE

Precise day: (One value corresponding to Coordinates (Lat/Long) maximum cell concentration. If cell concentration is not

available, use maximum toxicity available)

Initial date Final date

Additional Information

### MICROALGAE

#### SPECIES RESPONSIBLE

Species/Genus	Taxonomic class	Cells/L	Comments
---------------	-----------------	---------	----------

#### ADDITIONAL SPECIES

Species/Genus	Taxonomic class	Cells/L	Comments
---------------	-----------------	---------	----------

### OTHER BIOLOGICAL INFORMATION

Pigments: (Type/Concentration)

Cysts: (Presence/Quantity/ Distribution)

### ENVIRONMENTAL CONDITIONS

Weather: (prior or event conditions)

Wind direction and velocity

Current direction and velocity

Advected/Insitu population

Bloom location in the water column

Oceanographic conditions

Temperature (Max/Min/Avg)

Salinity (Max/Min/Avg)

Oxygen concentration pH

Turbidity: (Secchi disk)

Nutrients: (Nutrient type/Concentration)

### HARMFUL EFFECTS

Toxicity detected: YES/NO

Associated syndrome: (ASP, PSP...)

Unexplained toxicity: YES/NO

Organisms affected: (Humans, other terrestrial, birds, aquatic mammals, fish, shellfish, benthic life, planktonic life)

Species implicated	Toxin type	Concentration (ug/100 g)	Tissue tested	Assay Type
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Additional Information

Extent of effect: (Biological, not economical)

Management decision

Economic losses

### ADDITIONAL INFORMATION

Previous occurrences

Historical bibliography

Individual to contact

Biological material available

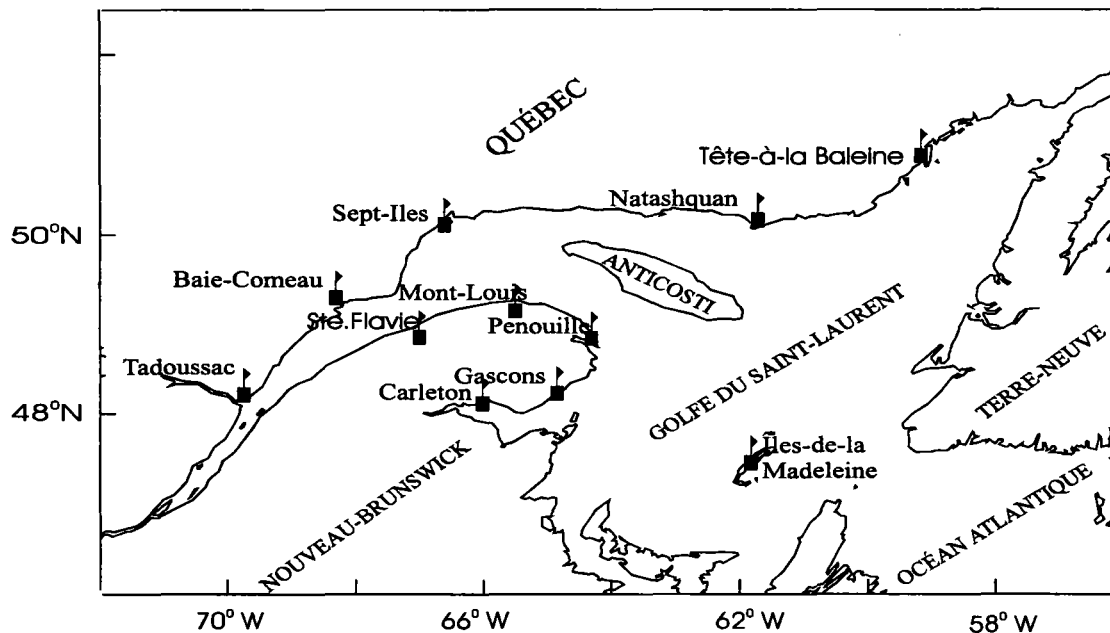
Additional information on the web

## ANNEX III -NATIONAL REPORTS

### CANADA

#### HARMFUL ALGAL EVENTS IN CANADA - 1998-1999

##### St. LAWRENCE



**Figure 1.** Location in the Gulf of St. Lawrence of the 11 stations of the Harmful algae Monitoring program of the Maurice Lamontagne Institute. The monitoring program was initiated in 1989.

##### EVENT 1. *Alexandrium tamarens* red-tide

1. **Location:** A red tide (100 km long by 1 km wide of discoloured water) developed along the south shore of the Lower St. Lawrence estuary (ca. 50 km east and west of Ste. Flavie; see Fig. 1) with cell concentrations reaching 2 million cells per liter.
2. **Date of Occurrence:** From July 7 to August 10
3. **Effects:** At least two persons became seriously ill and were hospitalised after eating toxic clams collected along the south-shore of the Estuary.
4. **Management decision:** Most of the coastal zone was closed for shellfish harvesting and the Department of Fisheries and Oceans, in collaboration with the Canadian agency for Food Inspection, sent a warning to the media to advise people that the shellfish may be extremely toxic this year.
5. **Causative species:** *Alexandrium tamarens*
6. **Environment:** *Alexandrium* cells were confined to relatively brackish (21-24 psu) and warm (12.5-14.5 °C) surface waters.
7. **Advised population or *in situ* growth:** *in situ* growth.
8. **Previous occurrences:** PSP toxicity has been measured by the mouse bioassay technique on a regular basis since 1961 in the St. Lawrence.

## EVENT 2 : Toxic Shellfish in the Magdalen Islands

1. **Location:** Magdalen Islands (see Fig. 1)
2. **Date of Occurrence:** July 1998
3. **Effects:** A party of 20 persons became ill after eating clams collected in this area historically considered as biotoxins-free. Affected people exhibited DSP symptoms (diarrhoea, vomiting). Only traces on DSP toxins (DTX-1) were found in the clams, but levels were too low to be responsible for the intoxication.
4. **Management decision:** Shellfish harvesting was banned for several weeks following this event.
5. **Causative species:** Examination of the phytoplankton community did not reveal the presence of a known DSP toxins producers.
6. **Environment:** No data available at this time
7. **Advised population or *in situ* growth:**
8. **Previous occurrences:** None

## EVENT 3 : Traces of Domoic acid in Magdalen Islands's scallops

1. **Location:** Magdalen Islands (see Fig. 1)
2. **Date of Occurrence:** August 1998
3. **Effects:** For the first time, traces of domoic acid have been measured in scallops (gonads) harvested in the vicinity of the Islands. Toxins concentrations were very low and presented no threat for human consumption. Nevertheless, this was the first report of the presence of domoic acid in shellfish collected in this part of the St. Lawrence.
4. **Management decision:** The monitoring of DA will continue next year. We are currently trying to isolate *Pseudo-nitzschia delicatissima* in order to determine its toxicity.
5. **Causative species:** During the same period, low levels of *Pseudo-nitzschia delicatissima* were measured in the laguna of Havre-aux-Maisons.
6. **Environment:**
7. **Advised population or *in situ* growth:**
8. **Previous occurrences:** None
9. **Individuals to contact:**

### **Phytoplankton**

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## **Biotoxins on the Pacific Coast of Canada in 1998**

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Phytoplankton monitoring is not conducted on the coast of British Columbia. The occurrence of toxic algae is determined by analysis of biotoxins in the sentinel species *Mytilus californianus*. The mussels are collected, bagged and distributed to wharves, quays and aquaculture sites in different areas along the north and south coasts (Figures 1 and 2). Samples are collected generally at weekly intervals in the summer and bi-weekly intervals in the winter and shipped to the Canadian Food Inspection Agency, CFIA, for analysis. Mouse bioassay is used for Paralytic Shellfish Poisoning (PSP) evaluation and an HPLC assay for domoic acid (DA). Areas monitored for biotoxins are illustrated Figures 1 and 2.

Table 1 presents the highest levels of PSP and DA determined by CFIA during 1998 in the areas specified. In areas other than those specified in Table 1, levels of PSP were generally < 42 µg/100 g, or when present were at least under

the 80 µg/100 g allowable level. Similarly, in all areas not specified in Table 1, DA was generally below the detectable level (n.d.), or when present was less than 10 ppm, which is half the allowable level.

Although somewhat anecdotal, densities and distribution of all phytoplankton throughout the coast were below normal, most probably resulting from a prolonged dry spring and summer. *Heterosigma carterae*, the major fish killer in British Columbia, was notable absent from most salmon farms in 1998, and recognised harmful algae were not responsible for any of the fish mortalities during 1998.

TABLE 1. Highest levels of Paralytic Shellfish Poisoning (PSP) and Domoic Acid (DA) in the sentinel species, *Mytilus californianus*, monitored weekly or bi-weekly in geographic areas during 1998 in British Columbia, Canada. Maps of geographic areas could not be reproduced in the body of the report. For further information contact Ian Whyte.

Month	Geographic area	PSP µg/100 g	DA ppm	Management decision
March	ALL	< 42	n.d.	None
April	7	260	n.d.	Closure to bivalve harvest
April	8	250	n.d.	Closure to bivalve harvest
April	9	82	n.d.	Closure to bivalve harvest
May	6	440	n.d.	Closure to bivalve harvest
May	7	560	n.d.	Closure to bivalve harvest
May	8	430	n.d.	Closure to bivalve harvest
May	9	340	n.d.	Closure to bivalve harvest
May	10	360	n.d.	Closure to bivalve harvest
May	23	130	n.d.	Closure to bivalve harvest
May	24	110	n.d.	Closure to bivalve harvest
June	6	390	n.d.	Closure to bivalve harvest
June	7	350	n.d.	Closure to bivalve harvest
June	12	560	n.d.	Closure to bivalve harvest
June	13	310	n.d.	Closure to bivalve harvest
June	18	200	n.d.	Closure to bivalve harvest
July	6	510	n.d.	Closure to bivalve harvest
July	12	190	n.d.	Closure to bivalve harvest
July	17	210	n.d.	Closure to bivalve harvest
July	27	170	n.d.	Closure to bivalve harvest
August	12	180	n.d.	Closure to bivalve harvest
August	15	320	n.d.	Closure to bivalve harvest
September	15	960	n.d.	Closure to bivalve harvest
September	17	330	n.d.	Closure to bivalve harvest
September	23	< 42	29.5	Closure to bivalve harvest
September	24	< 42	27.1	Closure to bivalve harvest
October	15	210	n.d.	Closure to bivalve harvest
October	26	180	n.d.	Closure to bivalve harvest
November	17	120	n.d.	Closure to bivalve harvest
November	18	82	n.d.	Closure to bivalve harvest
November	19	81	n.d.	Closure to bivalve harvest
November	12	390	n.d.	Butter clam analysis; closure to butter clam harvest
November	17	210	n.d.	Butter clam analysis; closure to butter clam harvest

## Harmful Algal Events in 1998 – Canada

1. **Location:** Southwest Bay of Fundy (Passamaquoddy Bay)
2. **Date of Occurrence:** late August/mid September
3. **Effects:** Water discolouration; mortalities from salmonid aquaculture operations as a result of oxygen depletion.
4. **Management Decision:** Additional sampling (oceanographic and phytoplankton), warning to salmonid aquaculturists
5. **Causative Species:** the ciliate, *Mesodinium rubrum* – cell concentrations greater than 1 million cells•L<sup>-1</sup> were observed from September 3-17.
6. **Environment:** Temperature range: 11.6-17°C, Salinity – 31.4-32.3 ppt, Water Column - mixed.
7. **Advected Population or in situ Growth:** Insitu.
8. **Previous occurrences:** There have not been any recorded incidents of fish mortalities in the past although it has been a common occurrence for red tides of *Mesodinium rubrum* to be observed in Passamaquoddy Bay – generally during late August or September.
9. **Additional Comments:** A number of aquaculture operations were moved from Lime Kiln Bay into Passamaquoddy Bay in the early summer of 1998. The purpose was to allow Lime Kiln Bay to be aquaculture free for a one year period as a result of infectious salmon anaemia (ISA) in the area. During past years when *Mesodinium rubrum* was observed at high concentrations, the number of sites in the area was limited.
10. **Individual to contact:** Jennifer Martin
- 9 **DEPARTMENT OF FISHERIES & OCEANS**

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**Harmful Algal Events in 1998 - Canada**  
**Paralytic Shellfish Poisoning**

1. **Location:** Bay of Fundy
2. **Date of Occurrence:** mid May to mid August
3. **Effects:** A lower number than normal of shellfish harvesting areas were closed to harvesting for a short period of time between late June and mid August. The highest levels of paralytic shellfish poisoning toxins were measured at Lepreau Basin on July 9, 1998 ( 320 µg/100g in *Mya arenaria*).
4. **Management Decision:** A number of shellfish harvesting areas in the southwestern Bay of Fundy were closed to harvesting for a short period during the summer due to levels of psp toxins exceeding the regulatory limit of 80 µg/100g. Areas affected include sites at Grand Manan Island, and other located sites outside Passamaquoddy Bay. The Bay of Fundy has been closed year round for more than 50 years to the harvesting of blue mussels, *Mytilus edulis*.
5. **Causative Species:** *Alexandrium fundyense*. Cells were observed from mid May to mid August with highest concentrations observed during 1998 (6,720 cells•liter<sup>-1</sup>) on June 23 at an inshore sampling location, Deadmans Harbour.
6. **Environment:** Temperature range: 8 - 12<sup>o</sup> C, Salinity - 32 ppt, Water Column - mixed inshore;stratified offshore.
7. **Advected Population or in situ Growth:** Advected.
8. **Previous occurrences:**Shellfish harvesting areas are closed to harvesting annually (generally during summer months) in the Bay of Fundy due to unsafe levels of psp toxins in shellfish tissues.
9. **Additional Comments:**
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**Harmful Algal Events in 1998 – Canada**  
**Domoic Acid**

1. **Location:** Bay of Fundy
2. **Date of Occurrence:** June, August - early September, 1998.
3. **Effects:** Domoic acid was not detected in shellfish.
4. **Management Decision:** No shellfish areas were closed to harvesting.
5. **Causative Species:** *Pseudo-nitzschia pseudodelicatissima*. Cells (*P. pseudodelicatissima* and *P. delicatissima*) were observed throughout the year with highest concentrations observed during June (*P. delicatissima*) and August (*P. pseudodelicatissima*). Highest concentrations observed during 1998 were 83,500 cells•L<sup>-1</sup> of *P. pseudodelicatissima* on August 4 at an offshore sampling location at the Wolves.
6. **Environment:** Temperature range: 8 - 14<sup>o</sup> C, Salinity - 32 ppt, Water Column - mixed inshore; stratified offshore.
7. **Advected Population or in situ Growth:** In situ as well as advected.
8. **Previous occurrences:** Although *P. delicatissima* and *P. pseudodelicatissima* have been observed annually in the Bay of Fundy, the only years that shellfish harvesting areas were closed to harvesting were during 1988 and 1995 and during blooms of *P. pseudodelicatissima*.
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## DENMARK

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The phytoplankton in Danish coastal waters and fjords in 1998 was characterised by relatively low concentrations and biomasses in the spring and most of the summer period. During spring a bloom of one or several species from the flagellate genus *Chatonella* was observed in some fjords connected to the North Sea (Ringkjøbing Fjord and the Limfjord) as well as in the northern part of the Kattegat. Minor fish kills (e.g., *Belone belone*) were observed in some areas. In the summer the biomasses were dominated by diatoms e.g., *Skeletonema costatum* and the dinoflagellate *Prorocentrum minimum* that bloomed in several locations. The low biomasses during the summer period were primarily the result of low input of inorganic nutrients from land, caused by low run-off during spring and summer. A bloom of *Gyrodinium aureolum* was observed in august-September in the Limfjord - but there were no reports on fish kills or kill off of benthic invertebrates related to the bloom.

The following toxic and potentially toxic algae were registered in high concentrations:

### Dinoflagellates

*Prorocentrum minimum*, *Prorocentrum cf. triestinum*, *Prorocentrum micans* and *Gyrodinium aureolum*.

### Others

*Chatonella* spp.

The following toxic and potentially toxic algae were registered in low concentrations:

### Dinoflagellates

*Alexandrium minutum*, *Alexandrium ostenfeldii*, *Alexandrium tamarense*, *Dinophysis acuminata*, *Dinophysis norvegica*, *Dinophysis acuta*, *Dinophysis rotundata*, *Prorocentrum lima*, *Gymnodinium sanguineum*, *Noctiluca scintillans*

### Diatoms

*Pseudo-nitzschia delicatissima*-group, *Pseudo-nitzschia seriata*-group

### Others

*Dictyocha speculum* (-"Si-skeleton"), *Phaeocystis pouchetii*, *Chrysochromulina* spp.

Intensified monitoring and/or closing of shellfishery due to concentrations of *Dinophysis acuminata*, *Dinophysis norvegica*, *Alexandrium* species and *Pseudo-nitzschia*-species exceeding the concentrations in the veterinary guidelines, were imposed at several occasions in Danish coastal waters. No algal toxins were registered in shellfish in 1998 and there are no reports of human intoxications caused by consumption of Danish shellfish in 1998.

## ENGLAND AND WALES

1. Location: Weymouth Harbour (Dorset, South Coast)
2. Date of occurrence: 1<sup>st</sup> July - 21<sup>st</sup> September
3. Peak cell concentration: 7,239,700 cells per litre (17 August)
4. Effects: none, non-toxic
5. Causative species: *Alexandrium tamarense*
6. Environment: no data.
7. Advected population or in situ growth: in situ growth
8. Previous occurrence: Yes
9. Individual to contact:  
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CEFAS  
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Conwy, LL32 8UB

### **ALGAL BLOOM REPORTS - ENGLAND AND WALES**

1. Location: Tyne Estuary, North East coast
2. Date of occurrence: April
3. Peak cell concentration: n/a
4. Effects: deaths of kittiwakes; guillemots and herring gulls also affected. DSP toxins in livers from dead birds.
5. Causative species: not known
6. Environment: no data.
7. Advected population or in situ growth: no data.
8. Previous occurrence: Yes, previous two years, but later months (June / July)
1. 9. Individual to contact:  
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## ESTONIA

### Monitoring of harmful microalgae in Estonian coastal and open sea waters

The **traditional monitoring** was performed since the early 1980s by the former Estonian Hydrometeorological Service. Since 1993, the regular monitoring of pelagic parameters was taken up by the Estonian Marine Institute. The monitoring activities are based on temporally sparse sampling (3–4 times per year) at 36 fixed stations according to the Baltic Monitoring Programme (BMP).

In addition, **increased monitoring sampling frequency** (10–15 times per year) is foreseen by the national monitoring programme at Tallinn (central Gulf of Finland) and Pärnu (eastern Gulf of Riga) areas.

The **unattended water sampling** provides a tool for studying the phytoplankton species variability and for an early warning system for harmful blooms when complemented with phytoplankton species identification. Estonian Marine Institute has also participated in elaborating of operative monitoring programme in the Gulf of Finland with the aim to follow both rapid and long-term changes in environmental conditions. The installation of automatic recording and sampling system on board passenger ferry "Wasa Queen" in April 1997 has been the first step in that field. That project has been supported by ministries of environment both in Finland and Estonia and operated in co-operation of several institutions. EMI has been responsible for phytoplankton analysis and weekly data reporting. Still, that project has not been financed by the Estonian Ministry of Environment in 1999.

Since the high frequency monitoring does not cover the whole Estonian coastal area, abnormal events in the marine environment are asked to be reported by local authorities. Training seminars have been arranged in 1994 and 1997 for the experts working at local environmental protection departments and appropriate manual has been published. Although respective short-term trainings are arranged and instructions distributed (incl. sheets of coastal observations), the **local monitoring grid** is not established until now.

Actions and public information with respect to algal blooms have been co-ordinated by the Ministry of Environment with the help of experts from different institutes. Information has also passed to the health protection authorities. Unfortunately, the application for the monitoring of harmful algal bloom in Estonian coastal waters in 1999 was also rejected.

In 1998 as well as in 1996, the intensive bloom of *Heterocapsa triquetra* (Dinophyta) was the most striking feature in the Gulf of Finland and adjacent areas. *H. triquetra* became dominant in the middle July. In Finnish coastal waters, *Heterocapsa*-bloom was observed until the end of August, while in Estonian coastal areas and the western Gulf the short-time maximum was recorded in the end of July/ beginning of August. However, the dinoflagellate *H. triquetra* disappeared eastward of 25° 30' E in the southern Gulf of Finland, i.e., by salinity < 5 psu.

Due to cold and windy weather conditions no large surface accumulations of blue-green algae were observed. The maximum concentrations of *Aphanizomenon flos-aquae* (blue-green algae) were recorded in the mid of July ( $6.5 \times 10^5$  filaments per litre). Mostly straight filaments of potentially toxic cyanobacteria *Nodularia spumigena* have been observed during July and August in relatively low numbers -  $\sim 10^4$  filaments per litre, which is an order smaller than in July 1997. The one more potentially toxic species *Anabaena lemmermannii* has been occasional in the phytoplankton of the Gulf of Finland in 1998.

Figures could not be reproduced in the body of the report-for further information, contact

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## GERMANY

### National report 1998: Germany, North Sea

1. **Locations:**  
South of Norwegian Waters, Kattegatt, Coastal waters of West Sweden, west coast of Denmark, north west coast of Schleswig-Holstein
2. **Date of Occurrence:**  
10<sup>th</sup> to 18 May 1998
3. **Effects:**  
none in German waters
4. **Management Decisions:**  
increased monitoring activity
5. **Causative Species:**  
*Chattonella verruculosa*
6. **Environment:**  
North Sea, coastal waters of Schleswig-Holstein
7. **Advected Population or *In Situ* Growth:**  
unknown
8. **Previous Occurrences:**  
not known, unlikely, as regularly monitored since 10 years
9. **Additional Comments**
10. **Individual to contact:**

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### **National report 1998: Germany, North Sea**

- 1. Locations:**  
North Sea, offshore from coast of Schleswig-Holstein and Niedersachsen, around Helgoland
- 2. Date of Occurrence:**  
Late April, early May, again late August, early September
- 3. Effects:**  
Discolouration of the sea surface, in some places several km<sup>2</sup>
- 4. Management Decisions:**  
none
- 5. Causative Species:**  
*Noctiluca scintillans*
- 6. Environment:**  
North Sea
- 7. Advected Population or *In Situ* Growth:**  
unknown
- 8. Previous Occurrences:**  
observed in most years, but size of water discolouration unusual large
- 9. Additional Comments**
- 10. Individual to contact :**

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## National report 1998: Germany, North Sea

1. **Locations:**  
German Bight, Wadden Sea between the islands Amrum and Sylt
2. **Date of Occurrence:**  
late August/early September 1998
3. **Effects:**  
Blue mussels with DSP contents up to 800 µg OA kg<sup>-1</sup> (dw hepatopankreas)
4. **Management Decisions:**  
stop of mussel harvesting, economic loss of about 200 000 Euro
5. **Causative Species:**  
*Dinophysis acuminata*
6. **Environment:**  
Wadden Sea of the North Frisian coast
7. **Advected Population or *In Situ* Growth:**  
unknown
8. **Previous Occurrences:**  
irregular, not each year
9. **Additional Comments**  
HPLC-measurements

0 10. **Individual to contact :**

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## National report 1998 : Germany, Baltic Sea

### 1. Locations:

Coast of Mecklenburg-Vorpommern

### 2. Date of Occurrence:

26. May 1998

### 3. Effects:

water discolouration

### 4. Management Decisions:

none

### 5. Causative Species:

*Aphanizomenon „baltica“*; *Planktothrix agaardhii*

### 6. Environment:

brackish water of the Baltic Sea

### 7. Advected Population or *In Situ* Growth:

unknown

### 8. Previous Occurrences:

regular occurrence, each year

### 9. Additional Comments

about  $3 \times 10^7$  trichoms  $l^{-1}$  of about 100  $\mu m$  length

### 10. Individual to contact:

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## National Report for Ireland, 1998

### Phytoplankton

In 1998, *Dinophysis acuminata* and *Dinophysis acuta* were present only in very low numbers and both species, when present in a sample, were typically detected at levels in the range 40 - 200 cells/litre. For *D. acuminata* the maximum cell count recorded was 4000 cells/litre in a surface sample taken in Bruckless Bay on 7 July while for *D. acuta* the maximum count was 1,200 cells/litre in a sample taken in Dunmanus Bay 25 August. These results are very similar to those reported for 1996 and 1997.

Several algal blooms, resulting in discoloured water, were recorded during 1998 and these are summarised table below.

Month	Species	Location	Comment
May	<i>Phaeocystis</i> spp.	SW Coast - Union Hall/ Glandore SE Coast - Waterford Estuary SE Coast - Wexford Harbour	Discoloured water
May	<i>Rhizosolenia alata</i> <i>Rhizosolenia delicatula</i>	SE Coast - Waterford Harbour	Discoloured water
August	Unidentified <i>microflagellate</i>	NW coast - Bruckless Bay	Discoloured water
September	<i>Gyrodinium aureolum</i>	West Coast - Streamstown Bay	Discoloured water Mortalities of abalone

### DSP toxins

A total of 967 shellfish samples were tested by DSP mouse bioassay in 1998 and only 8 samples gave positive results. The very low level of toxicity recorded in 1998 was similar to that recorded in 1996 and 1997. Each of the affected areas was closed for a period of 2 weeks.

### PSP toxins

The presence of PSP toxins above the regulatory limit was detected by PSP mouse bioassay in mussels (*Mytilus edulis*) in Cork Harbour on 15 June. The area was closed for harvesting 2 weeks.

### Azaspiracid

The presence of the novel toxin, azaspiracid, was detected in mussels (*Mytilus edulis*) from Arranmore Island, on the northwest coast of Ireland, in October 1997. The toxicity, as determined by the DSP mouse bioassay (Yasumoto, 1978) persisted from October 1997 through to May 1998. The source of the toxin remains unknown.

### Person to contact

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## NETHERLANDS

NO TOXIC EVENTS

## NORWAY

### HARMFUL ALGAL BLOOM IN NORWAY 1998

*Chattonella* aff. *verruculosa*

#### LOCATION

Along the Norwegian coast of Skagerrak the most dense concentrations were recorded in the Farsund-Flekkefjord area at the south-west coast of Norway. The same species also grew to high concentrations along the west coast of Denmark.

#### DATES

Along the Norwegian coast the bloom peaked in the first week of May, while it culminated about two weeks later along the Danish coast.

#### EFFECTS

About 350 tonnes of large (> 2–4 kg) Atlantic salmon in pens were killed at the southwest coast of Norway and some wild fish were killed along the Danish coast.

#### MANAGEMENT DECISIONS

Stop feeding of the salmon were recommended and a more intensively monitoring to follow the propagation of the bloom was established. Toxicity of the bloom was tested by mouse bio-assay with negative results (no toxicity was found).

#### CAUSATIVE SPECIES

Most probably *Chattonella* aff. *verruculosa*, but *Heterosigma akashiwo* (along the Norwegian coast) and *Dictyocha speculum* (along the Danish coast) was present as well.

#### ENVIRONMENT

Along the Norwegian coast the highest concentrations of *Chattonella* were recorded at temperatures around 8 °C and at salinities from 20 to 28. The bloom occurred in water-bodies with high concentrations of nitrate.

#### ADVECTED POPULATION

*Chattonella* seemed to grow to dense populations in the Skagerrak during April and was probably successively spread by advection while growing.

#### PREVIOUS OCCURRENCES

No, this is the first report on a bloom of this species in European waters.

#### INDIVIDUAL TO CONTACT

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### HARMFUL ALGAL BLOOM IN NORWAY 1998

Diarrhetic Shellfish Toxins

In 1992 a regular monitoring of algae and control of shellfish toxicity by mouse bioassay along the Norwegian coast, were established. The aim of the monitoring is to inform and advice the public interested in picking wild mussels for private consumption along the coast. In 1998 the programme consisted of 27 stations covering the whole coast. The monitoring period was March-October. The results from this programme, concerning Diarrhetic Shellfish Toxins are summarised.

#### LOCATION

*Dinophysis* spp. were recorded all along the Norwegian coast but most numerous along the south coast and at two stations, Sognefjord and Romsdal, at the west coast.

#### DATES

Toxins in mussels were recorded at three stations. At the station, Flødevigen, along the coast of Skagerrak in October; at the station Sognefjord in August and at station Romsdal in May-June.

#### EFFECTS

Toxins recorded above the action level according to mouse bioassay.

#### MANAGEMENT DECISIONS

Harvesting was locally banned. The public was warned against picking toxic mussels.

#### CAUSATIVE SPECIES

Most probably *Dinophysis* spp., with *D. acuminata* and *D. acuta* as the most potent species.

#### ENVIRONMENT

The problem occur over a wide range of temperatures and salinities.

#### ADVECTED POPULATION

Along the southern coast there are some evidence that the algae and toxin problems are spread by advection. But along the west coast the "hot spots" seems to be rather patchy which indicate local concentration of the algae and/or in situ growth.

#### PREVIOUS OCCURRENCES

A few more dubious historical records. A yearly, more or less large scale and long lasting phenomenon since 1984 according to mouse bioassay. The phenomenon has never been so extensively monitored as since 1992. The problems in 1997 were less than average.

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#### HARMFUL ALGAL BLOOM IN NORWAY 1998

*Prymnesium parvum*

#### LOCATION

Ryfylke, Sandsfjord system, the westcoast of Norway.

#### DATES

11 August – 6 September 1998

#### EFFECTS

No

#### MANAGEMENT DECISIONS

Monitoring.

#### CAUSATIVE ORGANISM

*Prymnesium parvum*

#### ENVIRONMENT

Brackish water.

#### ADVECTED POPULATION

Mainly *in situ* growth.

#### PREVIOUS OCCURRENCE

Yearly blooms since 1989, except 1997.

#### ADDITIONAL COMMENTS

#### INDIVIDUAL TO CONTACT

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#### HARMFUL ALGAL BLOOM IN NORWAY 1998

##### Paralytic Shellfish Toxins

In 1992 a regular monitoring of algae and control of shellfish toxicity by mouse bioassay along the Norwegian coast, were established. The aim of the monitoring is to inform and advice the public interested in picking wild mussels for private consumption along the coast. In 1998 the programme consisted of 27 stations covering the whole coast. The monitoring period was March-October. The results from this programme, concerning Paralytic Shellfish Toxins are summarised.

#### LOCATION

*Alexandrium* spp. occurred in low numbers all along the coast. Toxins above the action level were recorded at 10 of 27 stations, 2 along the Skagerrak coast, 5 along the west coast and 3 in northern Norway.

#### DATES

Along the Skagerrak coast toxins in mussels were recorded in two weeks in May-June. At the west coast paralytic toxins were recorded from early April to early August, while in northern Norway toxins were recorded from late April to early October.

#### EFFECTS

Toxins recorded above the action level (200 MU/100 g) according to mouse bioassay.

#### MANAGEMENT DECISIONS

Harvesting was locally banned. The public was warned against picking wild mussels.

#### CAUSATIVE SPECIES

*Alexandrium* spp.

#### ENVIRONMENT

No information

#### ADVECTED POPULATION

Mainly due to *in situ* growth ?

#### PREVIOUS OCCURRENCES

A few historical records exist. There have been more or less regular occurrences along the west coast the recent years, however, the spatial and temporal extent may vary from one year to another. In 1998 toxic mussels were again recorded in our northernmost county, Finnmark, at the Russian border.

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## PORTUGAL

### PORTUGAL 1998

#### DSP

DSP toxins were detected at:

##### 1. and 2. Location and data of occurrences

- Minho estuary: August– November.
- Viana castelo: June.
- Espinho: February; June.
- Aveiro: June.
- Aveiro Lagoon: July – September
- Mondego estuary: May.
- Óbidos Lagoon: May; July.
- Lisboa (Caparica): February – March.
- Setubal: February March.
- Sines: March.
- Algarve (Sagres): March; August – September; November.
- Algarve (Faro/olhão): February – March; May – August; October – November.
- Algarve (Formosa lagoon): March; May.
- Algarve (Tavira): February – March.

##### 3. Effects:

Most of the bivalves from these regions presented DSP toxins.

##### Highest detected concentration:

- Minho estuary: Sept. 22 - 92µg/g (*Mytilus edulis*).
- Viana Castelo: June 23 – 2.89µg/g (*Mytilus edulis*).
- Espinho: Feb.11 - 12µg/100 g (*Spisula solida*); May 27 – 8µg/100 g (*Spisula solida*); June 3 - 21–12µg/100 g (*Spisula solida*).
- Aveiro: June 7 - 9µg/100 g (*Spisula solida*).
- Aveiro Lagoon: May 19 - 9µg/100 g (*Cerastoderma edule*); July 8 - 19µg/100 g (*Solen marginatus*); August 25 - 11µg/100 g (*Venerupis pullastra*); Oct. 13 - 14µg/100 g (*Venerupis pullastra*).
- Mondego estuary: May 14 - 10µg/g(*Mytilus edulis*); July 28 - 17µg/100 g (*Cerastoderma edule*).
- Óbidos Lagoon: May 26 - 9µg/100 g (*Spisula solida*); July 28 - 11µg/100 g (*Tapes decussata*).
- Lisboa (Caparica): Feb. 18 - 20µg/100 g (*Donax* spp); March 17 - 13µg/100 g.(*Donax* spp).
- Setubal: March16 - 28µg/100 g (*Donax* spp).
- Sines: March 13 – 2.12µg/100 g. (*Donax* spp).
- Algarve (Sagres): March 18 – 2.06µg/g (*Mytilus edulis*); August 26 – 6.4µg/g (*Mytilus edulis*).
- Algarve (Alvor Lagoon): July 22 - 5µg/100 g (*Tapes decussata*).
- Algarve (Faro/Olhão):Feb. 12 - 131µg/100 g (*Donax* spp); May 20 - 37µg/100 g (*Donax* spp); August 3 - 113µg/100 g (*Donax* spp); Oct. 27 - 17µg/100 g (*Donax* spp).
- Algarve (Formosa lagoon). March 2 - 38µg/100 g; May 20 - 19µg/100 g (*Solen marginatus*) and 11µg/100 g (*Tapes decussata*);.
- Algarve (Tavira): March 20 - 23µg/100 g (*Donax* spp).

DSP toxins were determined both by the mouse bioassay and through HPLC.

##### 4. Management decisions:

Harvest of affected species closed during toxication.

## 5. Causative species:

*Dinophysis* cf. *acuminata* and also but only in Summer and early Autumn at Algarve *D. acuta*

### Highest detected concentration (cells/L):

- Minho estuary: Sept. 9 – 917 *D. acuminata*
- Viana Castelo: June 22 – 417 *D. acuminata*
- Espinho: Feb.10 - 750; May 19 – 250 *D. acuminata*; June 3 – 2417 *D. acuminata*.
- Aveiro: June 7 – 500 *D. acuminata*.
- Aveiro Lagoon: May 13 – 417; July 7 - 83; August 17 – 750; Oct. 19 – 583.
- Mondego estuary: July 7 – 250.
- Óbidos Lagoon: May 13 - 200; June 17 - 167.
- Lisboa (Caparica): March 16 – 417.
- Setubal: March 11 – 417.
- Algarve (Sagres): Feb. 2 – 6000; August 3 – 167 and 5000 (*D. acuta*).
- Algarve (Alvor Lagoon): July 22 – 100.
- Algarve (Faro/Olhão): Feb. 18 - 71429; May 20 – 1000; August 3 – 250 and 4083 (*D. acuta*).; Oct. 27 – 500 and 100 (*D. acuta*).
- Algarve (Formosa lagoon). Feb. 27 - 1417; May 21 – 500.
- Algarve (Tavira): March 20 - 700.

## 6. Environment:

Temperature range: 15° - 19°C

Salinity range: 24 - 37‰

## 7. Advected population or *in situ* growth:

Most probably a combination of both.

## 8. Previous occurrences:

Since 1987, the first year of confirmed occurrence, the problem has occurred every year, with a break in 1993. This year the most affected area was Algarve.

## 9. Individual to contact:

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## ASP

Domoic acid was detected in small amounts mostly  $<20 \mu\text{g/g}$  in some bivalve species, mainly in Autumn, around the Portuguese coast for short periods, coincident with the occurrence of *Pseudo-Nitzschia* spp mainly *P. australis* in concentrations below 100 000 cell/l. However values over  $20 \mu\text{g/g}$  were detected in cockles (*Cerastoderma edule*) from Aveiro Lagoon on the 26 of October ( $21.5 \mu\text{g/g}$ ) and in Mussels (*Mytilus edulis*) from Minho estuary on the 3<sup>d</sup> of November ( $22.6 \mu\text{g/g}$ )

### 1 and 2. Location and data of occurrences

ASP toxins over  $20 \mu\text{g/g}$  were detected at

- Minho estuary: November 3 –  $22.6 \mu\text{g/g}$
- Aveiro Lagoon: October 26 –  $21.5 \mu\text{g/g}$

### 3. Effects:

At Aveiro Lagoon cockles (*Cerastoderma edule*) presented Domoic acid , at Minho estuary it was mussels (*Mytilus edulis*).

ASP toxins were determined by HPLC through Lawrence, 1991 method.

### 4. Management decisions:

None as the affected areas and species were already closed due to DSP

### 5. Causative species:

*Pseudo-nitzschia* spp, mainly *P. australis*.

The highest detected concentrations (cells/l ) related with toxication were:

- Aveiro Lagoon Oct. 26: 30476
- Minho estuary Oct. 27: 56190

### 6. Environment:

Temperature range:  $15 - 17 ^\circ\text{C}$

Salinity range:  $32 - 35\text{‰}$

### 7. Advected population or *in situ* growth:

Most probably a combination of both.

### 8. Previous occurrences:

The first detected occurrence of Domoic acid in bivalves over  $20 \mu\text{g/g}$  was in smooth callista (*Callista chione*) in 1995 at Setubal region, since then, only this year we got again values over .  $20 \mu\text{g/g}$  and only twice.

### 9. Individual to contact:

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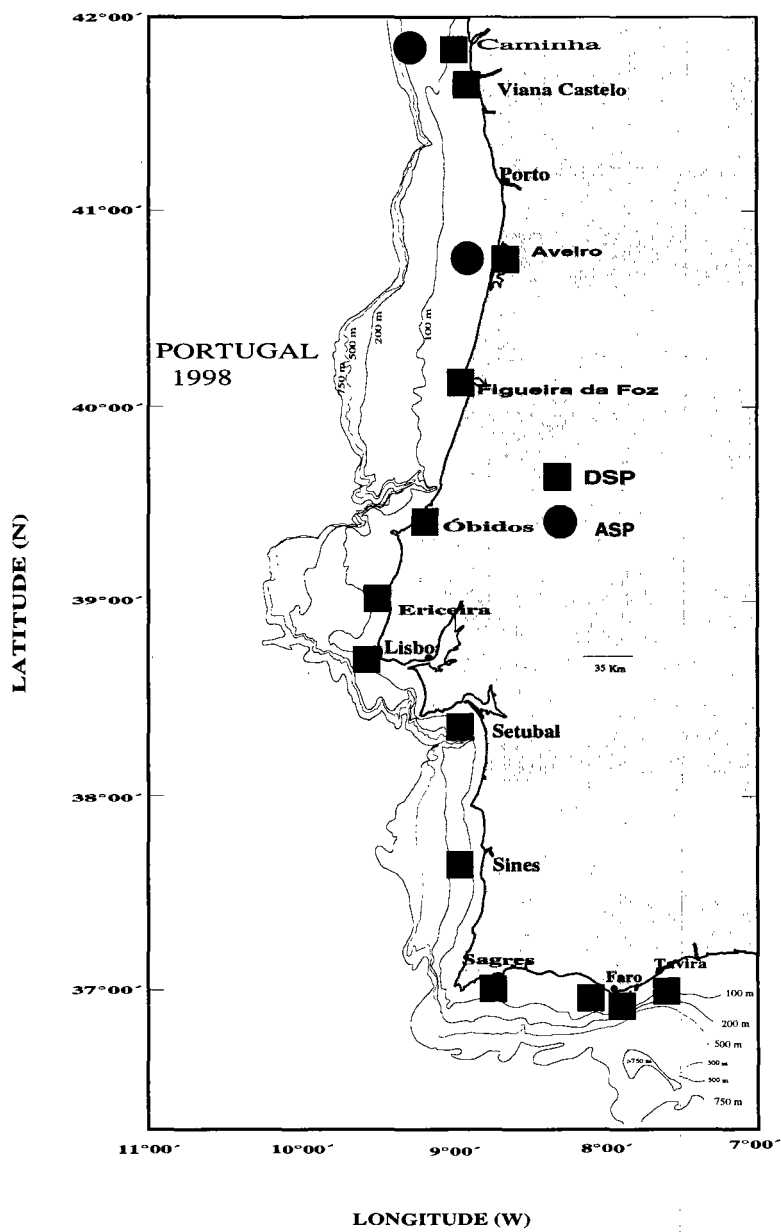
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## SCOTLAND

### NATIONAL REPORT - SCOTLAND 1998

1. Location: East Coast of Scotland
2. Date of Occurrence: 

<i>Alexandrium</i> spp.	Jan to Sept
<i>Dinophysis</i> spp.	June to Oct
<i>Pseudo-nitzschia</i> spp.	Feb to Dec
3. Effects: PSP first detected in mussels in early May. Maximum level recorded 150 µg STX eq./100 g on 11 May. Toxins persisted until early June.  
DSP toxins recorded from early August to early September  
ASP recorded from July to October. Toxin levels were greater than action level in July and August. A maximum level of 54 µg/g of domoic acid was found in scallops (*Pecten maximus*) at Stonehaven in July.
4. Management Decisions: Voluntary Closure Agreement (VCA) in Dornoch Firth during time when PSP and DSP toxins were above the permitted levels.  
No specific control measure put in place for ASP toxins, scallops were put on positive release.
5. Causative Species: *Alexandrium* spp. to a maximum concentration of 1,700 cells.l<sup>-1</sup>  
*Dinophysis* spp. to a maximum concentration of 2,100 cells.l<sup>-1</sup>  
*Pseudo-nitzschia* spp. to a maximum concentration of 612 x 10<sup>3</sup> cells.l<sup>-1</sup>
6. Environment:
7. Advected Population or in-situ growth: not known
8. Previous Occurrences: PSP has recurred on the Scottish east coast since 1990 (when current toxin monitoring programme began). However, PSP was first recorded in this region in 1967.  
DSP detected since 1996.  
ASP not previously recorded in this region.
9. Additional Comments:
10. Individuals to Contact: Marie Kelly/Godfrey Howard  
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### NATIONAL REPORT - SCOTLAND 1998

1. Location: Orkney Islands
2. Date of Occurrence: 

<i>Alexandrium</i> spp.	February to August
<i>Dinophysis</i> spp.	May to September
<i>Pseudo-nitzschia</i> spp.	February to December
3. Effects: PSP detected from May to December, maximum level recorded 1695µg STX eq./100 g  
DSP not detected  
ASP detected up to a level of 70 µg /g of domoic acid.
4. Management Decisions: Food and Environment Protection Act 1985 (FEPA) closure order in place from June to December. This order was partially revoked as areas became clear of toxins.

5. Causative Species: Alexandrium spp. to a maximum concentration of 5,000 cells.l-1  
Dinophysis spp. to a maximum concentration of 300 cells.l-1  
Pseudo-nitzschia spp.to a maximum concentration of 1,622 x 103 cells.l-1
6. Environment:
7. Advected Population or in-situ growth: not known
8. Previous Occurrences: PSP has regularly occurred in this area since 1991.  
ASP was first recorded in Orkney in 1997 at a level of 22 µg/g of domoic acid.
9. Additional Comments: Some scallop fishing areas to the east of the Orkney Islands still closed due to PSP toxins (March 1999).
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#### NATIONAL REPORT - SCOTLAND 1998

1. Location: Shetland Islands
2. Date of Occurrence: Alexandrium spp. April - June  
Dinophysis spp. August - September  
Pseudo-nitzschia spp. March - September
3. Effects: PSP toxins were detected from May to June and again in August up to a maximum level of 105 µg STX eq./100 g in mussels (Mytilus edulis)  
One positive DSP sample recorded in August.  
No ASP toxins found.
4. Management Decisions: Voluntary Closure Agreement (VCA) for any effected areas over the permitted toxin limits.
5. Causative Species: Alexandrium spp. to a maximum concentration of 1,300 cells.l-1.  
Dinophysis spp. to a maximum concentration of 200 cells.l-1  
Pseudo-nitzschia spp. to a maximum concentration of 657 x 103 cells.l-1
6. Environment:
7. Advected Population or in-situ growth: not known
8. Previous Occurrences: PSP has occurred since 1994  
ASP first detected in Shetland in 1996
9. Additional Comments:
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E-mail: [kellymc@marlab.ac.uk](mailto:kellymc@marlab.ac.uk)

## NATIONAL REPORT - SCOTLAND 1998

1. Location: West Coast
2. Date of Occurrence: Alexandrium spp. June to March  
Dinophysis spp. May to September  
Pseudo-nitzschia spp. April to October
3. Effects: PSP detected intermittently from May to August  
DSP detected from May to September  
ASP detected from June to August. Toxin levels over legal marketing limit were recorded at Scalpay at the beginning of August.
4. Management Decisions: Voluntary Closure Agreements (VCAs) put in place when necessary.
5. Causative Species: Alexandrium spp. to a maximum concentration of 500 cells.l<sup>-1</sup>  
Dinophysis spp. to a maximum concentration of 2,800 cells.l<sup>-1</sup>  
Pseudo-nitzschia spp. to a maximum concentration of 2,685 x 10<sup>3</sup> cells.l<sup>-1</sup>
6. Environment:
7. Advected Population or in-situ growth: not known
8. Previous Occurrences: PSP recorded in this region since 1990  
DSP recorded in this region since 1993–94
9. Additional Comments:
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## SPAIN

### Harmful Algal Bloom in Galicia in 1998

1. Location: Rías of Pontevedra and Ares.
2. Date of occurrence: October in the Rías of Ares and Pontevedra, November in Ría of Pontevedra.
3. Effects: ASP toxicity in bivalves (mussels and scallops).
4. Management decision: Harvesting was closed in culture areas when domoic acid concentration exceeded 20 ppm.
5. Causative species: *Pseudonitzschia spp* with máximun cell concentrations of 180.000 cells/l in Ría of Ares and approx. 100.000 cells/l in the Ría of Pontevedra.
6. Environment: variable conditions.
7. Advectioned population or *in situ* growth: probably *in situ* growth.
8. Previous occurrences: See our HAB report from 1997.
9. Additional comments: Since March 97 an autonomous legislation exists which regulates the closure level of ASP toxins in Galician shellfish.
10. Individual to contact:  
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### Harmful Algal Bloom in Galicia in 1998

1. Location: Inner part of Ría of Vigo.
2. Date of occurrence: September.
3. Effects: PSP mussel toxicity.
4. Management decision: Harvesting was closed in culture areas when the toxin concentration reached 80 µg STXeq./100 g meat.
5. Causative species: *Alexandrium spp.*
6. Environment: variable conditions.
7. Advected population or *in situ* growth: *in situ* growth.
8. Previous occurrences:
9. Additional comments:
10. Individual to contact:  
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### Harmful Algal Blooms in Galicia in 1998

1. Location: Rías of Vigo and Muros and mouths of the Rías of Arousa and Pontevedra.
2. Date of occurrence: June.
3. Effects: DSP mussel toxicity.
4. Management decision: Harvesting was closed in the culture areas affected.
5. Causative species: *Dinophysis acuminata* with maximum cell concentrations of 1120 cells/l in the Ría of Vigo, 6360 cells/l in the Ría of Pontevedra, 1040 cells/l in the Ría of Arousa and 1520 cells/l in the Ría of Muros.
6. Environment: variable conditions.
7. Advected population or *in situ* growth: Probably there was an initial advected population followed by *in situ* growth, specially in the Ría of Pontevedra.
8. Previous occurrences: DSP episodes caused by *D. acuminata* are a recurrent phenomenon with more or less incidence depending on the year.
9. Additional comments:
10. Individual to contact:  
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Peirao de Vilaxoán. D. P. 36611  
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### Harmful Algal Blooms in Galicia in 1998

1. Location: Rías of Pontevedra and Muros and mouths of the Rías of Vigo and Arousa.
2. Date of occurrence: second and third week of July.
3. Effects: DSP mussel toxicity.
4. Management decision: Harvesting was closed in the culture areas affected.
5. Causative species: *Dinophysis acuminata* with a maximum cell concentration of 2400 cells/l in the Ría of Vigo, 1600 cells/l in the Ría of Pontevedra, 600 cells/l in Ría of Arousa and 2080 cells/l in the Ría of Muros.
6. Environment: variable conditions.
7. Advected population or *in situ* growth: Probably advected population.
8. Previous occurrences: DSP episodes caused by *D. acuminata* are a recurrent phenomenon with more or less incidence depending on the year.
9. Additional comments:
- 10.- Individual to contact:  
J. Maneiro; Y. Pazos; A. Moroño  
Condicións Oceanográficas e Fitoplancto  
Centro de Control da Calidade do Medio Mariño  
Peirao de Vilaxoán. D. P. 36611  
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### Harmful Algal Blooms in Galicia in 1998

1. Location: Rías of Vigo, Pontevedra Arousa and Muros.
2. Date of occurrence: On the third week of August and September.
3. Effects: DSP mussel toxicity.
4. Management decision: Harvesting was closed in the culture areas affected.
5. Causative species: *Dinophysis acuminata* with a maximum cell concentration of 2120 cells/l in the Ría of Vigo, 11640 cells/l in the Ría of Pontevedra, 1520 cells/l in the Ría of Arousa and 1120 cells/l in the Ría of Muros.
6. Environment: variable conditions.
7. Advected population or *in situ* growth: advected population followed by *in situ* growth, specially in Ría of Pontevedra.
8. Previous occurrences: The DSP episodes caused by *D. acuminata* are a recurrent phenomenon with more or less incidence depending on the year.
9. Additional comments:
10. Individual to contact:  
J. Maneiro; Y. Pazos; A. Moróño  
Condicións Oceanográficas e Fitoplancto  
Centro de Control da Calidade do Medio Mariño  
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### Harmful Algal Blooms in Galicia in 1998

1. Location: Ría of Pontevedra, the mouth and middle part of Ría of Vigo and mouth of Ría of Arousa.
2. Date of occurrence: from the third week of October to the first week of November.
3. Effects: DSP mussel toxicity.
4. Management decision: Harvesting was closed in the culture areas affected.
5. Causative species: *Dinophysis acuminata* with a maximum cell concentration of 1120 cells/l in the Ría of Vigo, 3600 cells/l in the Ría of Pontevedra and 560 cells/l in the Ría of Arousa.
6. Environment: variable conditions.
7. Advected population or *in situ* growth: Probably there was an initial advected population followed by *in situ* growth, specially in the Ría of Pontevedra.
8. Previous occurrences: DSP episodes caused by *D. acuminata* are a recurrent phenomenon with more or less incidence depending on the year.
9. Additional comments:
10. Individual to contact:  
J. Maneiro; Y. Pazos; A. Morono  
Condicións Oceanográficas e Fitoplancto  
Centro de Control da Calidade do Medio Mariño  
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### Harmful Algal Blooms in Catalonia in 1998

1. Location: Alfacs bay (Ebro Delta, Catalonia)
2. Date of occurrence: winter season (december-march)
3. Effects: mussels mortality
4. Management decision:
5. Causative species: *Gyrodinium corsicum* Paulmier, max. conc.  $10^7$  cels/L
6. Environment: Salinity 35–37 psu, temperature 11–17°C
7. Advected population or *in situ* growth: *In situ* growth
8. Previous occurrences: previous 4 years on the same dates
9. Additional comments: This species was associated to fish and mussel mortalities since 1994 when first detected in this bay.
10. Individual to contact:  
Maximino Delgado  
Institut de Ciències del Mar  
Pg. Joan de Borbó, s/n  
08039 Barcelona  
Tel.: 34 93 2216450/ 2216416

### Harmful Algal Blooms in Catalonia in 1998

1. Location: Alfacs bay (Ebro Delta, Catalonia)
2. Date of occurrence: 19 January 1998
3. Effects: Detection of DSP
4. Mangement decision: Closing the extraction of bivalves in the bay.
5. Causative species: *Dinophysis sacculus*, reaching concentrations up to 19000 cells/L.
6. Environment: Salinity 33–37 psu, temperature 12–14°C
7. Advected population or *in situ* growth: ¿?
8. Previous occurrences: every year but in lower concentrations
9. Additional comments:
10. Individual to contact:  
Maximino Delgado  
Institut de Ciències del Mar  
Pg. Joan de Borbó, s/n  
08039 Barcelona  
Tel.: 34 93 2216450/ 2216416

### Harmful Algal Blooms in Catalonia in 1998

1. Location: Southern Catalanian coast
2. Date of occurrence: May-June 1998
3. Effects: Detection of PSP (max. concentration: 983 µg PSP/100 g mussel, in Tarragon Harbour)
4. Management decision: To close for extraction of bivalves in the area until levels of PSP were < 80 µg PSP/100 g (3 weeks)
5. Causative species: *Alexandrium catenella*, reaching concentrations up to 80 millions cells/L.
6. Environment: Salinity 35–38 psu, temperature 19–24°C
7. Advected population or *in situ* growth: ?
8. Previous occurrences: only detected low concentrations in some harbours since 1996
9. Additional comments:
10. Individual to contact:  
Magda Vila  
Institut de Ciències del Mar  
Pg. Joan de Borbó, s/n  
08039 Barcelona  
Tel.: 34 93 2216450/ 2216416

### Harmful Algal Blooms in Catalonia in 1998

1. Location: Barcelona Harbour
2. Date of occurrence: July-August 1998
3. Effects: Detection of PSP (max. concentration: 364 µg PSP/100 g mussel)
4. Management decision: Increase the surveillance in the harbour to intercept illegal extraction of mussels
5. Causative species: *Alexandrium catenella*, reaching concentrations up to 60 millions cells/L.
6. Environment: Salinity 37–38 psu, temperature 22–30°C
7. Advected population or *in situ* growth: *in situ* growth
8. Previous occurrences: every year since 1996, but in lower concentrations
9. Additional comments:
10. Individual to contact:  
Magda Vila  
Institut de Ciències del Mar  
Pg. Joan de Borbó, s/n  
08039 Barcelona  
Tel.: 34 93 2216450/ 2216416

### Harmful Algal Blooms in Andalusia in 1998

1. Location: Gulf of Cadiz, Atlantic coast of Andalusia.
2. Date of occurrence: February.
3. Effects: DSP *Donax* spp toxicity (detected by mouse bioassay).
4. Management Decision: Closure of affected shellfish grounds.
5. Causative species: *Dinophysis acuminata*. Maximum concentration of 17,560 cells/litre.
6. Environment: Rainfall before occurrence. During the event, calm weather (wind force < 2), irradiation increased and high nutrients concentration.
7. Advectioned population or *in situ* growth: Probably advectioned.
8. Previous occurrences: From March to July of 1997 at the same area.
9. Additional Comments: On March, April, May, June, September and November levels of *Dinophysis acuminata* > 800 cells/litre were detected at different places in the Gulf of Cadiz. In September, *D. acuminata* coexisted with *D. caudata* at Guadiana River mouth area, with a maximum concentration of 800 and 880 cells/litre respectively.
10. Individual contact:  
Luz Mamán  
D.A.P.- CICEM Aguas del Pino  
Ctra Punta Umbria-Cartaya s/n  
Cartaya, 21450 Huelva  
Spain  
e-mail: rompido@dap.es  
Phone: +34 959 504218  
Fax +34 959 504218 (as above)

### Harmful Algal Blooms in Andalucía in 1998

1. Location: San Pedro River Estuary (Cadiz Bay).
2. Date of occurrence: February.
3. Effects: Absence of DSP in shellfish (tested by mouse bioassay).
4. Management Decision: Water monitoring and toxin analyses were intensified.
5. Causative species: *Prorocentrum minimum*. Bloom of  $2,6 \times 10^6$  cells/litre.
6. Environment: Rainfall two days before bloom detection and strong SE winds before and during the event. Salinity: 10 ppt. High nutrient concentration and clear sky during the bloom.
7. Advected population or *in situ* growth: Probably *in situ* growth.
8. Previous occurrences: January of 1997 at the same place.
9. Additional Comments:
10. Individual contact:  
Luz Mamán  
D.A.P.- CICESM Aguas del Pino  
Ctra Punta Umbria-Cartaya s/n  
Cartaya  
21450 Huelva  
Spain  
e-mail: rompido@dap.es  
Phone: +34 959 504218  
Fax +34 959 504218 (as above)

### Harmful Algal Blooms in Andalucía in 1998

1. Location: Alboran Sea.
2. Date of occurrence: June.
3. Effects: ASP toxicity in the cockle *Callista chione* after the event. Important increase of ASP toxicity in scallops.
4. Management Decision: Closure of affected shellfish grounds.
5. Causative species: *Pseudonitzschia* spp. Top level detected of *P. "seriata"* was 790.000 cells/litre.
6. Environment: Salinity: 35,5–36,5 ppt, water temperature 16,5–18,5 °C, SE winds (force < 3).
7. Advected population or *in situ* growth: Probably advected population.
8. Previous occurrences:
9. Additional Comments:
10. Individual contact:  
Luz Mamán  
D.A.P.- CICEM Aguas del Pino  
Ctra Punta Umbria-Cartaya s/n  
Cartaya  
21450 Huelva  
Spain  
e-mail: rompido@dap.es  
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Fax +34 959 504218 (as above)



### Harmful Algal Blooms in the Balearic Islands in 1998

1. Location: Can Picafort, Santa Margarita (Mallorca Island). Harbour, very enclosed
2. Date of occurrence: From 27 July to 7 September
3. Effects: water coloration abnormally reddish brown
4. Management decision: The marine authorities increased the water renewal rate, without positive results
5. Causative species: *Alexandrium minutum* Halim
6. Environment: Very high temperatures and a high stability of the water column.
7. Advected population or *in situ* growth: *in situ* growth.
8. Previous occurrences: Possibly, but not so evident.
9. Additional comments:
10. Individual to contact:  
Gabriel Moyà, José María Valencia  
Universitat de les Illes Balears  
Dep. Biología (Ecología)  
Campus Universitari, Carr. de Valldemossa km 7.5  
07071 Palma  
Spain  
Phone: +34 71 173175  
Fax: +34 71 173184

### Harmful Algal Blooms in the Balearic Islands in 1998

1. Location: Peguera Beach (South of Mallorca Island)
2. Date of occurrence: August 1998
3. Effects: water greenish brown coloration near the coast
4. Management decision: none
5. Causative species: *Alexandrium taylori* Balech
6. Environment
7. Advected population or *in situ* growth: *in situ* growth.
8. Previous occurrences: previous three years on the summer period, and probably since 1993
9. Additional comments:
10. Individual to contact:  
Gabriel Moyà  
Universitat de les Illes Balears  
Dep. Biología (Ecología)  
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07071 Palma  
Spain  
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Fax: +34 71 173184

## NATIONAL REPORT OF HARMFUL ALGAL EVENTS –SWEDEN

### AND SHELLFISH POISONING 1998

**LOCATION:** Skagerrak and Kattegat

**DATE:** April - May

**SPECIES:** *Chattonella* cf. *verruculosa*. Identification not verified.

**CELL DENSITY:** Up to 6 million cells l<sup>-1</sup>

**TOXICITY CONCENTRATION:** Unknown

**TOXICITY ANALYSIS METHOD:** -

**EFFECTS:** Fish kills. Wild garfish, herring, mackerel

**MANAGEMENTS DECISIONS:** Public and media information

**ENVIRONMENT:** very varying

**ADVECTED POPULATION:**

**IN SITU GROWTH:** X

**PREVIOUS OCCURENCE:** New for this area

**ADDITIONAL COMMENTS:** *Chattonella* developed its maximum in the North Sea along the Danish west coast.

**CONTACT PERSON:** Odd Lindahl  
Kristineberg Marine Station,  
SE-450 34 Fiskebäckskil,  
Sweden  
tel 46 523 18512, fax 46 523 18502,  
E-mail o.lindahl@kmf.gmu.se

**NATIONAL REPORT OF HARMFUL ALGAL EVENTS – SWEDEN**  
**AND SHELLFISH POISONING 1998**

**LOCATION:** Northwest Baltic. Mainly along the coast

**DATE:** July - September

**SPECIES:** *Heterocapsa triquetra*

**CELL DENSITY:** Up to 23 million cells l<sup>-1</sup>

**TOXICITY CONCENTRATION:** Unknown

**TOXICITY ANALYSIS METHOD:** No analysis

**EFFECTS:** "Disturbing" for people living along the coast

**MANAGEMENTS DECISIONS:** Public and media information

**ENVIRONMENT:** Varying

**ADVECTED POPULATION:** X

**IN SITU GROWTH:** X

**PREVIOUS OCCURENCE:** Occasional blooms all around the Baltic coast in different years

**ADDITIONAL COMMENTS:** *Heterocapsa* blooms seem to have increased during the 90-ties.

**CONTACT PERSON:** Susanna Hajdu  
Dept. of System Ecology, Univ. of Stockholm  
Box 7050  
SE-750 07 Uppsala, Sweden  
tel 46 18 673155, fax 46 18 673156,  
E-mail hajdus@system.ecology.su.se

**NATIONAL REPORT OF HARMFUL ALGAL EVENTS – SWEDEN**  
**AND SHELLFISH POISONING                      1998**

**LOCATION:** Skagerrak coast

**DATE:** July - December

**SPECIES:** *Dinophysis* spp. ???

**CELL DENSITY:**

**TOXICITY CONCENTRATION:** Okadaic acid. 13–16 July: 0–70 µg/kg mussel meat, 20 July: 50–1629 µg/kg mussel meat, August: 20–600 µg/kg mussel meat, September: 20–700 µg/kg mussel meat, October: 10–1900 µg/kg mussel meat, November: 10–2000 µg/kg mussel meat, December: 80–2500 µg/kg mussel meat.

**TOXICITY ANALYSIS METHOD:** HPLC

**EFFECTS:** Mussel intoxication

**MANAGEMENTS DECISIONS:** Public and media information. Harvest ban.

**ENVIRONMENT:** varying

**ADVECTED POPULATION:**

**IN SITU GROWTH:**

**PREVIOUS OCCURENCE:** Every year, but different strength.

**ADDITIONAL COMMENTS:** Unusually high and long toxicity

**CONTACT PERSON:** Lars Edebo  
Dept. of Clinical Bacteriology,  
Univ. Of GöteborgGuldhedsg. 10,  
SE-413 46 Göteborg,  
Sweden  
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# HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

## MISSISSIPPI

1. **Location:** Harrison and Jackson Counties; Area 17.
2. **Date of Occurrence:** 28 August 1998 through 25 September 1998.
3. **Effects:** Water discoloration; moderate plankton mortalities in Mississippi Sound within blooms; not uniformly distributed.
4. **Management Action:** None. Blooms appeared to be dispersed by Hurricanes Georges.
5. **Causative Species:** *Alexandrium monilatum*. Inshore waters had cell counts ranging from 48,000 to 386,000 cells per liter; surface water samples from the vicinity of the barrier islands had cell counts in excess of  $1.6 \times 10^7$  cells per liter.
6. **Environment:** Occurred in vicinity of barrier islands and in nearshore waters with salinity ranges of 15 - 32 ppt, and water temperature range of 26 - 31°C.
7. **Advected Population or In Situ Growth:** Advected population from northern Gulf of Mexico waters south of Horn Island, one of Mississippi's barrier islands. Extensive *in situ* growth in the south half of the central and eastern segments of Mississippi Sound.
8. **Previous Occurrences:** Several; first documented in August-September 1979 [Perry et al. 1979. First record of a bloom of *Gonyaulax monilata* in coastal waters of Mississippi, Gulf Research Reports 6 (3): 313-316]; also reported during summer of 1986.
9. **Additional Comments:** Presence of toxins confirmed via mouse bioassay; mice dosed orally exhibited no response, while those dosed intraperitoneally died.
10. **Individual to Contact:**  
Dr. Cynthia A. Moncreiff  
USM Institute of Marine Sciences  
Gulf Coast Research Laboratory  
703 East Beach Drive, P.O. Box 7000  
Ocean Springs, MS 39566-7000  
Phone: (601) 872-4260; FAX: (601) 872-4204  
E-mail: cmoncrei@seahorse.ims.usm.edu

## MORTALITY OF FISH AND OTHER MARINE ORGANISMS

YEAR	MONTH	AREA (CODE)	COMMENTS
1998	September	17	Dead plankton (invertebrates and larval fish) mixed in bloom.

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES—1998

### LOUISIANA

1. Location: All shelf and estuarine waters examined to date. The highest numbers of *Pseudo-nitzschia* spp. ( $10^7$  cells/liter) and the highest frequency of occurrence are observed on the shelf in the plume of the Mississippi River. For the first time in 1997, we sampled approximately monthly many shallow Louisiana estuaries over oyster beds. Maximum abundances were  $10^6$  cells/liter and, depending on the estuary, between 8 and 36% of samples contained *Pseudo-nitzschia* spp.
2. Date of Occurrence: They occur all year in all locations, although highest abundances seem to be fall through spring.
3. Effects: Domoic acid measurements for 1997 and part of 1998 indicate cellular contents of up to 25 pg/*Pseudo-nitzschia* cell in phytoplankton over oyster beds, especially in the spring. So far there have been no reported cases of human illness or other animal mortality. Possible explanations for lack of human illness or animal mortality include: 1) failure of medical professionals to recognize symptoms, 2) lack of beaches and salt marsh dominated coastline reduce visibility of animal mortality events; 3) inability of oysters to accumulate toxin, 4) high toxicity but relatively low abundance of *Pseudo-nitzschia* most of the time in estuaries where oysters are harvested; or 5) some combination of all of these.
4. Management Action: None
5. Causative Species: *Pseudo-nitzschia multiseries*, *P. delicatissima*, *P. pseudodelicatissima*, *P. pungens*, *P. subfradulenta*, *P. cf. americana* and several unidentified species. We have determined from field data (up to 5 pg domoic acid/cell; Parsons et al. submitted) and clonal culture studies (Doucette, pers. communication) that *P. pseudodelicatissima* is more toxic than observed previously. We suspect that *P. multiseries* and *P. pseudodelicatissima* are the two most toxic species in this area.
6. Environment: Eutrophic, shallow estuaries and the highly eutrophic plume of the Mississippi River, 2 to 36‰ salinity, 9 to 30°C, often highly turbid, high nutrient inputs.
7. Advected Population or *In situ* Growth: *In situ* growth
8. Previous Occurrences: Spatial and temporal occurrence patterns repeated every year since 1990 in Mississippi River plume, since 1993 in Terrebonne Bay estuary.
9. Additional Comments: Abundances this year were more normal in comparison with last year which were very low.
10. Individual to Contact: Dr. Quay Dortch  
Louisiana Universities Marine Consortium  
8124 Highway 56  
Chauvin, LA 70344  
Phone: 504/851-2800 FAX: 504/851-2874  
E-mail: qdortch@lumcon.edu



## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998 FLORIDA

1. **Location:** Manatee to Collier counties, Florida west coast, Area 16. Evidently transported to Palm Beach County (Area 15) by the Florida Current in January 1998 when respiratory irritation was verified by the presence of *G. breve* inshore.
2. **Date of Occurrence:** Two events: mid-January to early March and then mid-November 1998 to early March 1999.
3. **Effects:** Offshore and inshore fish kills. Minor human respiratory irritation inshore. Toxic shellfish, no human illnesses.
4. **Management Action:** Closure of shellfish beds in Sarasota, Charlotte, and Lee counties. Shellfish being currently tested for toxicity (mouse units) to open closed harvesting areas (3/99).
5. **Causative Species:** *Gymnodinium breve*. Cell counts ranged up to 68.3 million cells per liter in January/February in offshore waters and 34.4 million cells in December when the November offshore red tide was concentrated inshore by winds and currents.
6. **Environment:** Occurred offshore on the continental shelf and the latter event in November was transported inshore to waters of salinities as low as 27 psu.
7. **Advected Population or In Situ Growth:** The January/February bloom was maintained offshore between 5 and at least 12.5 miles off Englewood. The November bloom started offshore on the shelf but was transported inshore and lasted until March, 1999.
8. **Previous Occurrences:** Written accounts of fish kills date back to 1844 and anecdotal information back to the 1500s. In the last 25 years, *G. breve* blooms known as "red tides" have occurred almost every year along the west coast of Florida except in 1993, although there was a continuance of the 1992 bloom into early 1993. In those years when there wasn't a reported inshore bloom, a bloom could have been maintained offshore as it was in February of 1997.
9. **Additional Comments:** The bloom in November off of Charlotte Harbor allowed the opportunity to study a bloom as it developed. This is a multi-investigator (multi-year) grant-funded program called ECOHAB: Florida supported by EPA and NOAA. In addition, monthly cruises in the high risk zone between Tampa Bay and Charlotte Harbor provide data needed to model the development and transport of *G. breve* blooms.

**10. Individual to Contact:**

Dr. Karen A. Steidinger  
Florida Department of Environmental Protection  
Florida Marine Research Institute  
100 Eighth Ave. S.E.  
St. Petersburg, FL 33701  
Phone: (727) 896-8626  
Fax: (727) 823-0166  
Email: steidinger\_k@epic7.dep.state.fl.us

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location** Neuse River, Craven County, North Carolina
2. **Dates of Occurrence:** 7/28/98
3. **Effects** Fish Kill (Atlantic Menhaden, *Brevoortia tyranus*)
4. **Management Decision** None
5. **Causative Species** Potentially *Pfiesteria* (See attached)
6. **Environment:** Chronic hypoxia in lower 1/3 of water column during June  
Lesioned fish 40-50%
7. **Advected Population or In situ Growth** Mixing event suspected (see attached)
8. **Previous Occurrences** The Neuse River has a history of fish kills during the hottest part of the summer in slow moving waters.
9. **Additional Comments** (attached)
10. **Individual to Contact**  
Pat Tester  
National Ocean Service  
101 Pivers Island Road  
Beaufort, NC 28516 USA  
Pat.Tester@NOAA.gov

Date	Subbasin	Kill Number	Waterbody	Location	Fish Species	Mortality	Comments
<b>County: Beaufort</b>							
9/25/98	030307	WA98017	PAMLICO RIVER	near Long Point	ATM	400	whitish sores seen on fish; dead menhaden ranged fro 8-10 cm; cause not specified ; NCSU Lab reported presumptive pfiesteria-like cell counts of 230 to 470 cells/ml
<b>County: Craven</b>							
7/14/98	030410	WA98005	NEUSE RIVER	near Flanner's Beach	CRK, ATM	25	dead fish found on beach very stiff but not decomposed; DO slightly supersaturated; Burkholder lab reported pfiesteria cell levels of 250 /ml in water samples; cast net samples from area showed 10% of menhaden with lesions; 104 fish observed in cast net samples; most lesions seen in anal region; additional menhaden seen in distress with lesions in Slocum Creek on 7/15; 44% had lesions in Slocum Creek
7/28/98	030410	WA98007	NEUSE RIIVER	from Fisher Landing Point to Hancock	ATM	188000	river monitors showed chronic hypoxia in lower third of water column during month prior from Trent River to Hancock Creek; possible large scale mixing in river on July 26-27. Pfiesteria- like cell counts from water samples taken in area by ESB ranged from 0 to 367 cells/ml; Pfiesteria- like cell counts by NCSU ranged from 260 to 1500 cells/ml (NCSU and ESB samples were taken at different locations); 40 to 50% of live fish in the area showed lesions; up to 90% of dead fish showed lesions.NCSU reported active toxicity confirmed from bioassays of water sampleswith test fish.

*Note: Kills on 7/14 and 9/25 did not have confirmatory bioassays for pfiesteria*

## MORTALITY OF FISH AND OTHER MARINE ORGANISMS

[illegible]

## Algal Bloom Reports - United States - 1998

1. **Locations:** Great South Bay, New York. The bloom was present throughout much of the bay with highest concentrations found in its central portion.

2. **Dates of Occurrence:** From late April to early July, with peak concentrations exceeding  $2 \times 10^5$  cells/ml occurring throughout the period.

3. **Effects:** Impacts on various shellfish species (scallops, hard clams, & mussels) and on submerged aquatic vegetation (eelgrass) have previously been reported. Other effects are aesthetic - water discoloration and reduced transparency.

4. **Management Decisions:** Continue monitoring as possible.

5. **Causative Species:** *Aureococcus anophagefferens*

6. **Environment:** Temperature: 11.0 -23.2 deg.C  
Salinity: 20-28 ppt  
Dissolved oxygen: 5.4 - 10.5 mg/l  
Water column stability: mixed

7. **Advected population or in-situ growth:** in-situ growth

8. **Previous Occurrences:** 1985, 1986:  $>10^6$  cells/ml  
1988:  $10^3$  -  $5 \times 10^5$  cells/ml (June-Aug)  
1989:  $<2.5 \times 10^4$  cells/ml (April-Sept)  
1990:  $<1 \times 10^4$  cells/ml (May-Dec)  
1991:  $<10^4$  cells/ml (Jan-June)  
1992:  $10^3$  -  $10^6$  cells/ml (Jan-Dec)  
1993:  $<10^3$  -  $2.6 \times 10^5$  cells/ml (Jan-Mar, Aug-Nov)  
1994: up to  $10^6$  cells/ml (June-July) up to  $1.2 \times 10^4$  cells/ml (Aug-Oct)  
1995:  $2.8 \times 10^5$  to  $>10^6$  cells/ml in July  
1996:  $1.3 \times 10^4$  to  $1.8 \times 10^5$   
1997:  $2.3 \times 10^4$  to  $4.7 \times 10^5$

9. **Additional comments:**

10. **Individual to Contact:**

Dr. Robert Nuzzi  
Bureau of Marine Resources  
Suffolk County Dep't. of Health Services  
Riverhead, New York 11901  
516-852-2082

## Algal Bloom Reports - United States - 1998

1. **Locations:** West Neck Bay, Shelter Island. Located within the Peconic Estuary System, on the eastern end of Long Island, New York.
2. **Dates of Occurrence:** From late May to mid-July with concentrations ranging from  $5.0 \times 10^4$  to  $5.6 \times 10^5$  cells/ml. The organism was also present in other locations in the Peconic estuary, but at much lower concentrations.
3. **Effects:** Impacts on various shellfish species (scallops, hard clams, & mussels) and on submerged aquatic vegetation (eelgrass) have previously been reported. Other effects are aesthetic - water discoloration and reduced transparency.
4. **Management Decisions:** Continue weekly monitoring program.
5. **Causative Species:** *Aureococcus anophagefferens*
6. **Environment:**  
Temperature: 20 - 26.8 deg.C  
Salinity: 25 - 27 ppt  
Dissolved oxygen: 5.4 - 8.7 mg/l  
Water column stability: mixed
7. **Advised population or in-situ growth:** in-situ growth
8. **Previous Occurrences:** The bloom was present throughout the entire Peconic system from 1985 through 1987, with densities occasionally exceeding  $10^6$  cells/ml. Cell numbers declined through 1988 and 1989, and were generally undetectable during 1990 with the exception of those from West Neck Bay. During 1991, densities of up to  $2 \times 10^6$  cells/ml occurred in Flanders Bay and West Neck Bay. During 1992, numbers approached  $8.5 \times 10^5$  cells/ml in Coecles Harbor and  $10^6$  cells/ml in West Neck Bay. It occurred briefly in May of 1994 in Flanders Bay (up to  $1.4 \times 10^4$  cells/ml) and in Great Peconic Bay ( $1.1 \times 10^4$  cells/ml). During 1995 concentrations exceeded  $10^6$  cells/ml at 12 of 31 stations sampled, with a peak value of  $1.7 \times 10^6$  recorded in July. During 1997, concentrations ranged from  $1.6 \times 10^3$  to  $3.8 \times 10^5$ .
9. **Additional comments:**
10. **Individual to Contact:**  
  
Dr. Robert Nuzzi  
Bureau of Marine Resources  
Suffolk County Dep't. of Health Services  
Riverhead, New York 11901  
516-852-2082

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** New Jersey – Barnegat Bay\* and back bay lagoons southward (Tuckerton and Sea Isle City); Raritan – Sandy Hook Bay
2. **Dates of Occurrence:** May 15 – June 3, 1998; June 7-9 (Sandy Hook area)
3. **Effects:** Reddish-brown water.
4. **Management Decision:** Maintain current surveillance.
5. **Causative Species:** *Prorocentrum minimum*.
6. **Environment:** Temp. 17-20°C; meso-poly haline (<18 – 24‰); cell densities  $\geq \times 10^3 - 10^4 \text{ ml}^{-1}$ .
7. **Advected Population or In situ Growth:** in-situ population.
8. **Previous Occurrences:** Commonly occurring estuarine species, occasional sporadic blooms
8. **Additional Comments:** No reported fish kills or toxic episodes  
(\*summer-long brownwater blooms of *Nannochloris atomus* persist; apparently no problem with hypoxia or toxicity, but some eelgrass die-off may result)
10. **Individual to Contact:** Paul Olsen  
New Jersey Dept. of Environmental Protection  
Division of Watershed Management  
Bureau of Water Monitoring  
P.O. Box 427  
Trenton, NJ 08625

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** New Jersey – Raritan -Sandy Hook Bay  
northern Monmouth County coast
2. **Dates of Occurrence:** May 19-27, 1998; June 17-24, 1998; July 24-30, 1998
3. **Effects:** Brown water; algal foams, floc  
Subsequent bottom hypoxia ( $1.2-2.7 \text{ mg l}^{-1}$ ) – late summer, one to three miles off southern Monmouth – northern Ocean Co. (Belmar to Seaside), south of primary bloom area.
4. **Management Decision:** Maintain current surveillance.
5. **Causative Species:** *Rhizosolenia* spp. (*delicatula*); *Skeletonema costatum*; *Thalassiosira* spp. (*norduskioldii*); *Asterionella glacialis*.
6. **Environment:** Temp.  $< 18 - 25^{\circ}\text{C}$   
Polyhaline – (19) 23 - 26 (28) %  
Total cell densities to  $5 \times 10^4 \text{ ml}^{-1}$ .
7. **Advected Population or In situ Growth:** in-situ growth, or advected from adjacent nearshore areas.
8. **Previous Occurrences:** Normal spring and summer occurrences.
9. **Additional Comments:** No fish kills or toxic episodes reported.
10. **Individual to Contact:** Paul Olsen  
New Jersey Dept. of Environmental Protection  
Division of Watershed Management  
Bureau of Water Monitoring  
P.O. Box 427  
Trenton, NJ 08625



## MORTALITY OF FISH AND OTHER MARINE ORGANISMS

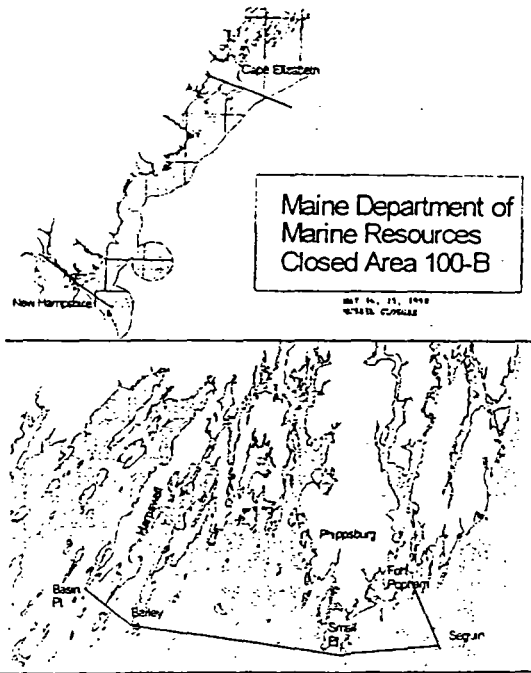
New Jersey 1989 –1998

YEAR	MONTH	AREA (CODE)	COMMENTS
1997+	May-July	9	Growth disruption on juvenile hard clams ( <i>Mercenaria</i> )
1995	May-July	Little Egg Harbor (Tuckerton)	Due apparently to brown tide blooms ( <i>Aureococcus anophagefferens</i> )
1992	July	Raritan Bay shore (Keyport vicinity)	Several hundred dead fish and shellfish of several different species (mostly demersal types) due to apparent hypoxia from an extensive red tide bloom dominated by <i>Katodinium rotundatum</i> and <i>Olisthodiscus luteus</i> , with several others abundant.
1990	June/July	Shrewsbury River (tributary to Sandy Hook Bay)	Localized kill of small fish; occurred between successional blooms of <i>Kirodindatem</i> and a few diatom species in bay and river.

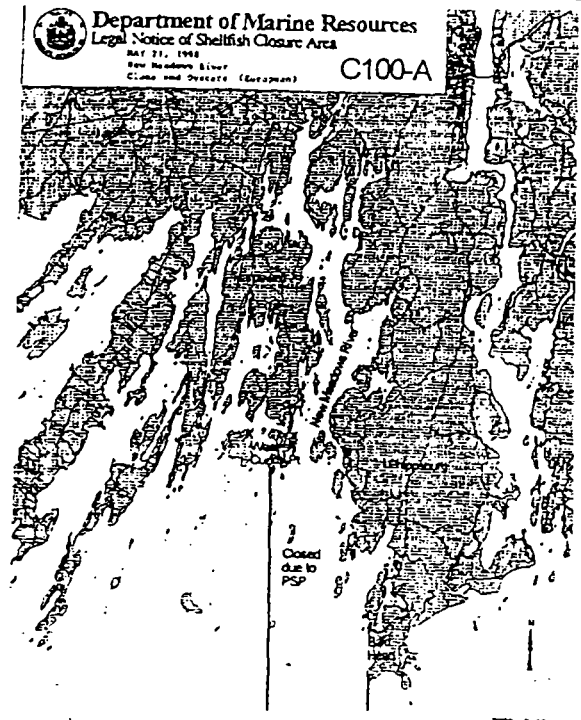
## ***HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998***

- 1. Location:** see enclosed maps.
- 2. Date of Occurrence:** see enclosed maps.
- 3. Effects:** PSP in mentioned species.
- 4. Management Action:** Affected areas closed to the harvest of above mentioned
- 5. Causative Species:** *Alexandrium tamarense*
- 6. Environment:**
- 7. Advected Population or In Situ Growth:**
- 8. Previous Occurrences:** Generally a yearly occurrence, since 1958, when monitoring began.
- 9. Additional Comments:**
- 10. Individual to Contact:** John W. Hurst, Jr.  
Laurie L. Bean  
Department of Marine Resources  
West Boothbay Harbor, ME 04575

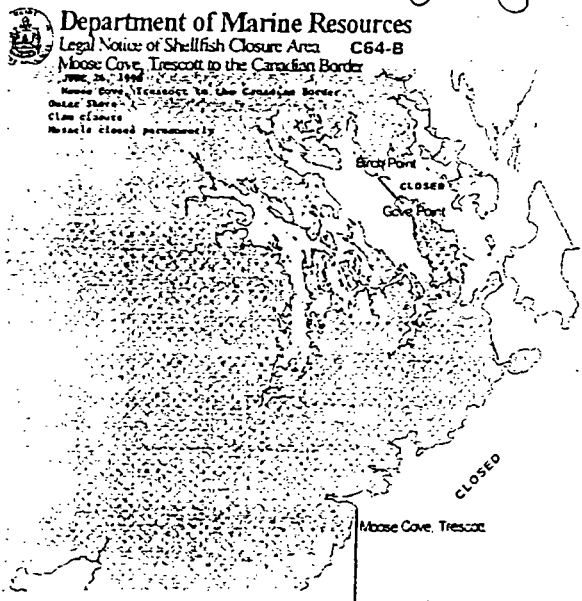
# 1998 Closures Made Due to Paralytic Shellfish Poisoning



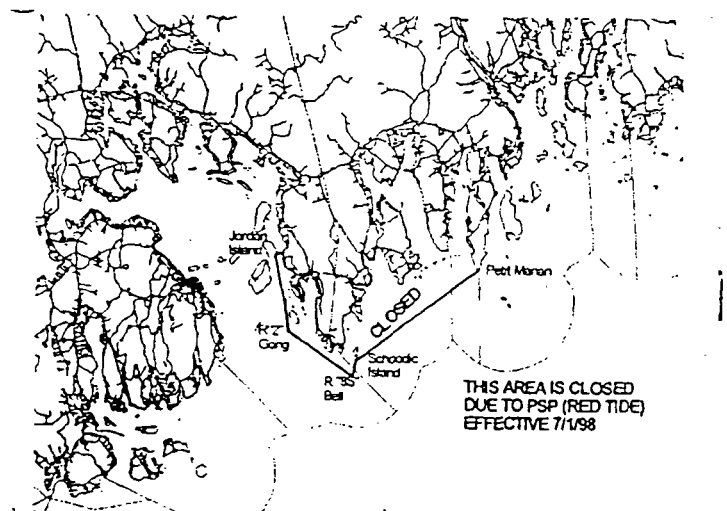
Kittery to Cape Elizabeth closed to Mussel and Carnivorous Snail harvesting, May 14, 1998. (top) 32 Aug/100g  
Basin Point, Harpswell to Fort Popham, Phippsburg closed to Mussel harvesting May 15, 1998. (bottom)  
Reopened July 9, 1998 732 Aug/100g



New Meadows River closed to clam and oyster (European) harvesting, May 21, 1998.  
Reopened June 3, 1998 11 Aug/100g



Moose Cove Trescott to Canadian Border closed to Clam harvesting, June 24, 1998. 8 Aug/100g  
Reopened July 9, 1998



Jordan Island to Petit Manan closed to Mussel harvesting, July 1, 1998  
Reopened July 16, 1998 78 Aug/100g

## **PSP events in the United States (New England) regions 1-7**

### **Location:**

- Gulf of Maine- eastern Maine (region 1)
- Gulf of Maine -Penobscot PSP sandwich area (region 2)
- Gulf of Maine - Western Maine Coastal Current (region 3)
- Gulf of Maine Mass Bay - (region 4)
- Cape Cod Salt Ponds (region 5)
- Gulf of Maine Georges Bank (region 6)
- Southern New England (region 7)

### **Dates of Occurrence:**

- Region 1 low toxicity in late June and early July
- Region 2 no toxicity, but cells detected offshore in June and July
- Region 3 April 29 -June 1998 - Region 3
- Region 4 mid May-early June- no toxicity in Mass Bay
- Region 5 salt ponds on Cape Cod showed some toxicity
- Region 6 no sampling offshore
- Region 7 no occurrences since 1996, but cells reported in some years

### **Management Decisions:**

- Region 1- closures in late June; barely above 80 ug/100g
- Region 2 - no closures
- Region 3 -shellfish closures in southern Maine, NH, and northern Mass. - mid-May through June max toxicity ~600ug/100g;
- Region 4 - no closures in Mass Bay
- Region 5- brief closure of salt ponds on Cape Cod in May
- Region 6- continued closure of surf clams (probably residual toxin from earlier event in 1990)
- Region 7- No closures

### **Causative Species:**

- Region 1&2 - Alexandrium sp. (probably fundyense) - ~2500 cells/liter offshore
- Region 3 -Alexandrium sp. (probably fundyense) maximum cell count from ~ 1,000/liter

### **Environment:**

- Region 3:
  - Temp range - 6-12 C
  - Salinity range- 26-30 psu

**Advised Population or In situ growth:** outbreaks from region 3 probably due to advection of populations from region 2 and local germination of cysts with subsequent accumulation and growth near frontal boundaries of river plume. River plume/coastal current advected populations into northern areas of region 4

**Previous Occurrences:** annually in region 1, 3, 5; area 2 generally free of toxin; region 4 every several years; region 7- No occurrences since 1996 - major bloom in 1985

**Additional Comments:** outbreaks along coast of region 3 coincident with downwelling conditions; region 2 free of toxin as usual (PSP sandwich) but low density of cells reported there (<100cells/liter)

**Individual to contact:** Dr. Don Anderson

## **HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998**

### **Location:**

- a) Northern and Central California (21 & 20)
- b) Southern California (19)
- c) Northern California, Monterey Bay, and San Luis Obispo in Central CA.

### **Dates of Occurrence:**

- a) April 7, 1998 through May 19.
- b) April 30 to August 18
- c) *Pseudo-nitzschia* observed April 30; DA detected May 12.

### **Effects:**

- a) PSP Toxicity above alert level
- b) PSP toxicity above alert level
- c) Domoic acid in anchovy: Marine mammal strandings

### **Management Decisions:**

- a) Implement quarantine on sport-harvested mussels.
- b) Implement quarantine on sport-harvested mussels
- c) Quarantine already in effect.

### **Causative Species:**

- a) *Alexandrium spp.*
- b) *Alexandrium spp.*
- c) *Pseudo-nitzschia*

### **Environment:**

### **Advection Population or In Situ Growth:**

- a) Advection most likely
- b) Advection most likely
- c) Advection most likely

### **Previous Occurrences:**

- a) Frequent: Annual event
- b) Infrequent
- c) 1991

**Additional Comments:** Information on marine mammal strandings: Dr. Francis Guillard, Marine Mammal Center, Marin, CA.

Information on D A. in anchovy: Dr. Susan Loscutoff, CA. Dept. of Health Services

**Individual to Contact:** Greg Langlois (510) 540-3423

## MORTALITY OF FISH AND OTHER MARINE ORGANISMS

### California

YEAR	MONTH	AREA (CODE)	COMMENTS
1998	May	21	Large impact to marine mammals in Monterey Bay, and perhaps along the San Louis Obispo coast, due to Domoic Acid from <i>Pseudo-nitzschia</i> bloom.

## DURATION OF TOXIC EPISODES

TYPE OF TOXICITY (PSP, DSP, ASP, NSP, ETC.): \_\_\_\_\_

[illegible]

This table should be used to indicate the duration of the toxic episodes and the maximum level of measured toxicity.



## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

- 1. Location:** South Puget Sound, Washington (Carr Inlet, including Burley Lagoon, and Pitt Passage)
- 2. Dates of Occurrence:** Bloom 1 - August  
Bloom 2 - October
- 3. Effects:** Bloom 1 - blue mussels had PSP levels of 2,442 µg; geoduck clams in Pitt Passage had PSP levels of 1,015 µg  
Bloom 2 - blue mussels from Burley Lagoon had PSP levels of 10,982 µg; geoducks from Pitt Passage had 180 µg. The second bloom also expanded into Case Inlet. Blue mussels were recalled from one company; geoduck recalls involved 5 commercial companies, including one tribal enterprise.
- 4. Management Decision:** Bloom 1 - harvest closure in July and August in Carr Inlet; geoduck closure in Pitt Passage from July to September.  
Bloom 2 - Burley Lagoon closed from October to December; geoduck harvest in Pitt Passage closed from October to November.
- 5. Causative Species:** Presumed to be *Alexandrium catenella*
- 6. Environment:** No data available
- 7. Advected Population or In situ Growth:** No data available, but probably in situ growth at least in Carr Inlet.
- 8. Previous Occurrences:** November 1997 to January 1998 - harvest closures in South Puget Sound, especially in Case Inlet (PSP = 6,799 µg) and extending to Pickering, Pitt, and Peale Passages, and Eld Inlet. This was a new high record PSP level for South Puget Sound. Areas were closed that had no previous record of PSP.
- 9. Additional Comments:** Five cases of PSP occurred from consumption of blue mussels from a commercial shellfish company located at the north end of Carr Inlet. This is the first year that two major blooms have occurred in the same inlet in one year. The high PSP toxin level in blue mussels from Burley Lagoon is the highest recorded in western Washington waters since the record high level of 30,000 µg in Island County (north Puget Sound) in 1978.  
Geoducks (*Panope generosa*) are a relatively new industry for Puget Sound waters, with the potential for > \$5-10 million/y. Tracts for harvest of natural populations are leased to commercial harvesters by the Washington State Department of Natural Resources. During 1998, four major harvest tracts were closed a total of 32 times because of high PSP toxin levels. Geoducks are also being raised at some aquaculture sites.
- 10. Individual to Contact:** Mr. Frank Cox  
Office of Shellfish Programs  
Washington Department of Health  
Agricultural Center, Bldg. 4  
P.O. Box 47824  
Olympia, WA 98504-7824

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Kalaloch on the Washington State Pacific coast
2. **Dates of Occurrence:** September through December, at least
3. **Effects:** Domoic acid levels in razor clams (*Siliqua patula*) reached 295 ppm in November.
4. **Management Decision:** Fall recreational harvest season not opened, some question whether spring 1999 recreational harvest will be allowed.
5. **Causative Species:** Presumed to be *Pseudo-nitzschia*, but not known for sure. Some cells of *P. pungens*, *P. fraudulenta*, *P. australis*, and cf. *P. pseudodelicatissima* identified in beach samples collected at this site in September and October, with relatively high concentrations of several *Pseudo-nitzschia* species in mid-September and early October (2 samples only taken two weeks apart, collected with a bucket and concentrated through a 20 µm mesh net). (Data from University of Washington School of Oceanography monitoring program).
6. **Environment:** In September, water temperature was ca. 13 C, salinity 32.5-34.9 psu; in November, water temperature was 13 C, salinity 27.1 psu; by December, water temperature was 8 C and salinity 23.9 psu (data from University of Washington School of Oceanography monitoring program).
7. **Advected Population or In situ Growth:** No data available, but probably advected
8. **Previous Occurrences:** October - December 1991
9. **Additional Comments:** Razor clams take at least 9 mo and probably longer to rid themselves of domoic acid. The Kalaloch site has been a hot spot for domoic acid since the first incidence of it on the U.S. west coast in 1991.
10. **Individual to Contact:** Mr. Frank Cox  
Office of Shellfish Programs  
Washington Department of Health  
Agricultural Center, Bldg. 4  
P.O. Box 47824  
Olympia, WA 98504-7824

## DURATION OF TOXIC EPISODES

TYPE OF TOXICITY (PSP, DSP, ASP, NSP, ETC.): ASP

[illegible]

This table should be used to indicate the duration of the toxic episodes and the maximum level of measured toxicity.

## DURATION OF TOXIC EPISODES

## HUMAN INTOXICATIONS

YEAR	MONTH	AREA (CODE)	COMMENTS
1998	October	24	5 people ill from mussels harvested at a commercial shellfish company in Carr Inlet.

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Pelican, Alaska, on Lisianski Inlet, in NW part of Chicagof Island.  
57° 57' 30"N., 136° 13' 30"W
2. **Dates of Occurrence:** 11/13//98
3. **Effects:** Numbness and tingling in mouth and around face and lips. Felt nauseated and vomited several times. Patient had dug and consumed two, large platefuls of fried butterclams. Littleneck clams were eaten previously and all were asymptomatic.
4. **Management Decision:** N/A.
5. **Causative Species:** Suspect *Alexandrium*.
6. **Environment:** Small inlet (closed).
7. **Advected Population or In situ Growth:**
8. **Previous Occurrences:** Yes.
9. **Additional Comments:** Decomposed samples prevented confirmation of PSP, but illness was counted as a case of unconfirmed PSP by the State epidemiologist.
10. **Individual to Contact:** Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
565 Cordova Street  
Anchorage, Alaska 99501  
Tel: (907) 269-7638  
FAX: (907) 269-7510  
E-mail: mostasz@envircon.state.ak.us

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Sentinel Island, 0.2 mile long in center of Favorite Channel, 0.6 mile SW of Benjamin Island and 25 miles NW of Juneau. 58° 32' 45"N., 134° 55' 15"W
2. **Dates of Occurrence:** 4/30/98
3. **Effects:** One person experienced tingling in his lips and fingertips after one hour of eating a meal of limpets. Limpets were boiled and siphons and viscera were not consumed.
4. **Management Decision:** N/A.
5. **Causative Species:** Suspect *Alexandrium*.
6. **Environment:** Area has had previous cases of PSP in the past with recreational/sports harvesters.
7. **Advected Population or In situ Growth**
8. **Previous Occurrences:** See #6
9. **Additional Comments** First case of PSP associated with consumption of limpets.
10. **Individual to Contact:** Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
565 Cordova Street  
Anchorage, Alaska 99501  
Tel: (907) 269-7638  
FAX: (907) 269-7510  
E-mail: mostasz@envircon.state.ak.us

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Kootznahoo Inlet, a water passage 6 miles long extending from Mitchell Bay to Chatham Straits, at Angoon, on W. coast of Admiralty Isl. (57° 32'N., 134° 31'W)
2. **Dates of Occurrence:** 9/1//98
3. **Effects:** Red discoloration to water.
4. **Management Decision:** trying to secure sample for identification at our laboratory.
5. **Causative Species:** Unknown.
6. **Environment:** Water temperatures have increased in this area from low 50's F. to 62°F. Plenty of rain seen during and before this siting.
7. **Advected Population or In situ Growth**
8. **Previous Occurrences**
9. **Additional Comments**
10. **Individual to Contact:** Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
565 Cordova Street  
Anchorage, Alaska 99501  
Tel: (907) 269-7638  
FAX: (907) 269-7510  
E-mail: mostasz@envircon.state.ak.us



## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Kosciusko Island, extends NE-SW 26 miles, separated from Prince of Wales Island by El Capitan Passage. (56° 03'N., 133° 33'W)
2. **Dates of Occurrence:** 8/30/98
3. **Effects:** 57, 61, 71, & 116 µg/100 grams seen in lot samples with oysters. Although concurrent Littlenecks were satisfactory at 57, 73, 47 and 43 micrograms/100 grams
4. **Management Decision:** Lot was rejected for sales of oysters only.
5. **Causative Species:** *Alexandrium*
6. **Environment:** Small bay – open on two ends.
7. **Advected Population or In situ Growth**
8. **Previous Occurrences**
9. **Additional Comments** The 116 µg/100 gram sample is the highest we've seen from this site location with oysters.
10. **Individual to Contact:** Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
565 Cordova Street  
Anchorage, Alaska 99501  
Tel: (907) 269-7638  
FAX: (907) 269-7510  
E-mail: mostasz@envircon.state.ak.us

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

**1. Location:** Juneau, Alaska, Outer Point, point of land on west tip of Douglas Island in Stephens Passage, 4 miles NW of Middle Point and 10 miles west of Juneau.

**2: Date of Occurrence:** 4/30/98

**3. Effects:** One person seen in emergency room with symptoms in six hours of numbness of face and tongue, diarrhea, lightheaded, headache, numbness in fingers and toes and continued numbness of tongue on 5/1/98.

**4. Management Decision:** Press release warning about harvesting from unapproved areas.

**5. Causative Species:** Raw butterclams      278  $\mu\text{g}$ /100 grams  
Cooked butterclams      212  $\mu\text{g}$ /100 grams

**6. Environment:**

**7. Advected Population or In situ Growth:**

**8. Previous Occurrences:** General area has had problems with psp episodes in the past.

**9. Additional Comments:**

**10. Individual to Contact:** Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
Department of Environmental Conservation  
555 Cordova Street  
Anchorage, ALASKA 995 01  
Tel: (907) 269-7638  
Fax: (907) 269-7510  
Email: mostasz@envircon.state.ak.us

## HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1998

1. **Location:** Kake, Alaska. Main boat harbor. 56°58'30"N., 133°56'30"W.
2. **Date of Occurrence:** 4/22/98
3. **Effects:** Red discoloration to entire area by boat harbor.
4. **Management Decision:** Town issued a general warning about harvesting clams in the area.
5. **Causative Species:** Water sample identified as *Mesodinium Rubrum*, a ciliate protozoan.
6. **Environment:**
7. **Advected Population or In situ Growth:**
8. **Previous Occurrences:** Usually in late spring to summer discoloration is noted.
9. **Additional Comments:**
10. **Individual to Contact:**  
Michael J. Ostasz  
Shellfish Coordinator, Seafood Program  
State of Alaska  
Department of Environmental Conservation  
555 Cordova Street  
Anchorage, ALASKA 99501  
Tel: (907) 269-7638  
Fax: (907) 269-7510  
Email: mostasz@envircon.state.ak.us

## ANNEX IV – DECADAL MAPS OF PHYTOPLANKTON TOXINS IN THE ICES AREA

### Period

1989–1998

The purpose of plotting events on maps is to obtain a global and visual overview of harmful events for the preceding ten years. Information, which is plotted, on maps includes indication of regular monitoring sites (phytoplankton and/or phycotoxins), and indication of the frequency of harmful events during the last ten years. Each map represents one type of event, and the different types of events are: DSP, PSP, ASP, NSP, CFP, animal and plant mortality, and cyanobacteria toxicity. The information plotted is the presence of toxins, or observations of mortality. Blooms of potentially toxic species with non-detectable levels of toxicity do not appear on maps.

### DISCLAIMER

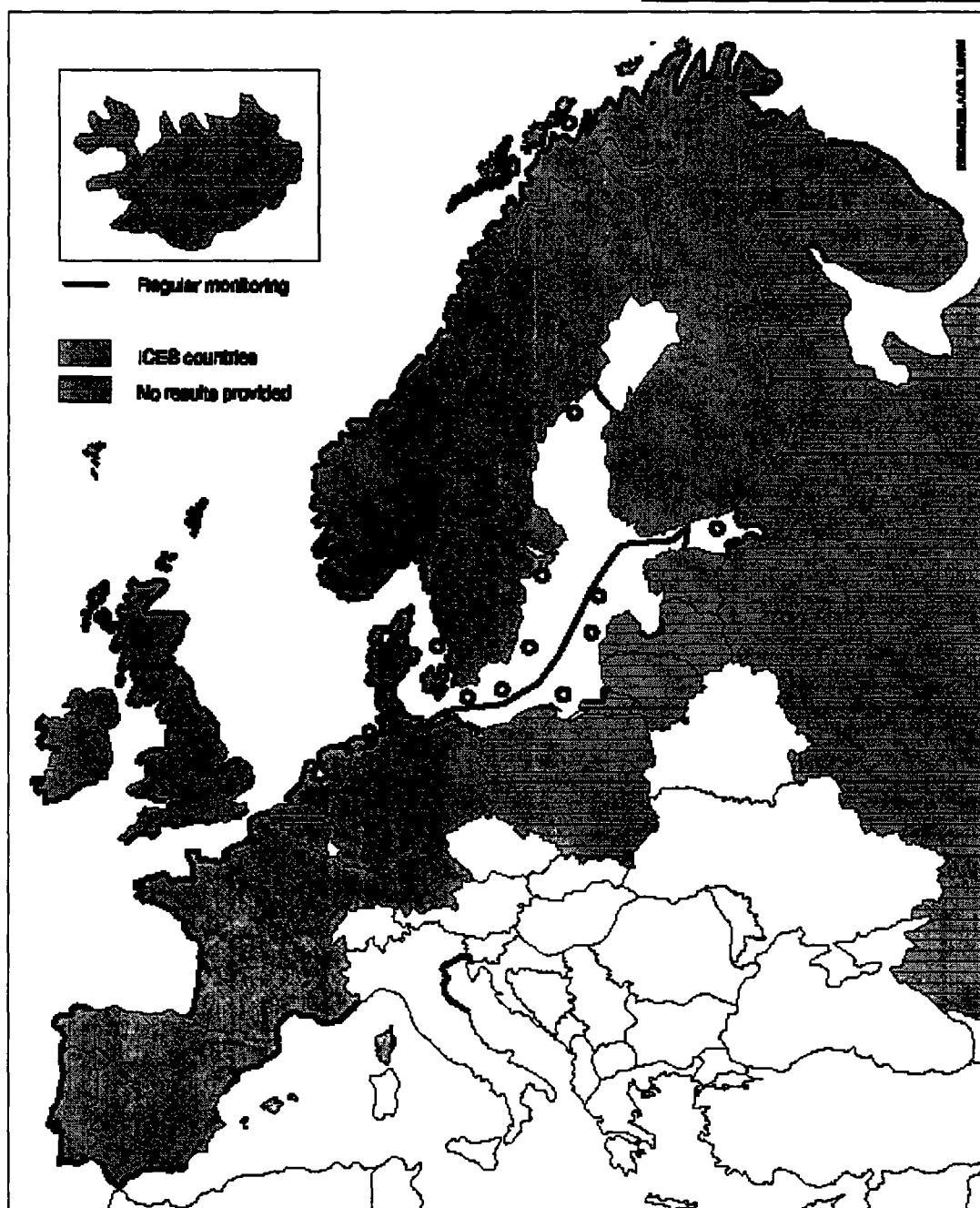
The information used for the maps is based on yearly national reports by ICES member states. The available information on individual events varies greatly from event to event or country to country. Monitoring intensity, number of monitoring stations, number of samplings, stations, etc. also varies greatly and therefore there is not a direct proportionality between recorded events and actual occurrences of e.g., toxicity in a given region. Furthermore, areas with numerous recorded occurrences of HAEs (Harmful Algal Events), but with an efficient monitoring and management programmes, may present a low risk of intoxications, whereas rare HAEs in other areas may cause severe problems and could present significant health risks.

Therefore, these maps should thus be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries.

IOC and ICES are not liable for any possible misuse of this information.

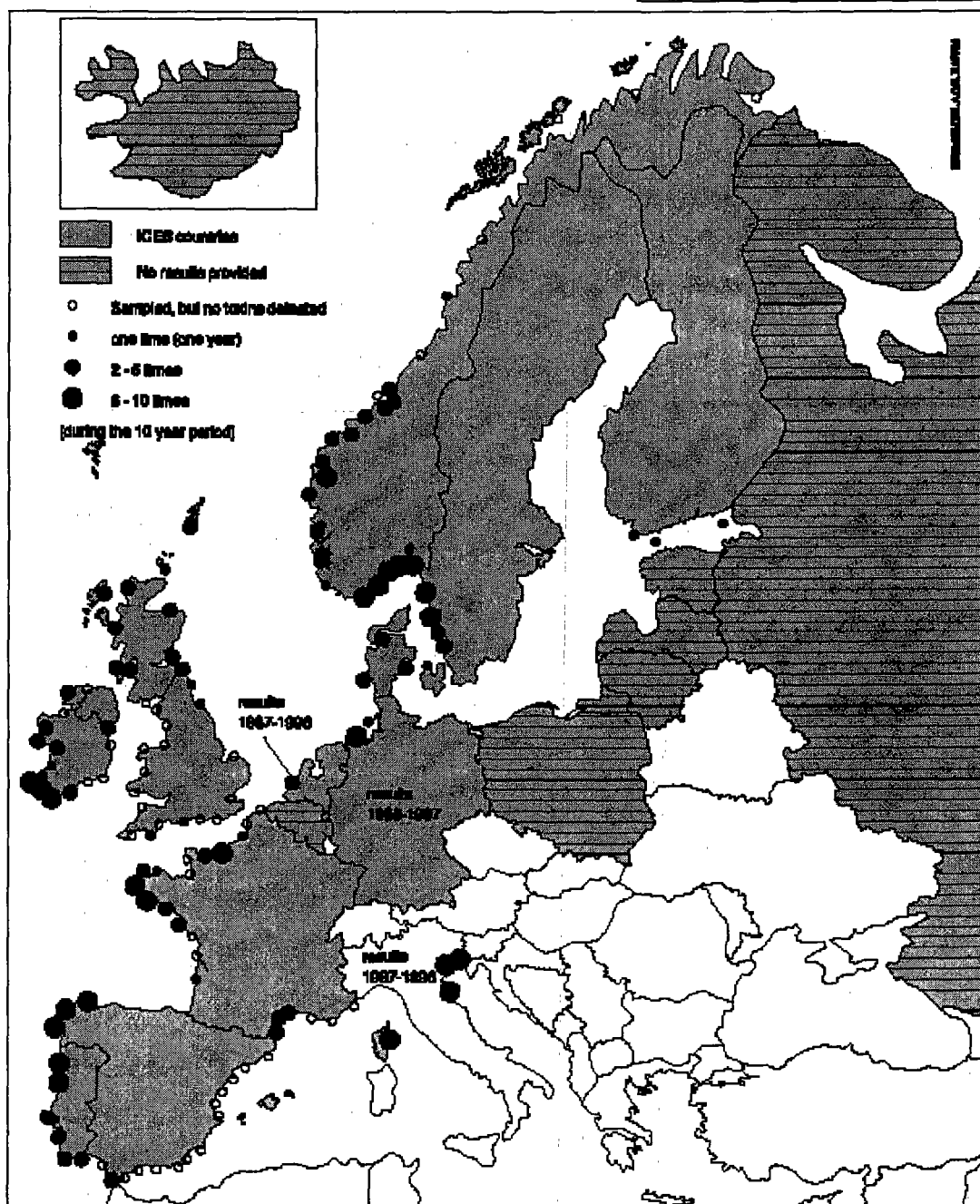
# Regular monitoring 1998

**DISCLAIMER - WARNING**  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.



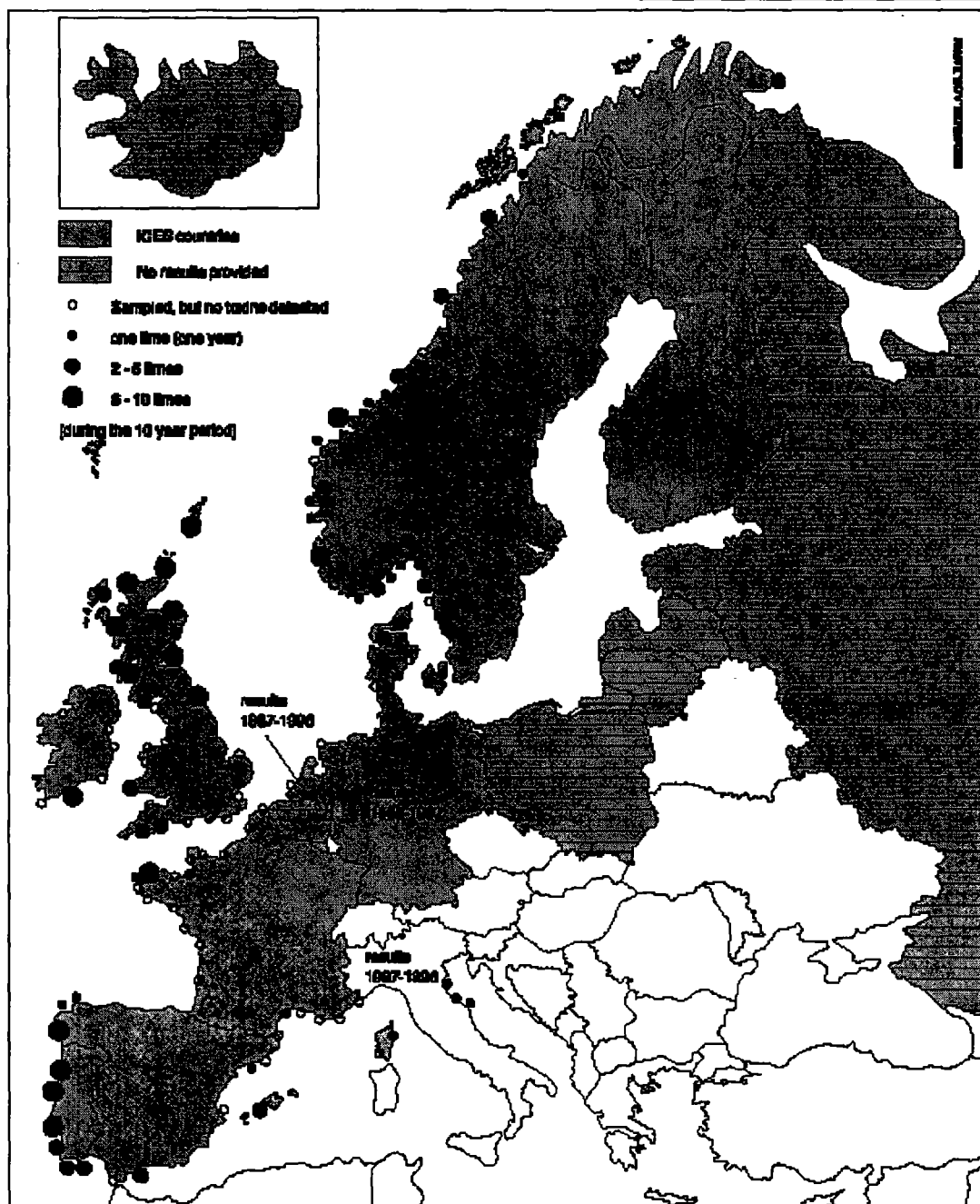
# Presence of DSP toxins 1989 - 1998

DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution  
regarding risk of intoxication by seafood products  
from the respective areas/regions/countries.  
The IOC and ICES are not liable for possible misuse  
of this information.



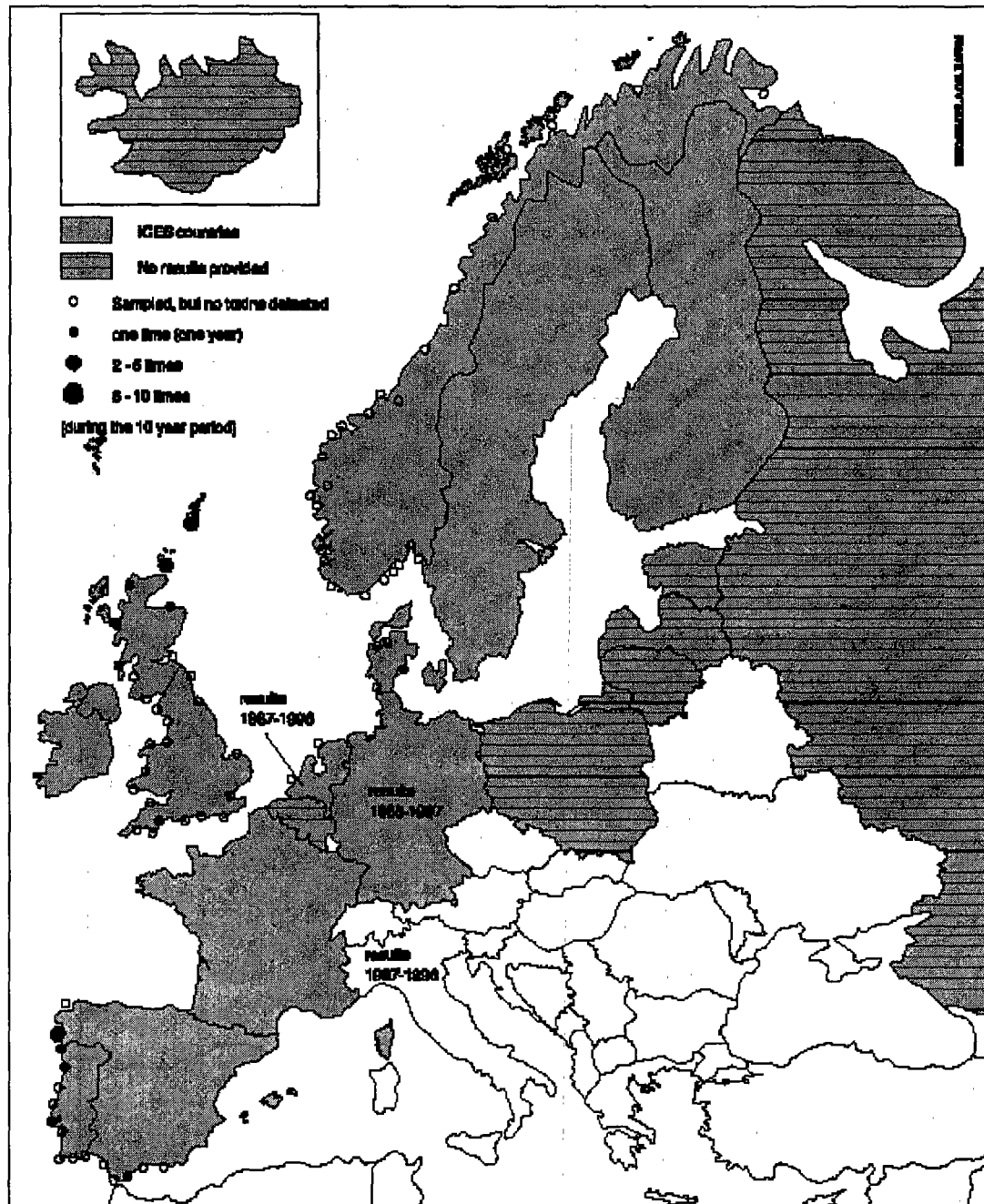
# Presence of PSP toxins 1989 - 1998

DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.



# Presence of ASP toxins 1989 - 1998

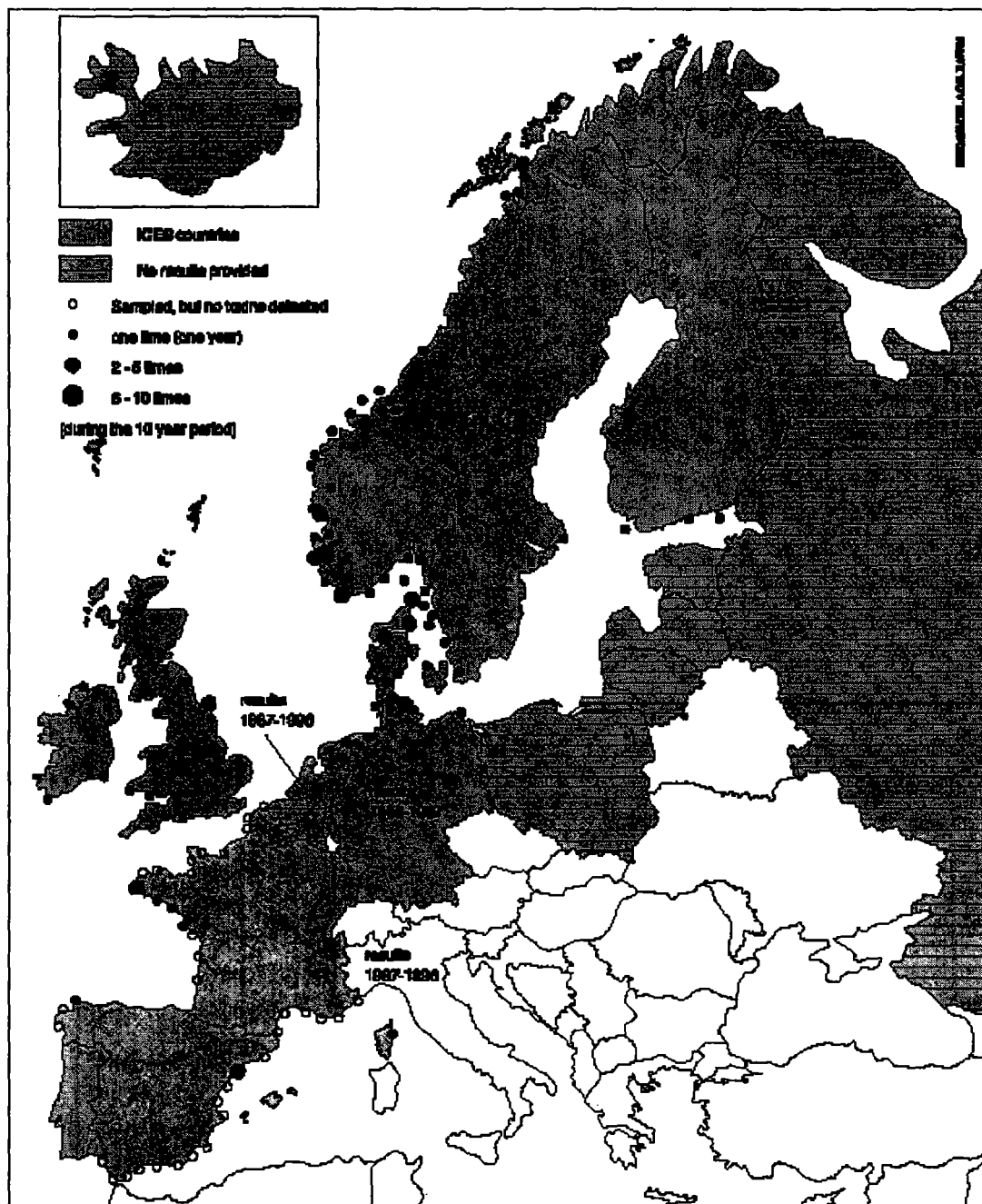
DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.





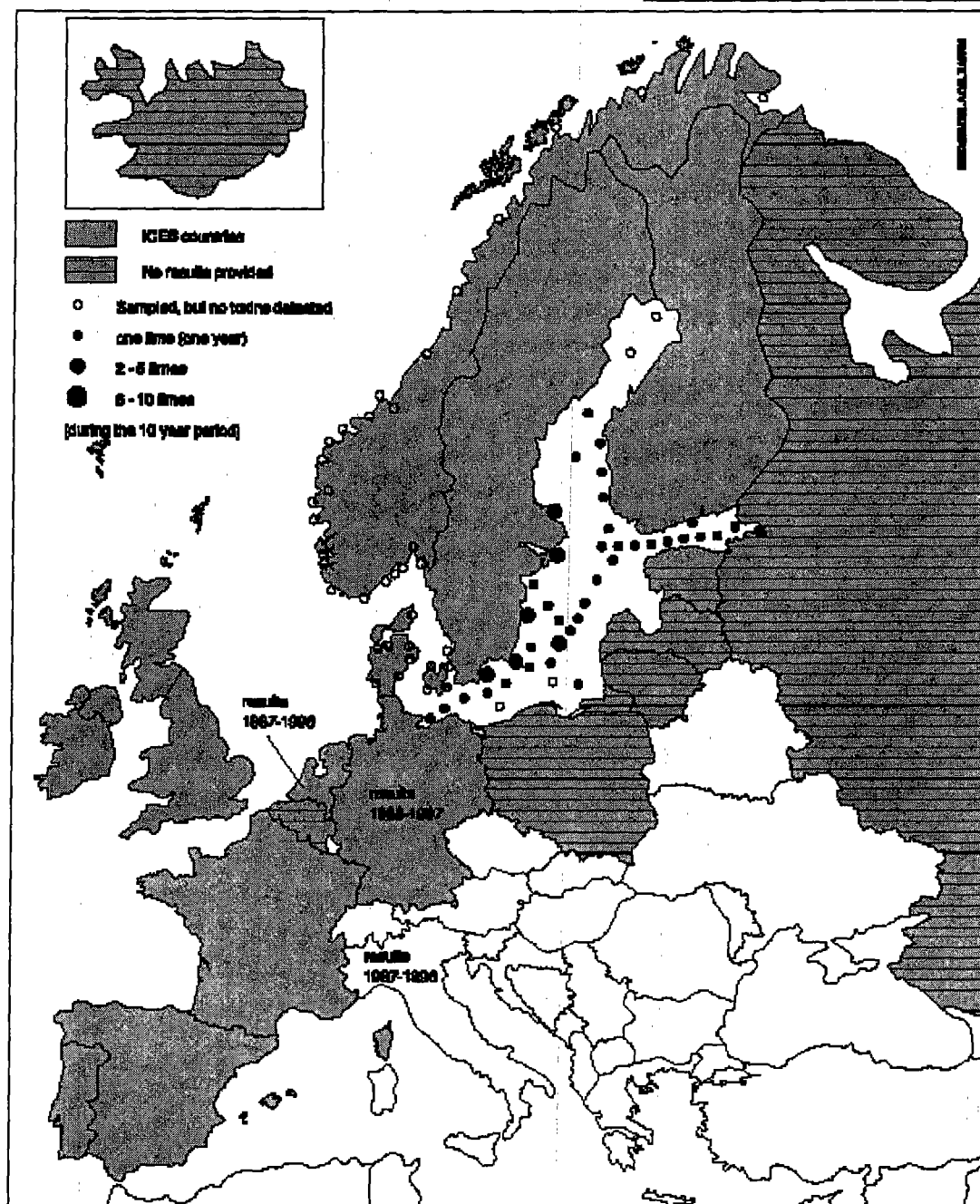
# Animal and plant mortalities 1989 - 1998

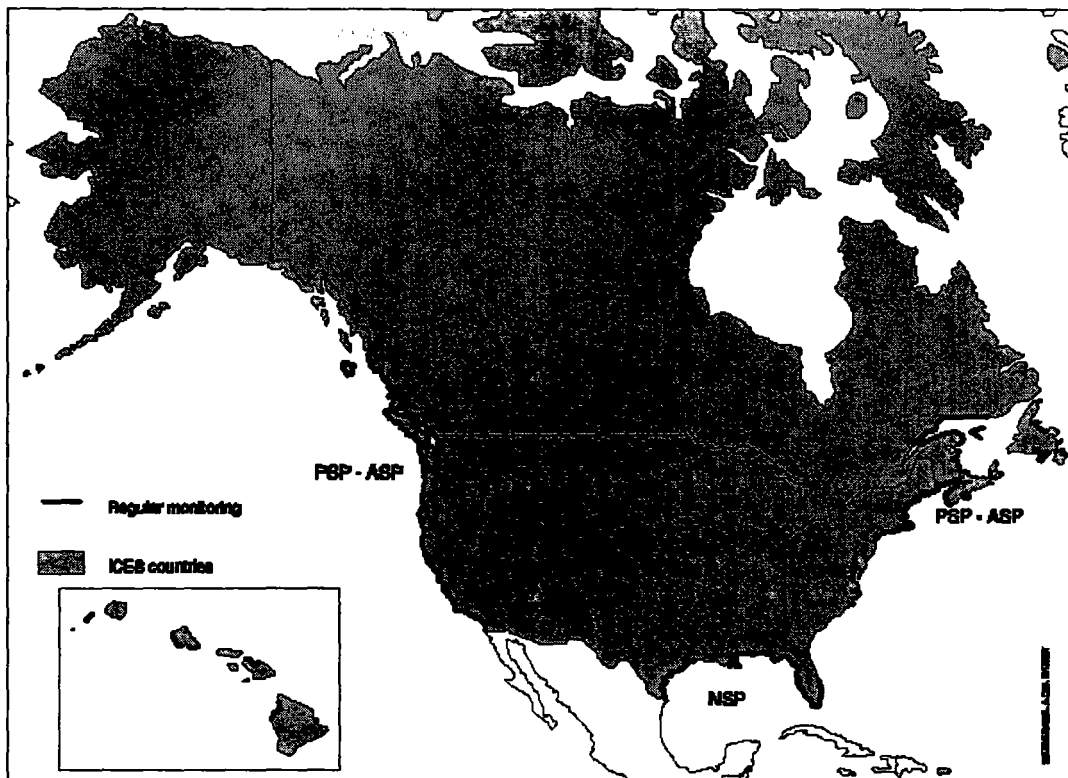
**DISCLAIMER - WARNING**  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.



# Other toxic effects cyanobacteria 1989 - 1998

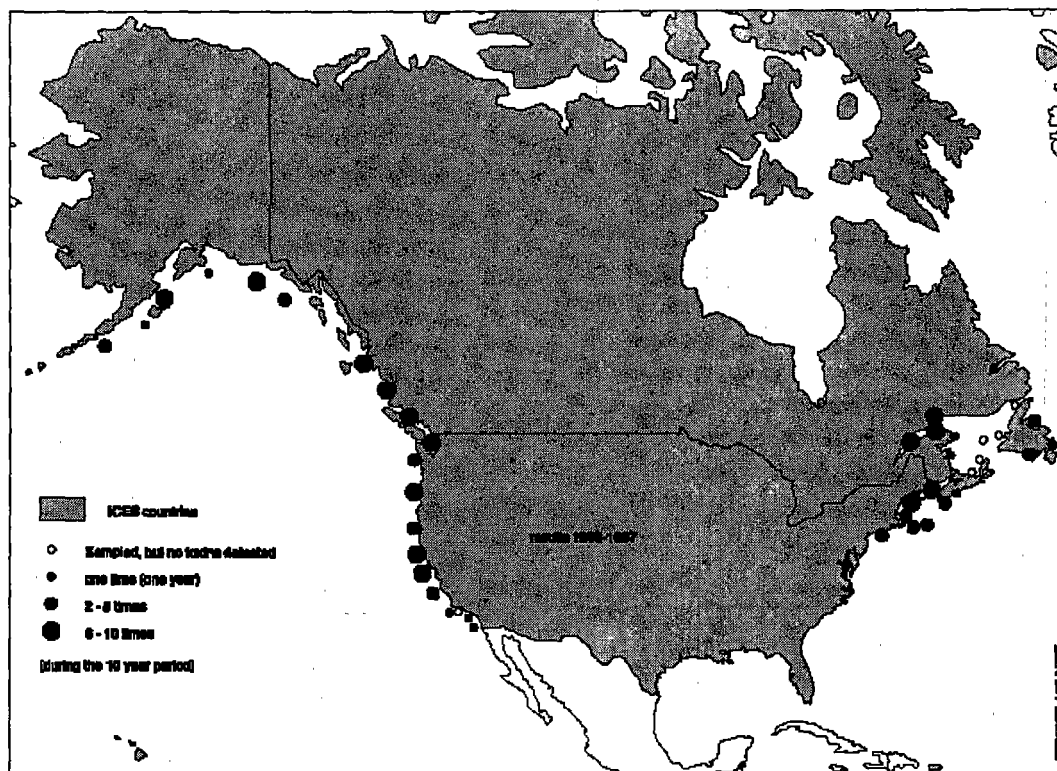
DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution  
regarding risk of intoxication by seafood products  
from the respective areas/regions/countries.  
The IOC and ICES are not liable for possible misuse  
of this information.



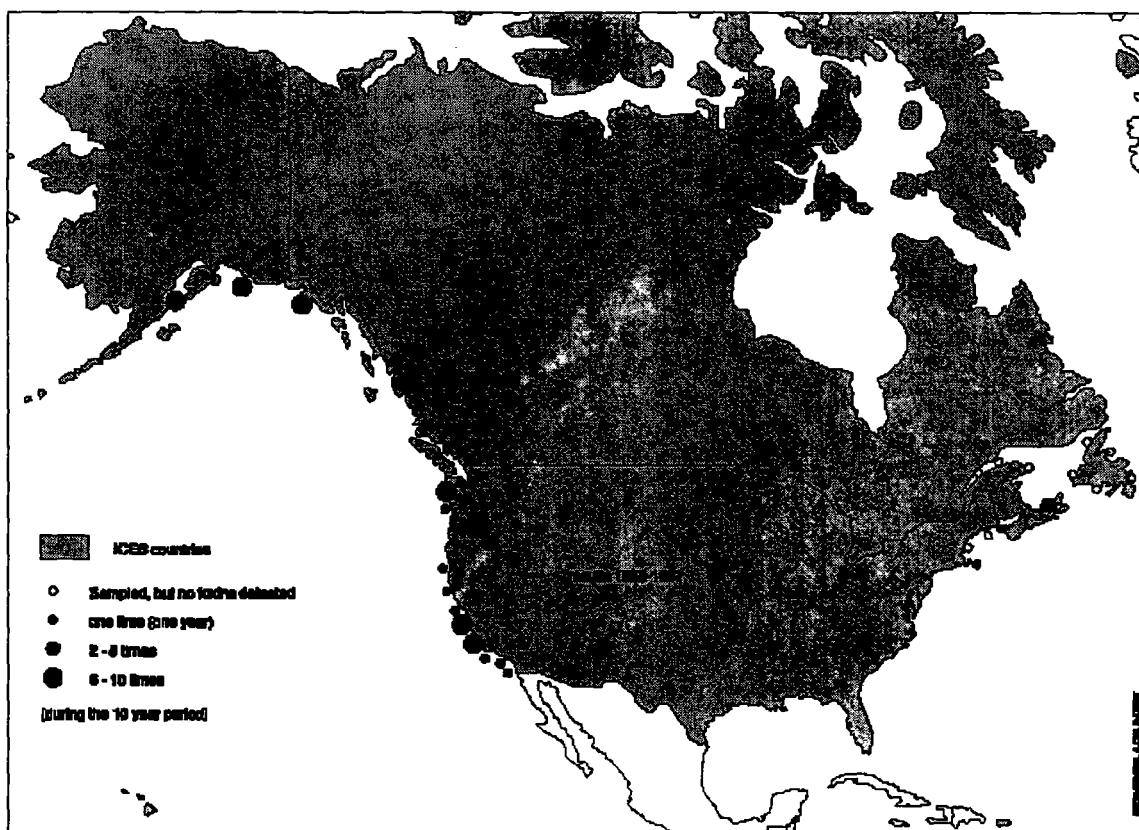


Regular monitoring  
1998

DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution  
regarding risk of intoxication by seafood products  
from the respective areas/regions/countries.  
The IOC and ICES are not liable for possible misuse  
of this information.

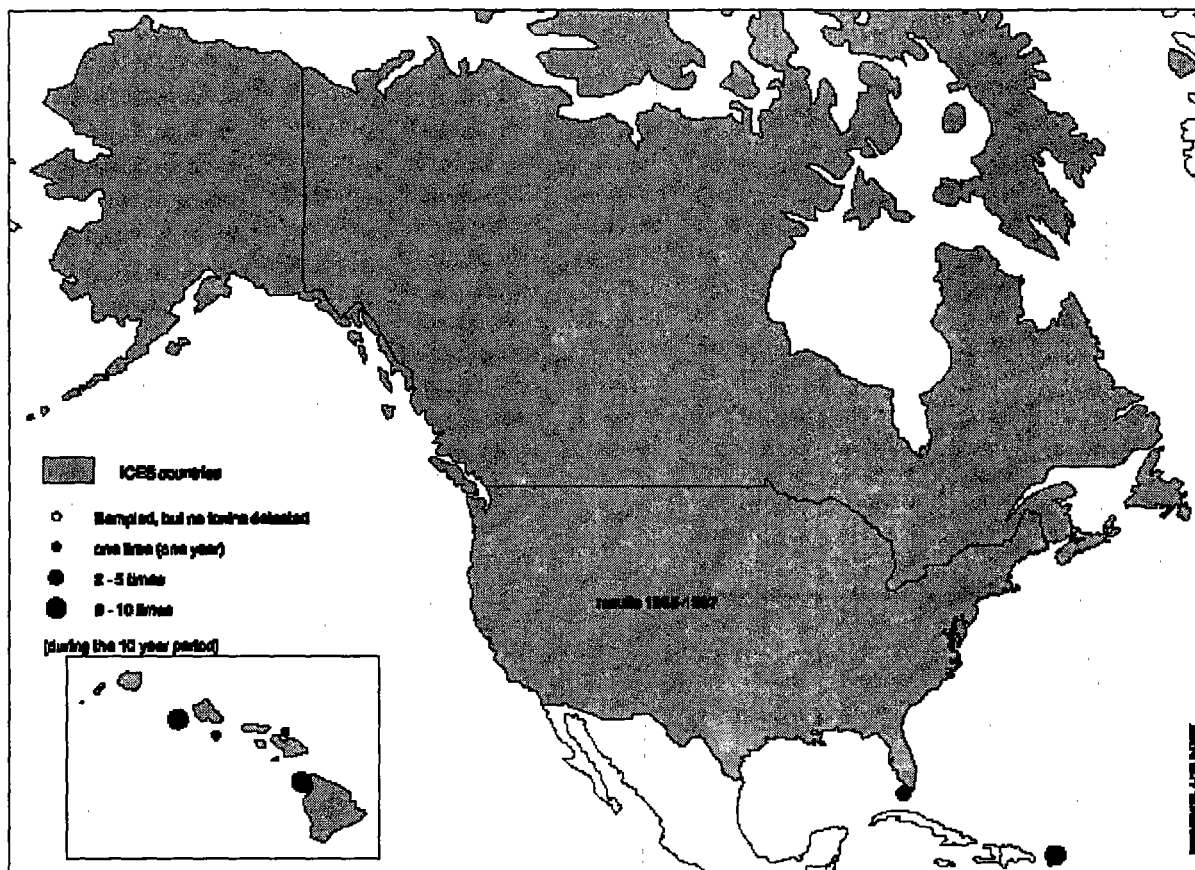


Presence of PSP toxins  
1989 - 1998



Presence of ASP toxins  
1989 - 1998

DISCLAIMER - WARNING  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.



### Ciguatera Fish Poisoning 1989 - 1998

**DISCLAIMER - WARNING**  
HAEDAT maps should be interpreted with caution regarding risk of intoxication by seafood products from the respective areas/regions/countries. The IOC and ICES are not liable for possible misuse of this information.



