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CIEM Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

Highlights

15 Scientists representing 9 countries participated in the meeting. This is somewhat lower than other years, but it was possibly due to the location of the meeting and tightening budgets. Next year's meeting will be held in Sweden so we would expect to have participation from the Baltic countries once more.

National Reports

The National Reports for 2008 were made on the status of HABs from all 9 countries that participated in this year's meeting.

Canada experienced a normal year following extensive problems due to PSP in 2008. Some limited salmon mortalities were experienced due to *Heterosigma akashiwo*, *Chatonella spp.* and *Chaetoceros concavicornis*.

USA also reported 2009 as basically a "normal" HAB year for most regions of the US, with several noteworthy events. Maine, New Hampshire, Massachusetts, Washington, Oregon, and California all recorded PSP toxicity in 2009, with a significant regional-scale *Alexandrium fundyense* bloom reported (and predicted by cyst counts) within the Gulf of Maine. The geographic extent of the event in Maine was unprecedented, with many areas of the coast showing high levels of toxicity. ASP was reported to be implicated in 200 sea lion strandings in California State. NSP and *Karenia brevis* blooms occurred in southwest Florida and in Texas. Three manatee mortalities were confirmed to be due to this bloom with seven more were suspected. An *Aureococcus* bloom 9up to 1.4 million cells/l) was reported from Long Island in New York State.

Denmark showed no levels of ASP, PSP or DSP above the regulatory limits, but did enforce some precautionary closure due to high levels of *Pseudo-nitzschia* and *Dinophysis acuminata*. Salmon and rainbow trout in marine aquaculture were killed off during an early bloom of the fish killing flagellate *Chattonella/Pseudochattonella.*

The Netherlands 2009 was a year with absence of any toxic events, but *D. acuminata* were detected in the western part of the Wadden Sea and in Lake Grevelingen.

Sweden reported no major harmful blooms in the Skagerrak and the Kattegat. The potentially harmful flagellate *Chrysochromulina* cf. *polylepis* was observed in bloom abundances (max. ca 1 500 000 cells per litre) in the southern Baltic proper the first half of June. No harmful effects were reported. The toxin producing species *Nodularia spumigena* was found in the water together with non toxic *Aphanizomenon* sp. and *Anabaena* sp.

Germany concurred on this with recorded occurrences of the potentially toxic species *Nodularia spumigena*, typically the dominant cyanobacterium, along the German Baltic coast. Low concentrations of *D. acuminata* up to 400 cells/l resulted in low concentrations of okadaic acid below closure levels

Spain reported a moderate year with PSP, DSP and ASP in Cataluña, Andalucía and Galicia, while there were no reports of HAB events in the Basque Country during 2009.

UK reported significant occurrences of *Pseudo-nitzschia* in samples from UK throughout 2009, with resultant ASP in shellfish in Scotland but not in England or

Wales. Similarly Alexandrium between April and July was implicated in PSP events in Orkney and the Western Isles and in Lough Fyne and later in July in the Fal Estuary. DSP was also widespread through the year including an exceptional 14 week closure in Lough Fyne.

Toxicity was generally low in Northern Ireland with no PSP but there were 5 detections of DSP toxins in shellfish. ASP was detected also, in Scallops from Strangford lough.

Ireland reported the occurrence of DSP, PSP ASP and AZP. ASP was present in shellfish following a *Pseudo-nitzschia* bloom in March, which was followed by DSP toxins particularly in the South West. A single occurrence of PS from Cork harbour was recorded in July, and Azaspiracid resulted in numerous closures from August onwards.

New findings

New findings reported at the Working Group Meeting included updates on the forecasting **Alexandrium blooms in the Gulf of Maine,** and enhancements to observational capabilities. Using large scale cyst maps has shown significant promise in the forecasting of *Alexandrium fundyense* blooms and resultant PSP in the Gulf of Maine. Considerable effort has gone into developing methods to analyze water and plankton samples rapidly and accurately using new technologies, including many that derive from biomedical research. A major breakthrough in this regard is the Environmental Sample Processor (ESP), and plans to deploy several of these instruments were reported.

An FP7 project "**ASIMUTH**" was described involving partners from Ireland, France, Spain, UK and Portugal. This project aims to utilise satellite, modelling and monitoring outputs in a standardised process to provide early warning of severe blooms to finfish and shellfish farmers to adapt their culturing processes in time to reduce potential losses. This will be achieved by identification of key past events to train the modelling system and the design of a regional model system and delivery of nowcast for specific HABs and location information, transport pathways and remote sensed data.

Bloom dynamics of Dinophysis acuta in Western Iberia that combined physical observations (SST, current measurements); weekly observations from monitoring programmes in Galicia and Portugal resulted in confirmation that increased numbers in the Galician Rías are not due to intrinsic growth but to physically driven accumulation.

A system has been developed in Sweden in cooperation with other Nordic countries to provide a definitive taxonomic database. This **Information system for aquatic microalgae and heterotrophic flagellates** was demonstrated and further development and quality control is ongoing.

A **major *Dinophysis* bloom event in Scottish waters in 2009** as mentioned in the national report was demonstrated with exceptionally high concentrations of total OA/DTXs. With the exception of one sample, total OA/DTXs exceeded the regulatory limit in mussels from mid-May to early September in Lough Fyne and Lough Striven. Cell counts up to 14000 cells/l were recorded during this event, with a hypothesis that the seed population for this was advected in to the area from the Clyde Sea.

Research carried out in Germany showed the influence of salinity, temperature and nutrients on the yessotoxin formation of different strains of *Protoceratium reticulatum*.

The species showed best growth at 15°C and 25-30% Salinity. The same research group also demonstrated Complex yessotoxins profile in different strains of Protoceratium reticulatum. This study on the complex toxin pattern of 18 strains of *P. reticulatum* from Germany, Norway, Japan, USA, New Zealand and Australia using liquid chromatography with tandem mass spectrometry (LC-MS/MS) was conducted to identify the characteristic YTXs profiles.

Another collaborative research project **Microarrays for the detection of Toxic Algae (MIDTAL)** was described. This project proposes to test and optimise existing and new rRNA probes for toxic species and immunoassays for toxins for their application to a microarray. This will be optimised for applications for the detection of harmful algae and to provide national monitoring agencies with and rapid test tool for their detection.

An update of the long-term coastal monitoring station at Stonehaven was presented to show c**hanges in the phytoplankton community in the North East of Scotland: observations since 1997.** Some significant findings from this work show the changing communities observed in these samples. For example, *Ceratium* spp appeared to diminish since 2002 with no large blooms of the group seen in the intervening period. Changes in zooplankton and predation pressures were also observed in this period.

A detailed study of the dinoflagellate genus **Alexandrium (Halim) in Scottish waters** formed a combined approach to assess diversity and toxin production. Cell culture combined with microscopic and molecular identification revealed the presence of four *Alexandrium* species: *A. tamutum, A. minutum, A. ostenfeldii* and *A. tamarense* and two different ribotypes of *A. tamarense*. PSP Toxin production was found in *A.tamarense* (Rib I) and *A.ostenfeldii.*

1 Welcome and opening of the Meeting

The **ICES-IOC Working Group on Harmful Algal Bloom Dynamics** meeting for 2009 was organised by the Woods Hole Oceanographic Institute (WHOI), USA and met at the Station of the Bermuda Institute of Ocean Science (BIOS), 6–10 April 2010. On behalf of the host and the venue local organisers Judy Kleindienst (WHOI) and Joe Silke opened the meeting and welcomed the participants to the working group meeting. The agenda was agreed and Eileen Bresnan (UK) and Jennifer Martin (Canada) were elected as joint *rapporteurs*.

15 Scientists representing 9 countries participated in the meeting. The list of participants is presented in Annex 1. The meeting agenda is presented in Annex 2. The meeting was very successful and with a full agenda of challenging and diverse terms of reference. An ICES SharePoint site was made available before and during the meeting. This proved to be a valuable tool to speed up the work and make exchange of information more efficiently. Over the course of the 5 day meeting the group made presentations addressing the terms of reference and prepared documents to service requests from ICES, this report presents a summary of these and subsequent discussions. Along with ICES, the IOC is a joint organiser of WGHABD, and provides valuable interaction regarding data collection and management of HAB data through the development of the HAEDAT database. As co-ordinators of the Intergovernmental Panel on HABs, the participation of IOC in WGHABD forms an important linkage between the working group and this panel. This year a request from IPHAB to examine the importance of HAB species transferral through ballast water was passed on to WGHABD and along with the working group on ballast and other ship vectors, WGBOSV an plan to deal with this request has been progressed. The IOC also takes responsibility to promote the working group among IOC Member Countries outside the ICES area to attend WGHABD and some years is in opposition to offer travel support. In 2010 there were no attendees from outside the ICES area however linkages to other ICES and IOC groups in developing countries are maintained by the interactions between IOC and WGHABD.

WGHABD is an important forum for ICES and IOC to review and discuss HAB events and to provide advice and updates on the state of HABs in the region on an annual basis. It also facilitates interaction between scientists working in diverse areas of HAB science and monitoring and provides a useful forum for interchange of useful terms of reference on various approaches to HAB research. The present working group was established in 1994 following a study group on the Dynamics of Algal Blooms, established two years earlier; however its origins go back further into the 1980s and evolved from other study groups within ICES. The group

In the opening session the chair, Joe Silke (Ireland) gave a summary of the presentation of the WGHABD 2009 report to the parent Steering Group on Human Interactions in the Environment (SGHIE) at the ASC meeting in Berlin, Germany. The report was very well received and feedback indicated the report was well organised, informative and the meeting was well attended. The participants (Annex 1) then introduced themselves and gave a short review of their scientific activities.

2 Adoption of the agenda

The group reviewed the agenda (Annex 2) and this was adopted without any change.

3 Terms of Reference

At the 96th Statutory Meeting (2009), *Berlin, Germany*, the ICES Science Committee SCICOM approved the WGHABD (2010) Terms of References as follows:

The ICES IOC Working Group on Harmful Algal Bloom Dynamics

2009/2/SSGHIE09 The ICES–IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD), chaired by Joe Silke, Ireland, will meet in Bermuda, 6–10 April 2010 to:

a) Assess national reports submitted to HAEDAT and review;
b) Collate and submit on line National reports no later than 1 February 2010 national reports 2002–2009 for HAEDAT, review at working group;
c) Review and assess the information compiled in the updated ICES- IOC database on HAB monitoring systems, MONDAT;
d) Discuss and formulate the description and justification for a thematic session on HABs and Modelling for the 2010 ASC;
e) Review the draft chapters for the cooperative research report;
f) Present any relevant information from compilation of data for cooperative research report;
g) Review the strategies being used to identify, enumerate, and otherwise investigate the life history stages of HAB species, and the information obtained from such efforts;
h) Discuss new findings that pertain to harmful algal bloom dynamics. Bring new findings in phytoplankton population dynamics models to the attention of WGHABD for discussion;
i) Review WGHABD contribution to the ICES White Paper on Climate Change;
j) Report to SSGHIE on potential and current contributions of your EG to the Strategic Initiative on Coastal and Marine Spatial Planning (SICMSP).
k) Report to SSGHIE on your plans to promote cooperation between EGs covering similar scientific issues.

4 Term of Reference A

4.1 Assess national reports for 2009 and review

4.1.1 Canada (Jennifer Martin)

West Coast:

PSP

2009 was considered to be a "normal" year with shellfish closures as a result of elevated levels of PSP toxins. The highest level observed was 3800 µg/100 g STX equiv. on June 25.

Salmon mortalities in fish culture operations

Heterosigma akashiwo was responsible for salmon mortalities that occurred over a 2 week period in the central coast of British Columbia when concentrations were 25 million cells· L^{-1} in late August. In Clayoquot Sound. *H. akashiwo* was observed at levels of 6 million from Aug 13 resulting in further mortalities.

In Esperanza Inlet, *Chatonella* sp. was observed at levels greater than 20,000 cells L in early August and caused salmon mortalities.

Chaetoceros concavicornis affected salmon in Clayoquot Sound on May 21, Sechelt and Salmon Inlets on May 27 and the Broughton Achepelago on May 27 for approximately one month. Concentrations in the Sechelt and Salmon Inlet events were 30,000 and 500,000 cells·L, respectively.

East Coast

PSP

Following a devastating year in 2008 in the St. Lawrence River where sea birds, seals, and beluga whale mortalities were linked to a large bloom of the PSP producing organism, *Alexandrium tamarensis,* 2009 was a more "normal" year with the regular periodic closures of shellfish harvesting areas due to unsafe levels of PSP toxins.

Newfoundland and the Gulf of St. Lawrence did not experience any shellfish closures in 2009.

The Bay of Fundy had highest concentrations of *Alexandrium fundyense* at Brandy Cove in Passamaquoddy Bay with 280,000 cells•L. This was a record high for this particular site, but not for other sites in the Bay of Fundy. Other sites in the Bay of Fundy experienced a "normal" year with periodic closures of shellfish harvesting areas as a result of PSP.

Salmon Mortalities

There were no salmon mortalities at aquaculture operations on the east coast associated with HABs in 2009.

4.1.2 Denmark (Per Anderson)

Toxins in shellfish – DK 2009

ASP- no observations above the regulatory limit - but some precautionary closures/restrictions due to high concentrations of *Pseudo-nitzschia* above the regulatory limit.

PSP – no – but few observations of PSP toxins below the regulatory limit in <u>one</u> production area in the Limfjord during a short period in May – max. conc. of *Alexandrium tamarense* = 400 cells/l. A revision of the current regulatory limit (500 cells/l) might be needed. A method for measurement of single cell toxicity test, similar to the one used routinely for *Dinophysis* is currently under development.

DSP - no observations above the regulatory limit, but a lot of precautionary closures/restrictions due to high concentrations of *Dinophysis acuminata* - above the regulatory limit

Using the "SINGLE CELL TOXICITY" many closures were turned into re-opening of production areas in the case of low toxicity of *Dinophysis acuminata*. In conclusion, the

"SINGLE CELL TOXICITY" approach worked out well. The *Dinophysis acuminata* populations investigated were very low in toxicity. No traces of DSP toxins showed up in shellfish.

Fish and invertebrate kills

Salmon and rainbow trout in marine aquaculture were killed off during an early bloom of the fish killing flagellate Chattonella/Pseudochattonella. Cod and whitefish were not affected. The bloom also resulted in a delay in the release of fish into the marine fish farms.

No invertebrate kills due to HAB's in 2009

Recreational HABs

No HABs caused problems for recreational use of Danish marine waters in 2009.

4.1.3 Netherlands (Marnix Poelman)

In the Dutch tradition the year 2009 was a year with absence of any toxic events. There have been no closures of shellfish fisheries as a result of presence of toxins throughout the year. There have been four periods in which the Early Warning System on harmful algae alerted for the presence of *Dinophysis acuminata*. The action limit for *D. acuminata* is set at 100 cells per litre.

The following data is compiled from the National monitoring program for shellfish food safety, data from national programs for environmental and trend monitoring such as MWTL were not included due to the fact that those data were still in validation trials.

In the western part of the Wadden Sea the threshold level for *D. acuminata* was exceeded in July, August and September 2009. In all cases *D. acuminata* counts were 110-220 cells per liter. Weekly shellfish samples at 9 locations in the Western part of the Wadden Sea were analysed for toxins within the DSP toxin group using the rat bioassay. As a result no presence of toxins above regulatory limits was observed. Following all shellfish samples which were taken during the presence of *D. acuminata* were analysed using LC-MS/MS. No detectible levels of toxins could be found (OA, DTXs, AZA, YTXs, PTXs). The samples were also analysed for spirolides, which were not found.

In Lake Grevelingen *Dinophysis acuminata* was observed throughout the period from mid July till September. In July cell counts of 150-160 cells per liter were observed, resulting in the operation of a higher alert mode and intensive sampling. In August cell counts ranged from 500 in the beginning of the month with increasing numbers towards the end of the month. By the end of August cell counts of 1.000 up to 3.200 cells of *D. acuminate* per litre could be measured. The observations (and higher alert mode for the shellfish industry) continued till the end of September. Cell number ranged from 140-610 in the beginning of the month, going down to 100 cells per litre in mid September. At the end of September cell numbers decreased after the observation of 100 to 600 cells per liter.

In reaction to this episode *Crassostrea gigas* (European oyster) samples (the prevailing commercial species in Lake Grevelingen) were analysed by LC-MS/MS, no toxins were observed. Throughout the whole period the rat bioassay showed absence of DSP toxicity in all samples (weekly samples).

4.1.4 Sweden (Bengt Karlson)

The Skagerrak and the Kattegat

No major harmful algal blooms occurred in the area in 2009. No harmful effects were reported. In March the harmful flagellate *Psudochattonella farcimen* (Dictyochophyceae) was observed in the Skagerrak and the Kattegat. Max abundance was 140 000 cells per litre. The potentially harmful flagellate *Chrysochromulina* sp. was observed in early June with abundances of max c. 800 000 cells per litre. The diatom *Pseudo-nitzschia* cf. *delicatissima,* potentially a producer of Amnesic Shellfish Toxin, was observed on several occasions during the year. The highest abundance was 1 000 000 cells per litre in December in the bay Skälderviken in the Kattegat. The diatom *Chaetoceros concavicornis,* known to affect the gills of fish negatively, was observed during the year. Other potentially harmful algae observed include *Akashiwo sanguinea, Karenia mikimotoi, Prorocentrum minimum* and *Karlodinium veneficium.*

Abundances of algae producing toxins accumulating in shellfish were below the warning level all year in the monitoring program for bivalve harvesting (National Food Administration). The species of interest are mainly *Alexandrium* spp. (Paralytic Shellfish Toxin, PST-producers), *Dinophysis* spp. (Diarrhetic Shellfish Toxin, DST producers), *Protoceratium reticulatum* (Yessotoxin, YTX producer), *Azadinium spinosum* (Azaspiracidic Shellfish Poisoning, AZT-producer) and *Pseudo-nitzschia* spp. (Amnesic Shellfish Toxins, AST producers). An improved method (LC-MS) for analysing algal toxins in shellfish was introduced early in the year. Azaspiracidic Shellfish Toxin was possible to detect and detected for the first time in Sweden. It was found in low quantities in February and September-October. In 2009 PST, DST, AZT and AST were not recorded at levels above the regulatory limits in blue mussels (*Mytilus edulis)*, oysters (*Ostrea edule*), pacific oysters (*Crassostera gigas*) or in cockles (*Cerastoderma edule)*. Yessotoxins above the regulatory limit of 1 mg kg^{-1} mussel meat were observed in May and June in blue mussels.

The Baltic proper

The potentially harmful flagellate *Chrysochromulina* cf. *polylepis* was observed in bloom abundances (max ca 1 500 000 cells per litre) in the southern Baltic proper the first half of June. No harmful effects were reported. Surface accumulations of cyanobacteria were observed around Bornholm and around the southern part of the island of Öland in the latter half of June. In early July surface accumulations of cyanobacteria were observed along the western coast of the Baltic proper, e.g. in Scania (Skåne), Blekinge, northern Öland and in the archipelago of Stockholm. Later in July relatively weak blooms of cyanobacteria were observed in a large part of the Baltic proper. The toxin producing species *Nodularia spumigena* was found in the water together with non toxic *Aphanizomenon* sp. and *Anabaena* sp. In October local blooms of cyanobacteria were observed in several locations along the Swedish coast of the Baltic proper. A red coloured bloom was observed in Moranviken in Nacka, near Stockholm, in the end of the month. Cyanobacteria blooms are often misidentified as spilled paint by laymen.

The Bay of Bothnia

Surface accumulations of cyanobacteria off shore were observed from satellite in the Bothnian Sea in the end of July and in August. The strongest accumulations were observed on the eastern side of the Bothnian Sea. These off shore blooms did not reach the Swedish coast. Local coastal blooms of cyanobacteria were observed in several locations along the Swedish coast. Species identified were *Nodularia spumigena, Aphanizomenon* sp. and *Anabaena* spp. In the end of October local blooms of cyanobacteria occurred along the Swedish coast of the Bay of Bothnia. The composition of the blooms was confirmed to consist of *Nodularia spumigena* and *Aphanizomenon* sp. The autumn blooms often look like spilled turquoise or green paint.

4.1.5 Germany (Allan Cembella)

The intensity of the cyanobacterial blooms changes dramatically from year to year, with high local variability evident along the Mecklenburg-Western Pomerania coast from mid-summer to autumn. As usual, in 2009 there were occurrences of the potentially toxic species *Nodularia spumigena*, typically the dominant cyanobacterium, along the German Baltic coast. These blooms were not associated with any dramatic consequences to human health or recreational activities, such as access to coastal bathing waters, beyond minor disturbances due to water discolouration and beach fouling.

Along the Wadden Sea coast of Lower Saxony (Niedersachsen) low concentrations of *Dinophysis acuminata* (maximum 400 cells L^{-1}) were reported in summer of 2009. Within several days of this maximum, blue mussels (*Mytilus edulis*) from this region contained detectable levels of okadaic acid, but these values did not exceed the regulatory threshold. No other phycotoxins were detected in mussels during this period. Within one month of the appearance of the dinoflagellate, neither *D. acuminata* nor any marine biotoxins were detectable.

In Schleswig-Holstein there were no remarkable concentrations of toxic algae (including *D. acuminata*) found along the Northfriesian Wattenmeer (Wadden Sea) or in the Flensburg Fjord in 2009. No significant concentrations of algal toxins (associated with ASP, DSP, AZP or PSP) were detected in blue mussels or oysters from these areas.

An oceanographic cruise in summer along the Wadden Sea coast from Bremerhaven to Skagen, Denmark revealed multiple lipophilic toxins in plankton with a general increasing trend northward along the Danish coast. In the German Bight and Wadden Sea coast of Germany the dominant toxins in the plankton size-fractions >20-200µm were domoic acid, 20-des-methyl spirolide G and dinophysistoxin DTX2, with traces of okadaic acid, and pectenotoxins PTX2 and PTX2-seco acid. Azaspiracids (AZA) were generally below detection limit.

4.1.6 Spain (Beatriz Reguera)

2009 was a "moderate" year concerning shellfish toxicity outbreaks and other harmful events.

Cataluña

PSP: Preventive closures after detection of *Alexandrium minutum* above trigger levels (max 3700 cells l^{-1}). Toxin content above R.L. in March (max 146 µg eq STX/100g shellfish).

DSP+YTX. There were 5 closures in the Ebro Delta bays and adjacent shelf after positive MBA results in February, March, May, July and September associated to the presence of *Dinophysis sacculus* (max 2000 cells l^{-1}) and *Prorocentrum lima* (150 cells l^{-1}); values of July affected by *Protoceratium reticulatum* (max 3000 cells l^{-1}).

ASP. A widespread bloom of *Pseudo-nitzschia* spp. above trigger levels occurred in January, March and from June to December (max $5 \cdot 10^6$ cells l^{-1}), but DA was detected under regulatory levels all along the coast in different species and areas.

Controls of water quality in harbours revealed proliferations of *Alexandrium minutum* (up to $6.8 \cdot 10^4$ cells $\cdot$ l^{-1}) around Barcelona in March-April, in Arenys (up to $5.7 \cdot 10^5$ cells $\cdot$ l^{-1}) in March and June, and in Vilanova y la Geltrú (up to $9.4 \cdot 10^5$ cells $\cdot$ l^{-1}) in March. *Alexandrium catenella* was only detected in Tarragona harbour in very moderate concentrations (up to 10^3 cells $\cdot$ l^{-1}). High densities of *Dinophysis sacculus* were found in l'Estartit in July and August (max $1.2 \cdot 10^4$ cells $\cdot$ l^{-1}), in Arenys in February, March and June (up to 3920 cells $\cdot$ l^{-1} in mid March) and Barcelona harbour (2120 cells $\cdot$ l^{-1}) in May. *Prorocentrum rhathymum* proliferated in Palamós (Girona) in September (up to 7600 cells $\cdot$ l^{-1}). Concentrations of *Pseudo-nitzschia* spp. above $5 \cdot 10^5$ cells $\cdot$ l^{-1} were observed in l'Estartit and Arenys de Mar in May, and in Tarragona harbour in late June.

Monitoring of beaches also revealed proliferations of *Pseudo-nitzschia* spp. in Llarga beach (Tarragona) in March and April, in Cavaió d'Arenys de Mar in March and May, and in Estartit 3 and the mouth of the Muga ((up to $1.1 \cdot 10^6$ cells $\cdot$ l^{-1}) and Platjola rivers in May and October. A bloom of *Gonyaulax spinifera* (up to $3.5 \cdot 10^5$ cells $\cdot$ l^{-1}) developed in Tarragona harbour and surrounding areas and in Vila-seca beach in August.

Interestingly, proliferations of *Ostreopsis* spp. that reached concentrations of $1\text{-}5 \cdot 10^5$ cells $\cdot$ l^{-1} in different beaches between late July to mid August did not cause any irritations associated with toxic aerosols. Green patches of *Alexandrium taylori* and gymnodinioids that upset tourists appeared in different beaches of the Costa Brava in July and August. Maximum concentrations ($3.0 \cdot 10^7$ cells $\cdot$ l^{-1}) were observed at l'Estartit in early July.

Andalucía

During 2009, there were several multispecific blooms that caused mild toxic outbreaks. There were no reports of PSP associated with *Gymnodinium catenatum* blooms in the Alboran Sea region (Mediterranean Sea).

<u>ASP</u>. A short-lasting (end of March to early April) bloom of *Pseudo-nitzschia*, dominated by *P. australis* (the main ASP producer in the region), spread through the whole Andalusian coast (except the extreme east end, Almería) and led to harvesting closures. Another minor outbreak occurred in the Atlantic coast (off Huelva) in July.

<u>DSP</u>: A combination of *D. acuminata*, *D. caudata* and *D. acuta* lead to harvesting closures, as usual, on the Atlantic coast (off Huelva) during spring and summer.

<u>AZP</u>: Detected by LC-MS-MS for the first time in samples off Huelva in summer. The suspected agent has been isolated and is under study. Preliminary results indicate that is not *Azadinium spinosum*, the only species confirmed so far as an AZP toxin producer.

Basque Country

There were no reports of HAB events in the Basque Country during 2009.

Analysis of DSP, ASP and PSP toxins were conducted in wild oysters from the Oka estuary once a week during the harvesting season for this resource, i.e. the first (Jan-Mar) and last (Oct-Nov) term of the year. Toxins results were below detection levels in all the samples.

However, potentially HAB species were observed in plankton samples collected during four seasonal cruises (spring, summer, autumn and winter) in coastal waters (aprox. 150 km) and at the main estuaries (12) of the Basque Country. These, in coastal waters included: *Dinophysis* sp., *D. acuminata, D. caudata*, *D. fortii,* and *Karenia* sp. (max. abundance, 2,124 cells · l^{-1}); *Alexandrium* spp., identified in a few samples in low abundance (20–100 cells · l^{-1}). In estuarine samples, the dinoflagellate cf. *Pfiesteria* was occasionally observed (max. concentration ~100,000 cells · l^{-1} in the Bidasoa estuary in spring, 6 · 10^5 10^4 cells · l^{-1} in the Oka estuary in summer). *Pseudo-nitzschia* spp. were observed all year round, in some coastal as well as in estuarine samples. The highest concentration in coastal waters was detected in February (~400,000 cells · l^{-1}). In estuaries, they reached a similar density during summer (Oiartzun estuary).

Other potentially harmful species included: i) Dinoflagellates: *Prorocentrum micans* and *Kryptoperidinium foliaceum* (~300,000 cells · l^{-1}), *Prorocentrum minimun* and *P. triestinum* (~30,000 cells · l^{-1}), *Prorocentrum balticum, P. compressum, P. gracile, Ceratium furca, C. fusus* and *Gyrodinium spirale*; ii) Raphydophyceans: *Heterosigma akashiwo* (51000 cells · l^{-1} in summer at the Oiartzun estuary; iii) Haptophytes: *Phaeocystis globosa* (up to 25 · 10^4 cells · l^{-1} in coastal waters in winter) and *Chrysochromulina* spp (up to 17 · 10^4 cells · l^{-1} in estuaries during summer).

Galicia

PSP. *Gymnodinium catenatum*, detected practically in all the sampling points throughout the summer (quite unusual) in very low levels (200 cells · l^{-1} in 0–15 m integrated samples), increased abruptly after downwelling events the first week of October in the four Galician Rías Baixas. Harvesting closures lasted from early October to mid November. Maximum concentrations (6720 cel l^{-1}) were observed in Ria de Arousa in mid October and the maximum toxin content (11400 µg STX · kg^{-1}) in mussels from Ria de Vigo in early November. Cells of *G. catenatum* were under detection levels by 9 November.

Alexandrium minutum was associated with PSP in natural shellfish beds in May-June in the Northern Rías, and in June, July and September in the inner part of Ria de Vigo.

DSP. *Dinophysis acuminata* caused prolongued closures for DSP in different parts of the Rias Baixas and the Northern Rias between April and August. The maximum detected was 6080 cells · l^{-1} at 0-5m in Ria de Pontevedra. At the end of the upwelling season, there was a bloom of *Dinophysis tripos* that was not associated with toxic events.

ASP. *Pseudo-nitzschia* spp. led to harvesting closures of raft mussels and natural shellfish beds in Rias of Pontevedra and Vigo from late March to early April (maximum of 2.2 10^6 cells · l^{-1} and 46.9 mg DA · kg^{-1}). Scallops (*Pecten maximus*) contained DA above regulatory levels all year round. Restricted harvesting (with evisceration, according to Directive 2002/226/EC) was possible only in Ría de Arousa at the end of the year.

Report presented by Beatriz Reguera (IEO, Spain) with information provided by regional monitoring programmes from the following institutions:

Andalucía. LCCRRPP. Fisheries and Agriculture Department from the Junta de Andalucía.

Basque Country. AZTI-Tecnalia. Taxonomical analyses carried out by the University of the Basque Country. Both funded by the Basque Government.

Catalonia. Data provided by IRTA (Tarragona) and by ICM-CSIC (Barce-lona) supported by the Agriculture and the Environmental Department, respectively, from the Generalitat de Cataluña.

Galicia. INTECMAR from the Fisheries and Maritime Affairs Department of the Xunta de Galicia.

4.1.7 U.S.A. (Don Anderson)

2009 was basically a "normal" HAB year for most regions of the U.S., with several noteworthy events.

PSP. Similar to previous years, Maine, New Hampshire, Massachusetts, Washington, Oregon, and California all recorded PSP toxicity in 2009. Oregon experienced a PSP bloom in June forcing the closure of recreational mussel harvesting until November. PSP concentrations in excess of 500 μg STX per 100 grams were recorded at stations from the California border to the Washington border, with the highest concentration (over 900) at the northern end of the coast.

A significant regional-scale *Alexandrium fundyense* bloom occurred within the Gulf of Maine in 2009. It is noteworthy that this bloom was predicted several months in advance based on the abundance of *A. fundyense* cysts in Gulf of Maine sediments. Toxicity was particularly high in eastern Maine but also extended south to Massachusetts Bay. In Maine, one human was hospitalized with PSP symptoms due to harvesting mussels from a closed area. The geographic extent of the event in Maine was unprecedented, with many areas of the coast showing high levels of toxicity. Another unusual aspect to this bloom was that areas where toxin had never been recorded (during the last 30 years of records kept by Maine DMR) saw toxicity in 2009. Virtually the entire state was closed to shellfishing. There were also unusual reports of mortality events in both short-nose sturgeon and eider ducks, which were suspected to be caused by the transfer of toxicity through the food web. The economic impact of this event was devastating with 97% of the state shellfish resources closed.

Florida experienced *Pyrodinium bahamense* blooms on both the east coast (Indian River Lagoon) and the west coast (Tampa Bay). To our knowledge this is the first time blooms have occurred on Florida's west coast. In that area, hard clams and oyster harvesting areas were closed. The Indian River lagoon bloom lasted from early June to late November with a maximum cell count of 2.4 million cells/L. The maximum cell concentration for the west coast bloom was 3.8 million cells/L. Hard clam and oyster harvesting was closed in this area; pufferfish harvesting has been banned in this area since the event of 2002.

ASP. California experienced approximately 200 sea lion strandings between San Luis Obispo and Sonoma counties (about 50% of the coastline). Once again, Washington State had very low levels of domoic acid with no closures reported. Oregon State did not have any closures due to domoic acid.

NSP. *Karenia brevis* blooms occurred in southwest Florida. Three manatee mortalities were confirmed to be due to this bloom with seven more were suspected. Texas experienced *K. brevis* blooms with discolored water and dead fish along the Gulf beaches from Port Aransas to the Rio Grande (approximately 150 miles). The bloom was detected in September by the Imaging Flow Cytobot and continued through the end of February 2010. There was intoxication and deaths of coyotes and domestic dogs along Padres Island National Seashore due to ingestion of dead fish. NSP shellfish toxicity was confirmed by the FDA.

Brown tide. Once again, the south shore of Long Island, NY experienced a significant brown tide bloom, which began in May and ended in November. Suffolk County reported 1.4 million cells per ml in July. This was the third year in the row with elevated *Aureococcus* concentrations, following a decade of very low levels. Before that, there was a decade of high concentrations, begining in 1987.

Other species. Blooms of *Cochlodinium polykrikoides* occurred in the York River in Virginia and the Chesapeake Bay Estuary. The York River bloom reached a magnitude of 3.8 million cells/L and was associated with an unpleasant odor in that area.

Bird mortalities – US west coast. Thousands of seabirds of multiple species appear to have been impacted by a widespread bloom of the algal species *Akashiwo sanguinea*. The species, believed to be non-toxic, produces soap-like foam that removes the waterproofing on feathers, making it harder for birds to fly and promotes the onset of hypothermia. Mortality and strandings began in September in Washington and late October in Oregon, impacting seabirds such as scoters, common murres, loons, northern fulmars, and western grebes. This seabird mortality event initiated off Washington's coast in early September with impacts primarily confined to surf and white-winged scoters.

4.1.8 United Kingdom (Eileen Bresnan)

Scotland

Pseudo-nitzschia spp. was present in approximately 92% samples analyzed as part of the Food Standards Agency, Scotland Monitoring Programme during 2009, and counts above threshold levels (50,000 cells *per* litre) were observed in 12% of all samples. Over 21% of the samples collected during June and July 2009 had *Pseudo-nitzschia* present greater than the threshold level with 19% of these above-threshold blooms resulted in detectable levels of ASP toxins in shellfish. Blooms of *Pseudo-nitzschia* were first recorded in 2009 on the Scottish east coast around Stonehaven and Dornoch Firth in mid March, and also around Shetland and on the west coast (Ross & Cromarty) in late March. Dense *Pseudo-nitzschia* concentrations were mostly absent in the monitoring sites around southwest Scotland and Argyll & Bute during 2009, and only two blooms above threshold, both of which were relatively short in duration, were observed before August. The largest recorded *Pseudo-nitzschia* bloom in 2009 was observed in SW Shetland (Vaila Sound, Riskaness) in mid July, with a maximum density of > 3.4 million cells per litre on 13-July. There were no enforced closures during 2009 due to high concentrations of Domoic Acid in *Mytilus edulis.*

Alexandrium spp. was most frequently observed between April and July, and was present in about 44% of all the samples during this period. The densest bloom recorded in 2009 was observed in Browland Voe (SW Shetland), with a maximum cell count of 61,720 cells per litre on 29-July. *Alexandrium* was abundant around SW Shetland throughout July but was not associated with PSP toxicity in shellfish. *Alexandrium* was also recorded at relatively high concentrations in Orkney (6,200 cells per litre on 23-July) and the Western Isles, Loch Roag (4,080 cells per litre on 22-June). The Loch Roag bloom was dominated by cells from the *Alexandrium minutum* group. Toxic *Alexandrium* were observed from March through to May in Argyll & Bute (SW Scotland) and throughout the Highlands (NW Scotland). A density of 1,200 cells per litre in Loch Fyne: Stonefield on 20-April resulted in PSP toxins in shellfish tissue reported above the permitted regulatory level by the following week. Likewise, high levels of toxins were detected in shellfish from Loch Scridain a week after the bloom peak of 960 cells per litre on 28-April.

Dinophysis spp. was observed in approximately 42% of all the samples analyzed during 2009, most frequently between May and August. *Dinophysis* was first observed in concentrations in mid April 2009 in sea lochs Fyne and Scridain in Argyll and Bute (SW Scotland). An above-threshold *Dinophysis* count (100 cells *per* litre) was also recorded from Elie Ness, Fife (East Scotland) at this time. The *Dinophysis* bloom that developed in Loch Fyne remained above threshold levels for a continuous period of 14 weeks at Stonefield (outer Loch Fyne) until mid July, reaching a maximum abundance of 3,620 cells per litre on 08-June. Cell counts remained above threshold at Ardkinglas (inner Loch Fyne) until late June, with a maximum abundance of 13,260 cells per litre observed on 19-May. This was the largest *Dinophysis* bloom recorded from the Scottish coastal monitoring sites during 2009. A bloom also developed in nearby Loch Striven between 05-May and 04-August, reaching a maximum density of 1,040 cells per litre, also on 19-May. Further south in Loch Ryan (Stranraer), *Dinophysis* was present at above-threshold levels in July and August, with a concentration of 540 cells per litre recorded on 07-July. Previous monitoring at this site (2006-2008) has never observed *Dinophysis* at this level of abundance. The blooms around Loch Fyne, Loch Striven and Loch Scridain were dominated by *Dinophysis acuminata* cells with D*inophysis acuta* and *Dinophysis rotundata* occasionally present, and were all associated with DSP toxic events, which were prolonged in Loch Fyne and Loch Striven. Elsewhere around Scotland, toxic *Dinophysis* blooms were recorded in Loch Beag (Highland: Lochaber) and Loch Laxford (Highland: Sutherland), with peak cell counts of 600 cells per litre in Loch Beag on 03-August, and 400 cells per litre in Loch Laxford on 18-August. *Dinophysis* was frequently observed above threshold levels around SW Shetland throughout July, with DSP toxic events occurring in Clift Sound and Browland Voe.

*Other species***:** *Prorocentrum minimum* was frequently observed at Scottish monitoring sites from mid April through to late July in 2009 however cell densities were considerably lower than in either 2007 or 2008. The maximum cell count recorded for 2009 was 230,902 cells per litre on 26-May-09 in Loch Roag, (Western Isles). *Prorocentrum lima*, was most abundant in the summer months, and the maximum cell density recorded was 1,100 cells per litre from the Kyle of Tongue (NW Scotland) on 18-August. *Protoceratium reticulatum* was recorded at low concentrations in approximately 4% of the samples analyzed during 2009, mostly around Argyll & Bute, the Highlands, Fife and Orkney. It was most frequently observed from May to July. Cell counts were higher than in 2008, with the largest recorded concentrations being observed in Argyll & Bute at Loch Fyne: Stonefield on 08-June (640 cells per litre) and Loch Creran on 15-July (480 cells per litre).

Lingulodinium polyedrum was observed at only one monitoring site, Loch Creran, in (West Scotland). A bloom developed from July through to September, with a peak of 23,680 cells per litre on 02-September.

Benthic mortalities: An exceptionally dense spring bloom was observed along the east coast of Scotland during 2009. The end of this bloom was associated with reports of dead amphipods washed up in the beaches around Dunbar and South of the Tweed (East Coast of Scotland). It is hypothesised that the die off from this bloom was associated with anoxic conditions which results in these invertebrate mortalities.

An exceptionally large bloom of the ichthyotoxic dinoflagellate *Karenia mikimotoi* was observed off south west Scotland, with various reports of associated invertebrate mortalities. Cell concentrations were recorded at a concentration of > 2.8 million cells per litre on 13-July in Loch Ryan (Dumfries & Galloway: SW Scotland). *Karenia miki-*

motoi remained above background levels into mid September in this area. Similarly, blooms developed in the south of Argyll & Bute (SW Scotland) from early June, in Loch Fyne (Stonefield and Ardkinglas) and Loch Striven, with *Karenia mikimotoi* dominating the phytoplankton assemblage throughout most of June and July. A density of > 1.5 million cells per litre was recorded at Loch Fyne: Stonefield on 13-July. Although *Karenia mikimotoi* was observed further up the west coast in late July and August, the blooms were on a much smaller scale.

England and Wales

Pseudonitzchia spp. were observed at most of the production areas in 2009. Cell densities breached the 'investigative' level (50,000 cells/litre) on 11 occasions, as opposed to 3 occasions in 2008, but only breached the action level (150,000 cells/litre) 5 times as opposed to 14 times during May - June 2008. No closures of shellfish harvesting areas had to be enforced during 2009 as a result of high concentrations of Domoic Acid.

Alexandrium spp. occurred slightly more frequently than in 2008, being recorded from 26 of the 53 sampled areas. Highest concentrations were once again found in the River Yealm (Devon: SW England) at concentrations of 1.5 million cells/litre in August, where it persisted from April to September. *Alexandrium* spp. was again found in samples from the Salcombe Estuary, Devon (SW England), from April - September with a maximum concentration of 410,000 cells/litre occurring in June. *Alexandrium spp*. were also found sporadically in samples collected from the Fal Estuary between April and September. PSP toxins breached action levels on 5 occasions, all in the Fal Estuary during August and September 2009, when they coincided with the presence of *Alexandrium spp*.

Dinophysis spp. (DSP) were found on 41 occasions, nearly double the previous year, and breached action levels 21 times, as opposed to four times in 2008. *Dinophysis spp.* occurred most frequently in the Fal area during July and August where maximum concentrations of 500 cells/litre were found in the Helford river during July. *Prorocentrum lima* (DSP) were found on 16 occasions with fourteen breaches of action levels as opposed to 4 breaches in 2008. It was once again found most frequently in the Fleet Lagoon, Weymouth, Dorset where it was present in 9 samples with a maximum concentration of 400 cells/litre. DSP toxins were recorded from 17 samples (only 4 samples contained DSP toxins in 2008) and they coincided with *Dinophysis spp*. at St Austell Bay, Cornwall in August (SW England).

Benthic mortalities: A large bloom of *Karenia mikimotoi* was observed along the South West coast of England in early August. Discoloured water (reddy brown) as well as mortalities of star fish, rag worms and Dover Sole were recorded by members of the public. A maximum cell density of 5.4 $X10^6$ was observed during this bloom.

Northern Ireland

In 2009, forty four sites were sampled routinely on a fortnightly basis from N. Ireland sea loughs and coastal waters and a total of 923 samples analysed.

Alexandrium spp. were recorded in 4.9 % of samples and the maximum cell abundance (1,560 cells l^{-1}) recorded in a sample from Belfast Lough in May. No PSP toxins were detected in shellfish in 2009.

Dinophysis spp. were present in 17.8% of water samples tested. Cells from this genus were detected in the water column throughout the year (January–December). Maximum abundance (2,420 cells l^{-1}) was recorded in a sample collected from Belfast

Lough in mid July. As in previous years the most abundant species was *D.acuminata* with only low numbers of *D.acuta*, *D.norvegica* and *D.rotundata* counted. Cells of *Prorocentrum lima* were present in 1.4% of samples with a maximum abundance of 80 cells l^{-1} recorded in samples from Strangford Lough and Carlingford Lough in June and July respectively. DSP toxins were detected in five of the 325 shellfish samples tested during the year but these were not associated with elevated phytoplankton levels.

Pseudo-nitzschia spp. were present in 71.5 % of samples and reached a maximum concentration of 251,776 cells l^{-1} in a sample from Belfast Lough in mid June. Toxicity due to domoic acid was confined to samples of scallops (*Pecten maximus*) from Strangford Lough.

4.1.9 Ireland (Joe Silke)

HAB events in Ireland in 2009 were limited to the occurrence of 4 shellfish poison types detected in the course of the national monitoring programme.

Amnesic Shellfish Poisoning

Domoic Acid concentrations were observed to increase to levels above the regulatory level in March / April in samples of *M.edulis* submitted from Bantry & Kenmare Bays (IRL SW IE-04). Highest concentration observed was 191.6µg/g Total Tissue. This event coincided with a bloom of *Pseudo-nitzschia seriata* group within the area, highest density observed was 129,228 cells/litre.

For samples of *P. maximus*, the highest DA concentrations in Gonad tissues was 44.8µg/g, in Adductor muscle 22.9 µg/g in a sample submitted from IRL W IE-06. The highest concentrations observed in Total Tissue was 640.3 µg/g, again in a sample submitted from IRL W IE-06.

Paralytic Shellfish Poisoning

Low levels of the causative PSP toxin producer, *Alexandrium spp.* were observed in 2009. These low levels were correspondingly observed in shellfish samples (clams, cockles, mussels & oysters) analysed by the AOAC method for PSP Bioassay, where all samples were well below the regulatory limit. The highest PSP concentration observed was 50µg/STXdiHCL100g^{-1} in a sample of *M. edulis* submitted from Cork Harbour (IRL S IE-03) during July.

Diarrhetic Shellfish Poisoning

The DSP event observed from June 2009 was observed to result in a number of closures in several regions of Ireland, affecting samples of *M.edulis* and in one locality in the West, samples of *S. solida.*

For the SouthWest (IRL SW IE-04), DSP concentrations were observed to increase from June, where the highest concentration observed was 1.44 µg/g^{-1} in *M.edulis*.

For the NorthWest (IRL NW IE-08) the highest concentration observed was 0.17 µg/g^{-1} in September.

For the WestNorthWest (IRL WNW IE-07) the highest concentration observed was 0.23 µg/g^{-1} in July.

For the West (IRL W IE-06) concentrations were observed to increase from June, where the highest concentration observed was 1.33 µg/g^{-1} in *M.edulis.* The presence of OA esters near the regulatory level was observed in samples of *S. solida* for a fortnight in July 2010.

Azaspiracid Shellfish Poisoning

Numerous closures were enforced due to the AZA contamination of mussels above the regulatory limit during 2009. Due to Azaspiracid contamination of mussels (mainly in the SW Ireland) from Aug 09 above the regulatory limit, these levels were slow to detoxify from the affected mussels, hence there was carryover of AZA levels into early 2010 above the regulatory limit (highest AZA level observed was 1.52µg/g^{-1} AZA equivalents) in SouthWest IRL SW IE-04. These levels were observed to decrease to levels below the regulatory limit by Feb 2010. In a phytoplankton survey taken during the onset of AZA in August in the south west of Ireland, the species *Azadinium spinosum* which has been shown to produce azaspiracid by scientists working in the North Sea was detected.

5 Term of Reference B

5.1 Collate and submit on-line National reports no later than 1 February 2010 national reports 2002–2009 for HAEDAT, review at working group HAEDAT

N° of reports per country added to HAEDAT

	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
Belgium		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR
Canada		44	81	14	7	29	13	12	21	8	9	3
Denmark		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	2	NSR	NSR
Estonia		NSR	NSR	NSR	NSR	NSR	1	1	1	NSR	1	2
Faroe		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR
Finland		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	1	NSR
France		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR
Germany		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	9	4	4
Iceland		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR
Ireland		NSR	NSR	NSR	NSR	NSR	NSR	3	NSR	61	46	26
Latvia		NSR	NSR	NSR	NSR	NSR	5	NSR	5	5	3	3
Lithuania		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR
Netherlands		NSR	NSR	NSR	NSR	NSR	NSR	NSR	2	NSR	1	1
Norway		NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	1	2	2
Poland		NSR	NSR	NSR	NSR	NSR	1	1	1	1	NSR	NSR
Portugal		NSR	18	NSR	NSR	NSR	2	2	3	3	NSR	NSR
Spain	1	10	1	NSR	NSR	NSR	9	24	11	23	25	20
Sweden		2	NSR	NSR	NSR	NSR	NSR	NSR	NSR	NSR	1	NSR

UK		6	NSR	4	3	NSR	NSR	2	11	20	23	16
USA		NSR	18	23	20	29	22	27	24	23	16	15

NSR	Not submitted report

The table shows the gaps in the HAEDAT database. As the system has been under re-development since 2005 there has been very little data added to the system in the past 5 years. At the WGHABD meeting in 2009, it was agreed that participants would make every effort to get their data added to the HAEDAT database by February 2010. Unfortunately there were still a number of countries that had yet to complete this task by the time of the 2010 working group meeting. The completion of the data was explained to the participants and gaps in the information were shown. It was agreed that as much data as possible would be added to the database before the next meeting and participants agreed that one means would be each year to add the current years data and at least two earlier years. In this way, the gaps will be filled, even by countries where the administrative resources to dedicate to filling the data are scarce.

6 Term of Reference C

6.1 Review and assess the information compiled in the updated ICES-IOC data base on HAB monitoring systems, MONDAT

Detailed data on HAB monitoring systems, legislation, thresholds / action levels for species and toxins, and responsible agencies in most of the countries that have such systems in place, are currently compiled and stored in the 'Design and Implementation of Some Harmful Algal Monitoring Systems' data component (MONDAT). Data were compiled in 1995/96 and 2000/01.

MONDAT contains data and information on:

- Resources to be protected by HAB monitoring
- Type of organisation / institution responsible for implementation of HAB monitoring
- Funding
- Monitoring parameters
- Organization / institution carrying out HAB monitoring
- Identification and quantification of algae
- Action limits – Algae
- Institutions responsible for evaluation and dissemination of HAB data
- Data released and method used for dissemination
- Management actions imposed upon harvest of shellfish
- Monitoring parameters – Shellfish
- ASP action limits and analytical methods
- PSP action limits and analytical methods
- DSP action limits and analytical methods
- Management actions – Shellfish
- Cost / benefit

Up to March 2007, MONDAT was available on-line but the database application is out of date. Work is in progress to retrieve MONDAT data from its present software, and import it into the HAEDAT platform. Hereafter, the data need to be updated.

In 2008-09 WGHABD revised and updated the 1999-2001 questionnaires for the MONDAT with the view to prepare for updating the database. The revised format was used for the description of the 'Harmful Algal Information System'. However, the re-launch of the online version of MONDAT will require re-development of the database and a user interface. This is part of the work for which the IOC seeks funding. Without funding MONDAT cannot be re-launched as an on-line database linked to HAEDAT. WGHABD members agreed collectively to watch out for funding opportunities including the possibility of including MONDAT and HAEDAT development in larger research or database projects funded nationally or regionally (EU).

http://www.ioc-unesco.org/hab/index.php?option=com_oe&task=viewDocumentRecord&docID=3467

7 Term of reference D

7.1 Discuss and formulate the description and justification for a thematic session on HABs in the Baltic for the 2010 ASC.

Two proposals for a special session on HABs were submitted to ICES - one as a result of the Study Group for Implementation of GEOHAB in the Baltic, and one as a result of the joint meeting on HAB modelling of the WGHABD and the WGPBI held during the 2009 working group meetings. ICES asked the groups to combine the two into one session, but the topics were viewed as being too different. Thus it was agreed that the Baltic session would be delayed until 2011 when the Annual Science Meeting will be in that region, and to broaden the scope of the WGHABD and WGPBI session for the 2010 meeting. The modelling session will be held during the Annual Science Meeting from 20 – 24 September 2010 in Nantes, France (La Cité des Congrès) and is to be convened by Don Anderson and Geneviève Lacroix.

The session synopsis is as follows:

Harmful Algal Blooms (HABs) are of great concern because of their toxicity and/or the damage they cause to ecosystems and coastal resources. Toxic HAB events in aquaculture can have adverse effects on ecoomy (fish or shellfish mortality) and public health (human disease, mortality) and high-biomass, non-toxic blooms can affect water quality and tourism. Aquaculture and tourism are mainly located in coastal zones that can be affected by eutrophication, sometimes cited as a cause of HABs. Amongst the challenges related to HABs we can cite the need to: (i) understand the physiolocal/biological/environmental factors that regulate HABs and in particular the underlying physical- biological interactions, (ii) forecast HAB events, (iii), describe and understand the role of introduced species and (iv) assess the impact of climate change on HABs (occurrence/frequency/magnitude). Recent developments in automated observations techniques are providing new insight into dynamics of HABs. Models, providing that they are carefully validated and adapted to the situation (region/species), are necessary tools for forecasting, assessing the impact of future scenarios and for process studies. The development of HAB models requires interdisciplinary (biological, chemical, and physical) research. Strong interaction between modelers and experimentalists is crucial and data availability essential. Recognizing the rapid progress in observation techniques and HAB modeling in recent years, we invite contributions of modeling studies, laboratory and experimental research, field studies and remote sensing investigations that advance our ability to understand underlying physical-biological interactions that control HABs, to improve HAB model validation, to forecast HAB events, or to assess effect of climate change.

It was agreed by WGHABD participants to promote the theme session and some particular persons were identified to approach for contributions.

8 Term of Reference E

8.1 Review the draft chapters for the Cooperative Research Report

Discussions were held over 2 days at the working group meeting to examine the status of a proposed CRR. The outcome of these discussions and draft content for the chapters is summarised below:

1) In Punta Umbria 2009, we suggested to ourselves that the CRR could be completed in 2010. This date has gone to ICES and is on the agenda for this year. Considering the process, formatting, illustrations, approval by ICES technical Editor, Approval by SCICOM… we need to consider our target deadline: **is it realistic**? If not, there needs to be a clear roadmap and responsibilities with milestones set to realise our goal.
2) What is the target audience? Should the CRR be written for informed individuals, policy people/ managers and scientists in general? So we should include a glossary? Is this report primarily for ICES so that ICES has, in one document, an up to date report on HABs and related issues. The 1992 report proved to have a broader appeal.
3) ICES has a protocol regarding authorship of CRRs. Editors go on the front page and these names are used to cite the report. Lead editors of chapters can go on the front page can be associated with individual chapters. Working group members can go in an annex.
4) If there are consensus views on particular issues within the WG should this be presented as 'expert opinion' in the report or should the report simply report? In the 1992 report there were statements like "*The working Group considers it essential that microscopic analysis of phytoplankton be given the highest priority*".
5) In relation to each topic, is there anything that was recommended in the 1992 report that is now out dated that we should flag as such?
6) Should we have a map of the ICES area? Or at least the ICES area covered by the report (or both). Does this mean that we should invite contributions from ICES member states that do not participate in WGHABD?

Suggested title

Harmful Blooms of Micro-algae and their Effects in Coastal Waters of ICES Member States

The 1992 report was called: Effects of Harmful Algal Blooms on Mariculture and Marine Fisheries.

General Introduction (Richard Gowen)

- Description of phytoplankton to include (in brief - what phytoplankton is, growth requirements, number of species, lifeform types (diatoms, dinoflagellates and microflagellates); what is a harmful species, how many are there and what is a harmful algal bloom (High biomass and low biomass HABs; agreed definitions, IOC manual etc).
- The purpose of this report i.e. to update the 1992 CRR to provide a synthesis of key issues relating to HABs and their effects in the ICES area. This will include a brief history of ICES Work on HABS beginning with 1984 special meeting in Copenhagen (annex with a list of meetings and chairs and annual reports and where they are located– do we want all of this included?)
- What the report covers i.e. contents of other chapters (what, if anything, it does not cover).
- References to other key documents/ reviews e.g. IOC manual.

Note: <u>Causes of HABs</u>. Do we want a separate section on causes or should a few paragraphs go in the introduction? I think it would be odd if the report did not include some consideration of the putative global increase, the nutrient enrichment – HAB hypothesis and climate change issues. The WG has already been asked for an opinion on HABs and climate change so this item would be relatively easy to summarise and direct readers to the appropriate link. The nutrient issue is rather more interesting and perhaps contentious.

2. Harmful Species (Beatriz Reguera)

In the 1992 report we simply presented descriptions, in alphabetical order, of what were considered (at that time) to be the most important HAB species and their effects. Do we want to do the same here and simply update names and occurrence and include new species/ effects? The following is the list of genus/ species in the 1992 report:

- *Alexandrium*
- *Aureococcus anophagefferns*
- *Chaetoceros*
- *Chrysochromulina polylepis*
- *Dinophysis spp.*
- *Gymnodinium catenatum*
- *Heterosigma akashiwo*
- *Karenia mikimotoi (Gyrodinium aureolum)*
- *Nitzschia* spp.
- *Phaeocystis pouchetii* [should this be spp.?] and see note 1
- *Prorocentrum lima*
- *Phytodiscus brevis*

The 1992 report also contained a list of species thought to have harmful effects in the ICES area.

An alternative approach would be to present descriptions of the effects (grouped by the type of effect) that are caused by different species. [Could we then turn this into a peer review publication?].

Do we want to present maps of the ICES area showing the current known distribution of important species (with all the caveats about what the maps represent) or should we put this as a summary at the end of chapter 7, Extended country reports? If we put it here what time period should we select?

Notes: **Phaeocystis:** Is this a harmful species or nuisance species? Do we need to consider this point?

3. Monitoring (Per Anderson)

In the 1992 report we considered the monitoring of coastal waters for phytoplankton and shellfish for the presence of toxins. The report contained details of what to consider when sampling for the presence of harmful phytoplankton including: historical records; water movement and the position of frontal boundaries; the use of nets, hose samplers and discrete water samples; sampling frequency. A range of issues were also considered in relation to monitoring for shellfish toxins.

In a European context, much of this is probably redundant since there are legal monitoring requirements (European Hygiene Directive) and presumable this is the case in the US and Canada. Nevertheless, we should comment on the relevance of what was presented in the 1992 report. It would be useful to document what the directive lays out and the detailed differences (and the reasons for them) that exist in monitoring programmes in EU member states together with details of the programmes in the US and Canada. This should include the species that are monitored and why and the sampling methods employed and why. Any key differences need to be identified and discussed.

New developments (what is currently working, what is in the pipeline and a bit of crystal ball gazing):

- Molecular methods
- Flow Cam and Cytosense technology
- ESP latest
- Satellite tracking of large biomass blooms
- Instrumented moorings for early warning
- Near real time information networks for early warning

In the UK at least, statutory monitoring is evolving and this means that sampling sites have changed. This is frustrating in that it is not possible to build time-series and look for trends. I think it would be worth raising this and related issues.

Should we include discussion of any limitations to current monitoring programmes even if this results in, for example, a criticism of the EU directive?

What about putting in details of the indicative costs of monitoring in relation to the economic value of shellfish/ aquaculture and impact on tourism? In the case of the latter, *Phaeocystis* foam on beaches is often cited as an example of a negative impact on tourism but I am unaware of any economic assessment.

4. Management strategies: country by country basis (Don Anderson)

The 1992 report gave details of a number of strategies to avoid or minimise the effects of HABs on aquaculture. The chapter was organised by first considering site selection criteria (including hydrodynamics e.g. (horizontal dispersion, fronts, and stratification) light and nutrients and historical records. This was followed by consideration of post-siting management (farm design (including detachable moorings) and monitoring bloom development. Management options during a bloom (e.g. moving stock, pre-emptive harvesting, *in situ* shielding) were also discussed.

Is the country by country review the best way of presenting this material? The 1992 recommendations should be reviewed to see is there any evidence that recommended strategies worked or did not work, before presenting the current state of the art.

5. Predicting occurrence (Keith Davidson)

This was quite a short section in the 1992 report, perhaps reflected the state of the art in terms of modelling at that time. I think the 1992 report provides some good background on this topic and we should look to use it in an introductory section to this chapter. As well as describing recent successes it will be important to identify current limitations and what is constraining future development.

What were the outputs from last year's GEOHAB modelling workshop in Ireland and can we obtain any documentation?

6. Detection and quantification of algal toxins (Alan Cembella)

The 1992 report contained quite a lot of detail on both detection and quantification. Much of it is likely to be out of date and I think it will be important to identify what and make the point clearly in the new CRR. The 1992 report also contains a section on future research requirements. It might be instructive to review this and see whether any of the ideas were taken forward and bore fruit in the intervening 18 years.

7. Extended country report over the last 10 years (Everyone)

There is no equivalent of this in the 1992 report.

Is the intention is to have a standardized national report (and did we agree the format) that summarises 'events' over the last 10 years. We need to make sure that there is not too much overlap between this chapter and chapter 2, Harmful Species. Perhaps any maps showing current known distribution should go in this chapter as an overall summary of occurrence of HABs in the ICES area. Are we reliant on the updating and verification of HAEDAT before we can complete this chapter? If 10 years is too ambitious, we could drop this chapter and in chapter two, indicate which are the most problematic phytoplankters and record some of the more noteworthy incidents.

9 Term of Reference F

9.1 Present any relevant information from compilation of data for cooperative research report

Discussions were held during the working group meeting and further communications between the lead chapter authors are planned for later in 2010 to make progress on the drafting and compiling of data necessary for the Cooperative Research Report. The use of the HAEDAT data was recognised as being important for report and the compilation of national data into this database was urged.

10 Term of Reference G

10.1 Review the strategies being used to identify, enumerate, and otherwise investigate the life history stages of HAB species, and the information obtained from such efforts

Overview

Beatriz Reguera

It is well established that life history stages are critically important in the population dynamics of many HAB species, particularly those that form cysts or other resting stages.

New Techniques

Unfortunately, our ability to identify these stages or to enumerate them or study their specific dynamics or physiology is quite limited. New techniques are being developed to accomplish these objectives, and there is thus great value in reviewing the methods being used or developed, and to explore the extent to which these methods can be transferred to other workers, or applied to other HAB species.

Model Formulations

A realistic model of a phytoplankton population should take into account all the life stages encountered by this same population as well as transitions. As an example, rate of production of gametes and the duration of this stage are essential to estimate a realistic encounter rate.

Despite the importance of including life history transitions in population dynamics models for HABs species most of them are based on the vegetative stages. Some models are initiated from germination of resting cysts but to our knowledge no mode predicts the formation of cysts or other resting stages. Work is in progress in this regard but it remains in the development stage.

It is likely that the duration of the free-swimming phase for planozygotes will determine the dispersal of cysts (analogous to the "seed–shadow" for terrestrial plants) and provide information about the termination of the bloom for some species. In the Bay of Fundy the planozygotes and other life stages such as fusing gametes of *Alexandrium* are being identified by light microscopy on the basis of their distinctive morphology and are indicative of bloom state. *Dinophysis* life stages are easily recognized because they are morphologically distinct; nevertheless the planozote stage can only be clearly distinguished in live samples which makes their quantification an impossible task. An exception is that some high resolution optical instruments such as the Imaging Flow-Cytobot (Campbell *et al.*, 2009) are able to recognize cells with two longitudinal flagella (an unequivocal indication of planozygotic cells).

Molecular methods to identify and quantify different stages of the life cycle of a given species are urgently needed in order to allow a proper validation of assumptions made in the elaboration of population dynamics models. Research is in progress to identify molecular markers indicative of gametes and planozygotes. This is still highly experimental but holds the promise that some day rapid and accurate molecular assays can be developed that could identify and enumerate the different life history stages that would occur throughout a harmful bloom.

Alexandrium fundyense life cycle stages in the Bay of Fundy

Jennifer Martin

Alexandrium fundyense population studies have been ongoing for more than 30 years in the Bay of Fundy. During many of these years concentrations have exceeded 50,000 cells•L^{-1} making it possible to differentiate between life cycle stages.

Vegetative cell size tends to range between 25–40 µm in width (with a similar length). For example, cell size can be (25 µm x 25 µm or 35 µm x 36 µm). Earlier in the bloom actively dividing cells are observed (duplets, triplets and quadruplets) and tend to be between 25–35 µm in size with all cells in a particular chain being the same size. Later in the bloom fusing gametes are observed and these are followed by the formed planozygote which can be 40–47 µm in width by 45-53 µm in length. These cells are denser than the vegetative cells. The planozygote forms into the resting cyst (which is only seen in the water column during very dense blooms and only present for a brief period). The cyst is 23–25 µm in width by 43-45 µm in length.

11 Term of Reference H

11.1 Discuss new findings that pertain to harmful algal bloom dynamics. Bring new findings in phytoplankton population dynamics models to the attention of WGHABD for discussion

11.1.1 Forecasting *Alexandrium* blooms in the Gulf of Maine, and enhancements to observational capabilities

Don Anderson, Woods Hole Oceanographic Institution

A coupled physical/biological model of *A. fundyense* population dynamics in the Gulf of Maine has been described in several recent publications (e.g., McGillicuddy *et al.*, 2005; Anderson *et al.*, 2005b; He *et al.*, 2008). The model is initiated from large-scale maps of cyst distribution, with germination rates parameterized through laboratory experiments. Likewise, the growth of the resulting vegetative cells is regulated by light, temperature, and salinity, again parameterized using laboratory cultures.

Examination of toxicity patterns as well as cruise observations suggests a strong relationship between the abundance of *Alexandrium* resting cysts and the size of the regional bloom that follows. The strength of this relationship suggests that seasonal forecasts or outlooks are possible using maps of cyst abundance obtained during the fall or winter preceding a spring/summer bloom season. To generate these forecasts, the cyst abundance map for a given year is used to initialize model runs that utilize the meteorological and hydrographic conditions for recent years for which we have hindcast simulations. In other words, one cyst map is used with a range of weather and oceanographic forcings to provide a series of model simulations that together constitute an ensemble forecast. The years used for this forecast are not representative of all conditions, but do include intervals with low toxicity as well as high toxicity. As our library of hindcast runs grows, the range of weather conditions being included in the ensemble forecast grows accordingly.

As described in last year's WGHABD report, based on the very large size of the 2007 cyst population, we predicted a "significant" regional *Alexandrium* outbreak in 2008. (See http://www.whoi.edu/page.do?pid=24039&tid=282&cid=41211 for the press release, including images of the cyst map and ensemble model runs). This outlook was confirmed when a major bloom occurred several months later, extending from Maine through New Hampshire and much of Massachusetts, leading to federal emergency assistance to these three states because of the "failed fishery". In 2009, a "moderately large" outbreak was forecast, based on the lower cyst abundance observed in the fall, 2008. (See http://www.whoi.edu/page.do?pid=24039&tid=282&cid=56567). This forecast was generally accurate, since the toxicity was more limited in scale than in the previous year, extending only to the middle of Massachusetts Bay. However, a resurgence of toxicity in June and July occurred in Maine, leading to very high and prolonged toxicity in that state. This second wave of toxicity could not have been anticipated in the seasonal forecast, and reflected unusual wind patterns in June and July.

An outlook for 2010 was recently issued, this time calling for another "significant" outbreak. (See http://www.whoi.edu/page.do?pid=24039&tid=282&cid=69586). A cyst abundance map obtained in the fall, 2009 showed the largest concentrations of *Alexandrium* cysts ever recorded in that region. Not only were the numbers higher than previous years, but the distribution had advanced significantly to the south, with serious implications for toxicity in the southern waters.

Enhancements to monitoring and forecasting

Considerable effort has gone into developing methods to analyze water and plankton samples rapidly and accurately using new technologies, including many that derive from biomedical research. A major breakthrough in this regard is the Environmental Sample Processor (ESP), developed at the Monterey Bay Aquarium Research Institute (MBARI). (Seehttp://www.mbari.org/ESP/). The ESP robotically collects discrete water samples from the ocean subsurface, concentrates microorganisms (particulates), and automates application of DNA probes to identify specific microorganisms and their gene products. The core ESP is designed to collect and process small- to moderate-sized samples. Analytical modules are stand-alone detection systems that can be added to the core ESP to impart different analytical functions downstream of common sample processing operations. A few modules have been developed, but many more are possible once investigators have access to the core ESP and learn about its capabilities. The instrument can be bundled with other sensors such as a CTD, fluorometer, transmissometer, and nutrient analyzer. Data are transmitted periodically from the deployed instrument to a shore station for analysis and interpretation.

With the ESP, researchers will be able to conduct molecular biological analyses remotely, in real-time over a sustained period, and with interactive capability. A wide variety of organisms of interest to science and society can be analyzed over time scales that are not otherwise possible, all in automated fashion and in a timely manner with significant reduction of costs. The instruments can be used for beach and harbor sanitation, HAB monitoring and shellfish safety, drinking and recreational water analysis, and for homeland security applications, to name just a few.

Two successful proposals were submitted to obtain funding for ESPs, and as a result, six instruments will be delivered to Don Anderson's lab at WHOI over the next several years. It is expected that these instruments will be moored in the Gulf of Maine and used to obtain data that can be assimilated into the numerical models, making the forecasts more accurate. At the present time, hindcasts are issued weekly during the *Alexandrium* bloom season, each one looking backwards in time, as well as forward three days using weather forecasts (http://omglnx3.meas.ncsu.edu/GOMTOX/2010forecast/dino_10.htm). With real-time cell abundance data from the ESPs, it will be possible to improve model accuracy in much the same manner that meteorological stations provide data to weather models. In future reports, we will provide updates on our efforts to deploy these instruments and utilize their data in the monitoring and management of HABs in the Gulf of Maine.

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11.1.2 ASIMUTH Project

A collaborative project to be funded under FP7 Theme 9 (Space) has been accepted for funding and will commence in the next year involving partners from Ireland, France, Spain, UK and Portugal.

Over the past few years there has been much discussion of satellites being able to track surface algal blooms. This has resulted in the production of some services that purport to be Harmful Algal Bloom (HAB) nowcasts and forecasts. Understanding biological phenomena in the ocean requires a more complex approach than this, though there is some merit in using satellite derived chlorophyll images to delineate high biomass near surface algal blooms. Much cutting edge HAB research work in recent years has focussed on thin layers, where HAB species are present in thin (<1m in thickness) layers of limited geographical extent often associated with strong density interfaces in the water column (Donaghay *et al*., 1997; Xie *et al*., 2007). Clearly, a HAB forecast needs to factor in changes in water column structure (including likely areas where HAB species will be retained) and transport pathways in order for such a forecast to be realistic. The forecast should also include all available biotoxin, phytoplankton count and bioassay data to support the model forecast and satellite imagery of a bloom.

GMES has developed and is overseeing the implementation of the Marine Core Service (MCS) as one of a number of fast-track operational services in Europe. The MyOcean project will deliver the key elements of the MCS to the intermediate user community. There has been significant progress made within the intermediate user community through the establishment and effective working of Regional Operational Oceanographic Systems (ROOSes) under the EuroGOOS umbrella, such as the North West Shelf Operational Oceanographic System (NOOS) and the Iberia, Biscay, Ireland Regional Operational Oceanographic System (IBI-ROOS).

There is now scope to provide a worthwhile HAB forecasting downstream service to the aquaculture industry using the combined model forecasts, satellite imagery and in-situ networks that the MCS and intermediate users will provide, combined with an array of biological samples collected and the expertise provided by HAB biology experts. Through ASIMUTH scientists and industry in 5 European countries will roll out the first realistic HAB forecasting capability as a GMES downstream service to users, in this case the European aquaculture industry along Europe's Atlantic Margin. The early warning of severe blooms will allow fish and shellfish farmers to adapt their culture and harvesting practices in time, in order to reduce potential losses and in turn increase their productivity.

The novel scientific aspects of ASIMUTH are summarised as:

Objective 1. The identification of key past events which will be re-analysed and used for training the modelling system

Objective 2. Incorporation of Kopernikus (GMES) Marine Core Services (MCS) with the above selected events will be used to develop model based hindcast products. These will be used to tune the system and move towards an operational model for forecasting events.

Objective 3. Design of regional model systems and delivery of nowcast for specific HABs and Location information, transport pathways, remote sensed data.

Objective 4. Population of HAB-TAC (Thematic Assembly Centre) from relevant data streams (phytoplankton, biotoxin, satellite, in-situ, etc).

Objective 5: Provision of expert interpretation of the available data by way of the web-portal which will be carried out on a periodic basis depending on risk. This assessment will be then issued via a warning system to end users.

11.1.3 Bloom dynamics of *Dinophysis acuta* in Western Iberia

Beatriz Reguera

Blooms of *Dinophysis* spp. associated with lipophilic shellfish toxin outbreaks (OA, DTXs, PTXs) are the main cause of shellfish harvesting closures in Northwestern Iberian waters from spring to autumn. Blooms of *Dinophysis acuta* are very seasonal (late summer-early autumn); they start earlier and reach higher densities in Northern Portuguese waters during the upwelling season. In contrast, populations in the Galician Rías and adjacent shelf are usually very moderate in summer but increase drastically by the end of the upwelling season when southerly winds promote advection of shelf waters into the rías. There is controversy about whether sudden increases in cell concentrations in the rías result from cross-shelf transport of populations previously established in adjacent shelf waters, or are due to longshore transport that brings populations located off Portugal to the North. In 2005, record concentrations of *D. acuta* were observed in Portuguese waters ($14 \cdot 10^4$ cell L^{-1}) off Aveiro in early September, while concentrations off the Galician coast were very moderate (10^2–10^3 cell L^{-1}). During the autumn transition from upwelling- to downwelling-favourable winds, *D. acuta* declined abruptly off Portugal while the annual maximum (up to 22 · 10^3 cell L^{-1}) was found in the Galician Rías.

A new approach was used that combined physical observations (SST, current measurements); weekly observations from monitoring programmes in Galicia and Portugal; weekly division rate (min) estimates of *D. acuta* in Ría de Vigo, together with monthly transects and additional *ad hoc* sampling in the Ría. During August and early September, division rates were high in Ría de Vigo but cell concentrations were low, whereas higher SST values in Portugal (a proxy for thermal stratification) seemed to promote the build up of high densities of *D. acuta*. During the last week of October and the first week of November, populations declined off Aveiro, whereas in Galicia, maximum concentrations were reached while division rate estimates were almost zero. Results presented here confirm that increased numbers in the Galician Rías are not due to intrinsic growth but to physically driven accumulation. A simple cell concentration budget calculated during the accumulation period suggests that the high net growth observed during downwelling, in the absence of cellular division, would not be possible unless a considerable proportion of the cells are imported by longshore transport.

Reference

Escalera, L., Reguera, B., Moita, T., Pazos, Y., Cerejo, M., Cabanas, J. M., and Ruiz-Villarreal, M. 2010. Bloom dynamics of *Dinophysis acuta* in an upwelling system: *In situ* growth *versus* transport. Harmful Algae, 9: 312–322.

11.1.4 A call for cooperation with a Swedish/Nordic/Global Information system for aquatic microalgae and heterotrophic flagellates

Bengt Karlson

An information system for aquatic microalgae and heterotrophic flagellates is being developed in Sweden in co-operation with the other Nordic countries. Species lists of aquatic microalgae from Sweden, Norway, Denmark and Finland have been combined and quality controlled. The system builds upon the existing web site for the *Skagerrak-Kattegat Checklist of Phytoplankton and heterotrophic flagellates* which was originally published on the Internet in 1996. This system has been moved to a modern platform and new user friendly functionality for uploading micrographs and video and to include biovolumes from HELCOM-PEG etc. has been developed in a prototype version available at www.test.b-neat.org.

Thanks to funding received from the Swedish Research Council as part of the project *Developing a Swedish LifeWatch infrastructure for integrated analysis of biodiversity data,* the system will be further developed to include, freshwater species, benthic microalgae etc. The system will also be renamed. Quality controlled species lists are a vital part of the system. This is managed trough a system operated by the Swedish Species Centre that handles synonyms, splitting and lumping of species etc. in a consistent and documented way. Information regarding harmfulness is obtained from the *IOC-UNESCO Taxonomic Reference List of Harmful Micro Algae.* Links to other web based systems handling microalgae taxonomy is vital. Examples include OBIS, GBIF, the World Register of Marine Species, AlgaeBase, ITIS, Planktonnet and Dinophyta.org.

Co-operation with HAB researchers and other phytoplanktologists within the ICES area welcome. During the WGHABD meeting it was suggested that the new system could be used also in intercalibration activities and for teaching.

11.1.5 Major Dinophysis bloom event in Scottish waters in 2009

Keith Davidson

The densities of biotoxin producing phytoplankton were monitored at two locations in Lochs Fyne and one in Loch Striven at the North of the Clyde Sea, Scotland in 2009. (Figure 11.1.5.1).

A major bloom of *Dinophysis* was evident within both lochs, markedly exceeding regulatory threshold density. The composition of the *Dinophysis* community was almost exclusively *D. acuminata*, with only sporadic observations of *D. acuta*.

Fyne: Stonefield

At Stonefield, during the "summer" period finite counts of *Dinophysis* were recorded from 15 April until the 3 August: a period of 17 consecutive weeks (Figure 11.1.5.2). Fourteen of these weeks were characterized by cell densities that were above regulatory threshold.

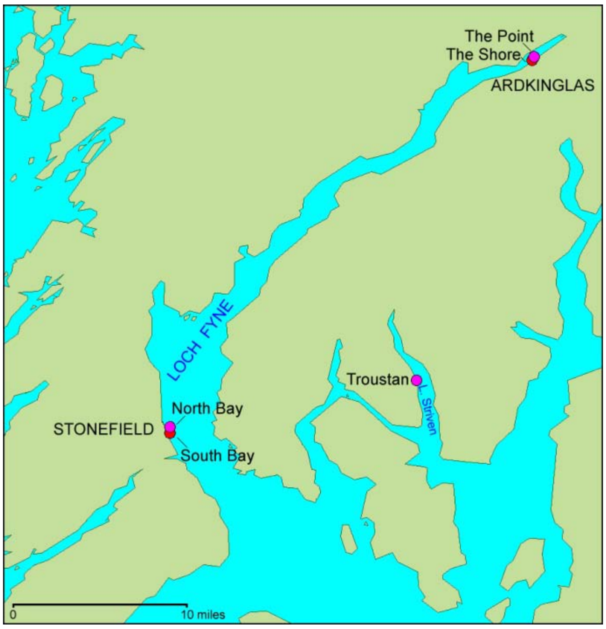


Figure 11.1.5.1. Sampling sites in Loch Fyne. Currently samples are collected at North Bay Ardkinglass (NR 867 724) and The Point Stonefield (NN 166 102). 099).

Fyne: Ardkinglas

At Ardkinglas, the duration of the period of elevated *Dinophysis* densities was even greater, being first evident on the 7th of April, and with the final finite observation being obtained on the 6th of October, 27 weeks later (Figure 11.1.5.2).

Striven: Troustan

Finite counts of *Dinophysis* were recorded over a period of fifteen consecutive weeks from 21st April to 4th August at Troustan, with the bloom peak of 1,040 cells L^{-1} coinciding with that at Ardkinglas on 19th May.

Lochs Fyne and Striven are is somewhat unusual among Scottish monitoring sites in terms of the southerly aspect of its mouth opening into the Clyde sea and hence an offshore bloom in this region could potentially become established in Loch Fyne, particularly following a period of southerly winds.

The only other Scottish phytoplankton monitoring site bordering the Clyde sea is Loch Ryan, which has a northerly aspect. Elevated cell densities were observed at this location between 7th July and 4th August, although not as great as those observed in Loch Fyne and Loch Striven. Other sites bordering the Clyde sea fall within the N. Irish monitoring programme where elevated *Dinophysis* densities were not observed until July, but again these N. Irish sites do not exhibit a southerly aspect.

Dinophysis densities in other sites in the region were compared to those in Lochs Fyne and Striven. These did not exhibit above threshold and were in line with typical summer densities.

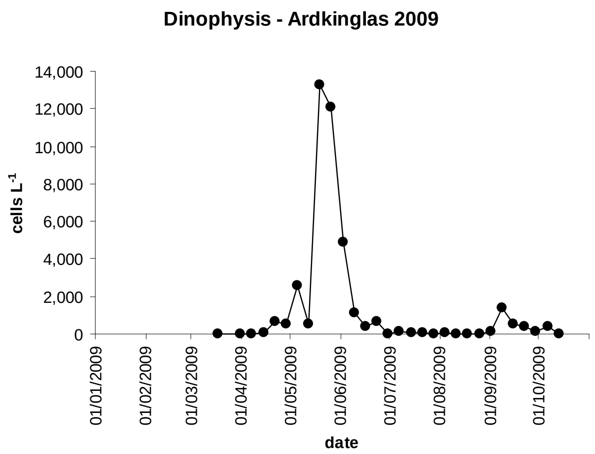
As a result of the *Dinophysis* bloom, mussels from Ardkinglas demonstrated exceptionally high concentrations of total OA/DTXs. With the exception of one sample, total OA/DTXs exceeded the regulatory limit in mussels from mid-May to early September.

At Stonefield OA/DTXs were also detected in mussels although concentrations were less than those reported in mussels from Ardkinglas. Between mid-May to late-July, total OA/DTXs were between 167 and 873 μg[OA eq.]/kg.

In Loch Striven, total OA/DTXs were above the RL between mid-May and mid-July.

In general temporal trends of toxin concentrations paralleled the bloom profile of *Dinophysis* with a 1–2 week lag between changes in cell counts and subsequent shellfish toxicity.

a)



b)

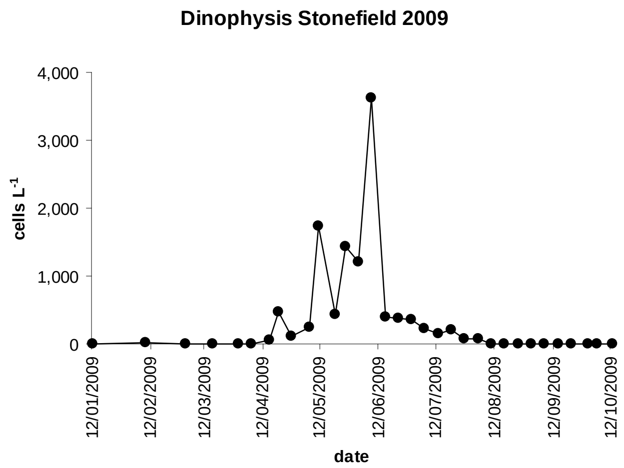


Figure 11.1.5.2. *Dinophysis* density at a) Stonefield and b) Ardkinglas during 2009.

The co-incidence in the initial increase in *Dinophysis* to above threshold densities at both sites in Loch Fyne and at the site Loch Striven suggests that a single event initiated the (first) bloom observed in early summer. The greater densities at these sites in comparison to elsewhere in Argyll leads one to hypothesize that the seed population for this bloom was advected into the lochs from the Clyde sea. This is also consistent with the observation that cell density increased more rapidly than would be expected by vegetative growth alone.

The greater density observed at Ardkinglas is potentially related to the more restricted nature of this site at the head of the loch. In the relatively good weather conditions of early summer, water stratification may have developed sufficiently to allow dense *Dinophysis* to become established and to dominate the community. The greater water exchange, and presumably mixing at Stonefield potentially allowed for other diatoms and dinoflagellates to compete for nutrients and somewhat reduce the *Dinophysis* density at this site compared to Ardkinglas.

11.1.6 Influence of salinity, temperature and nutrients on the yessotoxin formation of different strains of *Protoceratium reticulatum*

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Abstract

Protoceratium reticulatum as a producer of yessotoxin (YTX) and its analogues is common in several coastal environments. The YTX-producing strain of *P. reticulatum*, isolated from the German Bight (North Sea), was analysed to study toxin production under various autecological conditions. Experiments were carried out to investigate the influence of N/P ratio (2.44, 24.36 and 243.65), temperature (15 and 20 °C), salinity (5, 10, 15, 20, 25 and 30 ‰ salinity) and growth phase on YTX formation.

P. reticulatum showed the highest growth at 15 °C and higher salinities (25 and 30 ‰ salinity). The total YTX concentrations were higher at lower temperature. Furthermore, P-limited and control cultures exhibited the highest cell quota of YTX at the end of the stationary phase; a dramatic effect occurred at 15 °C under P-limitation, when the toxicity increased to tenfold higher values. An influence of the salinity on toxin concentration was also observable.

In addition, the *P. reticulatum* strain from the German Bight (North Sea) and YTX-producing strains of *P. reticulatum* from Japan (03071-YB-PR1), from the Pacific Ocean (CCMP 1889) and the Atlantic Ocean (CCMP 1720), were analysed to study influence of P-concentration on YTX formation in more detail (N/P ratio: 12.18, 24.36, 48.73 and 121.82). The observed findings partly confirmed the above mentioned results and indicated that the YTX-formation strongly depends on growth phase and the physical condition of the respective culture.

11.1.7 Complex yessotoxins profile in different strains of *Protoceratium reticulatum*

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Abstract

Protoceratium reticulatum is known to produce yessotoxin (YTX) and a wide range of analogues (YTXs). More than 100 YTXs are known and 40% are characterized concerning their exact chemical structure (Paz *et al*., 2008). The best known modifications at the YTX-backbone are: insertion of a methyl group between C-1 and C-2 as well as between C-41 and C-42; methylation of C-9; glycosylation of C-32; several modifications at the unsaturated side chain; absence of ring A; desulfonations and many variations of the former mentioned (Souto *et al*., 2005, Miles *et al*., 2005, Ciminiello *et al*., 2007; Finch *et al*., 2005). Beside those structural variations, another YTX-like toxin (Adriatoxin; ATX) was isolated from mussels of the Adriatic Sea (Ciminiello *et al*., 1998). YTX is mainly produced by *P. reticulatum*, albeit some strains have been found with homoYTX as the prominent analogue and the YTXs profile strongly depends on the origin of the respective isolate (Paz *et al*., 2008).

Therefore, a study on the complex toxin pattern of 18 strains of *P. reticulatum* from Germany, Norway, Japan, USA, New Zealand and Australia using liquid chromatography with tandem mass spectrometry (LC-MS/MS) was conducted to identify the characteristic YTXs profiles.

Results showed that YTX was mainly the prominent analogue but two strains contained homo YTX as the prominent YTXs. Furthermore, 32-arabinoside YTX was present in some strains in a high proportion. Especially in the Norwegian strain (U 10230) the 32-arabinoside YTX could be designated as major analogue. One strain from the USA (CCMP 1889) contains a low percentage of homo YTX besides YTX. 19 YTX analogues were detected beside YTX, homo YTX and 32-arabinoside YTX and those minor analogues were present up to 14 % of the total amount. ATX was not detected in any of the *P. reticulatum* strains.

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11.1.8 Microarrays for the detection of Toxic Algae (MIDTAL)

Beatriz Reguera

Harmful algae represent a potential threat to public health and economy. Intensive and costly monitoring programmes have been developed for the surveillance of phytoplankton and their toxins in coastal areas. However, the effectiveness of monitoring phytoplankton is limited by the fact that morphological analysis can be insufficient to give definitive species and toxin attribution. Molecular methods can provide a tool for preliminary detection of harmful algae before toxins surpass a safety threshold level. rRNA genes include regions valuable at species level.

The existing 18S-28S rDNA database established from previous EU projects enables the design of rRNA probes up to species level. Microarray technology is based on a DNA microchip that contains oligonucleotides spotted on a aminosilane coated glass slide.

The sample (extracts from field plankton concentrates) is fluorescently hybridised with the chip and the signal analysed by laser scanning fluorescence.

MIDTAL is a cooperated project covering several institutes over Europe coastal seas. Ten partners make up the consortium and include experts in probe design, microalgal physiology and monitoring from seven European countries and the USA. The objectives of MIDTAL are:

- To test and optimise existing and new rRNA probes for toxic species and immunoassays for toxins for their application to a microarray.
- To construct a universal microarray from the probes tested and optimised by all of the partners for the detection of harmful algae.
- To provide national monitoring agencies with a rapid molecular tool to recognise multiple toxic algae.
- The main challenges MIDTAL faces are:
- rRNA probe adaptation: FISH probes must be adapted to microarrays for its efficient interaction with RNA target molecules.
- Quantitative application: it is crucial to validate the fluorescent signal against cellular concentration of harmful species for its application in monitoring programmes.
- Dissemination of the chip: Once the chip has been validated and tested against field material, it will be commercialised for wider dissemination to the scientific community.

More information on the project and its achievements can be found at its web page: www.midtal.com

11.1.9 Changes in the phytoplankton community in the North East of Scotland: observations since 1997

Eileen Bresnan

A long term coastal ecosystem station, 5 km offshore of Stonehaven in the North East of Scotland (56º 57.8′ N, 02 º 06.2′ W), is monitored weekly for temperature, salinity, nutrients, phytoplankton and zooplankton. A number of changes in the phytoplankton community have been observed since the time series began in 1997. Dinoflagellate genera such as *Ceratium* show a decreasing trend in common with shorter time series from other Scottish coastal sites. During the early part of the time series the spring bloom was dominated by *Chaetoceros* species however since 2002, dense blooms of this genus are no longer observed and *Skeletonema* has become more abundant. A four year period was identified from 2001 to 2004 where mid month chlorophyll values during the spring bloom were reduced. During these years a change in the species dominating the *Dinophysis* population was also observed. This period is associated with a shift from negative to positive salinity anomalies. Changes in zooplankton composition and predation pressure have also been observed since monitoring commenced.

11.1.10 The dinoflagellate genus *Alexandrium* (Halim) in Scottish waters: A combined approach to assess diversity and toxin production

Eileen Bresnan

The dinoflagellate genus *Alexandrium* (Halim) is of particular interest in Scottish waters. Selected species can produce potent paralytic shellfish poisoning (PSP) toxins that can result in severe human illness if contaminated shellfish are consumed and can result in economic losses to the shellfish industry when shellfish harvesting areas are closed. Considerable interannual variation has been observed in both the concentration of PSP toxins detected in Scottish shellfish and *Alexandrium* cell densities in the water column with a decline in PSP toxicity observed since 2004. An in-depth study, combining molecular, microscopic, chemical and biochemical analyses was performed to better understand the dynamics of this genus in Scottish waters. Cell culture combined with microscopic and molecular identification revealed the presence of four *Alexandrium* species: *A. tamutum, A. minutum, A. ostenfeldii* and *A. tamarense* and two different ribotypes of *A. tamarense* (Group I) and (Group III). Chemical analyses revealed *A. tamarense* (Group I) and *A. ostenfeldii* to produce PSP toxins, while *A. ostenfeldii* formed spirolide toxins. Laboratory culture experiments showed toxin production to increase with light intensity when grown at 15 °C. This combined approach into the investigation of *Alexandrium* has considerably furthered our understanding of their diversity and toxicity in Scottish waters.

12 Term of Reference I

12.1 Review WGHABD contribution to the ICES White Paper on Climate Change

The draft chapter on Plankton was reviewed and comments were made and submitted to the editor of this white paper. It was recognised that this is still in draft format and our comments on the draft chapter and liaison with the Scientific Initiative on Climate Change are ongoing and liaison with this group is active through participation at their meeting by the chair of WGHABD Concerning the text of the white paper the following comments were made:

1) Some minor editing is necessary. For example: in the opening paragraph there is a mistake in the text that refers to phytoplankton as predators of fish; second paragraph, phytoplankton is the basis of marine food webs including fisheries but has no intrinsic economic value;

2) While recognising the importance of gelatinous zooplankton in pelagic food chains and the potential effects of climate change on their role in carbon flow, it was felt that their current importance is overstated in the opening paragraph;
3) This chapter should clearly distinguish between the effect of cyclical climate change driven by for example the NAO and long-term global warming;
4) There are numerous examples of changes in phytoplankton from the CPR. It would be better to reduce the number of examples and use them to show how climate interacts with physical oceanographic processes to influence phytoplankton dynamics. These examples should then be used to discuss or illustrate how global warming might have a similar effect;
5) With respect to changes in rainfall and the seasonal pattern of runoff, it should be made clear that the response by HAB species will depend on the particular combination of effects. For example, while increased runoff may increase thermohaline stratification and retain phytoplankton in the illuminated surface layers, an increase in CDOM and particulate material [it is not just CDOM that influences turbidity in coastal waters] associated with increased riverine discharge may reduce sub-surface irradiance and constrain phytoplankton growth;
6) In addition to the geographical spreading of warm water species, the potential for the seasonal window of growth to increase should be recognised;
7) While the effects of temperature and increased water column stratification on the growth and abundance of dinoflagellates as a functional group is clearly stated it is important to recognise that there is an underlying level of complexity and therefore uncertainty because different species of the same genus may respond differently. As an example, some species of *Dinophysis* will benefit from increased stratification and deeper thermoclines, while the same conditions will be detrimental for the more widespread *D, acuminata*. This species-specific response may help to interpret the observation on page 6: "*In the early 2000s in the North Sea, the abundance of the most common species of the armoured dinoflagellate Ceratium (e.g. C. furca, C. fusus, and C. horridum) decreased dramatically (Edwards et al., 2009)*"
8) It is unclear whether global warming will result in an increase in the strength of thermal stratification. Will warming of bottom water eventually result in the same surface to bottom temperature difference? It is important to get a view of this from the physical oceanographers
9) The example of *Lingulodinium polyedra* as a species that will benefit from global warming is perhaps not very appropriate. Detailed papers from Margalef on phytoplankton from Ria de Vigo in the 1950s showed that *L. polyedra* (together with other *Gonyaulax* spp.) was the dominant red tide (high density bloom causing discoloration) in the area. *L. polyedra* is now a rare species in that area despite the abundance of its cysts in the sediments (but it blooms in the Northern Galician Rías). It would be useful to put a graph of time series of SST anomalies to compare conditions in the 50s with the present. The same can be applied to *Gymnodinium catenatum* that bloomed in the beginning of the 20th century off Lisbon and was undetected for decades until its "return" was detected in 1976 in the Galician Rias Bajas.

13 Term of Reference J

13.1 Report to SSGHIE on potential and current contributions of your EG to the Strategic Initiative on Coastal and Marine Spatial Planning (SICMSP)

All EGs under the Steering Group on Human Interactions on Ecosystems (SSGHIE) were given this ToR to: "Report to SSGHIE on potential and current contributions of your EG to the Strategic Initiative on Coastal and Marine Spatial Planning (SICMSP)".

Proir to the WG meeting we were informed that the strategic initiative is still under development and therefore the SSGHIE Chair , Erik Olsen, asked that this ToR has been put on hold until further notice.

14 Term of Reference K

14.1 Report to SSGHIE on your plans to promote cooperation between EGs covering similar scientific issues

WGHABD is a regional group of experts in the area of Harmful Algal Bloom Dynamics, and should maintain that focus. Nevertheless, there are a number of activities where we can help lead global efforts. One example is in the format of database for algal event reports.

Examples of groups where WGHABD has particular cooperative activities:

WGBOSV: ICES IOC IMO Working group on ballast and other ship vectors

WGITMO: Working Group on Introduced and Transfers of Marine Organisms

See item 14.2 in this report as an example of this cooperative work in the area of invasive organisms with WGBOSV.

WGPME Phytoplankton and microbial ecology:

Over the years there has been overlap between ICES working groups on phytoplankton ecology and WGHABD. This new WG has a broad expertise in phytoplankton as well as microbial ecology and since it includes a number of members from WGHABD, overlap can be avoided. As long as there is participation in that new WG from WGHABD, we can stay informed of their activities and also avoid duplication.

WGPBI Physical and Biological Interactions

WGHABD already has had a joint meeting in 2009 and as a direct result we are jointly hosting a special session at the 2010 ASC. We are considering future joint meetings.

SICC Scientific Initiative on Climate Change

WGHABD has contributed to the preparation on a CRP on climate change setting out the position of ICES.

GEOHAB:

This WG contributed heavily to the formulation of GEOHAB development and objectives and will continue to participate in GEOHAB Core research program activities and promote them within the ICES region.

IPHAB Task Team on Algal Taxonomy:

We recommend that this WG review the list of harmful species provided by the IPHAB task team on algal taxonomy, annually, and provide feedback to the IPHAB task team.

IPHAB task team on HAB observations and forecasting systems within the global ocean observing system:

We recommend that this WG have a ToR in which the members review HAB related developments in observing and forecasting systems and provide input from the Regional Ocean Observing systems in the North Atlantic about HAB related developments. This should be done in synch with the IPHAB meetings (every 2 years).

IPHAB task team on the development of the Harmful Algal Information System:

The WGHABD has a longstanding involvement in compiling and disseminating information on HAB events. We should continue to prioritize improvements to be made in HAEDAT and communicate that to the task team and IPHAB.

IPHAB task team on biotoxin monitoring, management and regulations:

This WG will make recommendations about issues that should be addressed in relation to regulations and monitoring at the global level.

PICES

The following are potential opportunities for collaboration with the PICES HAB section:

- HAIS and HAEDAT. The PICES HAB section has adopted the HAEDAT forms and is contributing data.
- workshops or intercalibration exercises
- joint participation in special sessions
- cooperative research reports on specific topics
- exchange of "new findings" summaries
- exchange of participants, one representative per meeting

Given some structural differences between the PICES HAB section and this WG, there are definitely opportunities for collaboration but these might be opportunistic rather than formal and regular. For example, at the present time, WGHABD has no plans for a workshop or intercalibration exercise but when such activities are anticipated, it would be an excellent idea to inform the PICES HAB section and to work toward a joint activity.

SCOR-LOICZ WG 132 on Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems

WGHABD liaises with the activities of WG 3.

ROPME (Regional Organization for Protection of the Marine Environment):

ROPME has not yet established a group of experts on HABs although this is being discussed. Several members of WGHABD have participated in ROPME HAB meetings and this type of interaction is encouraged going forward. In particular, ROPME should be encouraged to adopt the HAEDAT forms and database for bloom reporting.

14.2 Response to request from ICES for information to aid the work of a proposed joint WGHABD/WGBOSV group to look at Ballast water and Invasive HABs

In the minutes from the IOC Intergovernmental Panel on Harmful Algal Blooms, Ninth Session 22–24 April 2009 it was recorded:

"**The Panel recognized** the difficulty of identifying an "invasive" phytoplankter or even providing lists of native phytoplankters so that future invasive species could be identified. **The Panel also recognized** that a list of harmful phytoplankton that could potentially be transported or introduced by ballast water is extensive and that it is complex or not possible to predict the likelihood of an introduced species becoming established in a new region.

The Panel concluded by acknowledging that there is a need to develop advice on the phytoplankters most likely to be successful as invasive species, the size of inoculums and conditions that would result in an invasive species. The risk of an invasive species having a negative impact on ecosystem health or the human uses of the ecosystem is determined by the combination of the probability of a species being introduced, its survival and spread, and impact. Therefore, priority should be given during the review to those phytoplankton species that are known to be or have a high probability of transport by ballast water, high survival (cysts/spore formation) and high ecological or economic impact. The intent is thus to be able to assess risk associated with incoming ballast water that has not been exchanged. The list would be a watch list or an indication of high risk waters where specific HAB species are known to occur and cause problems. A top ten or twenty of high risk phytoplankton species that would not be world-wide, but region or climate-zone specific.

The Panel requested IOC and ICES to request the WGHABD, in collaboration with WGBOSV, to consider this matter and in particular to determine whether: (i) it was possible to identify species of phytoplankton, especially HAB species (and their characteristics) which are more likely to be successful as invasive species, and have significant potential ecological or economic impact; (ii) there are particular characteristics of coastal waters which favour the establishment of invasive phytoplankters."

WGHABD discussed this request and agreed that a list could be generated based on the knowledge of identified harmful species and their life cycle strategies. Species with overwintering strategies such as cyst formation would have the potential to survive transport /discharge in ballast tanks or sea chests. It was also noted that cleaning of the ballast water sediments may also pose a risk of introduction of these stages to new environments. Epiphytic species may also be transported through hull fouling mechanisms. Species could be 'rated' on their capacity to survive transport in ballast water or as epiphytes, ability to become established in the new area and harmful impact on introduction. Species where life cycle stages are unknown (e.g. *Dinophysis*) can also be highlighted. Some indication of the geographic range of the species could also be included to highlight areas of potential risk. Baseline information from ports/regions around the world is also considered important.

Coastal waters with similar water column characteristics between the areas uptake and discharge would favour the success of establishment of invasive species. Coastal waters which can be subject to eutrophication and other destabilising anthropogenic influences may be more susceptible. Harbours and coastal embayments may provide a physical retention mechanism to promote blooms of introduced species.

The WG support the suggestion of a joint meeting between members of WG HABD and WG BOSV to generate a list as suggested by IP-HAB and will liaise with Tracy McCollin and Claus Hagebro to proceed with a proposed joint meeting in October 2010.

15 Draft Resolutions

The **ICES–IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD),** chaired by Joe Silke, Ireland, will meet in Gothenburg, Sweden, 5–8 April 2011 to:

a) Review progress in entering data onto the database;

b) Review draft chapters of the proposed CRR;

c) Review developments in automated HAB sampling devices in FerryBox systems and on other platforms;

d) Discuss the need for and logistics of a demonstration workshop on automated in situ techniques for quantitative harmful algal bloom species analysis;

e) Review output from the intersessional meeting of members from WG HABD and WG BOSV to generate a list of HAB species with the potential to become invasive through transportation in ship's ballast and other vectors;

f) Review the pre-column oxidation technique for routine analysis of PSP toxins in shellfish (Lawrence method);

g) Review the ICES special session on HABs that will be held during the Annual Science Meeting from 20–24 September 2010 in Nantes, France (La Cité des Congrès);

h) Draft aims and propose a structure for a joint meeting with the ICES Working Group on Physical–Biological Interactions (WGPBI) during 2012;

i) Report on new findings in the area of harmful algal bloom dynamics;

j) Deliver National Reports on harmful algal events and bloom dynamics for the year 2010.

WGHABD will report by 2 May 2011 (via SSGHIE) for the attention of SCICOM.

Supporting information

Priority	The activities of this group are fundamental to the work of the Oceanography Committee. The work is essential to the development and understanding of the effects of climate and man-induced variability and change in relation to the health of the ecosystem. The work of this ICES-IOC WG is deemed high priority.
Scientific justification	**Term of Reference a)** Review the relationship between HAEDAT and other databases (e.g. ICES/IOC) with a view to considering how updating the HAEDAT database can be streamlined The HAEDAT system is due to be populated to catch up on lost years while it was undergoing database re-design. The working group will assess • Status for upload of all records 2002-2010; • Status of quality assurance of HAEDAT records prior to 2002; • New decadal maps based on HAEDAT data Request the ICES database manager to give a presentation to WGHABD **Term of Reference b)** The working group agreed the following time table to progress to completion the CRR on: • September/October conference call/ opportunistic meeting to review progress on preparation of draft chapters; • 31 December 2010 complete draft chapters for dissemination to members of the WG. **Term of Reference c)** To observe HAB dynamics a sampling frequency high enough to resolve natural variability is important. Sampling from research vessels is often not frequent enough due to cost. Thus automated water sampling devices on ferries and cargo vessels as well as on stationary platforms such as buoys, poles (e.g. wind mills) etc. are of interest. The sampling platform is often available at no or at a low cost. New developments in automated sampling devices include the use of robotic arms to fill sample bottles and to filter water. Water samples are later analysed by microscopy. Filters are subsequently frozen for later analyses. Also water sampling devices used in sewage treatment plants have been deployed in HAB studies. Recent developments in the use of automated sampling devices

in HAB studies will be reviewed.

Term of Reference d)

Harmful algal blooms have severe consequences to public health, marine ecosystems, and local economies. To minimize impacts, early warning and forecasting systems are needed, and these would be greatly facilitated by in situ observations of HAB species. Recent development of in situ imaging technologies and of robotic instruments capable of species identification using molecular probes are promising in this regard. To spread the knowledge of the new techniques and the necessary skills to the scientific and marine monitoring community, a demonstration workshop should be considered. Initial WG discussions would be on the need for such a workshop, and if this is deemed useful by the WG, the logistics of the workshop, including the specific instruments to be considered, the nature of the demonstrations or trials, the venue for the meeting, and the types of samples to be analyzed. This effort will require careful planning and also time to raise necessary funds. The earliest possible dates for such a workshop would be 2012.

Term of Reference e)

During 2010 meeting the WG recognised the value of generating a list of HAB species with the potential to become established in new areas as requested by IP-HAB. Members of the WG agreed to work intersessionally to generate a list of species with this risk. During 2011 the WG will review the output from the interssessional meeting to generate this list and will prepare a statement on this review to be presented at the subsequent IP-HAB meeting during 2011

Term of Reference f)

Within the ICES region, regulatory authorities are continuing to search for and implement alternatives to the AOAC mouse bioassay for routine monitoring of PSP toxins in shellfish. Chemical analytical methods for analysis of PSP toxins in shellfish and toxigenic organisms have existed for several decades, but due to technical limitations of the methods, as well as the reluctance of regulatory authorities to abandon biological methods that directly measure toxicity, these methods are only inconsistently employed and international standardization has not been achieved. Analytical methods for PSP toxins typically involve separation of toxins (or their derivatives) by high-performance liquid chromatography followed by either fluorescence (LC-FD) or mass spectrometric (LC-MS) detection. For operational reasons and cost-effectiveness, attention has been focused on pre-column oxidation methods, specifically the Lawrence method, which has received AOAC certification as a validated method for analysis of PSP toxins. Nevertheless, some technical difficulties have emerged in the broader implementation of the pre-column oxidation approach to PSP toxin detection in a number of regulatory laboratories. The method is currently subject to another round of intercalibration at the international level. The WG intends to review the outcome of the intercalibration exercise and to consider methodological difficulties and advances in the implementation of this pre-column oxidation method as a viable alternative or supplement to the AOAC bioassay.

Term of Reference g)

The HAB special session "Oceanography and ecology of HABs: physical/biological interactions, climate change, and other current issues" will be held at the 2010 ASC in Nantes. The WGHABD will review the outcomes of this special session with a view to synthesising current understanding and likely key future developments. This review will also help to guide the content of the proposed joint meeting with WGPBI in 2012 (ToR h)

Term of Reference h)

The WGHABD and the WGPBI held a successful joint day meeting

	during 2009. A proposal was received from WGPBI for further extended (two day) joint meeting during 2011 to discuss a) small scale physical-biological processes and b) modelling, HABs and climate change. This proposal was discussed at the 2010 WGHABD meeting. Members of the WGHABD were enthusiastic about a further joint meeting to progress areas of common interest. However, sufficient ToRs, are already in place for the 2011 WGHABD meeting that a joint meeting will not be possible at this time. Moreover, while the suggested meeting themes were of interest, some further development was thought to be needed to optimise the aims and structure of the meeting. It is therefore intended to discuss these points, drawing on the outputs from the ICES ASM HAB meeting during autumn 2010 (TOR X) and the recent GEOHAB modelling workshop, the proceedings of which are due for publication soon. This will allow progress to a joint meeting, during 2012, with WGPBI. **Term of Reference i)** WGHABD is a useful forum to discuss and present new findings amongst the members. This is an excellent forum to promote and discuss topics of relevance. There are obvious reasons to continue this topic as an ongoing term of reference **Term of Reference j)** National Presentations and review occurrences of HABs in the ICES area, making use of the HADAT system.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	There are no obvious direct linkages with the Advisory Committee.
Linkages to other committees or groups	WGHABD interacts with WGZE, WGPME and WGPBI.
Linkages to other organizations	The work of this group is undertaken in close collaboration with the IOC HAB Programme. IOC should be consulted regarding ToR or discontinuation of the WG prior to the ASC. There is a linkage to SCOR through the interactions of the IOC-SCOR GEOHAB Programme.

16 Recommendations

16.1 WGHABD wish to jointly propose a Special Theme Session on Harmful Algal Blooms in the Baltic Sea for the 2011 Annual Science Conference

Rationale

Harmful Algal Blooms (HABs) have effects on the whole ecosystem in the Baltic Sea. Observations of known and entirely new types of HABs in the Baltic have inspired studies on the ecology and oceanography of the blooms and their effects on other trophic levels. The introduction(s) of new gelatinous zooplankton species (ctenophores *Mnemiopis leidyi* and *Mertensia ovum*) are likely to have effects on the structure of the plankton community including HAB species.

In the Baltic Sea blooms of nitrogen fixing cyanobacteria that form surface accumulations have been a recurrent phenomenon for a long time. The blooms are connected to increased phosphate concentrations which in turn may be related to the release of phosphate from sediment in hypoxic deep basins. These blooms, which include toxic species, are of great concern to the public and affect the regions tourism in summer. A new phenomenon in the Baltic in the recent years is small scale blooms of the dinoflagellate *Alexandrium ostenfeldii* which has been shown to produce paralytic shellfish toxins (PST) in the area. The toxins may accumulate in the food chain and can be a danger to humans. Other toxin producing dinoflagellates in the Baltic include the genus *Dinophysis*. Members of this mixotrophic genus produce diarrhetic shellfish toxins (DST). Recently a breakthrough in the investigations of the ecology of *Dinophysis* has been made since it is now possible to maintain it in laboratory culture. Blooms formed by dinoflagellates are elusive; they often occur in thin layers and have a strong physical regulatory component in addition to the complex biology of the organisms.

The fish killing species *Pseudochattonella farcimen* (Dictyochophyceae) has formed blooms in the southern Baltic Proper during the last few years. This organism was first observed in the eastern North Sea-Skagerrak-Kattegat in 1998 where it subsequently has become an established species. It has affected fish farms in the Danish part of the Kattegat in a few occasions. In 2008 and 2009 persistent winter blooms of the harmful species *Chrysochromulina polylepis* (Haptophyta) were observed in the Baltic Proper. No harmful effects were reported. This species formed a devastating bloom in the Skagerrak-Kattegat area in 1988 but no blooms have been observed in the Baltic up until the last few years.

Climate change may influence the future frequency and types of Harmful Algal Blooms affecting the Baltic. Changed temperature, salinity and input of nutrients, humic substances etc. as well as changes in turbulence conditions will influence the plankton community structure. Also possible changes in the carbonate system (pCO_2, alkalinity and pH) may have effects. Scientists in the Baltic Sea area have been forerunners in the use of ships of opportunity and satellites to observe HABs. Recent developments include new sensors and the inclusion of new types of sensor platforms.

Focus of session

- Ecology and oceanography of HABs in the Baltic Sea area
- Introduced species – effects on pelagic ecosystem structure including HABs
- Bioactive compounds produced by harmful algae - their biotransformation (including food chain transport and biodegradation) and effect on other trophic levels
- Climate change effects of HABs
- Eutrophication effects on HABs
- Automated HAB observing systems – results and new technology
- HAB forecasting

Conveners:

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16.2 Cooperative research report on HABs in the ICES Area

Improvements in monitoring capacity as well as technological advances has meant there is a requirement for a more up to date cooperative research report on the HABs and phytoplankton toxins in the ICES area. The WG was in agreement that this would be a useful document that would be of value to scientists and agencies responsible for the implementation of monitoring programmes. Most of the report would be produced intersessionally and chapter leads were identified. The nominated people will bring chapters and data with them to the next WGHABD meeting where the report will be assembled and edited. Chapter headings and responsible persons are listed below:

Proposed Chapters of Cooperative research report:

1) Introduction and definitions (Richard Gowen, UK)
2) Harmful species (Beatriz Reguera, Spain)
3) Monitoring: country by country basis (Per Anderson, Denmark)
4) Management strategies: country by country basis (Don Anderson, USA)
5) Predicting occurrence (Keith Davidson, Scotland)
6) Detection and quantification of algal toxins (Allan Cembella, Germany)
7) Extended country report over the last ten years (Richard Gowen, UK)

17 Closing of the meeting

The Chair thanked the host from WHOI and the local liaison team for their hospitality and generosity. He also thanked the participants for their input especially the 2 rapporteurs and closed the meeting on Saturday, 13:00 hours.

Annex 1: List of participants

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Annex 2: Agenda

Tuesday, 6 April:

09:30 Welcome Session

ICES Structure and our new Parent Body SGHIE

Feedback from 2009 ASC

Review of our TORs

ICES Science Plan and HABD… where we fit… competencies

10:30–10:45 Housekeeping

i. Meal Times, Wireless Internet … WEP Keys etc, Coffee Breaks

ii. Checkout Receipts etc,

iii. Plan excursion / BIOS Tour

10:45–11:00 Break

11:00 –11:30 Agenda Finalisation

12:00- 13:00 Lunch

13:00 Discuss new findings that pertain to harmful algal bloom dynamics. Bring new findings in phytoplankton population dynamics models to the attention of WGHABD for discussion;

i. Continuing seasonal forecasts of New England Alexandrium blooms and new developments for improving monitoring and model accuracy" D Anderson
ii. Alexandriunm limiting factors E Bresnan
iii. Stonehaven Monitoring Site E Bresnan
iv. Dinophysis in Loch Fyne K Davidson

14:30 Assess national reports submitted to HAEDAT and review;

National Reports Sweden, UK, Netherlands, Canada, USA

AOB / Report Drafting Session

Wednesday, 7 April:

09:00–09:45 Cooperative research report Session 1…things to think about during meeting

Other HAB related Activities:

09:45–

i. Methods of Enumeration Manual Update
ii. SCOR Working Group
iii. GESAMP Activities / Dead Zones
iv. News2Use modelling enrichment stakeholder meeting and funding opportunities
v. WGPME update – Long term data sets - Interactions -
vi. SSICC Update

vii. Steve Hay Molecular Working Group Questionairre

viii. Interaction with Invasives group Tracy McCollin Ballast and Other Ship Vectors: Request from Claus Hagesbro

Thursday, 8 April:

ToRs

09:00

i. Review WGHABD contribution to the ICES White Paper on Climate Change;

ii. Report to SSGHIE on potential and current contributions of your EG to the Strategic Initiative on Coastal and Marine Spatial Planning (SICMSP).

iii. Report to SSGHIE on your plans to promote cooperation between EGs covering similar scientific issues. (and IOC, PICES and HAIS)

iv. Review the strategies being used to identify, enumerate, and otherwise investigate the life history stages of HAB species, and the information obtained from such efforts;

AOB / Report Drafting Session

1300: Interactions with Physical Biological Interactions Group Future Joint Sessions

i. Shared meetings with WGPBI Discuss and formulate the description and justification for a thematic session on HABs and Modelling for the 2010 ASC;

ToRs

14:45 Assess national reports submitted to HAEDAT and review;

National reports from Denmark, Germany, Spain, Ireland.

15:30 Discuss new findings that pertain to harmful algal bloom dynamics. Bring new findings in phytoplankton population dynamics models to the attention of WGHABD for discussion;

i) Recent Biogeographical Distribution of Novel Toxigenic Microalgae and Associated Toxins in the North Sea and Adjacent Waters A Cembella

ii) Margueritte Towards the consolidation of Alfacs Bay as a GEOHAB site for the study of HAB population dynamics. Recent contributions on circulation patterns, microalgal population distribution and toxin identification. M Fernandez

iii) Beatriz MIDTAL Project

iv) Beatriz Bloom Dynamics of D acuta

v) Joe Introduction to the ASIMUTH project

vi) UK Infraction R Gowen

vii)Yessotoxins Bernd Luckas

- 16:30 Collate and submit on-line National reports no later than 1 February 2010 national reports 2002–2009 for HAEDAT, review at working group;

AOB / Report Drafting Session

Friday, 9 April :

ToRs

09:00

- Bengt: Taxonomic databases in HAB studies
- Review and assess the information compiled in the updated ICES-IOC data base on HAB monitoring systems, MONDAT

10:00 Coffee and Photo

10:30 Tour of Atlantic Explorer and BIOS station

11:00

i. Review the draft chapters for the cooperative research report;
ii. Sub Groups… review and return with suggestions
iii. Present any relevant information from compilation of data for cooperative research report;

Cooperative research report Session 2

AOB / Report Drafting Session

Saturday, 10 April

09:00 2011 Meeting Location

(1) Sweden

(2) AZTI

Terms of Reference for 2011

AOB / Report Writing

13:00 Meeting Adjournment