ICES-IOC WGHABD REPORT 2018

ECOSYSTEM PROCESSES AND DYNAMICS STEERING GROUP

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Interim Report of the ICES - IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD)

24-28 April 2018

Tarragona, Spain

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The ICES-IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD) 2018 meeting was hosted at IRTA, Tarragona, Spain, 24–28 April.

WGHABD has nine ToRs in its current work programme, seven of which were addressed at the meeting. The main focus was on the WGHABD data in the IOC-ICES-PICES Harmful Algal Event (HAEDAT) database and progress towards generating an ICES Harmful Algal Event Status report. This report will form the ICES contribution to Global HAB Status Report (GHSR), which is currently being produced by the Intergovernmental Oceanographic Commission of UNESCO (IOC).

The work of WGHABD was presented at the XIIIth session of the IOC Intergovernmental Panel for Harmful Algal Blooms (IPHAB) at UNESCO, Paris, May 2017. Progress with HAEDAT data was presented at a HAB data training week at the IOC office for IODE, Belgium, September 2017, and ICES WG Phytoplankton and Microbial Ecology, Aberdeen, UK, 2018. An abstract for an oral presentation on Regional Changes in HAB Distribution in the Atlantic Ocean using HAEDAT data was submitted to the Effects of Climate Change on the World's Oceans in Washington DC conference, June 2018. WGHABD also participated in the Symposium for High Throughput Methods in Marine Time Series, Germany and provided input into a number of activities of the IOC GlobalHAB Scientific Steering Committee.

WGHABD conducted a review and a quality check of historic data in the HAEDAT database at the 2018 meeting. The structure and content of the ICES Harmful Algal Event Status Report (ToRs C and D) was discussed. Lead authors for separate chapters were assigned. Pieter Provoost at the IOC Project Office for IODE in Ostend, Belgium played a key role in generating plots from HAEDAT data which greatly helped these discussions.

National reports (ToR A) showed that a variety of HABs continue to cause problems in the ICES area. *Pseudo-nitzschia* and Amnesic Shellfish Toxins continue cause widespread problems on the west coast of the USA and Canada and was once again recorded on the east coast. *Karenia brevis*, brown tides and *Cochlodinium* blooms also caused problems in USA. Shellfish toxins again caused problems in Europe; however, in some areas (Ireland) closures were of a shorter duration. There were a number of canine fatalities in the UK resulting from dogs eating starfish and fish that contained high concentrations of PSP toxins that had been washed ashore after a storm. Ciguatoxins were once again detected in fish from the Canary Islands. *Pseudochattonella* were observed in Danish, Swedish and Norwegian waters and cyanobacterial blooms were recorded in the Baltic. Tetrodotoxin (TTX) was again recorded in shellfish from Dutch waters but below the threshold level. Testing of historic shellfish samples from in Ireland did not reveal the presence of TTX.

New findings (ToR E) included a review of ongoing projects looking at satellite imagery and generating early warning of HAB events, dynamics of HAB species along the Catalan coast, molecular methodologies, bioanalytical devices for the detection of HAB species and oomycete parasites of *Pseudo-nitzschia*. An update about the OSPAR intermediate assessment and the Marine Strategy Framework Directive was presented as part of ToR F. ToRs G and H looked at the emerging risk from Ciguatera Fish Poisoning

in Europe, and projects underway to investigate analytical methodologies and toxicity of *Gambierdiscus* strains from European waters.

1 Administrative details

Working Group name

ICES-IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD)

Year of Appointment within current cycle

2018

Reporting year within current cycle (1, 2 or 3)

1

Chair(s)

Eileen Bresnan, UK

Meeting dates

24–28 April 2018

Meeting venue

Tarragona, Spain

2 Terms of Reference

ToR A) Deliver National Reports on harmful algal events and bloom dynamics for the years 2017, 2018 and 2019.

ToR B) There are a number of fish killing algae activities underway during the reporting period from 2017–2020 e.g. IP-HAB task team on fish killing algae, fish killing algae colloquium in 2018. Participants involved with these activities will update the WG with progress and a summary will be provided to ICES and the IOC and other relevant WGs

ToR C) ICES-PICES-IOC Harmful Algal Event Database (HAE-DAT) – the harmful algal event database will be updated by participants on an annual basis. This database will be used to produce 'products' such as spatial descriptions of harmful algal events in the ICES area . Examples include maps of incidence of toxicity and/or mortalities, updates to ICES Ecosystem reviews that can be updated annually or as required.

ToR D) ICES WGHABD will produce a HAB Status Report. This will represent the ICES contribution to the Global HAB Status Report for the North Atlantic area. This will use data and products generated from HAE-DAT and supplementary time series data as appropriate.

ToR E) Report on new findings in the area of harmful algal bloom dynamics

ToR F) HABs and the EU Marine Strategy Framework Directive (MSFD). Currently there is no consistent approach in Europe to including HABs in the assessment of GES for the MSFD. A commission decision on the MSFD is pending. .

ToR G) Review how physical, chemical and biological interactions control the dynamics of selected harmful micro-algae

ToR H) Ciguatera Fish Poisoning (CFP) is an emerging issue in the ICES area. This ToR will provide an update of CFP incidence in the ICES area, new developments in methodology to research the issue, modelling efforts, risk assessments to protect human health, initiatives in other bodies such as IP-HAB, PICES etc.

ToR I) Species specific HAB detection methods and other cutting edge technologies are now moving from research towards operational use. WGHABD will aim towards developing collaborations with other WGs working in this area to optimise practical applications in operational situations.

3 Summary of Work plan

Year 1	Finalise QC of HAE-DAT data, production of outputs and ICES Status report. Review EU commission decision and role of HABs in the MSFD. Update on activities in relation to CFP and implications for the ICES area. Present national reports, new findings, complete HAE-DAT entries for 2017 data. Work with IPHAB to finalise production of manuscript on fish killing algae, review HAB genera Gambierdiscus and Fukuyoa.
Year 2	Contribution of ICES input to the Global HAB Status Report and input into activities around its launch. Agree associated peer review publications to be produced for year 3. Activities on HABs and MSFD, and CFP as decided in Year 1. Present national reports, new findings, complete HAE-DAT entries for 2018 data. Review of Hab genera to be decided. Communicate with other WGs with regard to ToR I. Respond to advisory requests as appropriate.
Year 3	Production of peer review publications for Global HAB Status Report special issue. Input to associated activities as appropriate. Activities on Habs and MSFD and CFP as decided in Year 2. Present national reports, new findings, complete HAE-DAT entries for 2019 data. Review of Hab genera to be decided. Pariticipate in activity associated with ToR I.

4 List of Outcomes and Achievements of the WG in this delivery period

- The work of WGHABD was presented at the XIIIth session of the Intergovernmental Oceanographic Commission of UNESCO Intergovernmental Panel on Harmful Algal Blooms (IPHAB) in Paris, 2 – 4th May, 2017. A summary of the report from the previous three year reporting cycle including summary maps using HAEDAT data from this was presented and well received.
- WGHABD participated in an IOC –OBIS HAEDAT training session at IOC training office for IODE in Ostend, Belgium, September 25th – 28th 2017 and gave a presentation on progress within WGHABD on using HAEDAT data to produce a report on the status of harmful algal events in the ICES area.
- WGHABD submitted an abstract for an oral presentation to the Effects of Climate Change on the World's Oceans, Washington D.C, June 2018.

  Regional changes in harmful algal events in the North Atlantic area over the last two decades documented using the HAEDAT database:

  E. Bresnan, P. Andersen, D. Anderson, C. Belin, M. Branco, A. Cembella, K. Davidson, M. De Rijcke, W. Eikrem, M. Fernandez, G. Hafsteinn, B. Karlson, A. Kremp, J. Kobos, D. Kulis, M. Lemoine, H. Mazur-Marzec, A. McKinney, C. H. McKenzie, S. Milligan, L.

J. Naustvoll, Y. Pazos, M. Poelman, P. Provoost, B. Reguera, F. Rodriguez, R. Siano, J. Silke, A. Silva and H. Enevoldsen

- WGHABD presented the work on the HAEDAT data at ICES WG Phytoplankton and Microbial Ecology, Aberdeen, UK, March 2018.
- WGHABD participated in the Symposium on High Throughput Methods in Marine Time Series, Schloss Herrenhause, Hannover, October 11-13, a joint workshop lead by ICES WGPME, WGIMM
- WGHABD represented ICES at the GlobalHAB Scientific Committee at a number of different activities. These include:
    - Contribution towards the GlobalHAB Science Implementation Plan; GlobalHAB, 2017. Global Harmful Algal Blooms, Science and Implementation Plan. E. Berdalet *et al.* (eds.). SCOR and IOC, Delaware and Paris, 64 pp.
    - Contribution to the GlobalHAB Scientific Steering Committee meeting, Villefranche, March 2018.
    - Representation at the GlobalHAB 'Best practices guide to investigating HABs and Climate Change', Naples, Italy, April 2018.

5 Progress report on ToRs and workplan

ToR A: Deliver National Reports on harmful algal events and bloom dynamics for the years 2017, 2018 and 2019

National Reports were presented and submitted by correspondence. Summaries are given in Appendix C. *Pseudo-nitzschia* and amnesic shellfish toxins continue cause widespread problems on the west coast of the USA and Canada and was once again recorded on the east coast. *Karenia brevis,* brown tides and *Cochlodinium* blooms also caused problems in USA. Shellfish toxins again caused problems in Europe; however in some areas (Ireland) closures were of a shorter duration. There were a number of canine fatalities in the UK resulting from dogs eating starfish and fish that contained high concentrations of PSP toxins and had been washed ashore after a storm. Ciguatoxins were once again detected in fish from the Canary Islands. *Pseudochattonella* were observed in Swedish and Norwegian waters and cyanobacterial blooms were recorded in the Baltic. Tetrodotoxin (TTX) was again recorded in shellfish from Dutch waters but below the threshold level. Testing of historic shellfish samples from Ireland did not reveal the presence of TTX.

ToR B: Manuscript on fish killing algae

This ToR has been incorporated into the workplan of IOC IPHAB task team on Harmful Algae and Fish Kills. The manuscript is currently 54 pages in length and needs some editing before submission for peer review. This will be completed before the next IPHAB session in April 2019.

ToR C: IOC-ICES-PICES Harmful Algal Event Database (HAE-DAT) and ToR D ICES WGHABD HAB Status Report. This will represent the ICES contribution to the Global HAB Status Report for the North Atlantic area

WGHABD is using data within the IOC-ICES-PICES HAEDAT database to produce a status report of harmful algal events in the ICES area. This will form the ICES contribution to the Global HAB Status Report that is being produced by the IOC. A lot of time was spent on these two ToRs and considerable progress was made during the meeting. Delegates spent time reviewing historic data, the structure of the report was agreed and authors assigned to the specific chapters. Further details can be found in Annex 3.

ToR E: Report on new findings in the area of harmful algal bloom dynamics

New Findings presented included a review of ongoing projects looking at satellite imagery and generating early warning of HAB events, molecular methodologies, dynamics of HAB species along the Catalan coast, bioanalytical devices for the detection of HAB species and oomycete parasites of *Pseudo-nitzschia*. Summaries of these presentations can be found in Annex 4.

ToR F: HABs and the EU Marine Strategy Framework Directive (MSFD)

An update on the OSPAR intermediate assessment (https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/) was presented and the plankton life form approach used in Descriptor 1 (Diversity) for the Marine Strategy Framework Directive was reviewed. Some HAB species do not fit into this approach due to the limitations of routine light microscopy in separating toxic from non-toxic species and strains. However, this approach has the potential to investigate the increase of potential HAB genera within the phytoplankton community and HAEDAT data could be used in collaboration with this to examine increase of harmful algal events.

ToR G: Review how physical, chemical and biological interactions control the dynamics of selected harmful micro-algae and ToR H: Ciguatera Fish Poisoning (CFP) is an emerging issue in the ICES area

Both of these ToRs focused on work underway to investigate the ecology and toxin production in *Gambierdiscus* and *Fukuyoa*. Jorge Diogène (IRTA) presented briefly the results of the ECsafeSEAFOOD project (FP7, 2013–2017). The identification of CTXs and gambieric acid in shark was described, highlighting the importance of the selection of extraction and purification methods. Two new CTXs were identified and this would be the first identification of gambieric acid in fish. Investigation of the toxicity of strains of *Gambierdiscus australes* isolated from Madeira showed porduction of CTXs. Additionally the EUROCIGUA project (EFSA, 2016-2020), was presented, describing the outscope of the project and specific grants, which include the study of the epidemiology of ciguatera, the evaluation of CTXs in the environment and in food and the development of analytical methods. *Gambierdiscus australes* has been identified for the first time in the Balearic Islands. More information can be found at ECsafeSEAFOOD:

http://www.ecsafeseafood.eu/

and

EUROCIGUA:
http://www.aecosan.msssi.gob.es/AECOSAN/web/ciguatera/home/aecosan_home_ciguatera.htm

In 2019, ToR G will focus on harmful algal species in the Arctic.

ToR I: Species specific HAB detection methods and other cutting edge technologies

A number of initiatives exist within the general scientific community which can tie in with examining new methodologies for species specific HAB detection. Raffaele Siano IFREMER and Allan Cembella from AWI have already had a number of discussions about holding a workshop looking at molecular methods for HAB species, specifically generating calibration curves for QPCR methodology. Funding is essential for this to be successful and fitting in with other initiatives was discussed. In addition, during 2018–2019, WGHABD will discuss plans for a workshop on the use of imaging flow cytometry for HAB detection and quantification. WGHABD will seek collaboration with SCOR WG 154 and GlobalHAB to organize a workshop in year 2020 or 2021. A possible venue is a marine biological field station in Sweden. Additional information: SCOR Working Group 154: Integration of Plankton-Observing Sensor Systems to Existing Global Sampling Programs (P-OBS); http://www.scor-int.org/SCOR_WGs_WG154.htm and GlobalHAB www.globalhab.info

6 Revisions to the work plan and justification

None.

7 Next meetings

The 2019 meeting will be hosted by Wenche Eikrem at the Natural History Museum, Oslo, Norway, 2–4 April.

Annex 1: List of participants

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Annex 2: ToR A: National Reports

National Report: Canada

Cynthia McKenzie

In July 2017, Canadian HAB scientists held a workshop to establish national priorities and develop a research network. The workshop was organized and chaired by Dr. Ian Perry at the Institute of Ocean Sciences (IOS), Fisheries and Oceans Canada (DFO), Sidney, British Columbia, July 11-13, 2017. Sixteen workshop participants, representing DFO scientists as well as invited experts from the United States and Canada, discussed Canadian HAB priorities and the development of a network for HAB research in Canada.

Global and national events, including large HAB-related fish kills, HAB impacts on marine mammals and unprecedented domoic-acid-producing HAB events on the Pacific coast, have brought this issue forward as a national research priority. Specific concerns in Canadian marine waters were highlighted, including the impact of HABs as an ecosystem stressor and the negative consequences of HAB events caused by their phycotoxin production and its accumulation in shellfish and the food web. Little is known about HABs in Arctic and sub-Arctic regions of Canada, where climate change is expanding potential areas for such blooms. A concern was noted that low temperatures could result in slow phycotoxin depuration rates in several bivalve species, and this in turn could lead to toxin accumulations and impacts beyond single events. Other particularly vulnerable areas include Marine Protected Areas and aquaculture sites.

Priorities for workshop participants were to expand existing work and strengthen connections to related programs, such as environmental monitoring and invasive species studies, to provide more HAB information for Canada. The potential for linkages between Canadian interests and the priorities of international networks, such as ICES WGHABD, IOC IPHAB and Global HAB, was also discussed.

A recommendation from workshop participants was to produce a formal CSAS (Canadian Science Advisory Secretariat) research document and review to assess the status of knowledge in Canada, identify knowledge gaps and highlight areas of particular concern for current and future impacts of HABs on ecosystems and resources. The Science Advice on impact of marine HABs on the Canadian ecosystem is scheduled for early 2019.

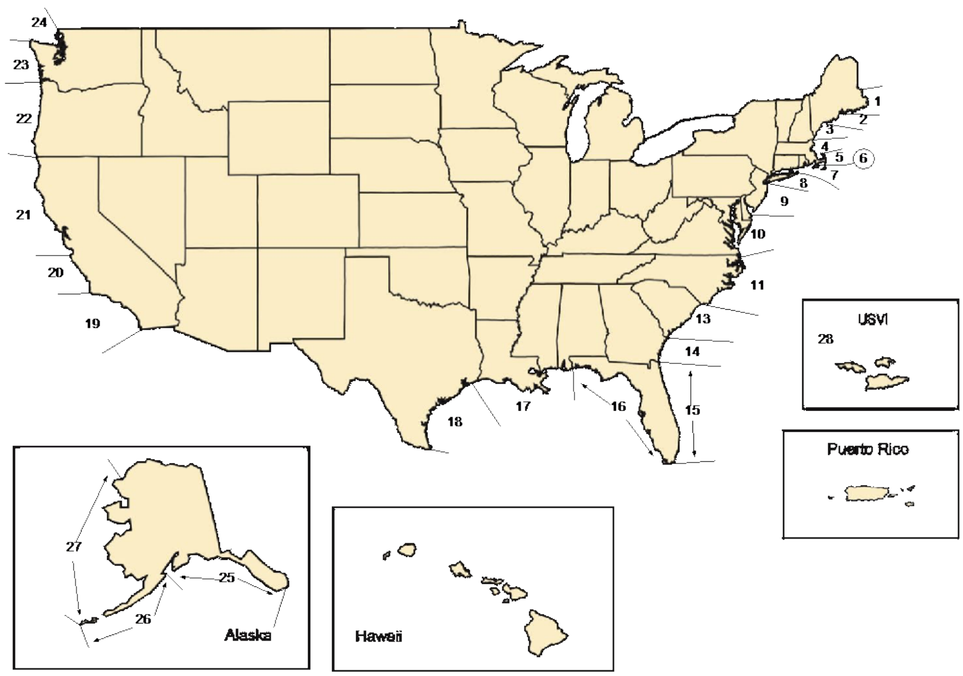
Membership of the Canadian HAB Working Group (CAN HAB) is currently composed of the workshop participants who have a broad range of expertise including taxonomy, genomic, modelling and remote sensing. However, it is hoped that the network will expand to include additional academic, federal and provincial researchers and managers interested in HAB issues in Canada. The Chair of CAN HAB is Cynthia McKenzie (Cynthia.mckenzie@dfo-mpo.gc.ca), a research scientist with DFO based in St. John's, Newfoundland and Labrador. She is the point of contact for more information on this HAB network.

Atlantic Coast of Canada (ICES regions)

No new toxins or unusual events were reported in 2017 in Canadian ICES regions. ASP and PSP closures were reported in areas where closures have typically occurred in the past. Annual closures continue due to PSP in the Bay of Fundy region and areas of the Gulf of St. Lawrence. Details of these closures are in the HAE DAT database. There were no cultured or wild fish kills due to phycotoxins reported on the Atlantic Coast in 2017.

National Report: USA

Don Anderson



New England (Regions 1-7)

PSP: In Maine *Alexandrium* spp were present in coastal waters from late March until early September. This resulted in shellfish closures due to PSP along the coastline at various times from early May through July 23rd with saxitoxin concentrations up to 3776 µg/100g shellfish. The maximum saxitoxin concentrations in shellfish were about three times higher than those of last year, but the closure durations and timings were similar to those seen in 2016. PSP toxicity in New Hampshire was more short lived, beginning on June 2nd and terminating on July 21st with a maximum toxicity of 1571 µg/100g shellfish.

For the first time since 2014, shellfish beds on the north shore of Massachusetts were briefly closed from June 22nd through July 18th when PSP test results on blue mussels rose to 115 µg/100g shellfish. Harvest was also banned in the Nauset Marsh from May 3rd – June 10th, with a small portion remaining closed until June 27th. The marsh typically experiences high density blooms of *Alexandrium catenella* each spring with cell concentrations exceeding 1,000,000/L during the height of the bloom.

ASP: As was the case in 2016, shellfish quarantines were required in 2017 in Maine and Rhode Island due to domoic acid (DA) concentrations exceeding the regulatory limit of 20 ppm brought on by *Pseudo-nitzschia* spp. blooms. In Maine, DA was detected on September 10th and persisted until December 26th 2017 with concentrations reaching 60.4 ppm. Quahogs (*Arctica* spp.), softshell clams (*Mya arenaria*), blue mussels (*Mytilus edulis*), and American oysters (*Crassostrea virginica*) all contained measurable amounts of domoic acid. The rapid accumulation of toxin by blue mussels prompted an immediate recall of this shellfish species following the quarantine order. As a result of this recall, along with one in 2016, Maine state regulators have adopted a new guideline for shellfishery closures. Beginning in April 2018, when domoic acid is found in plankton (water samples) the harvesting of shellfish will be banned.

In Narragansett Bay, RI, a *Pseudo-nitzschia* spp. bloom in October 2016 was followed by decreased abundance from November 2016 through January 2017. *Pseudo-nitzschia* abundance increased during February and March 2017, with DA toxin in shellfish detected late February 2017, leading to a closure from March 1st through March 24th, as domoic acid concentrations as high as 32 ppm were found in northern quahogs (*Mercenaria mercenaria*). While no ASP-related shellfish closures were required in Massachusetts, high densities of *Pseudo-nitzschia* spp. that typically do not produce high DA concentrations were documented. However, *P. australis*, which is highly toxic, was identified in Massachusetts water for the first time. All of this suggests that domoic acid toxicity resulting from blooms of *Pseudo-nitzschia* spp is now a significant threat to New England's shellfishery.

Connecticut experienced no HAB related problems in its coastal waters and this has been true for at least the past 10 years.

New York (Long Island; Region 8)

The coastal waterways of Long Island New York are subject to recurring HABs caused by *Aureococcus anophagefferens* (brown tides) *Alexandrium catenella* (PSP), *Cochlodinium polykrikodies* (fish and shellfish mortalities), and periodically by *Dinophysis acuminata* (DSP).

Brown tide: From May 5th through October 31st, brown tide affected over 100km of shoreline within multiple estuaries including: Great South, South Oyster, Quantuck, Moriches, Shinnecock, Moneybogue and Hewlett Bays. This marks the 11th consecutive year that *Aureococcus* cell densities have exceeded 1.5 billion cells/L in this region.

PSP: Three shellfish closures occurred in James Creek, Shinnecock Bay, and for the first time in Deep Hole Creek. Maximum *Alexandrium catenella* cell densities of 90,000, 19,000 and 1,000 cells/L respectively, were recorded during the April to June timeframe when the blooms occurred.

Cochlodinium: *Cochlodinium* has bloomed annually on Long Island since 2004 causing water discoloration and unexplained toxicity in shellfish (*Argopecten irradians*) and fish (*Menidia menidia*) as a result of very high cell densities of more than 7,000,000/L in 2017.

This year, Shinnecock Bay, Peconic Bay, Shag Harbor, and Three Mile Harbor waters were impacted from June through September.

New Jersey (Region 9)

Chattonella: Low oxygen conditions resulted from a very localized *Chattonella* spp. bloom (400,000,000 cells/L) in an isolated portion of a lagoon with poor flushing located in Beach Haven West. These low oxygen levels were suspected of promoting avian botulism and the poisoning of ducks. Abraxis kit test results for neurotoxic shellfish poisoning were also conducted and were negative.

ASP: *Pseudo-nitzschia* spp. concentrations of greater than 10,000 cells/L were found in the Sandy Hook/Raritan Bay area during the month of September. Abraxis domoic acid test kit results were negative on all shellfish samples.

Maryland, Virginia and North Carolina (Regions 10 & 11)

Brown tide**:** Chincoteague Bay has suffered major losses of seagrass beds due to persistent annual blooms of *Aureococcus anaphagefferens* with cell concentration of more than 100,000,000/L reported this year.

PSP: Once again no PSP toxicity has been documented in the Chesapeake Bay, however, high concentrations of cells in the *Alexandrium minutum* complex (>25,000,000/L), first detected in 2015, were recorded throughout the mid-bay area (Patuxent, Potomac, Eastern Bay, main bay).

ASP: Counts of *Pseudo-nitzschia* spp. continue as high densities exceeding 800,000 cells/L were found in water samples collected in the Isle of Wight Bay. Elisa test kits results for domoic acid were negative.

South Carolina and Georgia (Regions 13 & 14)

No report was submitted.

Florida (Regions 15 & 16)

PSP: In the Indian River Lagoon, on the East Coast of Florida, extremely high cell densities of *Pyrodinium bahamense*, 17,643,865 cells/L, caused water discoloration and closures of shellfish beds based on these high cell densities. PSP toxin values of up to 51 μgSTX equivalents per 100g shellfish were also recorded. As was the case last year, shellfisheries were closed on a precautionary basis from May to October and no human illnesses were reported.

ASP: A commercial shellfish closure in Saint Joseph Bay on the Florida west coast due to high domoic acid concentrations of up to 32 ppm shellfish tissue occurred from late July through late September. This area routinely has high concentrations of *Pseudo-nitzschia* spp. exceeding 1,000,000 cells/L.

NSP: Two significant, and persistent *Karenia brevis* blooms were documented in 2017 affecting the southwest coastal waters including Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee, Collier and Monroe counties. The first began in September of 2016 and continued until mid-June of 2017 with cell densities exceeding 12,000,000/L. The second bloom, with cell concentrations greater than 6,000,000/L arose on October 2nd and continues as of April 2018. During both of these blooms, which were extensive but patchy, there were reports of multiple fish kills, wildlife mortalities and respiratory irritation. Shellfish harvest is banned when cell concentrations exceed 5,000/L, but nonetheless, in March recreationally harvested gastropods (likely conch or whelk) resulted in documented human illnesses. Unfortunately, no meal remnants remained for testing. When cell concentrations drop below 5,000/L, and toxin levels are less than 20MU/100g shellfish, areas are reopened for harvest.

Central Gulf Coast (Region 17)

There were no reported HAB events in region 17 this past year. *Karenia brevis* and associated NSP impacts including shellfish bed and beach closures, as well as fish and marine mammal mortalities, periodically impact the central Gulf of Mexico waters.

Texas (Region 18)

There were no reported HAB events in region 18 in 2017, however, over the course of the past six years, *Karenia brevis* blooms have caused fish kills, shellfish bed closures and human respiratory irritation.

California (Regions 19, 20, 21)

PSP: Monterey Bay experienced two separate PSP events in 2017. The first began in January and lasted almost two months, and another started at the end of August and terminated early in October. Sonoma County also experienced a brief PSP event in October. California mussels and giant rock scallop were the main fisheries species affected, with maximum toxin concentrations of 1812 and 507 µg/100g shellfish respectively. The median toxin level for all mussels above the alert level was 162 µg/100g shellfish. PSP is somewhat common along the entire California coast, and similar events have occurred in years past.

ASP: For the third year in a row, domoic acid (DA) was found along the California coastline at various times of year. Contaminated shellfish and arthropods necessitated fisheries closures, and marine mammal health was affected. *Pseudo-nitzschia* blooms are common in Santa Barbara, the Northern Channel Island region, and Monterey Bay. However, these events are historically more rare north of San Francisco, making mussel contamination in Del Notre County this year notable. Mussel contamination along the coastline occurred in the spring through late June. Bay mussels and razor clam registered particularly high toxicities, with maximums of 350 and 390 ppm respectively. Razor clams tested positive for toxin year-round, and domoic acid was found to be more highly concentrated in the muscle tissue than the viscera.

Spiny lobster near Santa Cruz and North Coast Dungeness crab reached quarantine levels in late September and continued into December, with maximum toxin levels of 730 and 150 ppm respectively. Rock crabs in Santa Barbara channel were found to have elevated toxin levels on April 19th. In the Northern and Central California region, rock crabs had elevated toxin levels on January 16th, June 2nd and August 8th.

Oregon (Region 22)

PSP: In 2016 there were no closures due to PSP, however, in 2017, there were multiple areas on the mid and north Oregon Coast where shellfish harvesting was banned with concentrations as high as 149 µg/100g saxitoxin during the month of October.

ASP: There are areas of the Oregon coast that have been closed due to DA toxicity in razor clams for several consecutive years. This year, approximately half of Oregon Coast was closed for domoic acid in razor clams, and an ASP evisceration order was put in place for commercial Dungeness crab landed in the south. Levels peaked in April on the South Jetty of Columbia river at 120 ppm. A secondary bloom presumed to originate in the southern Oregon Coast peaked in December at Gold Beach with concentrations reaching 270 ppm, and at this time, levels as high as 62 ppm were detected in Dungeness crab viscera from the same area. DA toxicity caused significant and costly disruptions to the Dungeness crab fishery, the most important state fishery, with a delayed opening and a partial closure for the fishery after the opening. The closures and delays caused major economic losses in addition to a loss in market confidence.

DSP: No closures due to DSP were reported in 2017, as was the case in 2015 and 2016.

Washington (Regions 23 & 24)

Once again, recreational and commercial shellfish activities were disrupted by HAB closures, causing substantial economic loss to coastal communities.

PSP: This year saw a continuation in the annual PSP events that began in Puget Sound in 2012 with *Alexandrium catenella* being the main bloom species. The central section of Puget Sound experienced closures for over six months, from July 2017 into February 2018. Contaminated species included blue mussels, butter clams, geoduck clams, littleneck clams, manila clams and pacific oysters. Toxin levels were measured by mouse bioassays, reaching levels as high as 2535 µg/100g shellfish for blue mussels. Northern Puget Sound experienced saxitoxin contamination from June until the end of November. Mouse bioassays indicated contamination levels of up to 763 and 309 µg/100g shellfish in blue mussels and pink scallops respectively. Southern Puget Sound experienced a briefer PSP season, with closures from September until October. PSP closures along coastal beaches extended from June through November. In the Strait of Juan de Fuca, shellfishery closures due to PSP risk occurred from April 2017 though January 2018. Species registering high saxitoxin levels included blue mussels, littleneck clams, and geoduck clams, measuring up to 518, 163, and 447 µg/100g shellfish respectively.

ASP: *Pseudo-nitzschia* blooms disrupted razor clam harvest along Washington State's coastal beaches. ASP closure events that began in Fall 2016 extended into April 2017, and a second round of closure began in May and concluded in July. LC assays were used to measure domoic acid concentration, which reached a maximum of 53 ppm. Similar events have been occurring along the Washington State coastline since 1991.

DSP: The entirety of Puget Sound experienced DSP closures due to *Dinophysis* blooms in 2017. In Southern Puget Sound, DSP closures began at the end of August and have continued to the present (April). Blue mussels, rock scallops, and cockles have been most affected, with okadaic acid maximums of 250, 27 and 19 µg/100g shellfish respectively, measured by LC/MS assays. Central Puget Sound was closed from August through November, with blue mussels reaching toxin concentrations of 242 µg/100g shellfish. In Northern Puget Sound, closures began on July 7th and continued until August 15th. DSP also affected the Strait of Juan de Fuca from August through December, disrupting fisheries for blue mussels, manila clams, pacific oysters and rock scallop. The maximum toxin concentration recorded for blue mussel in Northern Puget Sound was 35 µg/100g.

Alaska (Regions 25-27)

PSP: Butter clams harvested from Sadie Cove, Kachemak Bay in August had some of the highest saxitoxin concentrations measured in this region of Alaska, 6624 µg/100g shellfish tissue. Around the same time, PSP levels of 575µg/100g were found in bivalves from St. George, a small island in the Bearing Sea that is part of the Pribilof Island chain. *Alexandrium* spp. was the causative organism in both situations. For the second consecutive year, monitoring by the Southeast Alaskan Tribal Ocean Research (SEATOR) group identified additional PSP hot spots in Southeast Alaska beginning in early June. This was earlier than normal, however, most of these locations reopened by mid-July.

In the Bering Straits region, between mid-August and the end of September, the deaths of 39 walrus may be attributed to saxitoxin poisoning. Gut contents of one freshly harvested animal had saxitoxin levels exceeding 800 ng/g. Additional testing is ongoing.

National Report: Portugal

A. Silva and M.A. Castelo-Branco, Phytoplankton Laboratory and M.J. Botelho, Marine Biotoxins Laboratory, IPMA

The Portuguese Monitoring of HABs and phytotoxins, carried out by IPMA (Portuguese Institute for the Sea and Atmosphere, www.ipma.pt/), covers the whole coast of Portugal except Madeira and Açores archipelagos. The sampling grid covers 10 coastal areas (21 stations) and 28 estuaries+coastal lagoons (35 stations). The sampling is carried out on a weekly basis: 56 samples from bivalve harvesting areas and phytoplankton retention areas (90% of the stations are coincident for water and bivalve samples and 10% are sentinel stations for HABs initiation).

During 2017, 32 HAB events were reported, seven more than the previous year, 13 events in coastal areas and 19 in estuaries+coastal lagoons (Table 1). The events have lasted a minimum a month and a maximum of eight months, starting, in the beginning of the year, with closures due to paralytic toxins (PSP syndrome and later in April due to lipophilic toxins (okadaic acid and dinophysistoxins, DSP syndrome) and amnesic toxins (ASP syndrome). From these events, 24 closures were due to DSP associated toxins above the critical limit, caused mostly by *Dinophysis acuminata*, 4 closures due to ASP in particular associated with *Pseudo-nitzschia seriata* complex and 4 due to PSP associated with *Gymnodinium catenatum*.

Table 1 - Spatial and temporal distribution of ban-on-harvesting periods in 2017 (Portugal).

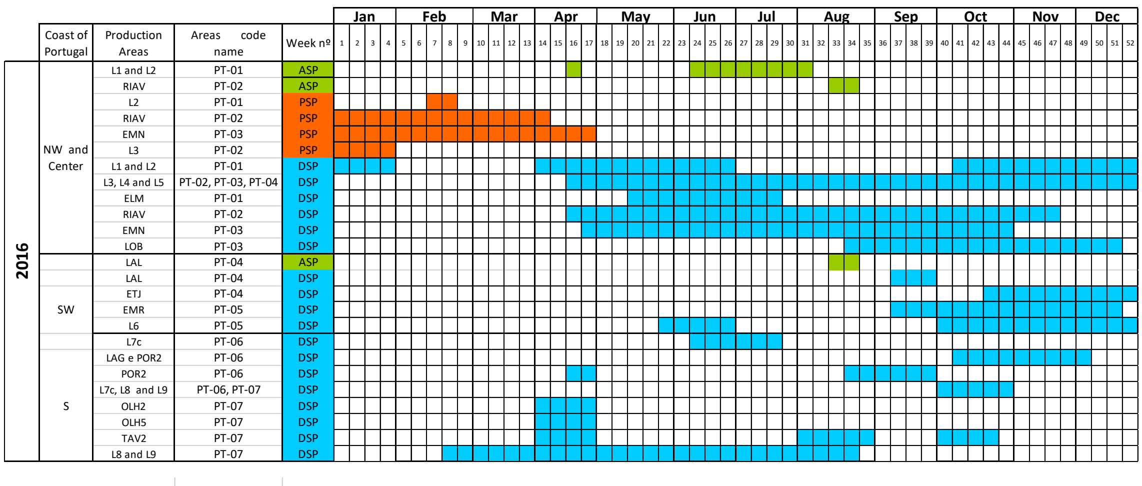


Table 2 – Characterization of each toxic event in terms of phytoplankton cell concentration and dominant species and maximum toxicity values in bivalves.

	Coast of Portugal	Production Areas	Areas code name	Maximum concentration (cells/L)	HAB SPECIES	ASP (mg/kg)	PSP (µg STX equiv. kg-1)	DSP (µg OA equiv. kg-1)	Bivalve specie
2017	NW and Center	L1 and L2	PT-01	1st event- 113600; 2nd event- 632000	*Pseudo-nitzschia Seriata group*	1st event- 72; 2nd event - ban by cell in the water			*Spisula solida*
		RIAV	PT-02	75200	*Pseudo-nitzschia Seriata*	34,8			*Venerupis corrugata*
		L2	PT-01	960	*G.catenatum*		1284		*Mytillus spp.*
		L3	PT-02	19040	*G.catenatum*		4155		*Mytillus spp.*
		RIAV	PT-02	2520	*G.catenatum*		5650		*Mytillus spp.*
		EMN	PT-03	160	*G.catenatum*		2753		*Scrobicularia plana*
		L1 and L2	PT-01	1st event- 300; 2nd event- 8140; 3rd event - 720	1st event-*D. acuminata* ; 2nd event-D. *acuminata* ; 3rd event - D. *caudata*			1st event- 411; 2nd event- >625; 3rd event - >625	*Mytillus spp.*
		ELM	PT-01	280	*D.acuminata*			304	*Mytillus spp.*
		RIAV	PT-02	5440	*D.acuminata*			693	*Mytillus spp.*
		L3, L4 and L5	PT-02, PT-03, PT-04	4120	*D.acuminata*			737	*Donax spp.*
		EMN	PT-03	1000	*D.acuminata*			978	*Mytillus spp.*
		LOB	PT-03	no data				404	*Solen marginatus*
	SW	LAL	PT-04	97600; 267200	*Pseudo-nitzschia Seriata*	no data			
		LAL	PT-04	200	*D.acuminata*			194	*Mytillus spp.*
		ETJ	PT-04	300	*D.acuta*			629	*Mytillus spp.*
		EMR	PT-05	360	*D.acuminata*			772	*Mytillus spp.*
		L6	PT-05	1st event-440; 2nd event- 660	1st event- *D. cudata* ; 2nd event- *Dinophysis*			1st event- 334; 2nd event - 681	*Donax sp.*
	S	L7c	PT-06	100	*D. caudata*			160	*Donax sp.*
		LAG e POR2	PT-06	1160	*D.ovum*			379	*Mytillus spp.*
		POR2	PT-06	1st event-120; 2nd event- 120	1st event- D. ovum; 2nd event- D. caudata			1st event- 171; 2nd event -224	*Mytillus spp.*
		L7c, L8 and L9	PT-06, PT-07	280	*D.acuminata*			692	*Donax spp.*
		OLH2	PT-07	100	*D.ovum*			173	*Mytillus spp.*
		OLH5	PT-07	120	*D.acuminata*			284	*Cerastoderma edule*
		TAV2	PT-07	1st event- 80; 2nd event- 80; 3rd event - 80	1st event-*D. caudata* ; 2nd event-*D. caudata* ; 3rd event - *D.ovum*			1st event- 411; 2nd event- >625; 3rd event - >625	*Mytillus spp.*
		L8 and L9	PT-07	940	*D. caudata*			>625	*Donax spp.*

ASP

Pseudo-nitzschia species were regularly observed in water samples. Thresholds for early-warning (100x10^3 cells/L) and bloom initiation (200 x10^3 cells/L) are currently being evaluated. As in previous years *Pseudo-nitzschia* blooms were reported only for the W coast of Portugal and in 2017, from April to July, along the coast and only during august in coastal lagoons. Bans normally last between one and two weeks (Table 1 and 2) and the highest concentration recorded in the water was 63x10^4 cells/L, lower than the previous year.

DSP

Dinophysis species were a regular presence in water samples and responsible for most of the bivalve harvesting closures. *D. acuminata* was the dominant species, followed by *D. caudata, D. ovum, D. acuta* (less abundant than in 2016) and *D. rotundata,* in decreasing order of cell concentration. Harvesting bans were longer and persistent, mainly in the estuaries of the W coast. The highest concentration reported in the NW coast, Aguda (L2, PT-01), was 8140 cells/L.

PSP

These events were only reported in the NW coast and the ban started in in December 2016. This event last until February in the coast and until April in the adjacent estuary. *Gymnodinium catenatum* reached 19040 cells/L in Torreira (L3, PT-02).

National Report: Spain

Basque Country

Report provided by AZTI (Pasaia) and the University of Basque Country (Leioa). Contacts: Marta Revilla (mrevilla@azti.es) and Aitor Laza (aitor.laza@ehu.eus). Web: http://www.azti.es/es/, https://www.ehu.eus/es/web/bve-lbe/ekologia-arloa.

In the Basque country, during the year 2017 two areas were monitored. The Oka estuary was monitored weekly for toxins in shellfish from January to March and from October to December; and quarterly for toxic phytoplankton. The second area monitored was an experimental pilot scale shellfish farm located in open waters off the Basque coast.

Paralytic Shellfish Poisoning (PSP): STX and derivatives were always below quantification limit in both sampling sites.

Diarrhetic Shellfish Poisoning (DSP): Okadaic acid (OA) was above regulatory levels during most of the spring, *Dinophysis acuminata* was considered the causative species as it was present during that period and reached a maximum of 1.9 x 10^3 cells/L in April together with the maximum concentration of OA. During these event other potentially DSP producers were observed (*D. acuta*, *D. caudata*, *D. fortii* and *Phalacroma rotundatum*) but at a lower abundance (< 10^2 cells/L).

Yessotoxins: YTXs were detected below regulatory levels in May at the pilot scale farm, in coincidence with the presence of *Lingulodinium polyedra* (80 cells/L) and *Protoceratium reticulatum* (20 cells/L).

Amnesic Shellfish Poisoning (ASP): In the Oka estuary, *Pseudo-nitzschia galaxiae* ($2x10^4$ cells/L) and *Pseudo-nitzschia multistriata* ($4x10^2$ cells/L) were found in summer. In winter and autumn un-identified cells of the genus *Pseudo-nitzschia* (10^2-10^3 cells/L) were observed.

In the sampling station located at the pilot scale farm, un-identified cells of the genus *Pseudo-nitzschia* were registered in high abundance in April (5.6×10^5 cells/L), together with *P. pungens* (2×10^4 cells/L), *P americana/brasiliana* (3×10^3 cells/L) and *P. multistriata* (1.8×10^2 cells/L). Domoic acid exceeded quantification level in April, but its concentration was below regulatory levels.

Cantabria

Information compiled from the online reports published by the Government of Cantabria. Web: http://www.cantabria.es/web/comunicados/detalle/-/journal_content/56_INSTANCE_DETALLE/16413/4720798

In Cantabria, there were DSP and ASP closures in San Vicente de la Barquera in April-May 2017. The causative species was not determined.

Asturias

Report provided by Consejería de Desarrollo Rural y Recursos Naturales del Gobierno del Principado de Asturias. Contact: Lucía García (LUCIA.GARCIAFLOREZ@asturias.org). Web: http://tematico.asturias.es/dgpesca/.

In Asturias, there were no HAB events in 2017.

Galicia

Report provided by Intecmar (Xunta de Galicia). Contacts: Yolanda Pazos (ypazos@intecmar.gal) and Silvia Calvo (scalvo@intecmar.gal). Web: http://www.intecmar.gal/default.aspx.

Paralytic Shellfish Poisoning (PSP): A bloom of *Alexandrium minutum* was detected in May-June 2017 in northern "Ría de Ares", where reached a maximum abundance of 10388 cells/L in station L3 on March 8th. In Camariñas the bloom of *Alexandrium minutum* lasted from the end of June to middle July and reached a maximum abundance of 17066 cells/L on June 26th in station GD. In these areas during the periods stated below, harvesting of infaunal mollusks was prohibited. The bloom of *Alexandrium minutum* did not affect mussel rafts. There were several closures related to blooms of *Gymnodinium catenatum*. At the beginning of the year, in January in "Ría de Pontevedra" (Bueu) and in "Ría de Vigo" (Cangas F) the closure was probably related the event that occurred at the end of 2016. An early event started in mid-February and affected mussel rafts in "Ría de

Pontevedra", outer and middle parts of "Ría de Vigo", "Ría de Baiona" and south of "Ría d'Arousa". This event lasted until mid-March, the maximum abundance detected was 360 cells/L in station V6 on February 6th. A third event affected mussel rafts in "Ría de Pontevedra" from August to September and an infaunal mollusks site in "Ría de Vigo" in September, the maximum abundance detected was 3840 cells/L in station P2 in August 28th.

Diarrhetic Shellfish Poisoning (DSP): There were DSP closures in shellfish rafts from March to mid-June due to the bloom of *Dinophysis acuminata* in "Ría de Muros-Noia" "Ría de Pontevedra", Baiona, "Ría de Ares-Betanzos", some areas of "Ría d'Arousa" and external areas of "Ría de Vigo". The first closures occurred in March in "Ría de Pontevedra" and in some areas of "Ría de Vigo", extending to the rest of the mentioned areas until the end of June. The maximum abundance detected was 360 cells/L in station V6 on February 6th. A second event started at the end of August and was detected in many stations of "Ría de Pontevedra" and "Ría de Muros-Noia" extending to the rest of the stations in both rías and as well as to "Ría of Ares-Betanzos", "Ría de Vigo", "Ría de Baiona" and many stations of "Ría de Arousa". This event due to the presence of *Dinophysis acuminata* and *Dinophysis acuta* and probably to *Dinophysis caudata* was observed at the end of November, it lasted until the end of the year in "Ría de Muros-Noia" The maximum abundance of *Dinophysis acuminata* was 4200 cells/L in station P3 of "Ría de Pontevedra" on October 10th. The maximum detected abundances of *Dinophysis acuta* and *Dinophysis caudata* were 1480 cells/L (August 28th) and 1360 cells/L (August 16th) respectively, both is station P2 from "Ría de Pontevedra". There were DSP closures from April until June affecting infaunal mollusks in the northern Rías, Costa da Morte, "Ría de Muros-Noia", and part of "Ría de Pontevedra". All of these areas except the northern Rías, were also affected at irregular intervals from August to the first weeks of November.

Amnesic Shellfish Poisoning (ASP): There were no closures due to the presence of ASP during the year 2017, neither in mussel rafts, nor in infaunal mollusks beds.

Canary Islands

Information compiled from the online reports published online by the Fisheries Directorate (Government of the Canary Islands). Web:
http://www.gobiernodecanarias.org/agricultura/pesca/temas/primera_venta/ciguatera.

During 2017 the monitoring program established by the regional government in the Canary Islands detected that 7.5 % of the finfish analyzed contained ciguatoxins. In the Islands it is not allowed to place 7 different species of fish above a certain weight on the market unless they have been tested for ciguatoxins. These species and the respective weights are listed and available on internet: *Seriola* spp (14 Kg), *Acanthoocybium solandri* (35 Kg), *Pomatomus saltatrix* (9 Kg), *Mycteroperca fusca* (12 Kg), *Epinephelus* spp (17 Kg), *Makaira nigricans* (320 Kg), *Xiphias glaudius* (320 Kg). In the Canary Islands there is no established monitoring program for toxic phytoplankton.

Andalusia

Report provided by "Laboratorio de Control de Calidad de los Recursos Pesqueros (L.C.C.RR.PP.) Agencia de Gestión Agraria y Pesquera de Andalucía. Junta de Andalucía". Contact: Luz Mamán (luz.m.menendez@juntadeandalucia.es), David Jaén (david.jaen@juntadeandalucia.es), Raúl Fernández (raul.fernandez.lozano@juntadeandalucia.es) .

Web: http://www.juntadeandalucia.es/agriculturaypesca/moluweb.

Paralytic Shellfish Poisoning (PSP): Average-high intensity and long duration of PSP events. There were PSP closures along the Mediterranean coast in January as a continuation of the PSP event occurred at the end of 2016, it affected mostly mussel aquaculture. A second event was detected in September along the Mediterranean coast. This event affected mainly mussel aquaculture but also harvesting from natural beds of clams (*Chamelea gallina*, *Callista chione* and *Venus verrucosa*). The level of toxins in mussels were higher than 4500 µg/kg and lasted from September to December, and from October to November for the natural beds of clams. The highest abundance of *Gymnodinium catenatum* ($2x10^4$ cells/L) was detected in November near the Bay of Algeciras (Cádiz). Such high abundances of *Gymnodinium catenatum* have not been detected since 2012.

Diarrhetic Shellfish Poisoning (DSP): Low intensity and low frequency of occurrence of DSP events. In the Atlantic coast, there were some DSP closures due to the presence of *Dinophysis acuminata* which reached a maximum abundance of 4.6×10^3 cells/L. There were some closures, also due to *Dinophysis acuminata* in the Mediterranean coast where this species reached much lower abundances, $5x10^2$ cells/L.

Amnesic Shellfish Poisoning (ASP): Low intensity and low frequency of occurrence of ASP events. High abundances of *Pseudo-nitzschia australis* were detected in March along the Mediterranean and the Atlantic coasts of Andalusia, the maximum was $8.8x10^4$ cells/L on the 27th March in San Roque (Cádiz). This event started at the Atlantic coast and moved towards the Mediterranean covering the whole coast of Andalusia as it has already happen in past years. Domoic acid was above regulatory levels in a sample of *Donax trunculus* from Torremolinos (Málaga), during March 2017 there was presence of domoic acid below regulatory levels in several samples from the Atlantic and the Mediterranean coasts.

Valencia

Report provided by the Government of Valencia-Generalitat Valenciana. Contacts: Contacts: Miguel Lull (lull_mig@gva.es) and Carolina Assadi (carolina.assadi@oceansnell.com). Web: http://www.agroambient.gva.es/ca/web/pesca.

During the year 2017, the levels of toxins were below regulatory level in all shellfish samples analyzed.

Paralytic Shellfish Poisoning (PSP): *Alexandrium catenella* and other species of the genus *Alexandrium* were detected occasionally; the maximum abundance detected was 1.5 x 10^4 cells/L cells/L in Peñíscola during the month of June.

Diarrhetic Shellfish Poisoning (DSP): The potential DSP associated species, *Dinophysis acuminata*, *Dinophysis caudata* and *Phalacroma rotundatum* were detected inside the harbors of Sagunto, and Valencia (Xità and Puerto Nuevo), the maximum abundance detected was 100 cells/L.

Yessotoxins: *Lingulodinium polyedrum*, *Gonyaulax spinifera* and *Protoceratium reticulatum* were detected inside the harbors of Sagunto and Valencia (Xità and Puerto Nuevo). The maximum abundance detected was 1.9 x 10^3 cells/L.

Amnesic Shellfish Poisoning (ASP): During the year 2017, species of the genus *Pseudo-nitzschia* were detected in most of the samples. Their abundance reached 5.5 x 10^5 cells/L in late June in Puerto de Sagunto and Xità (Puerto de Valencia) and in August in the new area of Puerto de Valencia.

Benthic HABs: *Ostreopsis* was present in a few samples collected during the year 2017, the maximum abundance (5x10^3 cells/L) was detected in July in the harbor of Valencia (Xità).

Catalonia

Research on *Ostreopsis*

Report provided by ICM-CSIC. Contacts: Magda Vila (magda@icm.csic.es); (berdalet@icm.csic.es). Web: http://icmdivulga.icm.csic.es/ostreorisk.

In 2017, the *Ostreopsis* bloom dynamics in Llavaneres followed the same pattern as the previous years, reaching huge abundances (above 10^5 cells/g FW macroalgae) during summer months. Low abundances were detected at ending May and they surpassed the threshold of 10^5 cells/g FW macroalgae the last week of June. Abundances above this threshold were maintained until mid-August, with a secondary bloom in October. In the context of the OstreoRisk project, several people living or working in front the sampling station answered a poll on their irritative respiratory tract symptoms related to *Ostreopsis* blooms and also they indicated the days of affectation. In spite the bloom lasted for more than 2 months, the (only) nine people who answered the questionnaires, all of them noticed the typical symptoms but only during one single week (from 3 to 9 July), which correspond to the end of the *Ostreopsis* exponential phase.

The results presented come from the National R+D+I project RETOS Program, OstreoRisk: "Noxious Proliferation of *Ostreopsis* in the NW Mediterranean: assessment of potential health risks" (CTM2014–53818-R).

Monitoring Program of Shellfish Growing Areas in Catalonia

Report provided by IRTA. Contacts: Margarita Fernández (margarita.fernandez@irta.cat), (Jorge Diogène) jorge.diogene@irta.cat.Web: http://www.marinemonitoring.org/, http://www.irta.cat/en/.

Paralytic Shellfish Poisoning (PSP): A preventive closure in Vilanova, at the end of May, was enforced after detection of *Alexandrium minutum* at abundances over warning levels, $7.9x10^5$ cells/L inside the harbor and $2x10^3$ cells/L at the shellfish growing area. The closure lasted for one week. In Alfacs Bay, *Alexandrium minutum* reached a maximum of $8x10^3$ cells/L the 13th of March, $1x10^6$ cells/L was the maximum attained inside the harbor of Arenys de Mar in March, the bloom burst the area of the harbor reaching a maximum abundance of $2.7x10^4$ cells/L in the waters of the adjacent shellfish growing area which was in closed season.

Diarrhetic Shellfish Poisoning (DSP): In Alfacs Bay *Dinophysis sacculus* reached a maximum of $4.8x10^2$ cells/L at the end of February while in Fangar Bay the maximum ($1.6x10^6$ cells/L) was detected in August. Along the open shore, cell abundances were very low (≤ 80 cells/L) in open waters and reached 10^3 cells/L inside some harbors. There weren't any DSP closures during the year 2017.

Amnesic Shellfish Poisoning (ASP): In Alfacs Bay *Pseudo-nitzschia* spp. reached high abundances $>1x10^6$ cells/L in March, August and September, reaching the maximum ($2x10^6$ cells/L) at the end of November. In Fangar Bay the maximum abundance was $4.9x10^5$ cells/L. Along the open shore, the maximum abundance detected for *Pseudo-nitzschia* spp. was $6.6x10^5$ cells/L in front of Arenys de Mar in June, while at the time when inside the harbor of this village the abundance of *Pseudo-nitzschia* reached $13x10^6$ cells/L. Despite the occurrence of the *Pseudo-nitzschia* blooms there were no closures since the concentration of domoic acid in shellfish was always below regulatory levels.

Balearic Islands

Report provided by LIMIA. Direcció General de Pesca i Medi Marí. Illes Balears. Contact: José María Valencia (jmvalencia@dgpesca.caib.es).Web: http://www.caib.es/sites/estatszonesdeproducciomolluscs

There was one closure due to Okadaic acid over regulatory levels in Puerto de Maó in September 2017. The causative species was not determined.

National Report: France

The Rephy monitoring program is actually structured in two distinct programs :
- REPHY: French observation and surveillance network for Phytoplankton and Hydrology in coastal waters (3 componants: Research, WFD/MSFD Monitoring and sanitary). 222 Sampling stations
- REPHYTOX: French monitoring network for Biotoxins in marine shellfish. 277 sampling stations

Three types of toxin events were observed in France during the year 2017: DSP, PSP and ASP.

DSP

As in previous years, *Dinophysis* cells (several species) were observed along a large part of the French coast. As usual, the highest concentrations were in Normandy, with 55 600 cells/L in Seine estuary. Toxic events, with toxin concentrations above the sanitary threshold (160 µg/kg for the group of OA+DTXs+PTXs), were observed mainly along the Atlantic coast, affecting especially mussels, scallops and *Donax*. A few other sites were affected, in Channel (mussels and scallops), and in Mediterranean (mussels, oysters and *Donax*). The highest toxin concentrations were observed in mussels (*Mytilus edulis*) of the bay of Seine (Normandy) with 3634 µg/kg, and in the *Donax* (*Donax trunculus*) of Douarnenez bay (2892 µg/kg). Azaspiracids and Yessotoxins, results were all below the European sanitary threshold.

PSP

Alexandrium was observed with concentrations above 100 000 cell/L in Palavasian lagoon (Mediterranean) with 706 000 cell/L (*A. tamarense and catenella*). Toxic episodes which followed these blooms, with toxin results above the sanitary threshold (800 µg/kg), affected mussels (*Mytilus galloprovincialis*) in Thau Lagoon with 3170 µg/kg.

ASP

Several species of *Pseudo-nitzschia* were observed on the whole French coast at high concentrations during spring, as every year. The highest concentrations were observed bay of Somme (North of France) with a maximum of 12 000 00 cells/L and in Mediterranean shore with 11 000 000 cell/L. Toxic episodes, with toxin results above the sanitary threshold (20 mg/kg), were observed in Western Brittany only, affecting mainly scallops. The highest toxin concentration was observed in scallops (*Pecten maximus*) in Brest bay with 400 mg/kg.

Ostreopsis was observed in very low concentrations, below 1000 cells/L, and no palytoxins analysis was performed on shellfish. The palytoxins searched in sea urchins showed an absence of these toxins

National Report: The Netherlands

In 2017 the shellfish production areas; North Sea, Lake Grevelingen, Wadden Sea, Oosterschelde and Veerse Meer were monitored for the presence of toxic phytoplankton and phycotoxins. This program is performed as part of the National Shellfish Food Safety Program, with a monthly sampling frequency from November until April and weekly from May until October. The results are used as an early warning mechanism for potential presence of toxins in shellfish (mussel, oyster, ensis and cockle). In total 337 phytoplankton samples have been collected at a total of 13 sampling locations.

Alexandrium ostenfeldii was reported in the marine system in lake Grevelingen and Lake Veere. These reports were based on samples from the end of July and the beginning of August 2017, the cell counts were low with a maximum of 180 cells per litre. In the Eastern part of the Eastern Scheldt maximum levels below 80 were reported.

Dinophysis acuminata mainly in the production areas Lake Veere and Lake Grevelingen. Abundance was highest, in Lake Veere in the end of July and August. *D. acuminata* levels reached up to 9.500 cells per litre in week 39. Toxins (OA eq) were found at concentrations up to 44 μg OA-eq per kg of shellfish product in week 30. Followed by a rapid decrease in the following two weeks.

In Lake Grevelingen *D. acuminata* has been found present throughout the period of June until September 2017. The pattern which was seen, is fluctuating in cell concentrations, with regular drops in cell abundance. In weeks 31 through 36 only low back ground levels were reported. Therefore two peaks of *D. acuminata* occured in this area. Maximum levels in the first peak peaked to 1.700 cells per litre. The second peak the maximum cell abundance was 600 cells per litre. No toxins were reported in this area.

The threshold value for *Pseudo-nitzschia* sp. was reached in May with maximum values of 1.5 million cells / litre, which was above the Dutch trigger limit of 500.000 cells / litre. The reports of these high values were in the production areas in the North Sea. *Pseudo-nitzschia sp*. was also reported in the Wadden Sea at levels up to 910.000 cells /per litre in week 20 (May). Toxicity due to Domoic Acid has not been reported.

In 2017 no toxins were found above the regulatory limit, nor were they reported in background concentrations. Monitoring was performed for lipophilic toxins (OA, DTX, AZA), Domoic Acid (DA) and derivates, STX and derivates.

Spirolides were reported in back ground levels in most of the analysed samples. RIKILT, Wageningen UR has been responsible for the toxin analysis. Wageningen Marine Research, Wageningen UR is responsible for phytoplankton analyses.

In 2017 monitoring on Tetrodotoxins (TTX) was also implemented in the official monitoring program, and additional research programs. The threshold level for TTX was set by the Dutch authorities at 44 ug per kg of shellfish product. TTX has been reported in the period of Mid-June until the beginning of July (3 weeks). These levels reached just below the threshold level. TTX peaked for one week and two weeks in diferent areas in the Eastern Scheldt (Eastern part and Northern branch) in mussels followed by a decrease below detection levels. There were no closures of shellfish production areas.

National Report: Germany

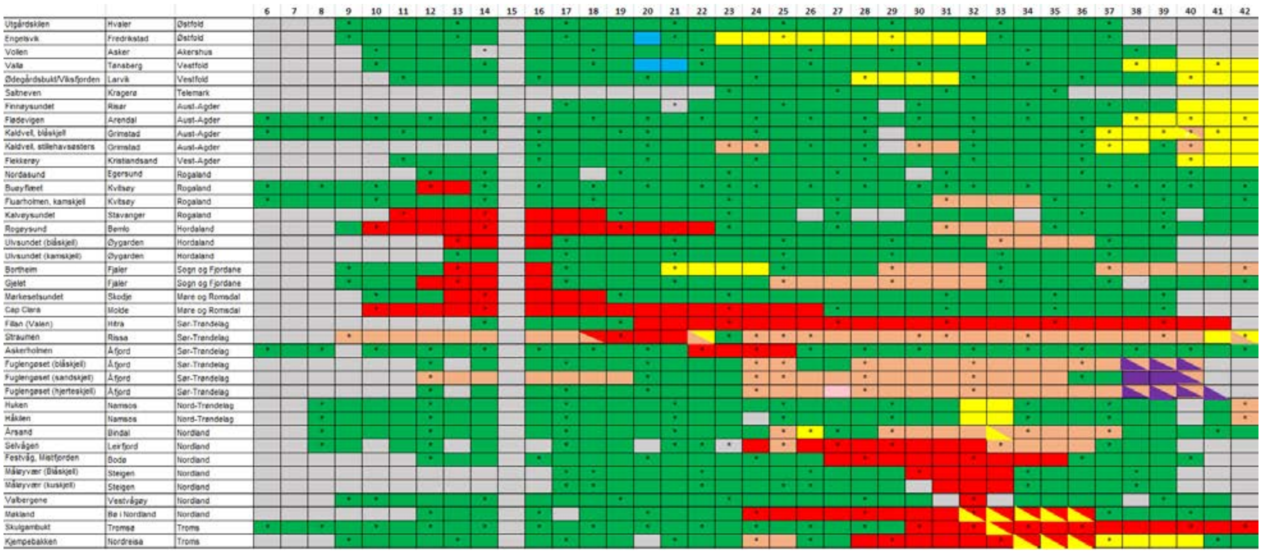
During the period 2017 through early 2018 no harmful algal bloom events or shellfish toxicities above regulatory limits were reported from the North Sea or Wadden Sea coast of Germany, including waters adjacent to Helgoland, and the states of Bremen, Lower Saxony and Schleswig-Holstein. Nevertheless, along the Wadden Sea coast near Sylt a dense and long-lasting bloom of *Noctiluca* was present for several weeks during summer 2017. Other potentially toxigenic dinoflagellates, specifically *Dinophysis acuminata*, *D. acuta* and *D. norvegica* were noted but only in low cell numbers, whereas *Alexandrium* cf. *tamarense*, *A. ostenfeldii*, and *A. minutum* occurred at higher (but not bloom) cell concentrations and for a longer period than usual in the eastern Wadden Sea. Phytoflagellates associated with fish kills, *Chrysochromulina* spp. and *Pseudochattonella* sp., were found only sporadically and in low cell abundance.

Within the region from Kiel Bight to the northern Baltic Sea, the 2017 annual summer cyanobacterial monitoring cruise detected substantial but not unusual cyanobacterial biomass in German coastal waters. In fact, the only major bloom anomaly in 2017 in the German Baltic region was the massive bloom (maximum 1221 mg/m^3) of *Pseudo-nitzschia pseudodelicatissima* recorded at the fixed coastal observatory station at Heiligendamm in late November. No toxin analysis was performed and therefore actual or potential toxicity consequences could not be evaluated.

National report: Norway

Lars Johann Naustvoll, IMR, Flodevigen

The national monitoring program for HA in Norway had a total of 38 stations in 2017. The program covers the Norwegian coast from south at the Swedish boarder to Tromsø in the northern Norway. The program ran from February to October 2017, except for 4 routine station that are monitored from January to December. Detailed information regarding HA and toxins is found at http://www.matportalen.no/verktoy/blaskjellvarsel and non-toxic species at http://algeinfo.imr.no. The figure below summaries the HAB events (HA and toxin accumulated) in 2017.



Norwegian HAB monitoring program 2017. Green; open (toxins and HA under threshold levels), Yellow; DSP or Dinophysis above threshold, Red; PSP or Alexandrium above threshold, Blue; ASP above and lilac; AZA above. Pink indicates periods with high concentrations of E. coli. Skagerrak stations at the top of the figure and northern part of Norway in the bottom.

Along the Skagerrak coast there were only some minor problems with DSP/Dinophysis during 2017 in June-August at one location in the inner part of Skagerrak, and agin late autumn (September/October and later). In the Bay of Flødevigen the DSP level were above threshold levels since September 2017. In the spring 2017 (March-April) the potential harmful species *Pseudochattonella* sp. were observed along the coast from the Oslofjord to Agder county. However, even in areas with cell concentrations above earlier observed fish mortality this year's bloom did not result in any mortality in fish farms or wild populations. From Rogaland (south coast) and up to Trøndelag (middle of Norway) the main problem was PSP/*Alexandrium* in 2017. The presence of PSP/*Alexandrium* result in closures several stations in Apri-Mail in the southern areas. At two stations on the Norwegian north-west coast and Trøndelag county there was a long closure due to PSP/Alexandrium, in Trøndalag from Mai to October in 2017. The dominating PSP producing species were *Alexandrium tamarense* during this period. For this part of the coastline there were only minor problems with DSP/*Dinophysis* at one monitoring site in 2017.

At most of the stations in Trøndelag (mid Norway) there were minor problems with HA species and toxic accumulation. One locations had longer period (May to October) with closures due to PSP/*Alexandrium*. Two other stations in this area had shorter period with closures due to PSP/*Alexandrium*. In the northern part of Norway there were closures due to PSP/*Alexandrium* and/or DSP/*Dinophysis* from May at some locations (Nordland county) and from June/July in Troms county. AZA/*Azadinium* resulted in 3-4 weeks of closures at three locations in the mid part of Norway (Trøndelag county) in November. ASP/*Pseudo-nitzschia* resulted in closures at two locations in the Skagerrak in Mai 2017.

National Report: Sweden

Bengt Karlson

Harmful Algal Blooms (HAB's) are recurrent phenomena in the waters surrounding Sweden. Most are likely to be of natural origin but some are related to eutrophication. Some HAB-species may have been introduced to the area. The HAB-problems for the waters surrounding Sweden are very different for the Baltic Sea and the Skagerrak-Kattegat areas. In the brackish water of the Baltic Sea blooms of cyanobacteria, e.g. the toxic species *Nodularia spumigena,* is the major problem while in the waters with higher salinities in the Skagerrak and the Kattegat fish killing species and species that produce toxins that accumulate in filter feeders (e.g. mussels) are the major concerns. However, both fish killing species and species causing shellfish poisoning occur in the Baltic Sea as well. Commercial farming and harvesting of wild mussels and oysters for human consumption is ongoing only along the Swedish coast of the Skagerrak at present.

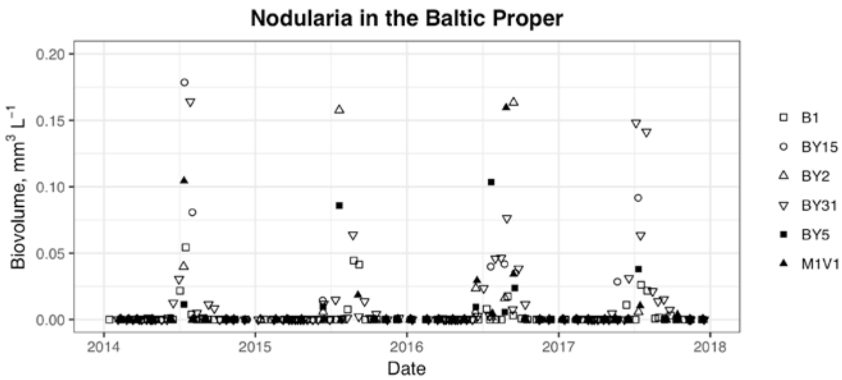
The Baltic proper

Satellite observations

An unusually warm second half of May 2017 set off a cyanobacteria bloom in the southernmost part of the Eastern Gotland Basin on the 18^{th} May. As persistent winds continuously mixed the water in June, surface blooms were more or less absent in large parts of the Baltic Proper until the beginning of July. As ample amounts of cyanobacteria were present in the water, surface blooms increased rapidly as the winds ceased in July. The peak was noted on July 22, when about 109 000 km^2 of cyanobacteria blooms were recorded from satellite data. A transit into windier August conditions meant a decline of the cyanobacteria bloom, which from mid-August was almost over in the Baltic Proper.

Water sampling and microscopy

The toxic species *Nodularia spumigena* was observed mainly in July. The non-toxic species *Aphanizomenon flos-aquae* was observed in high abundances in April and May, and dominated the bloom in July. It is likely to have been the most important component of the surface accumulations forming nuisance blooms. Also *Dolichospermum* spp. (synonym *Anabaena* spp.) is a major component of the cyanobacteria biomass.

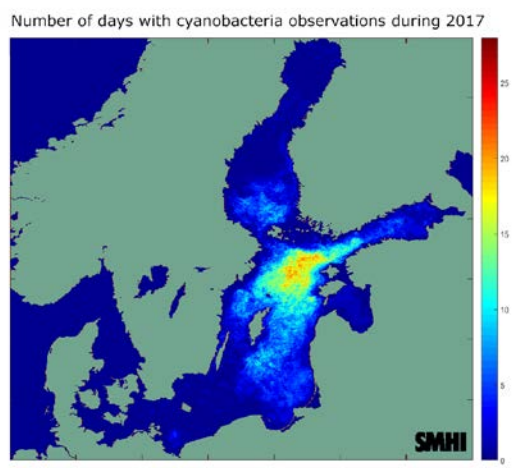


The biomass of Nodularia spumigena at six stations in the Baltic Proper 2014-2017. Data is from the national Swedish Marine Monitoring Program. Sampling was done suing Lindahl tube 0- 10 m depth except for staions B1 and BY31 where 0-20 m depth was sampled.

Pseudochattonella sp. was observed in deep chlorophyll fluorescence maxima at station B1 near Bornholm in late April. No harmful effects were observed. *Pseudochattonella* have caused fish mortalities elsewhere, e.g. in the southern part of the Kattegat.

Cyanobacteria accumulations in archipelagos and along the coasts

Accumulations of cyanobacteria were observed in several places, e.g. in the Archipelago of Stockholm.



The number of days of observations of cyanobacteria surface accumulations. Data from the SMHI Baltic Algae Watch System. Öberg, J., 2018.

http://www.helcom.fi/baltic-sea-trends/environment-fact-sheets/eutrophication/cyanobacterial-blooms-in-the-baltic-sea

The Bothnian bay and the Bothnian Sea

Satellite observations

Surface blooms of cyanobacteria were present in the southern Bothnian Sea mainly from the last week of July, and peaked in mid-August. Although the open sea blooms were over by the start of September, local coastal blooms were reported until the end of the month.

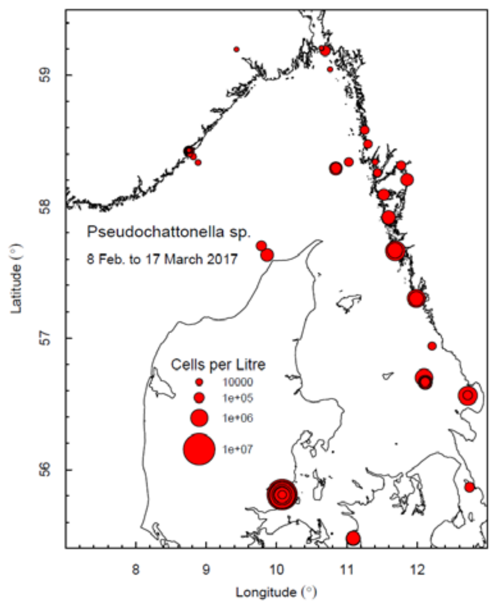
Cyanobacteria accumulations in archipelagos and along the coasts

Accumulations of cyanobacteria were observed in several places, e.g. in the counties of Kalix, Piteå, Hudiksvall and Örnsköldsvik.

The Skagerrak and the Kattegat

Fish killing algae

A bloom of *Pseudochattonella* sp. was observed in spring 2017. The first observations along the coast of Sweden were in February. The bloom extended from the Danish part of the Kattegat along the Swedish coast to the southern coast of Norway.



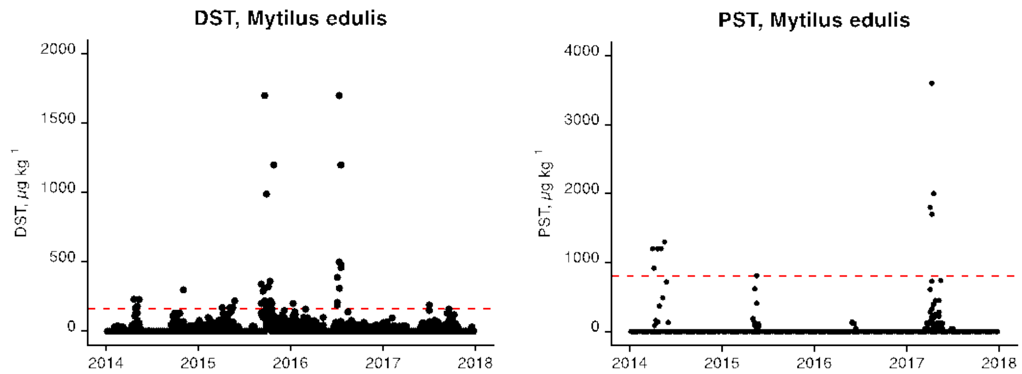
Cell abundances of Pseudochattonella sp. 8 Feb. to 17 March 2017. Several different organisations have contributed data.

Algae causing shellfish toxicity

The Swedish National Food Agency governs the monitoring of biotoxins producing algae and of algal toxins in bivalves. SMHI carries out analysis of plankton samples. Blue mussels (*Mytilus edulis*), flat oysters (*Ostrea edulis*), pacific oysters (*Crassostrea gigas*) and cockles (*Cerastoderma edule*) are harvested.

DST and *Dinophysis*

Concentrations of Diarrhetic Shellfish Toxins (DST) above the regulatory limit were detected only in a few samples in year 2017.



Top: concentrations of Dinophysis Shellfish Toxins and Bottom: Paralytic Shellfish Toxins in Mytilus edulis from the Swedish Skagerrak coast 2014-2017. The red lines denotes the regulatory limits. Data from the Swedish National Food Agency monitoring program.

PST and *Alexandrium*

Concentrations of Paralytic Shellfish Toxins (PST) were above the regulatory limit in spring 2017. Harvesting areas were closed during these events. The high concentrations of PST in 2017 coincided with high abundances of *Alexandrium* spp.

YTX, *Lingulodinium* and *Protoceratium*

Yessotoxins (YTX) above the regulatory limit were not detected in any of the harvested shellfish in 2017. The dinoflagellates *Lingulodinium polyedrum* and *Protoceratium reticulatum* are common in the area and are likely to be the producers of yessotoxins.

AZT and *Azadinium*

Concentrations of Azaspiracidic Shellfish Toxins (AZT) above the regulatory limit were not detected in 2017.

AST and *Pseudo-nitzschia* spp.

Concentrations of Amnesic Shellfish Toxins (AST) above the regulatory level were not detected in year 2017. High cell numbers (100 000 to 250 000 cells L^{-1}) of *Pseudo-nitzschia* spp. were observed in October to December 2017.

National Report: Poland

Justyna Kobos and Hanne Mazur-Marzec

In coastal waters of the Gulf of Gdańsk (Southern Baltic), toxic cyanobacteria occurred less frequently and at lower biomass than in previous years. This year, also the occurrence of *Alexandrium* was not recorded. On 20 July cyanobacteria warning were issued for eight beaches in the area of the Gulf of Gdańsk (PL-1). On 22-24 July, three bathing sites were closed due to the decreased water transparency. At the turn of July and August, the surface accumulation of cyanobacteria was observed in PL-2 area. The highest biomass of *Nodularia spumigena* (1.38 mg/L) and the highest concentration of nodularin (1.97 µg/mL) were recorded on 1 August. *Aphanizomenon flosaquae* (0.98 mg/L) and *Dolichospermum spp.* (0.2 mg/L) were also present.

National Report: Ireland

Joe Silke

The Irish monitoring programme for biotoxins in shellfish is carried out by the Marine Institute (MI) as part of national official controls on seafood. It is carried out in cooperation with the Sea Fisheries Protection Authority (SFPA) and the Food Safety Authority of Ireland (FSAI). This programme includes biotoxin analysis and phytoplankton analysis carried out at the MI by the Shellfish Safety team at the Marine Environment and Food Safety Services (MEFSS) labs.

Our data show that over 10 years the main problem that we have is from Lipophyllic toxins and these are mainly associated with DSP and AZA in Mussels, followed by Pacific Oysters and then Flat Oysters. The source of these toxins are *Dinophysis* sp (mainly acuta and acuminate) for DSP and *Azadinium spinosum* for AZA toxins.

Compared to years such as 2014 where we had severe and protracted toxicity for the most of the year, 2017 was a very mild year. Following a short 2 week ASP event in the south west, and west coast during May, an elevated level of *Dinophysis* resulted in toxin closures in the South west during June and July. This trailed off during August. AZA was detected in one area in the west for 4 weeks, which was in stark contrast to earlier years where it resulted in widespread and lengthy closures. One closure for a single week due to PSP was detected in Cork Harbour, which is a common annual occurrence.

Although not associated with HABs, we also carried out a survey of TTX in Irish shellfish on historical samples but all of these were negative. Other items of note included a newly launched web site at www.marine.ie/habs which gives details of our monitoring programmes for Phytoplankton and Shellfish Toxins on an ongoing basis

National Report: UK

Northern Ireland (April McKinney)

During 2017 a total of 611 water samples were received and results reported. As well as the four main target phytoplankton groups (*Alexandrium* spp., Dinophysiaceae (includes the genera *Dinophysis and Phalacroma), Prorocentrum lima* and *Pseudo-nitzschia* spp. the samples collected during 2017 also contained other target species *Karenia mikimotoi*, *Prorocentrum cordatum*, *Protoceratium reticulatum, Noctiluca scintillans* and *Phaeocystis* spp.

Cells of the genus *Alexandrium*, a potential producer of PST's (Paralytic Shellfish Toxins), were recorded in 5 of the 7 areas monitored and were present in 4% of samples analysed. The trigger level for *Alexandrium* spp. (≥ 40 cells L^{-1}) was breached on 10 occasions during the year with a maximum cell abundance of 640 cells L^{-1} recorded in a sample from Dundrum Bay taken on 2nd August. No official control shellfish flesh samples tested during the year contained levels above the regulatory value of 800µg STX/ Kg.

The trigger value for the species responsible for production of lipophilic toxins (some members of the Dinophysiaceae family as well as *Prorocentrum lima*) is set at ≥ 100 cells L^{-1}. Target species belonging to the Family Dinophysiaceae were recorded in 5 monitored areas, the exceptions being Foyle and Killough. Dinophysis spp. were present in 12% of samples with the trigger level of ≥ 100 cells L^{-1} being breached on 17 occasions. A maximum cell abundance of 3320 cells L^{-1} was recorded in a sample from Belfast Lough site on 4th September. *Prorocentrum lima* was rarely recorded. It was present in only 2.3% of samples, reaching a maximum abundance of 180 cells L^{-1} on 19th June in a sample from Strangford Lough. Results from the Biotoxin Monitoring Programme showed that no shellfish flesh tested as part of the Official Control Programme had lipophilic toxins above the regulatory limit set by the European Union.

The cosmopolitan genus *Pseudo-nitzschia* contains species which are capable of producing domoic acid. They were present in all 7 monitored areas and in 286 samples. Their occurrence ranged from 15% of Lough Foyle samples to 75% of Strangford Lough samples. A maximum abundance of 81,000 cells L^{-1} was recorded in a sample from a site in Dundrum Bay on 21st June.

Scotland (Sarah Swan)

A total of 1,301 Lugol's-fixed seawater samples were analysed as part of the Food Standards Scotland Biotoxin Monitoring Programme during 2016. Samples were obtained from designated shellfish harvesting areas in Scottish inshore coastal waters and examined, by light microscopy, for potentially toxic genera or species of phytoplankton. Samples were collected from monitoring sites on a weekly basis between March and mid October, with reduced sampling frequency and geographic coverage over the winter months. A maximum of 40 sites were monitored at any one time, the sampling sites occasionally changing to reflect harvesting activity.

***Pseudo-nitzschia* spp.**

Algal cells belonging to the genus *Pseudo-nitzschia* were observed in 91.70% of all samples analysed and were present throughout the year. *Pseudo-nitzschia* spp. counts in excess of

50,000 cells per litre (threshold level) were recorded in 6.15% of the samples, lower than that in 2015 (8.88%) or 2014 (9.13%), but more similar to that recorded in 2013 (6.54%). Cell densities at greater than threshold levels were observed in 10.00% of the samples analysed during March. The earliest bloom was recorded in Dornoch Firth (Highland: Sutherland) on 7th March, with an abundance of 245,770 cells/L. A late bloom occurred around the Isle of Mull (Argyll & Bute) in October and was detected in both Kilfinichan Bay and Loch Na Keal. The densest *Pseudo-nitzschia* spp. bloom was observed in Loch Roag: Linngeam (Lewis & Harris) on 21st June, where a maximum abundance of 1,127,883 cells/L was recorded. Some associated ASP toxicity was reported in common mussels from this site during the bloom period. Most of the blooms associated with ASP toxicity in 2016 occurred in May and June.

***Alexandrium* spp.**

Cells belonging to the genus *Alexandrium* were present in 32.36% of the total samples analysed. They were reported at or above the trigger level (set at 40 cells/L) in 21.52% of all samples, mostly between May and July, and were recorded at or exceeding trigger level in 44.38% of the samples analysed during July. The densest recorded *Alexandrium* spp. bloom was observed in Loch Creran (Argyll & Bute) on 18th July with an abundance of 5,860 cells/L, although no PSP toxicity was detected in Pacific oysters from this site. Toxic *Alexandrium* spp. blooms were detected in other areas around Argyll & Bute during spring, most notably Campbeltown Loch (440 cells/L on 11th April), Loch Striven (840 cells/L on 5th April), Loch Fyne: Otter Ferry (240 cells/L on 4th April), and Kilfinichen Bay (320 cells/L on 26th April). Some PSP toxicity was also associated with *Alexandrium* recorded in the Highland region in May, around Loch Sligachan (Skye & Lochalsh) and Loch Laxford (Sutherland). Overall, the percentage of *Alexandrium* spp. blooms at or exceeding trigger level during 2016 (21.52%) was very similar to that in 2015 (21.67%).

Dinophysiaceae

Algal cells belonging to the family Dinophysiaceae, which includes the genus *Dinophysis* and *Phalacroma rotundatum*, were present in 44.27% of the samples analysed during 2016 and were detected from March to October. Cells were observed at or above threshold level (set at 100 cells/L) in 19.75% of the samples, similar to the values recorded in both 2014 (19.29%) and 2015 (19.30%). The earliest bloom exceeding threshold level was recorded in Loch Striven (Argyll & Bute) in early April. The majority of *Dinophysis* spp. blooms occurred around the Scottish coast in June and July, with 55.63% of the samples exceeding threshold counts in July. Two exceptionally dense blooms were observed during 2016. An abundance of 24,340 cells/L was recorded in Loch Ewe (Highland: Ross & Cromarty) on 6th June and 90,274 cells/L in Loch Fyne: Ardkinglas (Argyll & Bute) on 22nd June. *Dinophysis* spp. blooms were widespread around Argyll & Bute, and the Highland region from late May to early September, with associated DSP toxicity reported in shellfish. Toxic blooms also occurred in Loch Stockinish and Loch Erisort (Lewis & Harris) in June. Blooms of *Dinophysis* spp. were recorded around the Shetland Islands from June to mid August, with widespread toxicity throughout July and August.

Prorocentrum lima

Prorocentrum lima was present in 17.52% of the samples analysed during 2016 from March to December, and was generally most abundant in July. It was detected at or above the threshold level (set at 100 cells/L) in 2.31% of samples. *Prorocentrum lima* was observed in samples from all regions and the densest blooms recorded in 2016 were 900 cells/L at Kyle of Tongue (Highland: Sutherland) and 780 cells/L at Loch Fyne: Otter Ferry (Argyll & Bute), both on 1st June.

Other species

Protoceratium reticulatum was detected in 2.84% of all samples between March and September, and was most frequently observed in May and June. The densest bloom occurred in Argyll & Bute, with 1,360 cells/L recorded at Loch Fyne: Ardkinglas on 22nd June, although no YTX toxicity was detected in Pacific oysters from this site. However, low levels of YTX toxins were detected in common mussels from Campbeltown Loch, Loch Striven and Loch Melfort (Argyll & Bute) when *Protoceratium reticulatum* was present.

Lingulodinium polyedrum is rarely abundant in Scottish coastal waters and was detected on only three occasions (0.23 % of samples), all in Argyll & Bute during 2016. One observation was recorded in Loch Creran in September, where it appears to bloom annually. It was also reported in Kilfinichen Bay in May. The maximum bloom density of 200 cells/L was observed in Loch Na Keal on 7th June.

Prorocentrum cordatum was present in 50.96% of samples analysed in 2016. It was observed from January through to November and was most abundant in May and June, being recorded in 81.72% and 77.19% of the samples analysed, respectively. The densest blooms of 2016 occurred around the Shetland Islands in June, with concentrations of 41,602 cells/L recorded in Weisdale Voe on 27th June, 35,892 cells/L at Clift Sound on 1st June, and 22,906 cells/L in Sandsound Voe on 6th June. It was also relatively abundant around the Highland region (Loch Torridon and Loch Inchard) in June.

The potentially problematic dinoflagellate *Karenia mikimotoi* was observed in densities likely to negatively impact aquaculture during 2016, and was detected in 14.30% of the samples analysed. A dense bloom of *Karenia mikimotoi* was observed around the Firth of Clyde in July and August, with a maximum density in excess of four million cells/L observed in Loch Ryan (Dumfries & Galloway) on 25th July. The bloom persisted through September and into October at this site.

England and Wales (Andrew Turner and Alex Milligan)

Pseudo-nitzschia and Amnesic Shellfish Poisoning (ASP)

Pseudo-nitzschia species (ASP toxin producer) were recorded in 590 samples from 50 production areas. The trigger level (set at 150,000 cells/L) was exceeded on 12 occasions from 6 production areas (Table 3, Figure 11). The highest cell density was recorded in a sample from Lantivet Bay: Sandheap Point collected on 15 August (893,000 cells/L). The number of samples which exceed the trigger level for *Pseudo-nitzschia* species has fluctuated considerably from year to year. There has been a decrease in the number of breaches compared to 2016, but is similar to the number seen in 2015.

746 inshore shellfish samples were tested for ASP toxins using a high-performance liquid chromatography (HPLC) method. ASP toxins were detected in 26 samples from 11 production areas (Figure 3). The greatest proportion of samples containing ASP originated

from the south-west of England (17 samples). The shellfish species affected included mussels (2 samples), Pacific oysters (6 samples), cockles (4 samples), hard clams (2 samples) and surf clams (12 samples). None of the inshore shellfish samples tested for ASP exceeded the maximum permitted level (MPL) of 20 mg/kg in 2017. The highest ASP concentration was recorded in March/April (3.8 mg/kg) from the Start Bay production area. Of the 12 samples collected from this area in 2017, all samples contained ASP between 3 and 3.8 mg/kg.

Alexandrium and Paralytic Shellfish Poisoning (PSP) toxins

Alexandrium species (PSP toxins producers) were recorded in 50 samples from 22 production areas (Table 3, Figure 12), representing a decrease in the occurrence of this genus compared to last year. Recorded maximum cell density was also less than last year, with a density of 2100 cells/L recorded from Salcombe: Geese Quarries. These levels are comparable to those recorded over the period 2013 to 2015, when annual recorded occurrences did not exceed 55 samples, and maximum cell densities did not exceed 27,000 cells/L in each year. In contrast, last year, annual recorded occurrences were from 107 samples, and maximum recorded cell densities was 13,617,000 cells/L. This was also from Salcombe: Geese Quarries.

833 inshore shellfish samples were screened for PSP toxins using the HPLC semi-quantitative method. Four samples also required analysis by the full quantitative method. This is a decrease on the number and levels detected in 2016. Three samples in total recorded PSP toxin levels above the MPL (800µg STX di-HCl eq.)]/kg). These were from the Fowey and Salcombe production areas. Four samples in total recorded PSP toxin levels above the trigger level (400µg STX di-HCl eq.)]/kg). These were from the Pont Pill and Geese Quarries sampling points (Figure 4 and 6).

The Salcombe production area recorded two results above the MPL between 09/08/2017 and 22/08/2017. *Alexandrium* spp. was the predominant toxin producing algal genera in this area, it was first detected on 11/04/2017. *Alexandrium* continued to be detected in 7 further samples in this area through to 20/09/2017. PSP toxins were first detected above the MPL (831 µg/kg) on 09/08/2017. The highest level of PSP toxins (1713 µg/kg) was recorded on 22/08/2017. Toxin levels fell rapidly following this peak. A second consecutive sample recorded below MPL on 20/09/2017 and the site was allowed to reopen. Toxins continued to be detected below MPL until 04/10/2017.

The Fowey production area recorded one result above the MPL (1590 µg/kg) on 01/08/2017. Prior to this event, *Alexandrium* was first detected on 06/06/2017 and, again from 19/07/2017 through to 01/08/2017, the date when the breach of the toxin MPL occurred. Toxin levels rose sharply and quickly declined during late Summer. A second consecutive sample recorded below MPL on 15/08/2017 and the site was allowed to reopen. Toxins continued to be detected below MPL through to 12/09/2017.

Storms at the end of Dec 2017 resulted in starfish, dab, crabs and other sea life being washed ashore along the coast of Norfolk in England. A number of dogs who were walking on the beach ate some of these starfish and fish, became ill and a number died. Analysis of the fish, starfish etc showed them to contain high concentrations of PSP toxins. A full description of the event can be found at http://www.mdpi.com/2072-6651/10/3/94.

Lipophilic toxins (LTs) - summary

A total of 762 inshore samples were analysed for LTs using the Liquid Chromatography - tandem mass spectrometry (LC-MS/MS) method. The lipophilic toxins are sub-divided into three regulated groups.

Yessotoxins (YTXs)

Not detected in any samples received in 2017.

Azaspiracid group toxins (AZAs)

Not detected in any samples received in 2017.

Okadaic Acid/Dinophysistoxins/Pectenotoxins (OA/DTX/PTX)

Dinophysiaceae (lipophilic toxins producers) were recorded in 75 samples from 28 production areas. The trigger level (set at 100 cells/L) was exceeded by 21 samples from 12 production areas (Table 3, Figure 13). This is a notable decrease (-80.2%) in the number of Dinophysiaceae trigger level breaches compared to 2016. The maximum cell density recorded in 2017 was 320 cells/L from Lantivet Bay: Sandheap Point in Cornwall, the same site as the highest Pseudo-nitzschia cell density, though at a different sampling time. This decrease is mostly due to fact that additional water sampling procedures had changed, with no water samples being collected when the beds were closed due to high levels of toxins in the flesh, resulting in weekly flesh testing.

Prorocentrum lima (lipophilic toxins producers) were detected in 9 samples from 7 production areas (Table 3, Figure 14). The trigger level (set at 100 cells/L) was exceeded by just 2 samples. The highest cell density was 200 cells/L in a sample from Conwy: Conwy West. *Prorocentrum lima* is considered an epi-benthic species, and it is likely that its detection in the water column is associated with sediment disturbance.

OA was detected in 40 samples from 10 production areas. This is the lowest number of recorded instances of this toxin group in inshore shellfish samples in the last four years. Four mussel samples from one production area (Lyme Bay) contained OA/DTX/PTXs above the MPL (set at 160 µg OA eq/kg). The Lyme Bay production area recorded four consecutive results above the MPL in samples collected between 12/07/2017 and 01/08/2017. The highest concentration during this event was recorded in a sample collected on 12/07/2017 (236 µg/kg). The second consecutive result below the MPL was recorded in a sample collected on 16/08/2017, however detection of toxins continued until mid-September. This toxin group appeared at a similar time in 2016, although peak concentrations and the number of results above the MPL were lower in 2017.

Other phytoplankton

Prorocentrum cordatum were recorded in 168 samples from 40 production areas. These figures show an increase in occurrence but with cell densities peaking in June at 4000 cells/L, which was similar to that in 2016.

Lingulodinium polyedrum were recorded in 2 samples from 2 production areas. The maximum recorded cell density was 200 cells/L from Lune - Wyre BC: Sea Centre South. *Protoceratium reticulatum* were recorded in a single sample from Burry Inlet - Carmarthenshire CC: Machynys at just 40 cells/L. Both *P. reticulatum* and *L. polyedrum* have typically been recorded at relatively low frequencies and densities in samples from English and Welsh shellfish production areas over the last twelve years.

During August 2017 and number of recreational visitors to the beach at Birling Gap were impacted by a haze coming in from the sea which caused stinging eyes, sore throats and breathing difficulties. Investigations at the time did not suggest this was an algal related event. For more details see http://data.parliament.uk/DepositedPapers/Files/DEP2018-0080/Annex_A_Birling_Gap_science_report.pdf.

Annex 3: ToR C and D

WGHABD members spent some time reviewing data in HAEDAT and products produced by Pieter Provoost at the IOC data centre in Ostende and came up with a plan for progress.

Delegates need to review historic data to ensure data for 'events' have been ticked properly within HAEDAT and not high cell densities or toxin concentrations beneath the closure limit. During the review process at the WGHABD meeting, issues with some historic data points were identified. These need to be checked and details of events to be deleted to be sent to Henrik Enevoldsen.

The report structure was discussed and lead authors for separate toxin syndromes assigned. If someone wants to help out with a chapter contact the lead author. Lack of consistency about how events were recorded pre and post the introduction of the area codes resulted in maps showing the number of years with 'events per area code' being chosen as the preferred graphic to report (see example a). It was felt that owing to inconsistency with monitoring programmes in the early years, it was valid to present the maps showing the number of HAEDAT events in 5 year blocks with the last year being 2017. Bar charts of number of events per year per grid code can be put in an appendix to the report (see example b).

Initial discussions about report structure focused on splitting the ICES area into different ecosystem areas (as described in ICES), however by the end of the week it was felt it was better to structure the report around the different toxin syndromes and events and summarise the ecoregions in a different chapter.

1. Executive Summary (summary of the report)

2. General Introduction to the purpose of the report – why are we writing it. (describe HAE (regional, temporal) in the ICES area, are HAE changing over time? General trend in ocean assessments (i.e. there are loads being done at the moment) *Eileen/Henrik*

3. Background info to include info on harmful algae and events in the ICES North Atlantic Area. (This could include dynamics behind events, pictures, trends from the published literature), intro to HAEDAT, short reasons behind report structure. *Eileen/Henrik/all*

4. Methodology chapter –detailed info on HAEDAT, inconsistencies, method changes, how to interpret it, why plots were chosen. Also info on other data that is included. *All*

5. Description of ICES Ecoregions and CA/USA management areas – oceanography of the region, Industries involved – shellfish industries, recreation, tourism, quantify if posible. Small table detailing monitoring programmes. *ICES text/All*

6. Harmful algal events separated by syndrome

ASTs	Cynthia
AZA	Joe
DSTs	Maud
Cyanos	Bengt/Hanne
CFTs	(currently not in HAEDAT for ICES area)
PSTs	Don/Anke
Fish kills/mortalities	Allan
Aerosolised toxins/NSP	Margarita
Other/wáter discolourations	Check data in HAEDAT

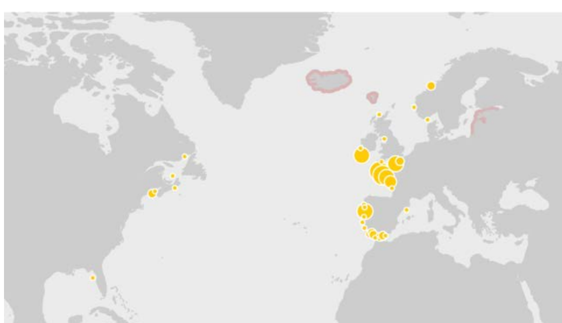
7. Individual chapters to contain (1) general background (2) maps of 'years with events' in 5 year chunks – final year 2017 (3) other data that may support this (4) interpretation per ecoregion (real changes/monitoring changes) (5) have things changed? (6) refer to bar-charts in the appendix.

8. Bar charts of grids with syndromes per year per (a) country and per (b) ecoregion. These can go in the appendix. Note years where monitoring not consistent need a marker to flag this.

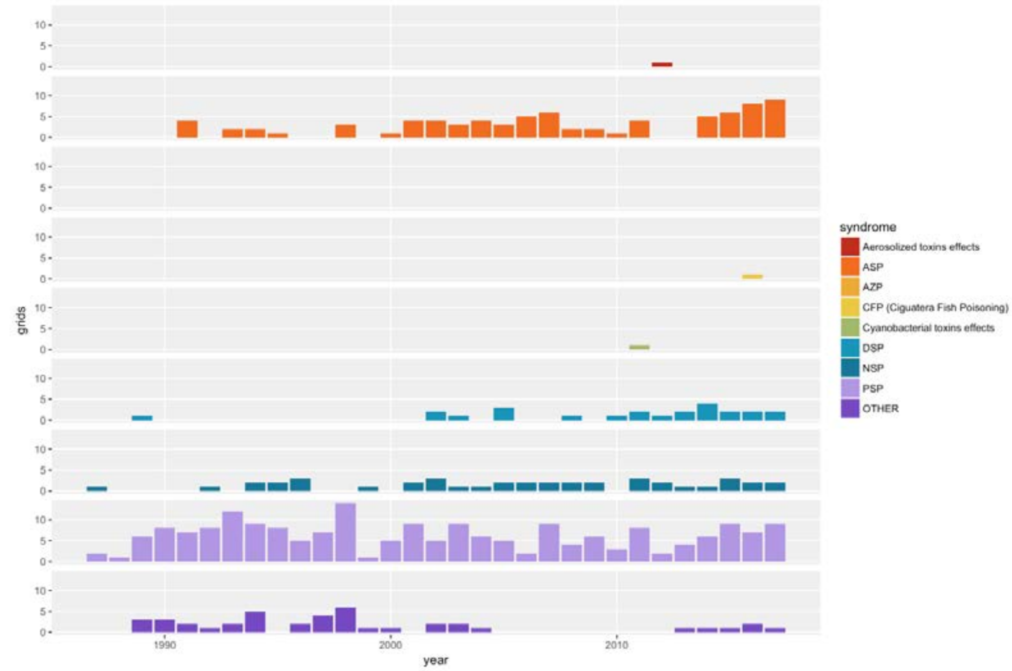
9. Final synthesis – are we seeing changes using HAEDAT data, how does it complement other sources of info.

The next time for report authors to meet is at the ICHA conference in Nantes. Agreed to meet to sign off report on 21/10/2018 before the icebreaker for the conference.

Prior to this, authors would discuss progress via WEBEX on 10 October.



Example A: maps showing years with events



Example B: Barchart graphic

Annex 4: ToR E: New Findings

Update on satellite techniques for monitoring for HABs

Peter Miller

The aim was to inform the WG about several ongoing UK and European projects developing Earth observation (EO) techniques for detecting HABs. **ShellEye** is developing a subscription service to provide early warning of water quality risks to aquaculture (mainly shellfish) farmers, via regional bulletins sent by e-mail, focused initially on the UK region. The bulletins comprise satellite monitoring and detection of certain dense HABs. It is also generating long-term satellite HAB risk maps for potential use by marine insurers. (Funded by UK research councils BBSRC and NERC). **S-3 EUROHAB** is developing a web-based alert system to track the growth of potential HABs, for marine managers, regulators, and the fishing industries within the French/English Channel region. The project is also creating a cross-border monitoring network and data portal for monitoring water quality, incorporating Sentinel-3 satellite data as well as *in situ* monitoring, and physical and ecosystem modelling. (Funded by Interreg France/England Channel.) **PRIMROSE** is to provide local HAB forecast bulletins for the aquaculture industry, based on hydrodynamic models, EO data on algal blooms, or linking these two approaches. (Funded by Interreg Atlantic Area, extending an earlier FP7 project ASIMUTH). Finally, TAPAS is supporting future sustainable aquaculture, including modelled ecosystem scenarios and environmental indicators such as the long-term risk of HABs. (Funded by EU Horizon 2020.). Peter summarised the current status of EO sensing of HABs, with the recent launch of the second ESA 300m resolution ocean colour sensor, the clear benefits of EO monitoring for salmon farming, and the need for continuing research effort to develop similar benefits for shellfish farming, combining with modelling to overcome the limitations of EO.

Dynamics of toxic phytoplankton species along the Catalan coast (NW Mediterranean Sea) Nagore Sampedro, Sílvia Anglès, Laura Arin, Magda Vila, Esther Garcés, Albert Reñé and Jordi Camp, Spain

There is a general concern that HABs are increasing worldwide maybe as a consequence of some factors favoring proliferations or maybe due to an increase of sampling efforts and the improvement of detection methods. To solve this question, studies on the dynamics of these algal species are required in places with a similar frequency sampling over a long period of time. Using time series of phytoplankton from several stations along the Catalan coast (NW Mediterranean), we analyze the trends of potentially toxic species. The objective was to determine if the proliferations of toxic species increased during the study period (2000-2012) along the Catalan coast.

While the blooms of potentially PSP producer species, increased in general in many of the confined stations studied, due to the increase of A. minutum, the A. pacificum were not more detected in most of the stations during the last years of the study period. The blooms of DSP producer species did not shown an increase but there was also a clear increase in the number of blooms of the genus Pseudo-nitzschia (genus with species potentially producing ASP toxicity) as a consequence of the increasing abundances in most of the confined stations.

Bioanalytical devices for the rapid, reliable and cost-effective detection of toxic microalgae

M. Campàs, A. Toldrà, K. B. Andree, M. Fernández-Tejedor, M. Rey, E. Dàmaso, V. Castan, J. L. Costa, J. Diogène

Biotechnological tools for the detection, discrimination and quantification of toxic microalgae have been developed in the framework of the Spanish projects SEASENSING AND CIGUASENSING (BIO2014-56024-C2-2-R and BIO2017-87946-C2-2-R, MINECO). The targeted microalgae have been *Karlodinium veneficum* and *Karlodinium armiger*, *Ostreopsis ovata* and *Ostreopsis siamensis*, and *Gambierdiscus/Fukuyoa*.

Different formats have been designed: colorimetric assays on microtiter plates, electrochemical biosensors and visual strip tests. All biotechnological tools include an isothermal DNA amplification step using tailed primers, followed by a sandwich hybridisation assay. The isothermal DNA amplification uses recombinase polymerase enzymes and is able to operate at low constant temperature (37 °C). In this process, a duplex amplicon is formed, with a tail that hybridises with a capture probe immobilised on a plate or on a magnetic bead (used as a support for the immobilisation on electrodes), and another tail, at the other extreme, that hybridises with a reporter probe. After enzyme substrate incubation, colorimetric and electrochemical measurements are recorded. Seawater and macrophyte samples have been analysed using these approaches, and results have been compared with qPCR and light microscopy, showing appropriate correlations.

Novel widespread oomycetes parasitising diatoms, including the toxic genus *Pseudo-nitzschia*: genetic, morphological and ecological characterisation

Andrea Garvetto, Elisabeth Nézan, Yacine Badis, Gwenael Bilien, Paola Arce, Eileen Bresnan, Claire M.M. Gachon, Raffaele Siano

Parasites are key drivers of phytoplankton bloom dynamics and related marine ecosystem processes. Yet, the dearth of morphological and molecular information hinders the assessment of their diversity and ecological role. Using single-cell techniques, we characterise morphologically and molecularly intracellular parasitoids infecting four potentially toxin producing *Pseudo-nitzschia* and one *Melosira* species on the North Atlantic coast. These sequences define two novel, morphologically indistinguishable, clades within the phylum Oomycota, related to the genera of algal parasites *Anisolpidium* and *Olpidiopsis* and the diatom parasitoid species *Miracula helgolandica*. Our morphological data are insufficient to attribute either clade to the still unsequenced genus *Ectrogella*; hence it is proposed to name the clades OOM_1 and OOM_2. A screening of global databases of the barcode regions V4 and V9 of the 18S rDNA demonstrate the presence of these parasitoids beyond the North Atlantic coastal region. During a biweekly metabarcoding survey of the Concarneau Bay (France), barcodes associated with the sequenced parasitoids coincided with the decline of *Pseudo-nitzschia* spp. and *Cerataulina pelagica* blooms. Our data highlight a complex and still unexplored diversity of oomycete parasitoids of diatoms and calls for the investigation of their phenology, evolution, and potential contribution in controlling their host spatial-temporal dynamics.

Annex 5: ToR G and H

CFP Initiatives:

Jorge Diogène (IRTA) presented briefly the results of the ECsafeSEAFOOD project (FP7, 2013-2017). The identification of CTXs and gambieric acid in shark was described, pointing at the importance of the selection of extraction and purification methods. Two new CTXs were identified and this would be the first identification of gambieric acid in fish. Toxicity evaluation on strains of *Gambierdiscus australes* isolated from Madeira showed porduction of CTXs.

Additionally the EUROCIGUA project (EFSA, 2016-2020), was presented, describing the outscope of the project and specific grants, which include the study of the epidemiology of ciguatera, the evaluation of CTXs in the envirnment and in food and the development of analytical methods. *Gambierdiscus australes* has been identified for the first time in the Balearic Islands.

ECsafeSEAFOOD: http://www.ecsafeseafood.eu/

EUROCIGUA:
http://www.aecosan.msssi.gob.es/AECOSAN/web/ciguatera/home/aecosan_home_ciguatera.htm