

ICES WGHABD REPORT 2016

SCICOM STEERING GROUP ON ECOSYSTEM PROCESSES AND DYNAMICS

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

19–22 April 2016

Brest, France



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Executive summary

The ICES - IOC Working Group on Harmful Algal Bloom Dynamics met in Brest, France, 19–22 April 2016. The meeting was hosted by Raffaele Siano from IFREMER. Sixteen members from eleven countries attended with a further two contributing by correspondence. A total of eleven ToRs were addressed as well as updates from other organisations such as Intergovernmental Oceanographic Commission of UNESCO (IOC) Intergovernmental Panel on HABs (IP-HAB) and Scientific Committee on Oceanographic Research (SCOR) GlobalHAB steering committee. A presentation was also made on behalf of scientists from PICES about the exceptional *Pseudo-nitzschia* bloom observed along the east coast of the Pacific during 2015.

Members presented national reports on HABs during 2015 (ToR a). Algal toxins continue to cause problems throughout the ICES area with shellfish closures enforced in a number of regions as a result of concentrations of paralytic, lipophilic and amnesic shellfish toxins exceeding the permissible limit. Brown tides and the organisms responsible for neurotoxic shellfish poisoning were observed in the U.S.A, the palytoxin producers *Ostreopsis* was observed in some areas in Spain and cyanobacterial scums were observed in the Baltic. ToR (d) provided an update on methodology and trigger levels for toxic phytoplankton monitoring from the EU National Reference Laboratory for Marine Biotoxins. ToR (e) new findings included presentations on mercury in phytoplankton in Poland, monitoring algal toxins in Scotland, *Ostreopsis* in Spain and the first reports of Tetrodotoxin (TTX) in shellfish from the Netherlands. Tor (h) provided a summary of the ICES-PICES-IOC climate change and HABs symposium in Gothenburg in May 2015. This symposium was attended by 60 scientists. A major review article about climate change and HABs arising from this symposium was published in Harmful Algae in 2015; Wells, M.L., Trainer, V.L., Smayda, T.J., Karlson, B.S.O., Trick, C.G., Kudela, R.M., Ishikawa, A., Bernard, S., Wulff, A., Anderson, D.M., Cochlan, W.P. (2015), 'Harmful algal blooms and climate change: Learning from the past and present to forecast the future.' Harmful Algae, 49, 68–93. ToR (i) presented experiences using molecular methods such as qPCR to identify HAB species. ToR (k) addresses the physical and chemical control of different HAB species. This year focussed on the dynamics of *Alexandrium minutum* in the Bay of Brest, France. Molecular methods applied to sediment cores provided information to improve understanding of blooms in this region. ToRs (g) and (l) updated the status of the OSPAR/JAMP Phytoplankton monitoring guidelines reviewed by the WG last year.

Three ToRs contribute towards the work of the IOC IP-HAB. ToR (b), a manuscript on fish killing algae is in the final stages of production and will be submitted for peer review before the end of 2016. WG members continue to update the ICES-PICES-IOC Harmful Algal Event database (HAE-DAT) as part of ToR (c). ToR (f) addressed the production of a HAB status report which will act as the ICES contribution towards a Global HAB Status Report (GHSR) that is currently being produced as a joint effort by the IOC, ICES, PICES, International Atomic Energy Agency (IAEA) and International Society for the Study of Harmful Algae (ISSHA) to document global occurrences and changes in HABs. This report will summarise the data in HAE-DAT to produce a status report of harmful algal events in the ICES area.

1 Administrative details

Working Group name Working Group on Harmful Algal Bloom Dynamics (WGHABD)
Year of Appointment within current cycle 2015
Reporting year within current cycle (1, 2 or 3) 2
Chair(s) Eileen Bresnan, UK
Meeting venue Brest, France
Meeting dates 19–22 April 2016

2 Terms of Reference

- a) Deliver National Reports on harmful algal events and bloom dynamics for the years 2014, 2015 and 2016.
- b) Finalise a review document quantifying the scale, nature and extent of the problems associated with fish killing algae in the ICES region.
- c) A one day Harmful Algal Event Data Workshop as part of the 2015 WGHABD Meeting (with intercessional work performed by delegates prior to WG meeting).
- d) Review the methodology used for the collection of phytoplankton samples in harmful phytoplankton monitoring programmes and the abundances used as threshold levels in harmful phytoplankton monitoring programmes.
- e) Report on new findings in the area of harmful algal bloom dynamics.
- f) Identify HAB datasets that could be used to investigate climate related changes in HAB species phenology; present the assessment of representative datasets to describe HAB initiation and temporal trends and spatial variability; review outputs using the standard WGZE and WGPME result formatting.
- g) Evaluate use of harmful/nuisance algae as an indicator of 'Good Ecological Status' for the Marine Strategy Framework Directive Descriptor 5 (Eutrophication). Review draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition.

- h) Review progress and advice the scientific steering committee for the planned joint ICES-PICES-IOC scientific symposium on climate change and harmful algal blooms. The symposium is planned to be arranged in 2015.
- i) Review progress in development and application of molecular genetic technologies for taxonomic identification, phylogenetic reconstruction, biodiversity, toxin detection and population dynamic studies of HABs .
- j) Review the existing knowledge and latest findings on BMAA, the amino compound β -methylamino alanine.
- k) Review how physical and biological interactions control of the dynamics of relevant harmful micro-algal blooms.
- l) Review of draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition ICES is requested to advise OSPAR on the revision of the OSPAR JAMP Eutrophication Guidelines which will be revised by experts from Germany, The Netherlands and Sweden. WGHABD is asked to address the identification of harmful algae species and blooms in line with MSFD Descriptor 5 and relevant monitoring and measurement techniques as mentioned in the background information.

3 Summary of Work plan

Year 1 Review of OSPAR and MSFD D5 Eutrophication guidelines, review of fish killing algae (ToR g and l) Updating and quality control of data in HAEDAT (ToR c), symposium on climate change and HABs (ToR H). Identify data sets and editorial team for the HAB status report (ToR f), current status of BMAA (ToR j). Review on HAB species *Gymnodinium catenatum* (ToR k).

Year 2 Completion of HAB status report (ToR f), review of sampling methodologies and threshold levels in monitoring programmes (ToR d), plan workshop on molecular techniques (ToR i), Contribute towards Global HAB report as required. Contribute towards MSFD as required. Review on HAB genera *tbc*. ToR to be decided.

Year 3 Contribute to a workshop on new/molecular genetic techniques, Review of new technologies, Review on Hab genera *tbc*. Contribute towards Global HAB report as required. Contribute towards MSFD as required. ToR to be decided.

Year 1-3 Work on Global HAB report, update the Harmful Algal Event Database, report new findings, physical-biological interactions – selected HAB genera

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

- Representation by ICES-IOC WGHABD chair at IOC Intergovernmental Panel on Harmful Algal Blooms, UNESCO, May 2015. A summary of WGHABD work for the last two years was presented.
- The ICES-PICES-IOC Symposium on HABs and climate change was held in Gothenburg, Sweden, 19 – 22nd May 2015. See ToR h for summary.

- Representation by WGHABD chair at ICES advisory drafting group on OSPAR/JAMP phytoplankton monitoring guidelines, June 2015.
- Proposal for a special session on phytoplankton and HAB time series for ICES ASC 2016 in Riga, Latvia was submitted and accepted.
- WGHABD was represented at SCOR - GLOBALHAB scientific steering committee meeting, Oban, UK, April 2016.

5 Progress report on ToRs and workplan

The ICES-IOC WGHABD met in Brest, France, 19–22 April 2016. The meeting was hosted by Raffaele Siano from IFREMER. Sixteen members from eleven countries attended with a further two contributing by correspondence. ToR a: National Reports. The list of participants is given in Annex 1 and the agenda in Annex 3.

ToR a: National reports

National reports of HAB events from twelve countries were presented. Detailed national reports for each country can be found in Annex 4.

ToR b: Finalise a review document quantifying the scale, nature and extent of the problems associated with fish killing algae in the ICES region

This ToR has been delayed owing to the retirement of the lead author. A draft of the manuscript has been circulated around co-authors and it is anticipated that the completed manuscript will be submitted for peer review before the end of 2016.

ToR c: IOC–ICES–PICES Harmful Algal Event Database

The hiring of a new computer programmer meant that a lot of the technical issues flagged by WGHABD during the 2015 meeting could be addressed. This means that HAE-DAT data can be QCed by the WG. Missing data has also been addressed. HAE-DAT data will be the ICES contribution for the Global HAB Status Report (GHSR) currently being produced as a joint effort by IOC, ICES, PICES, IAEA and ISSHA to document global occurrences and changes in HABs. See ToR f) for more detail.

ToR d: Review the methodology used for the collection of phytoplankton samples in harmful phytoplankton monitoring programmes and the abundances used as threshold levels in harmful phytoplankton monitoring programmes

This ToR is currently being addressed by the EU-National Reference Laboratory (NRL) for marine biotoxins. A number of WGHABD members attended an EU-NRL meeting in Brussels during March 2016. The aim of this EU-NRL initiative is to standardise the methodology between member states where possible. As a result WGHABD will receive updates about progress from the EU-NRL and feed into it as required. A summary of the EU-NRL meeting attended by Joe Silke (Ireland) is given in Annex 5.

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

Four new findings were presented during the course of the WG. These included reports of *Ostreopsis* in the Mediterranean (MF, Spain), mercury in phytoplankton in Puck Bay,

Poland (JK, Poland), SPATT monitoring in Scotland (JPL, UK) and the first record of TTX in shellfish harvested from the Netherlands (MP). In addition a summary of the exceptional *Pseudo-nitzschia* bloom in the west coast of the USA was presented (DA, USA on behalf of Trainer *et al.*). Detailed summaries of these can be found in Annex 6.

ToR f: Identify HAB datasets that could be used to investigate climate related changes in HAB species phenology; present the assessment of representative datasets to describe HAB initiation and temporal trends and spatial variability; review outputs using the standard WGZE and WGPME result formatting

WGHABD had an in-depth discussion about the production of a HAB status report. A Global HAB Status Report (GHSR) is currently being produced as a joint effort by IOC, ICES, PICES, IAEA and ISSHA to document global occurrences and changes in HABs. This report will be submitted to the IOC Intergovernmental Panel for Harmful Algal Blooms (IP-HAB). The ICES contribution to this report will come via WGHABD through the production of a report analysing the data held in the HAE-DAT database up to the end of 2015. The aim of the WG is to get a draft version of this report ready for the WGHABD in 2017 and also to feed into the GHSR being edited by Hallegraeff and Zingone with a draft report being submitted to IOC IP-HAB for the next meeting in 2017. It is critical that WGHABD ensure that the HAE-DAT data is appropriately represented in this GlobalHAB report. As WGHABD are experts in the status of HABs in the ICES area, they have the expertise to produce an accurate synthesis of the HAE-DAT data. Timings will be tight for WGHABD to get their contribution ready by the next WG meeting and timeline of actions and suggested format were agreed. These are given in Annex 7.

ToR g & i: HABs and eutrophication/Review OSPAR JAMP guidelines

WGHABD reviewed the OSPAR/JAMP Phytoplankton monitoring guidelines during the 2015 meeting. The WGHABD chair took part in the ICES Advisory group reviewing the OSPAR/JAMP Phytoplankton monitoring guidelines in June 2015 (ADGJAMP) and the final version submitted to OSPAR. WGHABD discussed the issue of HABs and eutrophication. This issue has been addressed by the WG previously. The WG felt that currently there was enough information in the peer review literature (some from WG members) addressing this issue and did not require further effort at this point in time.

ToR h: ICES-PICES-IOC HABs and climate change symposium, Gothenburg, Sweden, 19 -22 May 2015

The ICES-PICES-IOC HABs and climate change symposium took place in Gothenburg, Sweden, 19–22 May 2015. Approximately 60 participants from all over the world participated. Convenors were Bengt Karlson, Sweden, Angela Wulff, Sweden, Mark Wells, USA, and Raphael Kudela, USA. The conference was endorsed and/or received financial support from ICES, PICES, SCOR, the US HAB programme and the Swedish Research Council, Formas. More information can be found at http://www.pices.int/meetings/international_symposia/2015/2015-HAB/scope.aspx

A major output of the symposium is the in-depth review article published in Harmful Algae; Wells, M.L., Trainer, V.L., Smayda, T.J., Karlson, B.S.O., Trick, C.G., Kudela, R.M., Ishikawa, A., Bernard, S., Wulff, A., Anderson, D.M., Cochlan, W.P. 2015. Harmful algal blooms and climate change: Learning from the past and present to forecast the future. Harmful Algae, 49:68–93.

Continued research on the effects of climate change on the frequency and types of harmful algal blooms will be carried out at national levels as well as within the framework of the global research programme GlobalHAB supported by IOC-SCOR.

ToR i: Review progress in development and application of molecular genetic technologies for taxonomic identification, phylogenetic reconstruction, biodiversity, toxin detection and population dynamic studies of HABs

Discussions focussed on organising a workshop on molecular methods and overlap with similar ToRs with WG Phytoplankton and Microbial Ecology, WG Zooplankton Ecology, WG Integration of Morphological and Molecular Taxonomy and WG Introduction and Transfer of Marine Organisms. Subsequent discussions between WG chairs have agreed a way forward would be for a special session on molecular methods to be held at the ICES ASC 2017 which would provide an opportunity for members of the different WGs to discuss a future event which would streamline effort and avoid overlap. Ann Bucklin from WG IMT has submitted a proposal for the ASC. WGHABD has offered support for this initiative – see recommendation in Annex 2. WGHABD members will have intersessional discussions about issues specifically relating to HABs.

Experiences developing and implementing qPCR methods to identify the species of *Alexandrium* were also presented.

ToR k: Review how physical and biological interactions control of the dynamics of relevant harmful micro-algal blooms

An in-depth presentation on the dynamics of *Alexandrium minutum* in the Bay of Brest was given by R. Siano (Fr). Investigations focused on sediment cores and molecular methods detected the presence of this species over the last 40 years. A review article for peer review is planned for the work included in this presentation.

6 Revisions to the work plan and justification

During the meeting some alterations to the ToRs were discussed. These are detailed below along with the justification for the amendment.

Table 1: Amendments to year 3 of WGHABD work plan.

ToR a: National Reports

Amendment: Three year national report from 2014–2016 will be presented

Justification: Year 3 of reporting cycle

ToR c: HAE-DAT (overlap with ToR f)

Amendment: During year 3 plots and other outputs from HAE-DAT database will be reviewed

Justification: Plots automatically generated from the data by the Oostende programmer will be reviewed. These will be included in the ICES HAB status report (see ToR f).

ToR d: Review the methodology used for the collection of phytoplankton samples in harmful phytoplankton monitoring programmes and the abundances used as threshold levels in harmful phytoplankton monitoring programmes

Amendment: Feedback from EU-RL meeting on phytoplankton monitoring methodologies

Justification: The EU-RL will set methodologies that will become standard across Europe. The WG should be aware of developments in this area.

ToR f: Identify HAB datasets that could be used to investigate climate related changes in HAB species phenology; present the assessment of representative datasets to describe HAB initiation and temporal trends and spatial variability; review outputs using the standard WGZE and WGPME result formatting.

Amendment: Review draft HAB status report produced using HAE-DAT data

Justification: The WG has a tight deadline to produce a HAB status report before the next WGHABD meeting if it is to keep in line with the timelines of the GHSR. This HAB status report will be the ICES contribution to the GHSR.

ToR i: Review progress in development and application of molecular genetic technologies for taxonomic identification, phylogenetic reconstruction, biodiversity, toxin detection and population dynamic studies of HABs.

Amendment: WG members will discuss updates against this ToR in relation to activities in other WGs and potential special session in the 2017 ICES ASC. Issues specifically relating to HABs will also be addressed.

Justification: Other WGs, WG PME, WG ITMO, WG ZE and WG IMT also have ToRs relating to molecular methods. A proposal for a theme session on molecular methods has been submitted to the 2017 ICES ASC by WG PME and WG IMT to act as a forum for the WGs to discuss the way forward with this ToR to avoid overlap and duplicate effort. Issues specifically relating to HABs will also be flagged.

ToR k: Review how physical and biological interactions control of the dynamics of relevant harmful micro-algal blooms

Amendment: During the 2017 meeting this ToR will focus on *Alexandrium ostenfeldii* and nitrogen fixing cyanobacteria.

Justification: The location of the 2017 WGHABD meeting at the Finnish Environment Institute in Helsinki provides access to a considerable breath of expertise with these toxin producing species.

7 Next meetings

The WGHABD meeting in 2017 will be hosted by Anke Kremp of the Finnish Environment Institute, Helsinki, Finland, 25–28 April 2017.

Annex 1: List of participants

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Annex 2: Recommendations

RECOMMENDATION	ADDRESSED TO
WGHABD support the theme session on molecular methods submitted by Ann Bucklin (WGIMT). This will address the overlap in ToRs examining molecular methods between different WGs.	SCICOM

Annex 3: Agenda

ICES WG-HABD: Ifremer, Brest, France 19 th – 22 nd April 2016			
Time	ToR	ToR lead	Item
Tuesday 19th April			
10:00		Director Ifremer	Welcome to Ifremer
10:15		E. Bresnan R. Siano	Opening of meeting, introductions, logistics, adoption of agenda
10:25		E. Bresnan	Update on 2016 report and ICES ASC
10:45		New members	Introduction from new members
11:15	Health Break		
11:45		New members	Introduction from new members (ctd)
12:00		C. McKenzie	Update from WGITMO
12:15	B	K. Davidson (remotely)	Update: Document on fish-killing algae in the ICES area
12:25	D	J. Silke (B. Reguera)	Update: Review sampling methodologies and thresholds for collection of phytoplankton samples in harmful phytoplankton monitoring programmes
12:40	A	All	National Reports
13:00	Lunch		
13:45	H	B. Karlson	Update: ICES-PICES-IOC HABs and climate change symposium
14:00	E	All	New Findings
15:30	Health Break		
16:00		B. Karlson H. Enevoldsen	Update: GlobalHAB SSC meeting
16:30	A	All	National reports
17:30		Meeting close	

Wednesday 20 th April			
9:30	G/L	B. Karlson E. Bresnan	Review OSPAR JAMP Eutrophication Guidelines/ Evaluate use of HAB nuisance algae as an indicator of 'Good Environmental Status'
10:15	E	All	New Findings
11:00 Health Break			
11:20	C	H. Enevoldsen C. Belin	Update: IP-HAB, HAE-DAT and decadal maps, deadline for QC of historic data to be completed
12:30	A	All	National reports
13:00 Lunch			
13:45	F	E. Bresnan T. O'Brien	HAB datasets and HAB status report
14:30	K	R. Siano (and others)	Physical, chemical and biological controls of <i>Alexandrium minutum</i>
15:30 Health Break			
16:00	A	All	National reports
16:45		All	Report writing
17:30		Meeting close	
18:00		P. Hess	The Phycotox project
19:00			Cocktails hosted by Ifremer
Thursday 21 st April			
9:30	I	R. Siano A. Cembella	User experiences in the application of new technologies and developments for the study of HABs
11:00 Health Break			
11:45		D. Anderson	<i>Pseudo-nitzschia</i> in the Eastern Pacific
12:00		All	National reports New findings

13:00 Lunch		
13:45	All	National reports New findings Report writing
15:30 Health Break		
15:45	All	WG HABD 2017 meeting, location, ToRs & outputs for the group
17:30	Meeting close	
Friday 22nd April		
09:30	All	Confirm ToRs for 2017 meeting Complete text for resolutions Report writing
11:00 Meeting close		

Annex 4: ToR a) National reports

4.1. National Report: Spain (Francisco Roderiguez, IEO, Spain)

There were no exceptional HAB events during 2015 in Spain. Events (only DSP in the Atlantic side) were very mild in Andalucia. DSP toxins above regulatory levels were first reported in the Basque Country after including an offshore station in their monitoring programme. *Ostreopsis* blooms caused respiratory irritations in Catalonia and eastern (Mediterranean side) Andalucia. Galicia suffered intense DSP outbreaks, as has been the case in the last years, distributed in 3 main pulses from early spring to autumn.

Andalusia (Data provided by LCCRRPP (Junta de Andalucía, Huelva)

Only DSP was reported in 2015 in the Atlantic coast (Huelva) caused by *D. acuminata* blooms. Maximum cell numbers (3.6×10^3 cells L^{-1}) were observed between April and October off river mouths. Closures were enforced in January, April to October and December.

*(Note by F. Rodríguez: *Ostreopsis* events in Almeria (J. Gilabert, *pers. comm.*) at the end of June three Almería beaches were closed a few days due to occurrence of *Ostreopsis* and around 90 people were affected and had respiratory problems. Several newspapers covered this event at local and national scale, for example: El País, 29 June: http://politica.elpais.com/politica/2015/06/29/actualidad/1435572178_691276.html).

Basque Country (2014–2015: Data provided by: AZTI (Pasaia) and University of the Basque Country (Leioa)).

In 2014 and 2015, analyses of ASP, PSP and lipophilic (AO+DTX+PTX, AZA and YTX) toxins were conducted in wild mussels and oysters (*Mytilus galloprovincialis* and *Crassostrea gigas*) collected in the Oka estuary, once a week, during six months per year (from January to March, and from October to December). This small estuary is the only location along the Basque coast where the authorities allow shellfish harvesting activities. Monitoring for bivalves toxicity coincided with the harvesting seasons (winter and autumn) and the toxin concentrations were always below detection limits.

Also, water samples for phytoplankton quantification (Utermöhl) were collected quarterly (February, May, August and November) in surface waters of the Oka estuary. Among the dinoflagellates, toxic species were not detected during the winter and autumn campaigns. Several potentially DSP species were identified in spring 2014: *Dinophysis acuminata* (1600 cells· L^{-1}), *D. tripos* (300 cells· L^{-1}) and *Phalacroma rotundatum* (100 cells· L^{-1}). *Dinophysis ovum* was observed in summer 2014 (200 cells· L^{-1}). In 2015 there was only one record in this estuary of a potentially toxic (YTX) dinoflagellate: *Gonyaulax spinifera* (100 cells· L^{-1}), which was observed in spring.

Regarding potential producers of ASP, cells identified as *Pseudo-nitzschia* spp. were usually found in the Oka estuary, but their density never exceeded 7000 cells· L^{-1} . *Pseudo-nitzschia galaxiae* and *P. multistriata* were also identified, both in 2014 and 2015. The highest densities corresponded to *P. galaxiae* during the summer campaigns (~20000 cells· L^{-1}). *P. multistriata* was found at low densities in summer (~1000 cells· L^{-1}), and in autumn (in some samples together with *P. galaxiae*, both at low density).

In addition, toxins were analyzed in bivalves collected in offshore waters at a pilot-scale farm. Sampling was conducted almost monthly from May 2014 to June 2015. In 2 out of 13 campaigns, lipophilic toxins were above the allowed limits in mussels, both of them in spring (May 2014 and April 2015), when potentially toxic dinoflagellates (DSP) such as *Dinophysis acuminata*, *D. caudata*, *D. tripos* and *Phalacroma rotundatum* were observed. Oysters were analyzed in 5 occasions, and toxicity was not detected. .

Finally, *Alexandrium* sp. (*A. tamarense* complex) appeared as the dominant organism in the net sample of the seaward reach of the Nervión estuary in late summer 2015. The Utermöhl analysis showed a concentration of 4220 cells·L⁻¹. It was the first observation of a bloom of *Alexandrium* in this estuary during 15 years of monitoring.

Catalonia

Beaches during the summer season (Data provided by Group of Litoral Processes from ICM and national Project *Ostreorisk*).

During summer 2015, potentially harmful species were identified at 21 beaches from the Catalanian coasts. Most abundant species were dinoflagellates *Ostreopsis* spp., *Alexandrium taylori* and several gymnodinoids, and the diatom genus *Pseudo-nitzschia*.

Epibenthic *Ostreopsis* spp. is frequently detected in rocky shores rich on macroalgae. High densities are recurrent during summer months at the hot spot of Sant Andreu de Llavaneras beach. In 2015, high densities, with a peak of 6.8 x 10⁴ cells L⁻¹ in the water column and 1.1 x 10⁶ cells g⁻¹ wet weight macroalgae (*Ostreorisk* project data), were detected from early July to mid-August. There were a few cases (milder than usual) of local inhabitants affected by respiratory irritations. High densities were also detected in mid-July in Sitges-Terramar (up to 2.3 x 10⁴ cells L⁻¹) and in Sant Feliu (up to 6.2 x 10⁴ cells L⁻¹).

Alexandrium taylori was detected in all the Costa Brava beaches. Maximal densities were found by the mouth of Muga river (2.7 x 10⁶ cells L⁻¹) and at Gola de Sant Pere Pescador (1.8 x 10⁵ cells L⁻¹). Densities at the hot spot in La Fosca were unusually low (<10⁴ cells L⁻¹), probably due to changes in the sampling hours (early morning, when daily migrating cells have not reached surface waters). Nevertheless, high densities of *A. taylori* (7.2 x 10⁵ cells L⁻¹) were found for the first time further south at the Arenal (Ampolla) beach.

Blooms of *A. taylori* are usually accompanied by those of other naked dinoflagellate species (*Gymnodinium litoralis*, *Levanderina fissa* (= *Gymnodinium instriatum*), *Barrufeta bravensis*). As in previous years, densities (>10⁶ cells L⁻¹) of these co-occurring gymnodinoids have been higher than those of *A. taylori* at Montgó, La Gola (Torroella del Montgrí) and El Grau beaches. Further south, at the Arenal beach, densities >10⁵ cells L⁻¹ of *Gymnodinium* spp. co-occured with the unusual high densities of *A. taylori*.

Detected densities of other potentially toxic dinoflagellates, such as *Alexandrium minutum*, *Dinophysis sacculus*, *D. caudata*, *Phalacroma rotundatum* and *Prorocentrum lima* were very low but *Pseudo-nitzschia* spp at densities above 10⁵ cells L⁻¹ were found in early July in several beaches.

Catalonia coastal monitoring (Data provided by IRTA, Sant Carles de la Rápita, Tarragona)

PSP: In 2015 there was an unusual presence of *Alexandrium catenella* in January in Tarragona harbor (where it usually blooms in late summer). This bloom reached a maximum density of 4×10^3 cells L⁻¹. The other dinoflagellate species frequently associated to PSP events in Catalonia, *Alexandrium minutum*, was present along the coast and reached abundance maximum of 2.4×10^6 cells L⁻¹ in Arenys de Mar harbor in March. It was also present in high densities in Vilanova (8.9×10^4 cells L⁻¹) and port Ginesta (7.2×10^5 cells L⁻¹) harbors, in both cases in April. In shellfish growing areas, *Alexandrium minutum* reached a maximum of 6.8×10^3 cells L⁻¹ in Vilanova and 2×10^3 cells L⁻¹ in Alfacs Bay. There were no PSP associated closures during 2015; all shellfish samples tested for PSP toxins were below regulatory levels.

DSP/Lipophilic toxins: The main species involved in DSP events in Catalonia; *Dinophysis sacculus*, *Dinophysis caudata* and *Prorocentrum lima* were present in low densities in shellfish growing areas. Maximal densities detected for *Dinophysis sacculus* were 3×10^2 cells L⁻¹ in Alfacs Bay and 1.5×10^3 cells L⁻¹ in Fangar Bay, although *Dinophysis sacculus* reached high densities in Masnou harbor (1.3×10^5 cells L⁻¹) and port Ginesta (2.4×10^4 cells L⁻¹). Yessotoxin producing species, *Protoceratium reticulatum*, *Lingulodinium polyedrum*, and *Gonyaulax spinifera*, were present in very low density. All shellfish samples tested for lipophilic toxins were below regulatory levels.

ASP: Species of *Pseudo-nitzschia* reached high densities in the Ebro delta embayments: 1.4×10^6 cells L⁻¹ in Alfacs Bay and 3.9×10^3 cells L⁻¹ in Fangar Bay, both in April. Densities along the Catalan open coast were lower with maxima off Vilanova 1.3×10^6 cells L⁻¹ in June and 2.5×10^5 cells L⁻¹ off Masnou in March. All shellfish samples tested for ASP were below regulatory levels.

Other harmful microalgae: High biomass blooms were detected in confined waters: a bloom of *Gymnodinium impudicum* (6.3×10^5 cells L⁻¹) in Tarragona harbor in July, and *Alexandrium taylorii* (10^7 cells L⁻¹) in Illa de Mar harbor in June, July and August.

Karlodinium was frequently present along the coast; maximum densities were detected in Alfacs Bay in May (1.5×10^3 cells L⁻¹). *Ostreopsis* cf. *ovata* was detected in the water column below alert levels, maximum densities were detected off Arenys de Mar (3.7×10^3 cells L⁻¹) and Masnou (2.9×10^3 cells L⁻¹) in mid August.

Valencia: (Data provided by IRTA, Sant Carles de la Rápita, with permission from the Valencia Government).

PSP: *Alexandrium minutum* was present in low densities in Burriana (10^2 cells L⁻¹), and *Alexandrium catenella* reached densities over alert levels in Alicante in October ($\times 10^3$ cells L⁻¹). A closure was enforced in Sant Pola (South of Alicante) due to detection of PSP toxins over regulatory levels in one sample of wild mussels in January; a precautionary closure was enforced in although PSP toxins were below regulatory levels. There was no phytoplankton sampling in January in these areas.

DSP/Lipophilic toxins: *Dinophysis sacculus* and *Dinophysis caudata* were present in low densities (max. 10^2 cells L⁻¹) in May and October respectively, in Alicante. *Lingulodinium polyedrum* and *Gonyaulax spinifera* were frequent in low densities along the coast; maximal densities (10^2 cells L⁻¹) were detected in Valencia in May/June. Lipophilic shellfish toxins were below regulatory levels. Shellfish samples during 2015 were analyzed by the LC-

MS/MS method (the mouse bioassay was the method applied before). Many closures enforced in past years in these areas may have been in fact due to false positives, because presence of yessotoxin producing species in these areas is frequently observed.

ASP: *Pseudo-nitzschia* was frequent and abundant along the year reaching densities over alert level ($\times 10^5$ cells L⁻¹) in Valencia in June. ASP toxins were < regulatory levels.

Other harmful microalgae: The maximal density of *Gymnodinium impudicum* ($\times 10^3$ cells L⁻¹) was detected in Alicante in October, and of *Karlodinium* ($\times 10^3$ cells L⁻¹) in Valencia in May.

Benthic HABs: *Ostreopsis* reached 3.9×10^3 cells L⁻¹ in Valencia in June; this concentration is below the warning level for palytoxins used in other European countries (4×10^3 cells L⁻¹).

Galicia: (Data provided by INTECMAR, Xunta de Galicia)

Dinophysis acuminata bloomed in the spring (mid-April to end of May) and led to harvesting closures (lipophilic toxins) of mussels in the whole Rías Baixas (maximum of 1.4×10^4 cells L⁻¹ in the outer reaches of Ría de Pontevedra in early May). Closures affected also infaunal shellfish in the open coast. A similar situation was observed during a new outbreak in summer (mid-June to end of July). A record value of 9.7×10^4 cells L⁻¹ in this period was found in a surface sample at a costal station (Langosteira) in early July, and the maximal density inside the Rías, 9.7×10^4 cells L⁻¹ in Ría de Muros by the end of June. A last bloom of *D. acuminata* followed by *D. acuta*, triggered by downwelling conditions in mid-September, led to harvesting closures until December affecting all production areas in Pontevedra and Muros but only the outer reaches of Ría de Vigo (Liméns) and Arousa (O Grove). Infaunal shellfish was not affected. Maximal densities detected were 3.6×10^3 cells L⁻¹ of *D. acuminata* in Vigo (st. V7) and 2.3×10^3 cells L⁻¹ of *D. acuta* in Pontevedra (st P4) on Sept 22.

Gymnodinium catenatum was not detected in 2015. *Alexandrium minutum* bloomed briefly (2 weeks) in Ría de Ares-Betanzos and caused extensive mussel harvesting closures the second half of April (max. of 37×10^3 cells L⁻¹ at st L3; 1800 µg equiv STX di.HCl/Kg in Sada B with 15.6×10^3 cells L⁻¹ at L2). Blooms occurred also at Ría de Camariñas, leading to infaunal shellfish closures (2160 µg equiv STX di.HCl/Kg in cockles on early July). This last event co-occurred with a brief period of ASP (49 mgAD/Kg).

Pseudo-nitzschia spp. bloomed briefly in early April and closures for ASP toxins affected mussels in Ría de Muros, outer reaches of Arousa, Ría de Pontevedra and Ría de Vigo (including Baiona estuary). It also affected infaunal shellfish in Costa da Morte (open coast) and all the Rías Baixas (max. of 133 mgAD/Kg in mussels from Vigo (st A) first week of April, and 2.4×10^5 cells L⁻¹ of *Pseudo-nitzschia australis* in the nearby V4 station.

Scallops (*Pecten maximus*) contained DA above regulatory levels. Restricted harvesting with evisceration, according to a Commission Decision 2002/226/EC (establishing special health checks for the harvesting and processing of certain bivalve mollusks with a level of amnesic shellfish poison (ASP) exceeding the limit laid down by Council Directive 91/492/EEC) was applied the whole year round.

in the water (100×10^3 cells/L). Events were all on the NW coast, mostly associated with *P. seriata* complex proliferations;

- i) PT-01, 116×10^3 cells/L (54 mg/Kg in *Mytilus galloprovincialis*) in 07/04/15
- ii) PT-01/PT-02, 258×10^3 cells/L (22 mg/Kg in *Mytilus galloprovincialis*) in 09/04/15
- iii) PT-02, 165×10^3 cells/L from *P. seriata* group (26 mg/Kg in *Mytilus galloprovincialis*) in 06/04/15 and 339×10^3 cells/L from *delicatissima* group, also in April (28/04), with no shellfish toxicity (4 mg/Kg in *Venerupis corrugata*) but the area was closed for harvesting by the presence of *Pseudo-nitzschia* genus above 200×10^3 cells/L,
- iv) PT-02, 93×10^3 cells/L (23 mg/kg in *Cerastoderma edule*) in 04/08/15
- v) PT-01/PT-02, 267×10^3 cells/L in 18/8/15, the area was closed for harvesting by the presence of *Pseudo-nitzschia* genus above 200×10^3 cells/L.

DSP: *Dinophysis* species are a regular presence in water samples and responsible for most of the shellfish harvesting closures. *D. acuminata* was the dominant species, followed by *D. acuta*, *P. rotundata*, *D. caudata*, *D. ovum*, in decreasing order of concentration.

NW coast: Five events were reported along the NW coast, a short event (3 weeks) in January-February (cells below warning levels for cells in the water), and four others from April until December:

- PT-01, 5840×10^3 cells/L, (>850 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 21/04/15
- PT-02, 1840×10^3 cells/L (>850 μ g OA equiv. Kg⁻¹ in *Venerupis corrugata*) in 11/05/15
- PT-01-PT-02, 3300×10^3 cells/L (394 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*), in 12/05/15
- PT-03, 760 cells/L (118 μ g OA equiv. Kg⁻¹ in *Cerastoderma edule*) in 21/07/15

SW coast : Nine events were reported along the SW coast, from mid-April until the end of December. The highest concentrations were observed in:

- PT-05, 3500×10^3 cells/L (96 μ g OA equiv. Kg⁻¹ in *Ensis siliqua*) in 01/09/15
- PT-04, 1520×10^3 cells/L (370 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 07/09/15
- PT-05, 3320 cells/L (>850 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 14/09/15
- PT-04, 2340×10^3 cells/L (>850 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 26/10/15

S coast: Seven events were reported along the S coast, from mid-April until the end of December. The highest concentrations were observed in:

- PT-06, 3000×10^3 cells/L (217 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 14/04/15
- PT-07, 1300 cells/L (189 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*), in 08/06/15
- PT-07, 4920×10^3 cells/L (143 μ g OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 31/08/15

- PT-06, 4600x10³cells/L (207 µg OA equiv. Kg⁻¹ in *M. galloprovincialis*) in 08/09/15

As in the last two years, no PSP outbreaks occurred in 2015.

4.3. National Report: France (Catherine Belin, Ifremer, Nantes)

Three types of toxic episodes were observed in France during the year 2015: 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 35 400 cells/L recorded north of the Seine estuary, and 12 400 cells/L south of Seine estuary. Toxic episodes, with toxin results above the sanitary threshold (160 µg/kg for the group of OA+DTXs+PTXs), were observed mainly along the Atlantic coast, affecting especially mussels, oysters 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 galloprovincialis*) of the Salses-Leucate lagoon (Mediterranean) with 3000 µg/kg, and in the mussels (*Mytilus edulis*) of Arcachon bay (2800 µg/kg). Concerning Azaspiracids and Yessotoxins, all results were below the European sanitary threshold.

PSP: *Alexandrium* was observed at three sites with concentrations above 100 000 cells per liter; Morlaix Bay and Brest Bay in Brittany with more than 200 000 cells per liter (*A. minutum*), and Thau lagoon in Mediterranean with 800 000 cells per liter (*A. tamarense* and *catenella*). Toxic episodes which followed these blooms, with toxin results above the sanitary threshold (800 µg/kg), affected oysters (*Crassostrea gigas*) in Morlaix bay with 1620 µg/kg, mussels (*Mytilus*) in Brest bay with 2430 µg/kg, mussels (*Mytilus galloprovincialis*) in Thau lagoon with 3,135 µg/kg.

ASP: Several species of *Pseudo-nitzschia* were observed on the whole French coast at high concentrations during spring, as each year. The highest concentrations were observed around the Loire estuary with a maximum of 6 500 00 cells/L. Toxic episodes, with toxin results above the sanitary threshold (20 mg/kg), were observed in Western and Southern Brittany, and between Loire and Gironde estuaries on the Atlantic coast, affecting mainly scallops. The highest toxin concentration was observed in scallops (*Pecten maximus*) in Brest bay with 285 mg/kg. In other sites the maxima stayed below 50 mg/kg.

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

4.4. National Report: The Netherlands (Marnix Poelman)

In 2015 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 based on the National Shellfish Food Safety Program and sampled monthly 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 the shellfish (mussel, oyster, ensis and cockles). In total 324 phytoplankton samples have been collected at a total of 13 sampling locations.

As in many previous years toxins have not been reported above regulatory limits. However, during the period of end of July till end of September *D. acuminata* was reported present above threshold values (100 cells/litre). The main affected areas is Lake Grevelingen. At Lake Grevelingen the presence of *D. acuminata* peaked on Lake Grevelingen with cell counts up to 8600 cells / litre. The majority of the results in this period at levels ranging from 100–1400 cell/litre. One sample in the Wadden Sea was reported above threshold limits.

Although no high toxin levels are found, back ground levels of lipophilic toxins (OA, DTX) are reported in one sample of mussels at 63 µg OA-eq /kg. Two oyster samples were found to contain 10–12.3 µg OA-eq/kg.

Besides OA and derivatives, also Cyclic Iminines are found in 2 mussel samples (Max 12.6 µg/kg 13-des Me SPX C). RIKILT, Wageningen UR has been responsible for the toxin analysis. IMARES, Wageningen UR is responsible for phytoplankton analyses.

Besides the report on back ground levels of lipophilic toxins, the Netherlands reported TTX in oyster and mussel samples. The toxins were found in an additional research program, analysing all relevant samples for TTX. In samples from July 2016, 7 samples were reported to contain TTX above the LOQ. The maximum reported value is 124 µg TTX / kg. The causative organism is not yet confirmed. This report is further described in the new finding section. RIKILT is responsible for the analysis.

4.5. National report: Germany (Allan Cembella, AWI, Bremerhaven)

No harmful algal events were reported in Germany during 2015.

4.6. National Report: Ireland (Joe Silke, Marine Institute)

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.

The main problematic species in Ireland are those producing shellfish toxins. Other blooming species that result in fish kills are rare, and red tide discolourations are also not often observed. In contrast to 2014 when the detection of an extensive and protracted series of biotoxin events led to the closure of many shellfish production areas from early summer through to year-end; 2015 showed more typical late summer/ autumnal toxicity characterised by DSP which was moderate and mainly limited to the South West. The monitoring of shellfish toxins in Ireland is by chemical analysis; supported by phytoplankton monitoring and molecular biological assays to detect the presence of both the toxin and causative organisms. Some 3111 samples shellfish samples were submitted in 2015, and a total of 11 250 analytical tests were performed on these samples with 230 of these being positive for toxin content above regulatory levels which was less than half the positives recorded in 2014. The Marine Institute scheduled extra testing and additional monitoring to ensure that the re-opening of areas was permitted at the very earliest once safe to do so.

Killary were also observed to increase above regulatory levels during August in Killary Outer.

These cell concentrations of *D. acuminata* and *D. acuta* cells were observed at moderately high concentrations during Sept, particularly in the SW. *D. acuminata* cells were observed to decrease during Oct, whereas *D. acuta* cell concentrations remained at higher concentrations during this period. This impacted on the DSP concentrations in both *M. edulis* and the non-edible tissues of the scallop *P. maximus* which remained at high levels in Sept and the beginning of October in samples submitted from Roaringwater Bay, Bantry, Kenmare and Dunmanus Bays. Towards the end of Oct, first week of November, DSP concentrations were decreasing, however site closures remained in place within these bays through until the year end.

ASP Summary : At the start of the year ASP conc.'s above regulatory levels were observed in the non-edible remainder tissues of scallops from South West classified production areas in Adrigole, Castletownbere, Dunmanus, Glengarriff (where some elevated concentrations were also observed in the Gonad tissues) & the West site at Rosmuc. ASP conc.'s above regulatory levels were also observed in the gonad tissues of scallops from offshore areas ICES rectangle 38-E4 & 37-E4

During February, there was a large population increase in the no.s of *Pseudo-nitzschia* spp. In inshore phytoplankton samples submitted due to the spring bloom observed in a number of bays in the SouthWest. DNA Molecular analysis was also conducted where it was observed the known ASP toxin producing species *P. australis* was present in a number of sites within Bantry Bay in Feb & Mar, ASP toxin analysis was conducted in samples of shellfish from these sites where typically the levels were <LOQ or Not Detected.

From March ASP conc.'s > regulatory levels were observed in the remainder tissues of scallops from a number of classified production, and the population *Pseudo-nitzschia seriata* spp. Group increased in phytoplankton samples in a number of bays in the SouthWest & South. DNA molecular analysis was also conducted where it was observed the known ASP toxin producing species *P. australis* was present in a number of sites within Bantry Bay and Dungarvan. Quantifiable ASP toxin concentration results (below reg level) were observed in samples of *M. edulis* in Castletownbere & Adrigole, and in samples of *C. gigas* in Adrigole, Dungarven and Loughras Beag. From June onwards all samples (except scallops) were either <LOD or Not Detected for ASP. *Pseudo-nitzschia* spp. Cells were observed to be decreasing from June onwards along all coasts, both in *delicatissima* and *seriata* groups, whereas in August, cell densities increased in the *seriata* group but no ASP toxicity was detected.

AZA Summary: No AZA concentrations were observed above the regulatory level during the first half of the year in samples of shellfish submitted. Low concentrations were observed during June and July. During August, increases in AZA conc.'s were observed in oysters in a number of sites along the NorthWest coast, particularly in Tra Eanach, and also in a sample of razor clams from the SouthEast, but were below regulatory levels. Along with the sharp increases in DSP toxicity within Dunmanus, Bantry, Kenmare and Roaringwater bays during the last week of August and first week of September, AZA conc.'s were also observed to increase in all mussel sites within these areas, where in Roaringwater Bay, AZA concentrations had increased to reach the regulatory level. Levels above regulatory levels were observed in mussel samples submitted from Kenmare,

Bantry, Dunmanus & Castlemaine during Sept and Oct, and in one cockle sample from Castlemaine Hbr during Oct. but these diminished by year end.

PSP Summary: PSP toxicity increased to above regulatory levels (highest conc. 1128 μg STX diHCl equivalents/Kg) during the last week of June and first week of July in mussels in Cork Harbour. PSP was also observed to increase in samples of *C. gigas* but remained below regulatory levels. PSP analysis was conducted in numerous sites, particularly along the West and South Coasts where *Alexandrium spp.* cells were observed, where no PSP concentrations were observed except at low levels in a sample of oysters in Oyster-haven.

Other HABs: A series of isolated blooms of *Noctiluca scintillans* were reported along the coast in September following a period of calm sunny weather. This resulted in orange discolourations in sheltered bays and attracted much public attention. Cell counts of several million per litre were recorded and there was associated bioluminescence observed in several locations. The blooms did not cause any reported fish kills, but there were local reports of reduced catches of lobster, crab and shrimp. The blooms dissipated after 2 weeks following increased south westerly winds.



4.7. National Report: United Kingdom

Northern Ireland: (April McKinney, Agri-Food and Biosciences Institute, Belfast)

In 2015, 19 sites were routinely sampled, fifteen of them fortnightly and the remaining four weekly from N.Ireland sea loughs and coastal waters. Results from 579 samples were reported.

The genus *Alexandrium spp.*, a potential producer of PST's (Paralytic Shellfish Toxins), was recorded in 3.3% of samples. The trigger value for *Alexandrium spp.* is set at ≥ 40 cells L^{-1} and was breached on 19 occasions during the year. A maximum abundance of 80 cells L^{-1} was recorded on the 26th May in a sample taken from a Belfast Lough site. Results from the Biotoxin Programme showed that no official control shellfish flesh samples tested during the year, from any site, contained levels above the regulatory value of 800 μg STX/ Kg.

The trigger value for the target Okadaic Acid/Dinophysistoxins/Pectenotoxins (OA/DTX/PTX); (Lipophilic toxin group) producers (*Dinophysiaceae* and *Prorocentrum lima*) is set at ≥ 100 cells L^{-1} . Cells of *Dinophysiaceae* were recorded in all seven monitored

area and in 13.5% of all samples tested. The maximum cell abundance recorded was 800 cells L⁻¹ in a sample taken from a Belfast Lough site on 29 June. *Prorocentrum lima* was counted in only 1.7 % of samples reaching a maximum abundance of 740 cells L⁻¹ in a sample taken from Carlingford Lough on 7th September. Results from the Biotoxin Programme showed that no shellfish flesh samples contained lipophilic toxins above the set European Union regulatory value of 160 µg/kg.

The potential AST (Amnesic Shellfish Toxin) producer, *Pseudo-nitzschia* spp., was present in all seven of the monitored areas with occurrence ranging from 56% of samples (Larne and Foyle) to 79% of samples (Dundrum Bay). There was also a large difference in the maximum cell abundance recorded for each area, ranging from 17 000 cells L⁻¹ in Lough Foyle to 633 200 cells L⁻¹ in Belfast Lough. The latter figure was recorded in a sample from Belfast Lough on 6th July. Three official control shellfish flesh (mussel) samples from the Biotoxin Monitoring Programme contained domoic acid above the regulatory value of 20 µg/g. These were collected on the 6th July for testing and recorded a maximum value of 58 µg/g.

England and Wales (Steve Milligan, CEFAS)

Amnesic Shellfish Poisoning (ASP) toxins:

Pseudo-nitzschia species were recorded in 449 samples from 46 production areas. The trigger level (set at 150,000 cells/L) was exceeded on 10 occasions from 8 production areas. The highest concentration was recorded in a sample from Burry Inlet: Machynys collected on 06/05/2015 (873,000 cells/L). The number of samples which exceed the trigger level each year varies considerably. There were relatively fewer breaches in 2015 and the peak concentration recorded was lower than in recent years.

794 inshore shellfish samples were tested for ASP toxins using a high performance liquid chromatography (HPLC) method (46 analysed retrospectively). ASP toxins were detected in 21 samples from 12 production areas. The greatest proportion of samples containing ASP originated from the south-west of England (17 samples). None of the inshore shellfish samples tested for ASP exceeded the maximum permitted level (MPL) of 20 mg/kg in 2015. The shellfish species affected included cockles (1 sample), mussels (10 samples), Pacific oysters (5 samples) and surf clams (5 samples).

The highest ASP concentration was recorded in April (15 mg/kg) from the Brixham production area.

Ninety-three samples of king scallops were analysed for ASP toxins, comprising 50 whole shellfish samples and 43 samples which had been shucked prior to submission to the laboratory (pre-shucked). Of the 50 whole king scallop samples, 48 contained ASP toxins, with 36 exceeding the MPL. All samples which exceeded the MPL were collected by LAs along the south west coast of England (Cornwall to Dorset). Where ASP toxins were detected in whole scallop samples, concentrations ranged from 2.9 to 178 mg/kg. Results peaked in October 2015. Of the 43 pre-shucked samples, 12 contained low levels of ASP toxins, ranging from 1.2 to 3.7 mg/kg.

Paralytic Shellfish Poisoning (PSP) toxins:

Alexandrium species were recorded in 55 samples from 19 production areas. Since 2013, the number of recorded occurrences and the concentrations detected in England and

Wales have remained comparatively low. Recorded occurrences have not exceeded 55 samples per calendar year and maximum concentrations have not exceeded 27 000 cells/L. Between 2006 and 2012, recorded occurrences exceeded 80 in each year and highest concentrations exceeded half a million cells/L. Part of this decline can be attributed to a reduction in the monitoring of sites with historic issues with PSP toxins and *Alexandrium* species (e.g. Milford Haven). Also, the lower number of recorded instances of PSP toxins in flesh samples reflects the decrease in *Alexandrium* species detection over the period from 2013 to 2015.

794 inshore shellfish samples were screened for PSP toxins using the HPLC semi-quantitative method (5 analysed retrospectively). No samples required analysis by the full quantitative method. This is consistent with the number and levels detected in 2014, however, is still markedly lower than detection rates recorded between 2010 and 2013.

Ninety-three king scallop verification samples were analysed for PSP toxins (50 whole scallops and 43 pre-shucked samples). One sample (originating from "Off Exmouth") required analysis by the quantitative method, however concentrations did not exceed the method reporting limit of 160 µg STX eq/kg.

Lipophilic toxins (LTs):

A total of 795 samples were analysed for LTs using the Liquid Chromatography - tandem mass spectrometry (LC-MS/MS) method (41 analysed retrospectively). The lipophilic toxins are sub-divided into three regulated groups.

Yessotoxins (YTXs):

Not detected in any samples received in 2015

Azaspiracid group toxins (AZAs):

Detected in 21 inshore samples, all from the south Cornish coast. Seven samples from Lantivet Bay and the Fowey production areas contained AZAs below the MPL, with results ranging from 28 to 128 µg AZA1 eq/kg between August and October.

AZAs were detected consistently in St. Austell Bay from late July to late October. Peak concentrations exceeded the MPL on three occasions; once in late August (177 µg AZA1 eq/kg) and twice in late September (251 and 188 µg AZA1 eq/kg). The St. Austell Bay production area was already closed due to the earlier presence of OA/DTX/PTX group toxins exceeding the MPL (described below).

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

Dinophysiaceae were recorded in 78 samples from 21 production areas. The trigger level (set at 100 cells/L) was exceeded by 47 samples from 17 production areas. This is a reduction in the number of trigger level breaches from 2014. However, *Dinophysiaceae* did occur more frequently and at higher concentrations than in previous years. *Dinophysiaceae* were detected consistently prior to and during toxins events at several production areas in Cornwall. The highest cell concentration (2,800 cells/L) was recorded in a sample from the Helford River, Cornwall in July.

Detected in 98 samples from 12 production areas. This is the highest number of recorded instances of LTs in inshore shellfish samples since the LC-MS/MS method was intro-

duced in 2011. Thirty-four mussel samples from six production areas contained OA/DTX/PTXs above the MPL (set at 160 µg OA eq/kg); (Table 1).

The St. Austell Bay production area recorded 16 results above the MPL between 15/06/2015 and 14/10/2015. *Dinophysiaceae*, the predominant toxin producing algal genera in this area, were detected in a water sample on the 28/05/2015, prior to the detection of OA/DTX/PTX group toxins above the MPL (297 µg/kg) on 15/06/2015. Two subsequent flesh samples, collected on the 22/06/2015 and 24/06/2015, returned results below the MPL and the production area was briefly allowed to reopen. In late June, *Dinophysiaceae* were again detected and from 09/07/2015 toxin levels increased sharply, rising above the MPL (668 µg/kg). Toxin concentrations reached a peak on 06/08/2015 of 3277 µg/kg. Toxin levels subsequently fluctuated over the following weeks but a general decreasing trend was observed. It was not until a sample collected on the 25/10/2015 that the site recorded a second consecutive result below the MPL and was allowed to reopen. Toxins continued to be detected in this production area until the end of November 2015 (due to unsafe weather conditions, the area could not be sampled in December 2015). The initial detection of this toxin group occurred at a similar time of year in 2014, although in 2015 the MPL was exceeded earlier and the occurrence of toxins has continued to the end of the reporting period. The peak concentration recorded in 2015 was lower than that recorded in 2014 (3700 µg/kg), but occurred in early August in both cases.

The Fowey production area (adjacent to the St. Austell Bay area), recorded three results above the MPL in mussel samples collected between 22/07/2015 and 06/08/2015. These samples were collected from the Pont Pill monitoring site. The highest concentration recorded during this event was from a sample collected on 22/07/2015 (425 µg/kg). Closures for this toxin group occurred at a similar time in 2014, although peak concentrations and the number of results above the MPL were lower in 2015. Of the two monitoring sites in the Fowey production area (Wisemans and Pont Pill) it is Pont Pill that has recorded the highest concentrations and the longest period of toxin occurrence in 2014 and 2015.

Lantivet Bay (also adjacent to St. Austell Bay and Fowey production areas) was a new production area for 2015. Monitoring commenced in late April. From 09/07/2015 *Dinophysiaceae* were detected consistently in water samples, with OA/DTX/PTX group toxins exceeding the MPL from 15/07/2015 to the 14/10/2015. In total, eight samples exceeded the MPL with the highest concentration (1107 µg/kg) recorded on 28/07/2015.

The Taw/Torridge production area recorded three consecutive results above the MPL in samples collected between 10/08/2015 and 25/08/2015. The highest concentration during this event was recorded in a sample collected on 10/08/2015 (260 µg/kg). The second consecutive result below the MPL was recorded in a sample collected on 07/09/2015. This toxin group continued to be detected in this production area until the end of September. This toxin group appeared at a similar time in 2014, although peak concentrations and the number of results above the MPL were lower in 2015.

The Porlock production area was introduced to the programme in February 2015. One sample, collected on 15/06/2015, exceeded the MPL with a result of 205 µg/kg. Subsequent samples recorded results below the reporting limit (<RL) and the second negative result was recorded on 15/07/2015. No *Dinophysiaceae* were recorded in this particular event.

Lyme Bay was also a new production area for 2015. The first two samples collected on the 22/07/2015 and 12/08/2015 contained OA/DTX/PTX toxins, with the latter exceeding the MPL with a result of 328 µg/kg. The subsequent two samples also exceeded the MPL with the highest concentration recorded on 27/08/2015 (339 µg/kg). The second negative sample was recorded on 21/09/2015 and no further toxins were detected from November onward.

Ninety-three king scallop verification samples were analysed for LT toxins (50 whole scallops and 43 shucked samples).

OA/DTX/PTX group toxins were detected in 6 whole king scallop samples. Two offshore samples landed at Scarborough in January and February and one from Plymouth in July returned results which exceeded the MPL for this toxin group. Two subsequent samples from Plymouth recorded results below the MPL in August. One further sample, taken from Guernsey waters, recorded toxins below the MPL in September. YTXs and AZAs were not detected in any of the whole scallop samples.

No lipophilic toxins were detected in the processed scallop samples submitted for analyses.

Table 1: Summary of sites where either ASP, PSP or lipophilic toxins were detected above the maximum permitted limits in 2015.

Toxin	Samples where toxin levels exceeded the maximum permitted level (ASP: > 20 mg [domoic + <i>epi</i> -domoic acid]/kg [shellfish flesh]; OA/DTXs/PTXs: >160 µg [OA eq.]/kg [shellfish flesh]; AZAs: >160 µg [AZA1 eq.]/kg [shellfish flesh]; YTXs: >3.75 mg [YTX eq.]/kg [shellfish flesh]; PSP: > 800 µg [STX eq.]/kg [shellfish flesh])			
	Local Authority	Production area & site	Date samples collected	Highest value reported (Shellfish species)
ASP	None	None	None	None
OA/DTXs/PTXs	Cornwall PHA	St. Austell Bay: Ropehaven Outer	15/06/2015 & 09/07/2015 to 14/10/2015 (15 samples over this period)	3277 µg/kg (Mussels)
		Fowey: Pont Pill	22 & 28/07/2015 & 06/08/2015	425 µg/kg (Mussels)
		Lantivet Bay: Sandheap Point	15/07/2015 to 22/09/2015 (7 samples over this period), 14/10/2015	1107 µg/kg (Mussels)
	Torridge DC	Taw/Torridge: Spratt Ridge East	10, 17 & 25/08/2014	260 µg/kg (Mussels)
	West Somerset Council	Porlock: Porlock Beach	15/06/2015	205 µg/kg (Pacific oysters)
	Torbay BC	Lyme Bay: Site 1	12, 19 & 27/08/2015	339 µg/kg (Mussels)
AZAs	None	None	None	None
YTXs	None	None	None	None
PSP	None	None	None	None

Scotland (Sarah Swann, Scottish Association of Marine Science)

A total of 1306 Lugol's-fixed seawater samples were analysed as part of the Food Standards Scotland Biotxin Monitoring Programme during 2015. 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 91.6% 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 8.9% of the samples, similar to the percentage recorded in 2014, with 16.9% of the samples analysed in September having greater than threshold cell densities. The earliest blooms were recorded around the Shetland Islands, Dornoch Firth (Highland: Sutherland) and Loch Scridain (Argyll & Bute) during early March. *Pseudo-nitzschia* spp. was widespread around the Highland region, Lewis & Harris, and the Orkney Islands in June and July, and then around the Shetland Islands in August. The densest *Pseudo-nitzschia* bloom was observed in Loch Ailort (Highland: Lochaber) on 21-Sep-15, where a maximum density of >1.2 million cells/L was recorded. Some associated ASP toxicity was reported in Pacific oysters from Loch Ailort at this time. *Pseudo-nitzschia* blooms were also detected nearby at Arisaig: Morar Sands (Highland: Lochaber) and in Argyll & Bute, around the Isle of Mull (Loch Scridain, Loch Na Keal) and Loch Melfort through September and into early October.

Alexandrium spp.: Cells belonging to the genus *Alexandrium* were present in 31.7% of the total samples analysed. They were recorded at or above the threshold level (set at 40 cells/L) in 21.7% of all samples. *Alexandrium* spp. was most frequently observed during April, May and June, and was recorded at or exceeding threshold level in 30.2% of the samples analysed during April. The densest recorded *Alexandrium* blooms were observed at Tingwall Pier (Orkney Islands) on 27-Jul-15 with an abundance of 10,400 cells/L, and Loch Eishort (Highland: Skye & Lochalsh) on 25-May-15 with an abundance of 9,600 cells/L. Highly toxic *Alexandrium* blooms were detected around North Ayrshire and Argyll & Bute during April and May, most notably Arran: Lamlash Bay, Campbeltown Loch, Loch Striven, Loch Fyne: Otter Ferry and Loch Fyne: Ardkinglas. PSP toxins were detected in common mussels sampled from Campbeltown Loch (Argyll & Bute) at more than 34 times the regulatory limit of 800 µg STX eq. kg⁻¹, and in common mussels from Arran: Lamlash Bay (North Ayrshire) at more than 25 times the regulatory limit. Blooms associated with PSP toxicity also occurred throughout the Highland region in May and June around Loch Eishort (Skye & Lochalsh), Loch Torridon (Ross & Cromarty), Loch Laxford and Loch Inchard (Sutherland). Toxic *Alexandrium* blooms were observed in Loch Roag: Miavaig and Loch Roag: Barraglom (Lewis & Harris) in early July. *Alexandrium* blooms at or exceeding threshold level were less frequently detected in 2015 compared with both 2013 and 2014, which may be due in part to the absence of prolonged blooms around the Shetland Islands, in contrast to previous years.

Dinophysiaceae: Algal cells belonging to the family Dinophysiaceae, which includes the genus *Dinophysis* and *Phalacroma rotundatum* (synonym *Dinophysis rotundata*), were present in 42.2% of the samples analysed during 2015 and were detected from February to October. Cells were observed at or above threshold level (set at 100 cells/L) in 19.3% of the samples, similar to the percentage recorded in 2014. The earliest bloom exceeding threshold level was recorded in Loch Melfort (Argyll & Bute) in late April. Dinophysiaceae remained in Loch Melfort at or above threshold level for a continuous period of sixteen weeks, from late May until mid-September. Overall, the majority of Dinophysiaceae blooms occurred around the Scottish coast in July and August, with 51.5% of the samples exceeding threshold counts in July. The densest Dinophysiaceae blooms were both observed in north-west Scotland in Highland: Ross & Cromarty. An abundance of 16,960 cells/L was recorded in Loch Torridon on 30-Jun-15, and 9,540 cells/L in Loch Ewe on 28-Jul-15. Dinophysiaceae 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 Roag (Lewis & Harris) in July and August. Although *Dinophysis acuminata* type cells tend to dominate Dinophysiaceae blooms around the Scottish coast, a bloom of *Dinophysis acuta* was observed in south-west Scotland in late summer, reaching a maximum density of 1,780 cells/L at Barassie (South Ayrshire) on 25-Aug-15. This bloom was accompanied by a shift in the profile of DSP toxins found in common mussels, with an increase in the amount of dinophysistoxin-2 detected. The blooms of Dinophysiaceae that were observed around the Shetland Islands in July and August 2015 were not as dense as those that occurred in 2013, although Dinophysiaceae recorded in August and September did have some associated DSP toxicity.

Prorocentrum lima: *Prorocentrum lima* was present in 14.3% of the samples analysed during 2015 from March to December, and was generally most abundant in June and July. It was detected at or above the threshold level (set at 100 cells/L) in 1.4% of samples. It was most frequently observed in samples from Colonsay: The Strand East and Loch Melfort (Argyll & Bute), Traigh Mhor (Uist & Barra) and Tingwall Pier (Orkney: mainland). The densest bloom of 2015 of 500 cells/L was recorded in Vaila Sound: East of Linga (Shetland Islands) on 12-Aug-15.

Other species: *Protoceratium reticulatum* was recorded at low concentrations in 2.5% of samples between March and September, and was most frequently observed in April and May. The densest bloom occurred in North Ayrshire, with 180 cells/L recorded in Arran: Lamlash Bay on 07-Apr-15, and some associated YTX toxicity at this site.

Lingulodinium polyedrum was detected from June to September 2015 on only seven occasions (0.5 % of samples). It occurred most frequently in Loch Creran, where it appears to bloom annually, although it is rarely abundant. One other observation was recorded in Loch Leven (Highland: Lochaber), as was the case in 2014. A maximum bloom density of 380 cells/L was observed in Loch Creran on 26-Aug-15.

Prorocentrum cordatum was present in 53.1% of samples analysed in 2015. It was observed from February through to October and was most abundant in May and June, being recorded in 81.9% and 81.7% of the samples analysed, respectively. The densest blooms of 2015 occurred in Largo Bay (Fife) at a concentration of 162,769 cells/L on 13-Jul-15, and also in Braewick Voe (Shetland Islands) at 123,898 cells/L on 03-Jun-15.

Similar to 2014, the potentially problematic dinoflagellate *Karenia mikimotoi* was not observed in densities likely to negatively impact aquaculture during 2015, and was detected in only 3.5% of the samples analysed. The densest *Karenia mikimotoi* bloom was observed in Arran: Lamlash Bay on 07-Apr-15, with an abundance of 340 cells/L.

4.8. National report: Norway (Lars Johann Naustvoll, IMR, Flodevigen)

The national monitoring program for HA in Norway had a total of 44 stations in 2015. The program covers the Norwegian coast from south at the Swedish boarder to Tromsø in the northern Norway. The program ran from March to November 2015, 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>.

Along the Skagerrak coast the main problem in 2015 was DSP/*Dinophysis*. DSP and *Dinophysis* cells appeared in early May and were present throughout the monitoring period at one or several monitoring sites. The inner and eastern part has more problem with *Dinophysis*/DSP then the south-west part of Skagerrak where *Dinophysis*/DSP only were observed above warning levels from July and in the autumn. PSP/*Alexandrium* were present during the spring and result in closure for shorter periods in April-May.

From Rogaland (south coast) and up to Trøndelag (middle of Norway) the main problem were PSP/*Alexandrium* in 2015. The presence of PSP/*Alexandrium* result in closures at most monitoring sites from late March to May in this area. The dominating PSP producing species were *Alexandrium tamarense* during this period. At some few stations DSP/*Dinophysis* were above warning levels in autumn.

At some few stations in Trøndelag (mid Norway) there were no or few problems with HA species and toxic accumulation. Most of these sites are located in the outer coast. From northern part of Trøndelag and up to Nordland there were shorter periods with closures due to DSP/*Dinophysis* in March and June at the southern stations. Whereas at stations in the northern area *Alexandrium tamarense* resulted in closures in April – May. In the Troms county *Alexandrium* resulted in accumulation of PSP above warning levels from June to September.

Azaspiracids were only found above warning levels at one station at the south coast of Norway in November.

4.9. National report: Sweden (Bengt Karlson, SMHI, Gothenburg)

Harmful Algal Blooms (HAB's) are recurrent phenomena in the waters surrounding Sweden and most are likely to be of natural origin. 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 biotoxins that accumulate in filter feeders (e.g. mussels) is the major concern. 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 Bothnian bay and the Bothnian Sea: Surface accumulations of cyanobacteria were observed from satellite in offshore parts of the Bothnian Sea from 10 August to end of August. No harmful events, such as accumulations of cyanobacteria on beaches, from these offshore blooms were reported on the Swedish coast. A coastal bloom of the cyanobacteria *Dolichospermum lemmermannii* was observed in Norafjärden in early August. A local bloom of unidentified cyanobacteria was observed on 21 September in the yacht harbour of Hudiksvall.

The Baltic proper: Surface accumulations of cyanobacteria were observed in the archipelago of Stockholm in early July (Figure 1). Also later in July surface accumulations were observed along the Swedish coast, e.g. on July 17th between Västervik and Oskarshamn. Satellite observations of cyanobacteria from the Baltic Algae Watch System (Swedish Meteorological and Hydrological Institute) show some surface accumulations in July but the surface accumulations were mainly observed in August. Intensity was moderate and the bloom was mostly off shore. During a monitoring cruise in late July toxic species *Nodularia spumigena* was common. Also the non-toxic species *Aphanizomenon flos-aquae* was common as well as *Dolichospermum* sp. These three taxa were common also during a 4–7 August.

This year was unusual in the sense that most observations of surface scums of cyanobacteria in off shore waters observed from satellite were noted in August. In most years blooms have been observed mainly in July. It is possible that this is due to the unusually cold, cloudy and windy weather in July. Turbulence caused by wind mixes the cyanobacteria in the water column and surface accumulations are less likely to form. Clouds make satellite observations of cyanobacteria (ocean colour) impossible. Low water temperatures may cause lower growth rates of cyanobacteria. However, the cyanobacteria may have been blooming but they simply did not form surface accumulations that were observed from satellites. FerryBox data on phycocyanin fluorescence indicate that off shore blooms occurred also in July.



Figure 1. Surface scum of cyanobacteria at the island of Yxlan in the county of Norrtälje, 1 July 2016. Source The information centre for the Baltic Sea, County administration board of Stockholm.

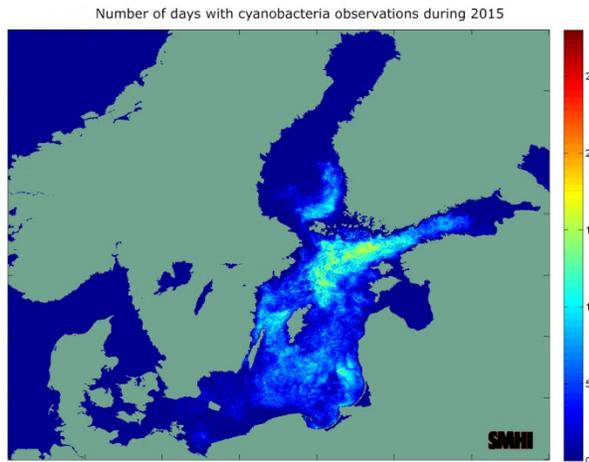


Figure 2. Number of days of satellite cyanobacteria observations in the Baltic Sea June-AUGUST 2015. From: Öberg, J. 2015. Cyanobacterial blooms in the Baltic Sea in 2015, HELCOM Baltic Sea Environment Fact Sheet 2015, Published on 3 March 2016.

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

The Skagerrak and the Kattegat: During 2015 no major harmful algal blooms occurred in the area. In spring *Alexandrium* sp. caused increased levels of paralytic shellfish toxins in blue mussels. Only one sample had a concentration above the regulatory limit. In autumn *Dinophysis* spp. caused levels of Diarrhetic Shellfish Toxins above the regulatory level in blue mussels.

Observations of potentially harmful species:

The Kattegat

- *Prymnesiales* bloomed in April and May
- *Alexandrium* spp. over the warning limit in April and June
- *Pseudo-nitzschia* spp. over the warning limit of 100 000 cells L⁻¹ in November and December

The Skagerrak

- *Prymnesiales* 1 300 000 cells L⁻¹ in April
- *Alexandrium* spp. over the warning limit in April and May max 6300 cells L⁻¹
- *Dinophysis acuta* in autumn
- *Karlodinium veneficum* in October
- *Karenia mikimotoi* on the coast in October and November
- *Heterosigma akashiwo* in the fjords in November
- *Pseudo-nitzschia* spp. over the warning limit in November and December max 310 000 cells L⁻¹

Toxins in shellfish: Commercial harvesting of shellfish is only carried out along the Skagerrak coast (eastern part of the North Sea). In European flat oysters (*Ostrea edulis*), pacific oysters (*Crassostrea gigas*) and cockles (*Cerastoderma edule*) concentrations of algal toxins (DST, PST, AZT, YTX and AST) above the regulatory level were not detected. One exception is that one sample of *Ostrea edulis* had DST above the regulatory level of 160 µg kg⁻¹. Results regarding blue mussels (*Mytilus edulis*) are found below)

DST: Concentrations of Diarrhetic Shellfish Toxins (DST)) above the regulatory limit were detected in blue mussels (*Mytilus edulis*) collected at the Swedish Skagerrak coast causing closures of harvesting of wild and farmed mussels in some areas (Figure 3).

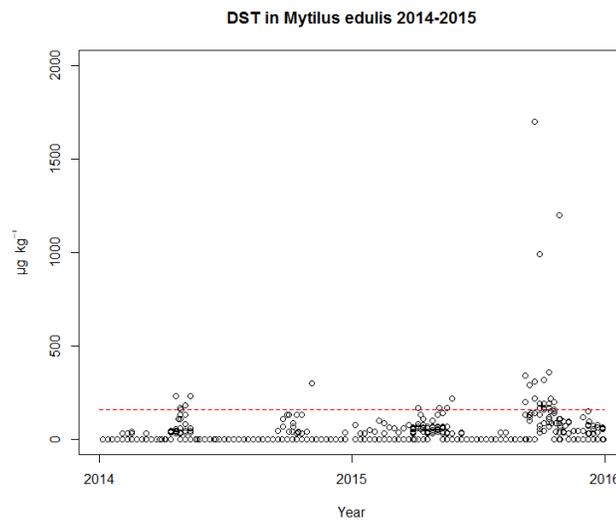


Figure 3. Concentrations of Dinophysis Shellfish Toxins in blue mussels from the Swedish Skagerrak coast 2014/2015. The red line denotes the regulatory limit Data from the Swedish National Food Agency monitoring program.

PST: Concentrations of Paralytic Shellfish Toxins (PST)) above the regulatory limit were detected in blue mussels (*Mytilus edulis*) collected at the Swedish Skagerrak coast (Figure 4) causing closures of harvesting of wild and farmed mussels in some areas. The problem occurred in spring.

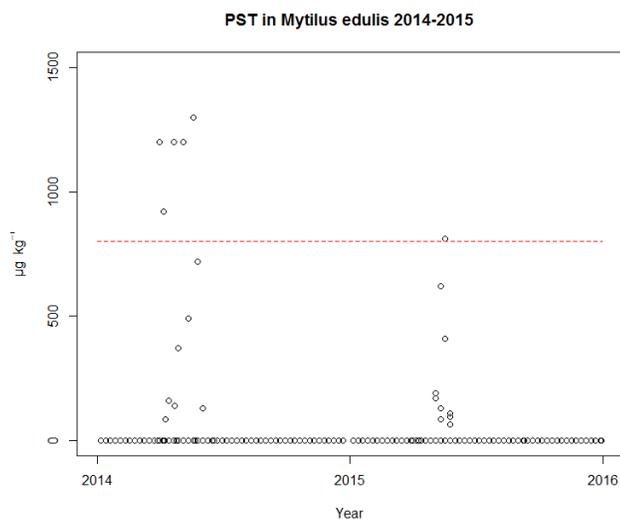


Figure 4. Concentrations of paralytic Shellfish Toxins in blue mussels from the Swedish Skagerrak coast 2014/2015. The red line denotes the regulatory limit Data from the Swedish National Food Agency monitoring program.

4.10. National report: Poland (Justyna Kobos & Hanna Mazur-Marzec)

In the open and coastal waters of the Gulf of Gdańsk, cyanobacterial blooms occurred during the summer of 2015. This is an annual event but they were recorded later, compared to previous years (probably due to shift in summer temperature maximum). In July, the non-toxic species *Aphanizomenon flos-aquae* Ralfs ex Bornet & Flahault dominated the bloom. In August, massive bloom of nodularin-producing *Nodularia spumigena* Mertens ex Bornet & Flahault was observed. Additionally, the presence of microcystin-producing *Dolichospermum lemmermannii* (Richter) P.Wacklin, L.Hoffmann & J.Komárek was recorded. In coastal areas, the highest biomass of *N. spumigena* (3,016.5 mg/L) and the highest concentration of nodularin (35 280.0 µg/L) were recorded on 11 August. In the samples collected on that day, *D. lemmermannii* (58.0 mg/L) was also present and two microcystins variants were detected: MC-LR (87.7 µg/L) and MC-YR (26.7 µg/L). LC-MS/MS analysis did not reveal the presence of anatoxin-a. The biomass of co-occurring *Aph. flosaquae* was 85.8 mg/L.

Similarly to previous years, *Alexandrium ostenfeldii* (Paulsen) Balech & Tangen was observed in Puck Bay (inner part of the Gulf of Gdansk) in the August. The highest cell number of this species (collected on 05 August) was only 67 cells/L.

Poland has about 98 bathing places located on the Baltic coast. Each year thousands of tourists spend their holidays on the beaches. To be in line with the EU Bathing Water Directive (2006/7/EC), the water quality and the presence of cyanobacteria at these sites are monitored. In the 2015, between 2/3 July and on 4 August, due to water discoloration, warnings were given and 3 beaches were closed. Other incidents of beach closure were between 10–14 August. During that time, 12 beaches were closed per 1–5 days due to the massive occurrence of toxic cyanobacteria. All they were located in Pomeranian District: Gulf of Gdansk; area code PL-01.

3.1.1. National report: United States of America (Don Anderson, WHOI)



New England (Regions 1-6)

The New England region once again experienced relatively moderate levels of PSP toxicity in 2015 where localized blooms in the Nauset Marsh in Massachusetts closed the shellfishery and more extensive blooms quarantined shellfish beds from the Star Island, New Hampshire to eastern Maine. In addition, DSP toxicity in Massachusetts was recorded in shellfish from Salt Pond located on the northern flank of the Nauset Marsh system

PSP: In Massachusetts the entire Nauset Marsh Estuary was closed due to PSP toxicity from 5/8 – 6/11/15 as a result of one assay, 84 µg/100g shellfish (blue mussels) on 5/18/15 which was above the regulatory limit.

Connecticut reports that they have had no HAB events in the waters of Long Island Sound within the past 10 years.

Along the New Hampshire coastline, region 3, PSP concentrations exceeded quarantine levels on 5/12/15 when 102µg/100g shellfish was reported for Star Island. Prior to that, and following, as well as along the rest of the New Hampshire coast, PSP levels were below regulatory limits.

The eastern coastline of Maine experienced PSP closures from 6/22 – 8/1/15 with toxin concentrations as high as 484 µg/100g shellfish determined by HPLC. Western Maine shellfish beds were closed from 5/20 – 6/30/15 with lower levels of toxin (186 µg/100g shellfish) while the shellfish in the Penobscot region did not reach quarantine levels for PSP.

ASP: Three regions along the Maine coastline were closed in 2015 due to domoic acid toxicity. On 6/1/15 the western Maine area was closed until 6/30/15 and this was followed by closures in eastern Maine and the Penobscot region on 8/1/15 which lasted until 9/1/15. Toxin levels ranged from <0.8 to 5.5 ppm DA in *Mytilus edulis* and *Pseudo-nitzschia* cell densities of over 375 000 cells/L were enumerated. The Penobscot region, traditional-

ly has had consistent *Pseudo-nitzschia* blooms in the recent past, whereas, they tend to be more intermittent in western and eastern Maine areas.

DSP: For the 1st time, a waterway in Massachusetts, Salt Pond on the northern flank of the Nauset Estuary, was closed due to DSP toxicity. Persistent high densities of *Dinophysis acuminata* (>1 million cells/L at time) were recorded for several months beginning in April and this was followed by shellfish toxicity on 6/30/15 until 8/20/15 as DSP toxin levels of 9.0 to 19.0 µg/100g shellfish were measured by the FDA. The regulatory threshold in Massachusetts is 16.0 µg/100g shellfish. High densities of *D. acuminata* have been documented in many saltwater embayments in Massachusetts and the Northeast in the past but due to the low levels of toxin produced by these cells, shellfish toxicity has not been found.

New York (Long Island; Region 8)

PSP: In 2015, for the 1st time since 2007, there were no shellfish closures due to PSP toxicity on the north shore or eastern end of Long Island, NY. This year, closure limits >80µg/100g shellfish were reported in Meetinghouse Creek, and Shinnecock Bay and for the first time in James Creek where toxin concentrations of 350µg/100g shellfish were found. The highest PSP concentrations measured in blue mussels during the April through June bloom events was 540µg/100g shellfish with maximum *Alexandrium fundyense* cell densities of 47 000 cell/L recorded.

DSP: Northport Bay, and Cold Spring Harbor both experienced high cell concentrations of *Dinophysis acuminata* of up to 10 000 cells/L but no DSP toxicity was detected. Last year, DSP toxin levels of 20 µg /100g shellfish in blue mussels and soft shell clams in the Northport Bay and Cold Spring Harbor regions were recorded.

Brown tide: For the ninth consecutive year high *Aureococcus anophagefferens* concentrations (maximum, 800 000 000 cells/L) were recorded from May through September in Great South Bay, Moriches Bay, Quantuck Bay and Shinnecock Bay.

Cochlodinium: The Peconic Bay Estuary, Shinnecock Bay, Weesuck Creek, Sag Harbor, Accabonic Harbor and Three Mile Harbor all experienced *Cochlodinium* blooms with cell densities up to 13 000 000 cells/L during the months of August and September.

Maryland and Virginia (Chesapeake Bay; Region 10)

Gymnodinium aureolum: The Saint Martin River within the Chesapeake Bay system had the first reported algal bloom in March of 2015 accompanied by water discoloration caused by *Gymnodinium aureolum* with maximum cell concentrations at 3.7×10^6 cells/L.

Dinophysis acuminata: From mid-April through mid-May, routine monitoring in the Saint Martin River, Assawoman Bay and its creek tributaries showed the presence of *Dinophysis* sp. which appears to be morphologically similar to *D. acuminata*. Ongoing analysis is being conducted to genetically to characterize it. Peak cell concentration were 2.4×10^4 cells/L and ribbed mussels tested using the PP2A inhibition assay were positive for okadaic acid, but at levels below regulatory limits.

Alexandrium sp.: At the end of May, there was a bloom of *Alexandrium* in the Saint Martin River and lower Assawoman Bay. The maximum cell concentration was 1.3×10^5 cells/L and preliminary genetic analyses suggest this species is in the *A. minutum*-complex.

Ribbed mussels tested during the peak of this bloom were negative for saxitoxin by mouse bioassay.

Chattonella cf verruculosa: Blooms of *Chattonella cf verruculosa* occurred in the Saint Martin River and in Grey's Creek (on the MD – DE border) from the end of June through the end of July. The maximum cell concentration was 1.2×10^7 cells^{-L}. Samples from these blooms were negative for brevetoxin by LC/MS testing. Despite the presence of high biomass and potentially toxic species, no adverse environmental impacts were noted.

Heterocapsa triquetra and *H. rotundata*: The Chesapeake Bay experienced its annual *Heterocapsa triquetra* and *H. rotundata* blooms, noted as water discoloration, in March through April. *H. triquetra* blooms were centred around the lower James River and reached 8.4×10^7 cells^{-L}. *H. rotundata* blooms were found throughout the Bay and its major tributaries with a maximum concentration of 4.9×10^7 cells^{-L} occurring in Baltimore Harbor.

Cochlodinium polykrikoides & *Alexandrium monilatum*: *Cochlodinium polykrikoides* bloomed in the meso- and polyhaline stretches of the York and James Rivers, as well as the Hampton Roads area of the lower Chesapeake Bay, from June through August. Peak cell concentrations were 4.2×10^7 cells^{-L}.

Alexandrium monilatum bloomed in the Hampton Roads area and along Virginia Beach's Atlantic coastline during August. Maximum cell concentrations were 7.6×10^6 cells^{-L}. Although toxicity has been demonstrated with both of these species in laboratory bioassays, in 2015 there were no environmental impacts in the lower Chesapeake Bay environments outside of discoloured water (both species) and bioluminescence (*A. monilatum*).

Prorocentrum minimum and *Karlodinium veneficum*: *Prorocentrum minimum* and *Karlodinium veneficum* were found throughout the Maryland coastal bays and the Chesapeake Bay throughout the year. However, *P. minimum* did show two distinct blooms in 2015. The first bloom occurred in May in the Rappahannock River with a maximum cell concentration of 5.5×10^6 cells^{-L}. The second bloom occurred in December in Baltimore Harbor with a maximum cell concentration of 1.2×10^7 cells^{-L}. With both of these blooms, the water was discoloured but no other environmental impacts were noted.

For most of these reported blooms, samples were collected through routine monitoring programs that were scheduled on a weekly to monthly basis. Samples were surface water samples or samples collected as water column composites above the pycnocline.

North Carolina, South Carolina and Georgia (Regions 11, 13, 14)

In 2015 there were no HAB events in any of these waters aside from microcystin toxicity with associated fish kills in some brackish coastal ponds in South Carolina.

Florida (Regions 15–16):

NSP: Patchy *Karenia brevis* blooms occurred on the west coast of Florida as well as in the northern Panhandle waters. Both blooms occurred in the fall through winter months resulting in fish kills (multiple species) and respiratory problems in humans associated with the bloom along the west coast. The west coast bloom reached cell densities of 41.9 million cells /L; the Pan Handle bloom reached 10.8 million cells/L. There were no reports of *Karenia brevis* on the east coast. Shellfish toxin levels of 95 MU/100g shellfish were

measured in the Pan Handle region, while on the west coast, toxicity values of up to 34 MU/100g shellfish were found.

PSP: *Pyrodinium bahamense* blooms of up to 6.5 million cells/L were present in Indian River Lagoon on the east Florida coast. The bloom lasted approximately five months and shellfish beds were closed from 1 July to 14 October 2015 as saxitoxin concentrations of up to 137 µg/100 g shellfish were found in hard shell clams (*Mercenaria mercenaria*). No human illnesses were reported.

Brown tide: Time series monitoring indicates that *Aureoumbra lagunensis* commonly occurs in Indian River Lagoon phytoplankton assemblages. Increased abundance of this organism was observed beginning in September and continues through March of 2016, with densities over 100 000 000 cells/L through much of the northern and central area of this waterway.

ASP: No ASP toxicity was reported in Florida waters in 2015.

Alabama (Region 17)

An infrequent NSP event occurred along the north Gulf of Mexico coastline from the Florida Panhandle to Louisiana. In Alabama, high densities of *Karenia brevis* were detected on November 16th, 2015 and these persisted until early January 2016. Resulting from this was NPS toxicity causing shellfish closures from 11/16/2015 until 1/31/2016 with NSP toxin levels >20MU detected with mouse bioassay. Previous to this bloom, the last reported shellfish closure in Alabama waters was in 2007.

In Mississippi, cell concentrations of more than 1 million cells/L were recorded causing beach and shellfish closures from late November to early January 2016. Dead fish and dolphin mortalities have also resulted from the *Karenia* bloom.

The Louisiana Department of Health and Hospitals closed Oyster Beds east of the Mississippi River in December as a result of the extensive and high density *Karenia* bloom affecting the northern gulf shore.

Texas (Region 18)

NSP: *Karenia brevis* blooms from Freeport south to the U.S./ Mexico border were observed from September 13 to late November 2015. Cells densities up to 134 000 cells/L caused water discoloration, fish kills and shellfish toxicity in various locations and times. The greatest fish kill impact was along the southern gulf shores from San Jose Island to U.S./Mexico border. Menhaden kills at Quintana beach and Sargent beach are also suspected to be red tide related. The greatest fish kill impacts within the bays were in Corpus Christi Bay, the northern area of the Upper Laguna Madre and the Lower Laguna Madre. Fish kills were also observed in the Matagorda and San Antonio Bay systems.

DSP: No shellfish closures related to DSP toxins were reported.

Brown Tide: The Laguna Madre experienced a significant *Aureoumbra lagunensis* brown tide bloom during the month of April.

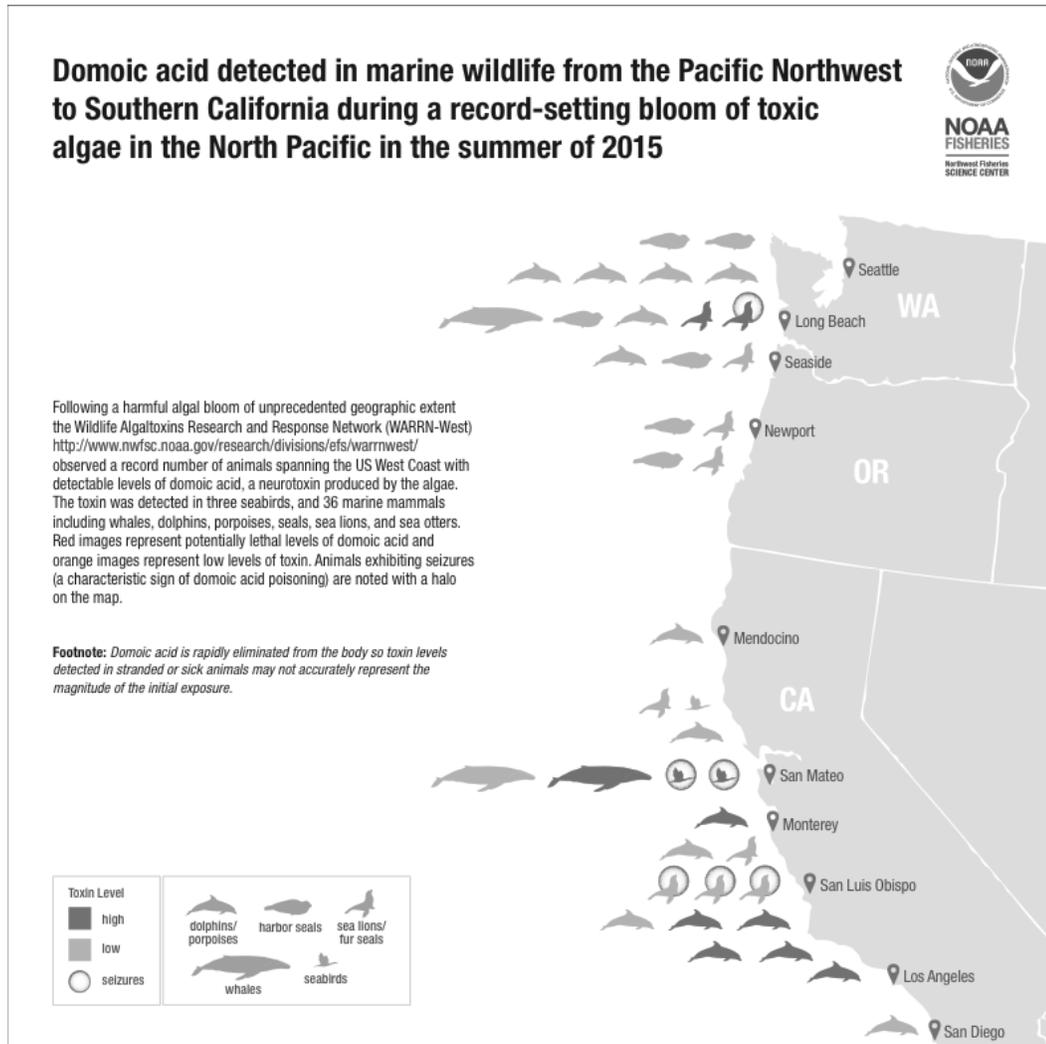
The US Continental West Coast

In April through September 2015, high domoic acid concentrations were found in 3 seabirds, and 36 marine mammals of various types. Figure 1 shows the geographic distribution of these observations.

California (Regions 19–21)

PSP: There were no closures due to PSP toxicity in California in 2015

ASP: There were extensive ASP related closures along the California coastline as a result of a massive *Pseudo-nitzschia seriata* (complex) bloom that first began on 3 April in the Monterey Bay area with closures first implemented on 29 April. Two weeks later, the waters around Santa Barbara were closed to shellfishing as a result of high domoic acid levels and the ASP toxicity extended northward along the entire California coastline to the Oregon border, where traditionally, ASP toxicity is less frequent. Concentrations of domoic acid of 180 ppm in California Mussels; 170 ppm in Bay Mussels, and 1000 ppm in Rock Crab viscera closed the region 19 area to shellfishing on 12 May. Areas reopened on July 13th for bivalve shellfish while rock crab retained elevated levels of domoic acid through February 2016.



In region 21, central to northern California, California Mussels were found to contain 96 ppm DA; Razor clams, 340 ppm; Rock Crab viscera, 190 ppm; Dungeness Crab viscera, 270 ppm; Anchovy viscera, 1298 ppm; Sardine viscera, 220 ppm.

The Monterey Bay bivalve shellfishery, which closed on 29 April, was reopened on June 10 while rock crab remained toxic into 2016. On 16 August, Humboldt County after about a 1-month closure, was reopened to bivalves except razor clams, which remained at elevated DA levels through March 2016 and Dungeness crab remained toxic through March 2016 in some areas as well.

In 2015, just over 220 California sea lions stranded alive along the central California coast due to domoic acid toxicosis, representing approximately 10 % of the stranded sea lions in that area. Other animals stranded emaciated due to prey shifts associated with warmer coastal waters in the area. In 2014, 250 sea lions stranded alive along the same coastline due to domoic acid toxicosis, representing about 20 % of the total live stranded sea lions. In 2015, cases of domoic acid toxicosis were also observed in 3 Guadalupe fur seals.

DSP: As was the case last year, there were no reports of DSP toxins in shellfish this year.

Oregon (Region 22)

PSP: PSP toxin levels reached 428 µg/100g shellfish in mussels resulting in closures from the mid-north coast to a little north of the California border on 9 May 2015. This closure was extended to the Columbia River (north boundary of the state) on 22 May. Mussels remained below 80µg/100g shellfish at the Gold Beach sampling location, so, from that point south, remained open the entire year.

Harvesting of mussels began to be opened up on 22 June from the mid-north coast, and by 17 July for the remainder of the coast.

The closure was only for mussels and did not extend to oysters or clams as neither of these saw any significant levels of PSP during this time

ASP: A domoic acid closure in one section of the Oregon coast from Tillamook Head (south of Seaside) to the California border began in September of 2014 and has continued through the end of 2015; levels climbed to 170 ppm in razor clams whereas in 2014 the concentrations were 53 ppm. There was a delay in the Dungeness crab season opening due to concerns over domoic acid levels in the crabs. Levels up to 70 ppm were found in the viscera prior to the season opening. Normal season opening is December 1st, however, the season did not open till later in January 2016 meaning that the industry lost out on the important Christmas and New Year holidays to sell crab. It's unclear what this ultimate economic impact of this will be, but it was a significant blow.

The razor clam fishery was also negatively impacted with the harvest season closed for part of the year. This affected the commercial fishery and continues to impact the recreational razor clam fishery for most of the coast. The razor clam closure remains in effect for most of the coastline for recreational harvesting.

Washington (Regions 23–24)

The Washington State coastal waterways which encompass regions 23 and 24 are plagued by HAB events caused by *Alexandrium fundyense*, *Dinophysis* spp and *Pseudo-nitzschia* spp and the situation became more pronounced as for the 1st time, PSP toxicity was detected in the Hood Canal growing area. A breakdown of the various events follows.

PSP: For the 4th year in a row, the central Puget Sound experienced PSP toxicity which caused closures from 7/29/15 until 11/4/15 with toxin concentrations ranging from 86 to 880 µg/100g in blue mussels, butter clams and geoduck clams. In the northern end of Puget Sound higher PSP values were recorded (319-1581µg/100g shellfish) from 4/14/15 to 8/28/15. A more long-lasting closure occurred throughout the Straits of Juan de Fuca where PSP up to 506 µg/100g shellfish was detected in shellfish from 4/2/15 – 10/16/15 as a result of high densities of *A. fundyense*. Along the coastal beaches and estuaries, PSP toxicity (93–253 µg/100g shellfish) was found from 5/29/15 to 6/16/15.

In the Hood Canal region, PSP toxicity expanded further south than previously recorded and shellfish beds in that region had to be closed from 4/30/15 to 7/21/15. Coincident with the closure, toxin values ranged from 105 to 1031µg/100g in a variety of shellfish including blue mussels, geoduck, manila, pacific and varnish clams.

ASP: As noted previously, commercial fishery closures resulting from ASP were a major problem not only for shellfish but also for the Dungeness crab seasons. ASP toxins rang-

ing from 62 to 169ppm were found from May 7th 2015 until February 2016 resulting in razor clam and Dungeness crab closures. The Dungeness crab season closed on 6/5/16 for the southern Washington coast and 8/3/15 for the northern Washington coast. Recreational Dungeness crab season reopened 9/25/15 and the commercial season did not reopen until 1/4/16. All told, this was a huge economic loss to the Washington State coastal community.

DSP: The north Puget Sound waters were closed to shellfish due to DSP toxicity from 6/8/15 to 7/24/15 with maximum toxin concentrations of 19µg/100g shellfish measured by LC/MS. In the central Puget Sound area from 15 July until 9 December 2015, DSP toxins up to 157µg/100g shellfish were measured in blue mussels which resulted in bed closures. In the south Puget Sound waters, DSP was recorded on 10/6/15 and has persisted into March of 2016 with toxin concentrations of 43µg/100g measured in blue mussels. DSP toxins were also found in the Straits of Juan de Fuca where shellfish measurements from 16 to 43µg/100g were found from 6/12/15 to 12/4/15. Since the first DSP toxicity and resulting closures reported in 2011, DSP has become a serious and persistent problem for Washington state.

Heterosigma fish kills: There were no reported fish kills due to *Heterosigma* in 2015.

Alaska (Regions 25–27)

ASP: Much warmer than normal water and air temperatures as a result of an unusually persistent high pressure ridge that first developed in 2013 on the USA and Canadian west coasts, and the significant El Niño event that continued along the Alaskan coastal areas during the spring and summer of 2015. Accompanying this were low nutrient values in Alaska coastal waters including Kachemak Bay recorded by NOAA and also in Gulf of Alaska by University of Alaska and other researchers. Additionally, satellite imagery revealed a persistent and extensive bloom of *Pseudo-nitzschia australis* extending along the entire continental shelf from Ketchikan to the Aleutian Islands. Toxicity testing of water samples from this bloom revealed very low DA concentrations, and ASP toxins in shellfish samples from May through September 2015 in region 25 were also low. At least 45 whale strandings were reported in the Gulf of Alaska in 2015 with a possible link to domoic acid poisoning being investigated with sand lance, herring and krill as potential toxin vectors. Dead Sea otters, sea lions and birds were also found along Gulf of Alaska coastlines but the cause of death is unknown as of now. It is hypothesized that 100 000 murrelets died due to starvation as a result of PSTs and DA reducing zooplankton populations and disrupting the food web.

Pseudo-nitzschia australis has been shown to produce domoic acid in the past in other regions, and it was the causative toxic species along the California coast this year. Studies have shown that this species typically produces more toxin when subjected to nutrient stressed conditions, and as noted above, Gulf of Alaska waters were nutrient poor this year so it is interesting that water samples collected during the *P.australis* bloom did not contain high domoic acid levels.

PSP: Mussels, butter clams, krill, sand lance, herring and Dungeness crab in region 25 all had measurable amounts of saxitoxin with the maximum concentration of 1135 µg/100g shellfish determined by HPLC by the Alaska Department of Environmental Conservation and Environmental Health Lab. In region 26, concentrations up to 6580 µg/100g were

found in shellfish (blue mussels, butter clams, sand lance, herring). One False Pass gull tested positive for PSP. PSP toxicity caused production value decreases in some areas as a result shellfish closures and a direct loss of subsistence and personal use of bivalve clams and Dungeness crab was also realized. In Kachemak Bay, for the first time in 10 years, a toxic HAB event was recorded as PSP was detected in 2 sub-bays in oysters and blue mussels.

4.12. National report: Canada

West Coast

The west coast of Canada experienced a massive *Pseudo-nitzschia australis* bloom, similar to the bloom described in the United States report. The bloom first appeared off the coast of Vancouver Island in May 2015 with closures for shellfish harvesting occurring along Vancouver Island north of Tahsis. The bloom continued and expanded along the entire coastline, appearing to peak around 17 June 2015. The entire west coast was closed throughout June. Levels were decreasing by 29 June. Domoic acid levels in mussels were 10X less than those reported in the U.S. in razor clams probably due to the rapid depurate rates in mussels compared to razor clams which are the standard test organism for CFIA in Canada.

East Coast

PSP: Cheney's Passage and Grand Manan, New Brunswick, the Bay of Fundy, were closed to soft shell clam harvest, *Mya arenaria*, 10 July 2015 due to values above 80 ug 100g STX equiv. It was reopened 20 August 2015. Newfoundland and the Gulf of St. Lawrence did not experience any shellfish closures in 2015.

DSP: No DSP related closures were reported in 2015 in Atlantic Canada.

ASP: Only one location in Quebec (CA 01) had levels of domoic acid above 20 ug/g (23 ug/g) and these levels fluctuated from 22 July 2015 to 1 October 2015. It is speculated that these levels are not a result of a bloom in 2015 but residual toxicity from a large toxic bloom in July 2013. *Placopecten megallanicus*, the test organism for these values, is known to require long periods of depuration and an indication of these residual values.

Annex 5: ToR d) Phytoplankton monitoring guidelines

NOTES FROM THE WORKING GROUP ON MONITORING OF TOXIN PRODUCING PHYTOPLANKTON 12th April 2016, Madrid. (Joe Silke, Marine Institute, Ireland)

Topics discussed included:

Sampling frequency

Objective is to advise the commission on **establishing guidelines for phytoplankton monitoring in Europe**. Phytoplankton monitoring is required in shellfish producing waters, but the purpose is ill defined, the frequency and sampling/analysis methods are not prescribed and the species to be monitored are not stated in the legislation.

It is desired to prepare a **harmonised guideline** on sampling frequency in order to use phytoplankton to trigger risk based shellfish testing and increase flesh testing frequency. It is expected that a minimum sampling frequency of weekly would be advised, with exceptions made during low risk periods. However this could result in a resolution problem.

Detection of toxic species in the water column (sentinel stations)

A discussion was held on using integrated samples in order to resolve the detection of toxic species in deep stations (> 5m). Surface bucket or discrete samples are sufficient in shallow/intertidal waters (less than 5m). It was proposed by the chairman that vertical high resolution sampling in sentinel sites may be necessary to obtain data on the proportion of toxic species, population trends and full species composition. However the participants did seem to think this may be impractical due to time and resource constraints. Net samples were also proposed in high production areas. Best practice should be used based on the knowledge of the area to be sampled by the competent authority. Development of best practice SOPs on sampling, labeling and preservation of the samples

Mouse bioassay: Substitution of MB by Phytoplankton

As bioassays are no longer routinely carried out, the importance of Phytoplankton monitoring as a tool to predict new phytoplankton species producing toxin compounds (novel toxins) was identified. New toxins in EU waters were mentioned as possible emerging unknowns, the phytoplankton monitoring may yield early detection of these including pinnatoxins and tetrodotoxins, cyclic imines ciguatera and others. Phytoplankton monitoring tools including molecular probes for example may be required to resolve these

Epi-benthic species

The monitoring of sand-dwelling forms may be necessary in certain regions e.g. *Vulcanodinium rugosum* pinnatoxin producer. Gap in knowledge: not only epi-benthic species but also cyst stages of toxic dinoflagellates may be detected but these could only be carried out at Sentinel sites only. Greece have a problem with the epi benthic species *Gambierdiscus* and blooms of these have been recorded blooms. OBIS database and the IOC list were discussed as useful lists of toxic harmful algae globally.

Population trends

The importance of population trends were discussed. Reasons for this include understanding community structure, which may allow forecasting and early warning. These forecasts rely on an integrated approach and understanding of species dynamics, historical events to detect and ultimately predict changes in the abundance of a species in the water column through time. Long term trends may not be possible yet, but 3-5 day forecast may be within reach. Harmonised data across member states would help management decisions and development of forecasting tools.

Ancillary data

CTDs in sentinel stations and satellite information, may be useful, but the guideline should define where and how frequent these measurements are taken. Other measurements such as Biovolume + carbon content + molecular tools. During the meeting it was stated by some CAs that they were thinking about stopping phytoplankton monitoring all together, Germany and Denmark in particular.

Annex 6: ToR e) New Findings

6.1. Tetrodotoxin in shellfish the Eastern Scheldt, the Netherlands

Marnix Poelman

In 2015 Tetrodotoxins (TTX) were found in 16 samples in the Eastern Scheldt in the Netherlands. Following the international reports of TTX in shellfish (primarily Greece, and UK) RIKILT performed an analysis on all available samples from the National monitoring program. These were done separate from the common analysis. In total 402 samples were analysed for the presence of TTX. Seven samples were shown to contain TTX. The results ranged from LOQ to 124 ug TTX / kg tissue. All of these samples were derived from the Eastern Scheldt. Five were oysters from the production site Yerseke Bank, and two were mussels from production site Mastgat. The records were all done in the month of July. This record could not be matched with any known phytoplanktonic occurrence. Given that analysis of the specific samples were measured with a time delay, additional research to evaluate the source of TTX could therefore not be performed. Based on the results and given that no limits for TTX in shellfish are available in Europe, the Dutch authority (NVWA, Food Safety Authority) commissioned a Risk Assessment on TTX in shellfish, and provided a provisional threshold of 20 µg TTX / kg shellfish tissue is introduced, and discussed on a national and European level.

6.2. A widespread harmful algal bloom in the northeast Pacific

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In the late spring and summer 2015, a widespread toxic bloom of the marine diatom *Pseudo-nitzschia*, stretching from central California to British Columbia, Canada, resulted in significant impacts to coastal resources and marine life. Blooms of *Pseudo-nitzschia* produce a potent neurotoxin, domoic acid, which can accumulate in shellfish, other invertebrates, and sometimes fish, leading to illness and death in a variety of seabirds and marine mammals. Human consumption of toxin-contaminated shellfish can result in Amnesic Shellfish Poisoning (ASP), which can be life threatening. Detectable concentrations of toxin, although well below levels of concern for human consumption, have been measured in finfish like salmon, tuna, and pollock. The greatest human health risk is from recreationally-harvested shellfish; commercial supplies are closely monitored and have not resulted in human illnesses. States maintain websites indicating where shellfish can be safely harvested. Although these blooms can occur annually at “hot spots” along the U.S. West Coast, the largest impacts and most widespread closures typically occur in the fall. Samples collected on 2 research cruises in June and July 2015 demonstrated that domoic acid was measurable at most sites along the west coast of North America (Figure 1).

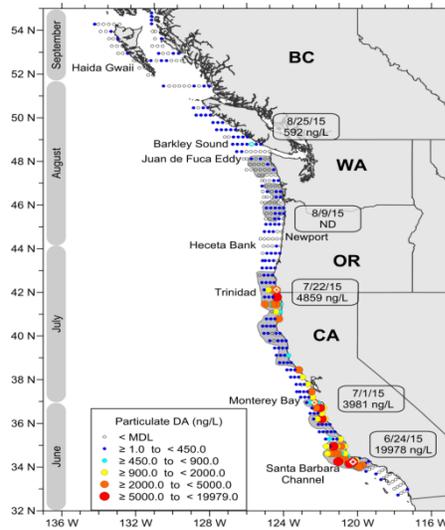


Figure 1. Particulate DA in surface (3 m) seawater samples collected aboard the NOAA Ship *Bell M. Shimada* from June through September Gray shading along the coast indicates regions where *Pseudo-nitzschia* was the dominant phytoplankton.

The 2015 bloom was detected in early May, and in response, Washington closed its scheduled razor clam digs on coastal beaches. The abundance of *Pseudo-nitzschia* and concentrations of domoic acid in razor clams on Washington State beaches in 2015 greatly exceeded values observed during springtime blooms that have only rarely occurred on the Washington coast since domoic acid events were first recognized on the US west coast in 1991. A typical springtime bloom experienced in 2005, compared to the 2015 domoic acid event is shown in Figure 2.

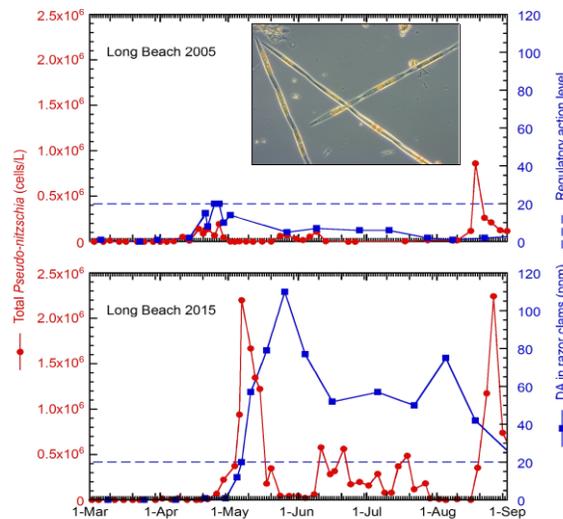


Figure 2. Concentrations of *Pseudo-nitzschia* (cells/L) from 1 March – 1 September 1 and domoic acid in razor clams (ppm) in 2005 (top panel), and 2015 (bottom panel). Inset: Chains of overlapping *Pseudo-nitzschia* cells, the diatom that produces the toxin, domoic acid.

Scientists quickly recognized that the bloom extended from California's Channel Islands to as far north as Vancouver Island. The bloom is the largest and its effects have been the longest-lasting of all US west coast *Pseudo-nitzschia* events in at least the past 15 years, and concentrations of domoic acid in seawater, some forage fish, and crab samples were among the highest ever reported for this region. By mid-May, domoic acid concentrations in Monterey Bay, California were 10 to 30 times the level that would be considered high for a normal *Pseudo-nitzschia* bloom. California did not open the Dungeness crab fishery in 2015, and requested federal disaster relief in February 2016 in response to the massive economic losses. Other HAB toxins also have been detected on the West Coast. For example, an increase in saxitoxin-producing algae has been reported in areas of Alaska.

Impacts include shellfish and Dungeness crab harvesting closures in multiple states, targeted finfish closures, public health advisories for certain fish species in some areas of California, and sea lion strandings in California and Washington. Other marine mammal and bird mortalities have been reported in multiple states but domoic acid has not been confirmed as the primary cause of death, although toxin has been detected in recovered birds. On August 20, 2015, NOAA declared an Unusual Mortality Event for large whales in the Western Gulf of Alaska. Since May 2015, scientists have recorded the mortality of 30 large whales. HABs are suspected of playing a role in the deaths of these whales given the noted warmer than usual ocean temperatures in the Gulf of Alaska and the algal bloom documented in neighbouring areas. However, there is no conclusive evidence at this date linking the whale deaths to HAB toxins.

While exact causes of the severity and early onset of the bloom are not yet known, unusually warm surface water in the Pacific is considered a factor. With the spring transition to upwelling-favourable conditions and delivery of nutrient-rich water to the euphotic zone, a spring bloom of phytoplankton is observed annually over the continental shelf. The survival of *P. australis* in the anomalously warm and nutrient-depleted waters, its unusual presence along the entire continental margin of the western US prior to the upwelling season, followed by its rapid uptake of nitrate supplied by the spring transition to upwelling, resulted in the coastwide, high-impact bloom.

First reported along the West Coast in the 1990s, *Pseudo-nitzschia* blooms have also been observed off the U.S. East Coast and in the Gulf of Mexico.

6.3. Mercury in phytoplankton of Puck Bay (Southern Baltic Sea)

Justyna Kobos and Magdalena Beldowska

Among a variety of climate change impacts in the Southern Baltic, there is a tendency towards warming waters, especially in autumn-winter. As a result, the icing of the coastal zone often fails to occur. This is conducive to the thriving of phytoplankton, in which metals, including mercury, can be actively accumulated. Mercury (Hg) exhibits nephrotoxicity, immunotoxicity, neurotoxicity and mutagenicity (O'Shea 1999). This metal is introduced to the human organism mainly through consumption of fish and seafood, showing the marine environment to be especially sensitive to pollution of Hg. The Baltic environment has been monitored by the Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM) for years and, in recent times, decreased Hg concentrations have been noted in the Baltic Sea (HELCOM 2010). The input of Hg from the atmosphere during heating seasons is more intense than in non-heating seasons,

owing to the combustion of fossil fuels for heating purposes. The relatively high temperatures that persist here lead to intense growth of phytoplankton even in late autumn or winter and winter temperatures are expected to increase more than summer temperatures (Lassen *et al.* 2010). In this situation mercury from atmospheric deposition, whose concentration is higher at this time of the year, does not deposit on the bottom of the bays as it is instead accumulated by the algae. In this way, despite the decrease of Hg input to the Baltic Sea (Bartnicki *et al.* 2012), the annual mercury load entering the trophic web may be higher than that of a year featuring a cold winter, when the growth of phytoplankton is limited.

This has resulted in studies into the role of phytoplankton in the introduction of Hg into the trophic chain during the heating season, as a function of autumn and winter warming in the coastal zone of the boreal environment. The samples were collected monthly from December 2011 to May 2013, at 2 coastal stations: Chałupy and Ośłonino. Both stations were located in the area of the Puck Lagoon (west part of Gulf of Gdańsk, Baltic Sea), where the average depth is 3 meters, in a shallow part of the bay with a mean depth of 0.5 m.

The collected data confirm that Hg from atmospheric deposition was quickly adsorbed in water, which considerably increased the content of this metal in phytoplankton, the first link of the marine trophic chain. The problem of bioaccumulation and biomagnification of atmospheric mercury in the marine trophic chain in polar regions has been emphasized (Dommergue *et al.* 2009) but, as shown in the present study, it is also important in the coastal area of the southern Baltic. The medians for Hg concentrations in phytoplankton near Ośłonino and Chałupy in the heating season (October - April) were significantly higher than in the non-heating season (May - September). In addition to the aforementioned factors, the level of Hg concentration in algae was also determined in relation to the phytoplankton species (Beldowska and Kobos 2016). Among the species that were identified, the autotrophic ciliate *Mesodinium rubrum* Lohmann was the one that accumulated mercury the most effectively. This organism is a member of Chromista (Litosomatea) but, owing to its complex symbiosis with the cryptophytes, it is considered to be a phytoplanktonic, photoautotrophic organism (Crawford 1989; Hansen and Fenchel 2006) and can be found *en masse*, forming non-toxic red tides (Crawford *et al.* 1997). The highest Hg concentrations in phytoplankton were noted in periods when it was still/already warm enough for *M. rubrum* to grow, but at the same time cold enough for fossil fuels to be used in order to heat buildings: in Chałupy in October 2012, Ośłonino in October 2012, April 2012 (Beldowska and Kobos 2016). The lowest ability to accumulate Hg was exhibited by the dinoflagellates and diatoms: in Ośłonino in August 2012 and in September 2012. At that time, the concentration of Hg dropped down to a few ng g⁻¹ dw. This is probably related to the fact that metals do not accumulate well on the surface of dominant species of phytoplankton.

Climate changes that stimulate the development of *Mesodinium rubrum*, particularly during the heating season, are likely to lead to increased Hg accumulation in the trophic chain. On the other hand, lower mercury accumulation in algae was influenced by the dominance of dinoflagellates or diatoms. Thus it may be stated that Hg concentration levels in phytoplankton in the autumn-winter-spring seasons were influenced by the proportion of *Mesodinium rubrum* and dinoflagellates and/or diatoms.

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6.4. Solid Phase Adsorption Toxin Tracking (SPATT) in Scotland: a monitoring tool for the detection of dissolved algal toxins

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Solid Phase Adsorption Toxin Tracking (SPATT) is a passive sampling technique used by Marine Scotland Science (MSS) since 2005 to investigate the temporal and spatial distribution of various dissolved algal toxins at several coastal locations around Scotland. SPATT samplers are filled with a highly porous polystyrenic adsorbent resin (Sepabeads® SP700, Mitsubishi Chemical). This type of resin is particularly adapted to the adsorption of lipophilic compounds such as diarrhetic shellfish toxins (okadaic acid, dinophysistoxins 1 & 2), but also pectenotoxins, azaspiracids and yessotoxins. Algal toxins belonging to these groups are known to regularly accumulate in marine bivalves reared in Scotland with adverse effects on the aquaculture industry.

Lipophilic toxins monitoring at Loch Ewe (West Coast)

Loch Ewe was the first location in Scotland where SPATT passive samplers were deployed on a weekly basis since April 2005 for the monitoring of lipophilic toxins. In 2015, concentrations in SPATT of okadaic acid (OA) and pectenotoxin-2 (PTX-2) started to rise at the end of May, gradually increasing throughout the following weeks and reaching a maximum of 447 ng/g of resin and 159 ng/g of resin for OA and PTX-2 respectively at the beginning of August. Dinophysistoxin-1 (DTX-1) concentration also started to rise in SPATT samplers alongside OA and PTX-2, however the maximum was reached at the end of June (82 ng/g of resin), five weeks earlier than for OA and PTX-2. There was no increase in the concentration of dinophysistoxin-2 (DTX-2) in SPATT during the 2015 spring-summer season. The maximum DTX-2 concentration was reached at the end of January (41 ng/g of resin). The concentration of azaspiracid-1 (AZA-1) stayed very low throughout the year, with a maximum concentration of 5 ng/g of resin reached at the end of January. Yessotoxin (YTX) was not detected in any of the SPATT samplers deployed throughout 2015.

Lipophilic toxins monitoring at Scapa (Orkney Islands)

Scapa is the second site in Scotland where SPATT passive samplers were deployed on a weekly basis since May 2011 for the monitoring of lipophilic toxins. In 2015, concentrations in SPATT of okadaic acid (OA) and pectenotoxin-2 (PTX-2) started to rise mid-July, gradually increasing throughout the following weeks and reaching a maximum of 137 ng/g of resin for both toxins at the end of August. The accumulation of dinophysistoxin-1 (DTX-1) in SPATT samplers throughout 2015 followed a similar pattern to OA and PTX-2 with a maximum DTX-1 concentration of 15 ng/g of resin reached at the end of August. Dinophysistoxin-2 (DTX-2) concentration started to rise in SPATT samplers alongside OA and PTX-2, albeit at much lower concentration, and reached a maximum of 22 ng/g of resin at the end of August. Similarly to Loch Ewe, the maximum DTX-2 concentration for 2015 was also reached at the beginning of the year (mid-January, 63 ng/g of resin). The concentration of azaspiracid-1 (AZA-1) stayed very low throughout the year, with a maximum concentration of around 3 ng/g of resin reached mid-January. Yessotoxin (YTX) started being detected in SPATT samplers deployed in May. There was a gradual increase in YTX accumulated in SPATT, reaching a maximum concentration of 44 ng/g at the beginning of June.

Lipophilic toxins monitoring at Scalloway (Shetland Islands)

Scalloway is the third Scottish site where SPATT passive samplers have been deployed on a weekly basis since May 2011 for the monitoring of lipophilic toxins. In 2015, concentrations in SPATT of okadaic acid (OA) and pectenotoxin-2 (PTX-2) increased mid-July, quickly reaching a maximum of 11 ng/g of resin for PTX-2 while OA reached a maximum later at the end of August (3 ng/g of resin). Accumulation of dinophysistoxin-1 and 2 in SPATT samplers followed a similar trend to OA with increased levels observed mid-August and an identical maximum reached in early September for both toxins (2 ng/g of resin). Traces of AZA-1 (0.2 ng/g resin) were detected in two of the weekly deployed SPATT samplers (April and September) while YTX was not detected in any of the SPATT samplers.

Lipophilic toxins results from SPATT monitoring carried out at Loch Ewe, Scapa and Scalloway in 2015 showed variations in toxin accumulation. This is especially valid for OA, PTX-2 and DTX-1 during the summer period which saw much larger accumulation of these toxins at Loch Ewe than at Scapa and Scalloway. Furthermore, the maximum concentration for OA, PTX-2 and DTX-1 in SPATT samplers peaked earlier in 2015 at Loch Ewe (early August) compared to Scapa and Scalloway (late August) mostly likely the result of more favourable environmental conditions earlier on the west coast of Scotland supporting the development of *Dinophysis sp.* blooms. Very low concentration of AZA-1 (below 5 ng/g of resin) accumulated in SPATT samplers at Loch Ewe and Scapa during the winter months while only traces were detected in SPATT samplers at Scalloway. This highlights the likely absence or very limited presence of *Azadinium spinosum* in the water column at these three sites during 2015. Finally, YTX was not detected in any of the SPATT samplers deployed throughout 2015 at the three monitored sites.

Annex 7: ToR f) HAB status report

A Global HAB Status Report (GHSR) is currently being produced as a joint effort by IOC, ICES, PICES, IAEA and ISSHA to document global occurrences and changes in HABs. The ICES contribution to this report will come via WGHABD through the production of a report analysing the data held in the HAE-DAT database up to the end of 2015. The aim of the WG is to get a draft version of this report ready for the WGHABD in 2017 and also to feed into the GHSR being edited by Hallegraaf and Zingone with a draft report being submitted to IOC IPHAB for the next meeting in April 2017 (see summary from Enevoldsen in this report).

It is critical that WGHABD ensure that the HAE-DAT data is appropriately represented in this GlobalHAB report. This will be achieved by WGHABD producing this CRR HAE-DAT report. As WGHABD are experts in the status of HABs in the ICES area they have the expertise to produce an accurate synthesis of the HAE-DAT data including what HAE-DAT can and cannot be used for. Timings will be tight for WGHABD to get their contribution ready by the next WG meeting and a draft timeline of actions is listed below. Confirming HAE-DAT QC by the end of June will be critical for the timely completion of the report.

1. Post WGHABD 2016: EXAMINE HAEDAT data
2. End of June: CONFIRM HAEDAT QC incl. update of 2015 data
3. August - September: begin examining HAEDAT data
4. September *GHSR* editors starts analysis on HAEDAT
5. End Sept: IOC HAEDAT plots to WGHABD
6. Early Nov: finalising plots
7. Dec: Report writing
8. Jan 2017: Pull regional chapter together
9. WGHABD 2017: Draft version of HAEDAT CRR

The IOC data manager Pieter Provoost will produce the plots for the report. Initially Cynthia McKenzie will send the Canadian data (previously QC-ed by Jennifer Martin) to Pieter for some initial exploration of routine plotting options using raw HAE-DAT data.

WG members after completing the HAE-DAT QC for their country and familiarising themselves with this data will request Peter to draw the plots specifying syndrome, regions and years to be plotted. Plotting will follow format at end of document. Decadal maps of the different syndromes will need to be requested from Pieter at this stage.

A tentative report structure is given below. Note: these are not the final chapter titles. Lead authors for the relevant chapters are underlined. Selected case studies containing more detail can be included in the chapters (not more than two pages but these should not detract from the HAE-DAT synthesis underway).

Report structure

Introduction

Methodology

HAEDAT from Ca and USA

HAEDAT from the Baltic Sea

HAEDAT from the North Sea/Skagerrak/Kattegat/English channel

HAEDAT from the Northeast Atlantic

HAEDAT from the Bay of Biscay and western Iberian Shelf

HAEDAT from the Mediterranean Sea

Synthesis