

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

2020/FT/EPDSG04 The ICES-IOC Working Group on Harmful Algal Bloom Dynamics, chaired by Dave Clarke, Ireland, will work on ToRs and generate deliverables as listed in the Table below.

	MEETING DATES	VENUE	REPORTING DETAILS	COMMENTS (CHANGE IN CHAIR, ETC.)
Year 2021	20–23 April	Online meeting		
Year 2022	April (tbc)	TBC		
Year 2023	April (tbc)	TBC	Final report by DATE to SCICOM	

ToR descriptors

ICES-IOC WGHABD had a long discussion at the beginning of the 2020 meeting about developing a new suite of ToRs for the coming reporting cycle and how they would align with the UN Decade of Ocean Science for Sustainable Development. ToR h has been developed in the context of this longer-term view.

TOR	DESCRIPTION	BACKGROUND	SCIENCE PLAN CODES	DURATION	EXPECTED DELIVERABLES
a	Deliver National Reports on harmful algal events and bloom dynamics for the years 2020, 2021 and 2022.	HAB events may affect human activities and marine ecosystems at different levels. Understanding can best be achieved by integrating multiyear data sets. This links to ICES Science Priorities <i>Ecosystem Science, Seafood Production, Conservation and Management Science</i> .	1.3, 5.6, 6.5	Year 1,2,3	Yr 1-3 Summary of national reports in Annex in WGHABD annual scientific report. These will also support events reported in ICES-PICES-IOC HAEDAT database and annual HAEDAT maps that will be used.
b	Progress in the discovery of climate-driven changes in the distribution of planktonic and benthic HAB taxa (incl. cyanobacteria) will be reported by the WG members. In addition, the WG will have a yearly thematic focus on specific HAB topics in relation to climate change to improve our foresight and engage more scientists during the reporting period 2021-2023. Yr1: Climate-driven chang-	The effects of climate change on HABs is an area of interest due to potential negative impacts on the ecosystem and ecosystem services. The changing distributions of HAB species in the Arctic and increasing records of impacts from benthic HABs in Europe create unique challenges and opportunities to study HAB dynamics in relation to climate change. New approaches have also been developed	1.3, 5.6, 6.5	Year 1,2,3	Yr 1: Update WG on the emerging issues with <i>Gambierdiscus</i> spp. and Ciguatera Fish Poisoning with a focus on environmental influences including climate. Report on the findings of CoClima project related to benthic HABs such as <i>Ostreopsis</i> spp and relevant activities under GlobalHAB. Yr 2: Report new discoveries on the diversity and distribution of HABs in

	<p>es in benthic HABs</p> <p>Yr2: HABs in the Arctic environment</p> <p>Yr3: Hindcasting the past to understand the future</p>	<p>focusing on the sediment archive to understand the dynamics of HABs in the past. When merged with Earth System models, the ecological knowledge gained from these activities to improve our seasonal to decadal forecasting capabilities. This ToR links to Science Priorities <i>Ecosystem Science</i>, <i>Seafood Production</i>, <i>Conservation and Management Science</i> and will link to future ICES Science and advisory activities focusing on Climate Change and Arctic science.</p>			<p>the Arctic, with particular attention to fjord regions and their coastal resources, and climate drivers that steer the community dynamics of functional groups in the Arctic.</p> <p>Yr 3: Review the potential of sedimentary DNA and ancient DNA to study past HAB dynamics and search for commonalities with sedimentary cyanobacterial HAB reconstructions.</p>
c	<p>The ICES-PICES-IOC harmful algal event database (HAEDAT) will be updated by delegates on an annual basis. HAEDAT can be used to produce 'products' such as spatial descriptions of harmful algal events in the ICES area. Examples include maps of incidence of management actions associated with toxicity and/or mortalities which can be fed into ICES Ecosystem Overviews that can be updated annually or as required. The processes of using HAEDAT during the production of the IOC Global HAB report will be reviewed. The feasibility of compiling a parallel dataset of phytoplankton and toxicity data from selected stations in the ICES area as a supplement to event data and to build time series of HAB and toxicity occurrences will be investigated.</p>	<p>The ICES-PICES-IOC database plays a key role in the production of the first ICES Harmful Algal Event Status Report and remains an important source information about the global distribution of Harmful Algal Events. This will continue to be updated so that the ICES area can contribute to future HAB reporting initiatives such as updates to the IOC Global HAB Status Report, OSPAR assessments and more. This ToR links to Science Priorities <i>Ecosystem Science</i>, <i>Seafood Production</i>, <i>Conservation and Management Science</i> as well as contributing to the 'Safe Ocean' objectives of the UN Decade for Ocean Science for Sustainable Development.</p>	1.3, 5.6, 6.5	Year 1,2,3	<p>Yr 1-3 Delegates update HAEDAT. Liase with IOC about HAEDAT as required.</p> <p>Yr 1 Entry forms reviewed, particularly in relation to fish mortalities, and recommendations passed to IOC.</p> <p>Yr 2 Identify time-series of phytoplankton counts and toxin concentrations and products to be generated.</p> <p>Yr 3 Review of reporting products from HAEDAT and time series datasets. Presentation at ICHA conference.</p> <p>Production of factsheets from the ICES area to promote information from HAEDAT.</p>
d	<p>In the aquatic environment globally, a wide range of natural compounds from microalgae, cyanobacteria</p>	<p>New toxin detection methods are continually in development, this allows new information regarding</p>	1.3, 5.6	Year 1,2,3	<p>Yr 1 &2: Members to update group on emerging toxin discoveries from their</p>

	<p>and unknown sources are considered as toxins and pose a risk to food safety. Additionally, new discoveries continue to be made within existing toxin groups and new information can lead to a reassessment of the toxicity of known compounds. Many of these toxins are either novel to the ICES region or are not currently monitored, they include regulated and non-regulated groups of compounds. WGHABD will aim to synthesise information on the prevalence of these along with appropriate methods to detect them.</p>	<p>harmful microalgal and cyanobacterial producers to be determined, allowing the identification and better management of risk to human health. During the coming reporting cycle the WG will explore the expansion of toxin risks from known sources and highlight novel toxin detections and detection methods. This links to Science Priorities focussing on Ecosystem Science and Seafood Production and will also feed into the IOC Intergovernmental Panel on HABs (IPHAB) task team on Algal Toxins.</p>			<p>countries along with new toxin detection methods and/or toxic compounds discovered.</p> <p>Yr 3: Produce a short synthesis of current thinking/knowledge within the North Atlantic ICES region for emergent toxins. This will feed into research direction, policy and future HAEDAT recordings/categories.</p>
e	<p>Report on new findings in the area of harmful algal bloom dynamics</p>	<p>The dynamics and impacts of HABs and the technologies to monitoring them are evolving rapidly. WG members report new findings on the topic of algal bloom dynamics in the ICES area. This ToR feeds into ICES Science Priorities <i>Ecosystem science, Emerging Technologies and Techniques, Observation and Exploration.</i></p>	1.3, 3.3, 4.1	Year 1,2,3	<p>Yrs 1-3 A report on new findings in the area of harmful algal bloom dynamics will appear in the WGHABD science report.</p>
f	<p>Mortalities of both farmed and wild fish are common if episodic events throughout the ICES north Atlantic region. There are also a number of ongoing initiatives (IPHAB Task Team on fish killing microalgae, outputs from GlobalHAB Fish-Killing Algal Events symposium) which are focused on addressing issues of fish killing algae and associated faunal mortality events. Historical records tend to report fish mortalities circumstantially linked to only high biomass algal</p>	<p>Food security continues to be a science/strategic priority for ICES, with fish health implications for human consumers of seafood. The specific role of known ichthyotoxins versus non-specific lytic compounds causing gill damage remains to be fully elucidated. The role of harmful phytoplankton as a co-stressor in these circumstances has yet to be investigated. WGHABD will open discussions with WG PDMO to consider comparative overlap on this topic. This ToR relates</p>	5.6	Year 1,2,3	<p>Yr 1 Review outputs from IPHAB, GlobalHAB Colloquium on Fish Killing Microalgae. Discuss with AQUA SG and align and review options for contributions for ICES Aquaculture Overviews.</p> <p>Yr.2. Open dialogue with WGPDMO to review plankton as a co-stressor for CGD with a view to potential shared or back to back meeting to explore areas of common interest and synergies.</p>

	<p>blooms of “fish-killing” species. The impact of sublethal effects, however, of harmful phytoplankton as multi-stress contributors to fish morbidity, e.g. in complex gill disorders (CGD) of farmed fish has yet to be fully investigated. Delegates will update the WG on progress with external initiatives, and clarify mechanisms for reporting fish mortality events (overlap with HAEDAT ToR c), build communication links and synergy with WG Pathology and Diseases of Marine Organisms (WG PDMO), and contribute to ICES aquaculture overviews.</p>	<p>to ICES science priority Seafood Production and is of relevance to the Aquaculture Steering Group.</p>			<p>Yr.3. Potential shared day with WGPDMO to review phytoplankton as a stressor on assessment of CGD. Production of review article based on experiences from both WGs.</p>
8	<p>This ToR will support the implementation of automated observation systems for harmful algal bloom observations to improve early detection and warnings of HABs in the ICES area. Automated samplers are becoming more common in the ICES area however some are still ‘novel’ technologies. Delegates will share experiences with these new technologies to contribute to the integration of these techniques into HAB monitoring and research programmes.</p>	<p>Early detection of harmful algal blooms is needed for HAB warnings to protect human health, the aquaculture industry etc. Standard methods include manual sampling and microscope analyses of samples. Novel technology, i.e. imaging flow cytometry, is available for automated sampling and automated analysis of plankton composition and abundance. At present three at least different systems are available commercially. An ICES-IOC-SCOR GlobalHAB automated plankton observations symposium planned for June 2020 has been postponed until 2021, this will bring together people working in this new area to consolidate experiences in implementing this technology. These feeds into the <i>Observation and Exploration, Emerging technologies and Techniques</i></p>	3.3, 4.1, 5.6	Year 1,2,3	<p>Yr 1 Report progress with the GlobalHAB automated plankton observations workshop.</p> <p>Yr 2 Report the outcomes of the GlobalHAB automated plankton observations workshop postponed until 2021.</p> <p>Yr 3 Contribution of a chapter to an Ocean Best Practice manual on automated phytoplankton observations using imaging flow cytometry.</p> <p>Produce an overview of experiences of Harmful Algal Bloom observations using imaging flow cytometry.</p>

<i>and Seafood Production.</i>						
h	Produce protocols and guidelines for qPCR methodologies for the study and monitoring of HAB species using eDNA	The use of environmental DNA approaches are becoming routine for microbial community and species distribution studies. Work undertaken in the previous two reporting cycles have lead WGHABD to identify the qPCR method based on eDNA as the most appropriate method for HAB species ecological studies and monitoring. WGHABD have taken a longer term view here with this ToR and see it lasting two reporting cycles. The final outcome will be agreement on common protocols and assays and on the potential of applying of qPCR in routine HAB monitoring. This has direct relvance to ICES Science priorities <i>Ecosystem Science and Emerging Techniques and Technologies.</i>	1.6, 1.8, 4.4	Year 1,2,3	<p>Yr 1 – review qPCR strategies along with metabarcoding approaches across the ICES countries for the field detection and ecological studies of HAB species.</p> <p>Yr 2 – Organisation of a qPCR meeting with experts outside the WGHABD (PICES etc) to discuss and elaborate common qPCR strategies and protocols (ICHA 2022/2023 Hiroshima, Japan).</p> <p>Yr 3 – Discussion with other ICES WG working groups about the eDNA approaches and presentation of the specificity of the WGHABD strategy.</p> <p><i>For next reporting cycle</i></p> <p>Yr 4 – Production of guidelines and protocols for the ICES area for qPCR methods.</p> <p>Yr 5 – Discussion and feedback from the monitoring systems about the feasibility of the application of the protocols.</p> <p>Yr 6 – Organisation of a practical qPCR workshop to show the chosen protocols.</p>	
i	To ensure the WG's visibility and the promotion of its work, a website will be developed and deployed for public access for the purposes of disseminating its activities where it will be updated and further developed on an annual basis. Further	WGHABD has close links with IOC and PICES and thus a requirement was identified for promoting and disseminating the outputs of the Working Group and to have a visible presence on a number of media platforms where users can		Year 1,2,3	<p>Yr 1. Discuss with ICES options around website, which is envisaged to be developed through Marine Institute, Ireland. Ensure relevant links to ICES and IOC are included.</p> <p>Yr 2 Deploy webite and</p>	

media platforms including social media will be looked at as further vectors as pathways for information dissemination. WGHABD will liaise with ICES throughout with links to the ICES sharepoint WGHABD webpage. The website will be used as a portal and will have links to data products from HAEDAT (ToR C) as well as other ICES and IOC sources	access information relating to the group activities, monitoring stations, research and publications all in one place. This is will be an important promotion of the work of ICES-IOC WGHABD and links with other scientific bodies and panels such as IOC UNESCO, SCOR GlobalHAB and more. This feeds into the vision and mission of of ICES through the provision of information, advice and guidance.	review material to be included on website. Yr 3 Update website and review activity.
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Summary of the Work Plan

Year 1	Present national reports, new findings and update HAEDAT database. Review the role of environmental drivers on benthic HABs in the ICES area. Review HAEDAT reporting forms and report to IOC with recommendations. Update WG on emerging toxins and report on external initiatives focused on fish killing microalgae. Report on progress with workshop on automated imaging technologies and review molecular methodologies used for the detection of HABs within the WG. Develop WGHABD website.
Year 2	Present national reports, new findings and update HAEDAT database. Report new findings about the diversity and distribution of HAB species in the Arctic. Identify time series of phytoplankton counts and toxicity data to support HAEDAT data and products. Open dialogue with WG PDMO to discuss activities around CGD. Report progress with automated imaging workshop. Organise qPCR methodologies meeting with external partners to discuss approaches and protocols for qPCR methodologies. Deploy WGHABD website.
Year 3	Present national reports, new findings and update HAEDAT database. Review potential of sedimentary eDNA to inform on impacts of climate change on HABs. Review products from HAEDAT and presentation at ICHA conference in 2023. Produce document on status of emerging toxins in the ICES area. Contribution to Ocean Best Practices Manual on automated imaging technology. Discussion with other ICES WGs about their eDNA strategy. Potential shared day with WG PDMO about role of phytoplankton in CGD.

Supporting information

Priority	Hamrful algal blooms can negatively impact ecosystems and ecosystem services within the ICES area. ICES-IOC WGHABD are have developed a suite of ToRs that address the rising issues associates with HABs in the North Atlantic. The current activities of WGHABD address multiple science priorities within ICES. These are Ecosystem Science, Observation and Exploration, Emerging Techniques and Technologies, Seafood Production and Conservation and Management Science. In addition WGHABD is also involved with a number of global initiatives via the IOC Intergovernmental Panel for HABS and the IOC Global HAB Status Report which is placing ICES Science on a global stage.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. Some countries have not attended in recent years due to limiting resources.

Participants	WGHABD is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and group under ACOM	Output from HAEDAT and ICES Harmful Algal Event Status report will provide material for ACOM should requests for advice require consideration of impacts from HABs.
Linkages to other committees or groups	There is a working relationship with WGPME, WGZE, WGITMO and WG BOSV. During the coming reporting cycle linkages with WG PDMO will be strengthened and relationship with the Aquaculture Steering group enhanced.
Linkages to other organization	WGHABD is co-sponsored by the IOC and works closely with it under a number of HAB initiatives.