



GlobalHAB - the International SCOR-IOC Science Program on Harmful Algal Blooms

Program Activities 2018-2019 and Plans for the 2019-2021 period

GlobalHAB Scientific Steering Committee members

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The GlobalHAB Scientific Steering Committee (SSC) acknowledges the financial and logistic support received from SCOR and IOC during the 2015-2019 period. The funds made possible the elaboration of the GlobalHAB Science and Implementation Plan, representation of the program at international meetings and publications completing the work of the GEOHAB program. SCOR funds are also contributing to the implementation of some initiatives prioritized by GlobalHAB at short-term. The GlobalHAB activity is described next.

1. Meetings of the GlobalHAB SSC members

Since the last meeting at the Laboratoire d'Océanographie de Villefranche (LOV) in Villefranche-sur-mer (France) on April 10 and 11, 2018, the GlobalHAB SSC members worked on the implementation of the GlobalHAB implementation by communication through email and virtual meetings of small groups. In addition, most SSC members (including representatives of ISSHA, IPHAB, ICES, PICES) had an opportunity meeting during the 18th International Conference on Harmful Algae (ICHA) held in Nantes, France, October 21-26, 2018. Among other items, the SSC reviewed the status of ongoing activities and prioritized new ones. Given that many activities are under progress, the SSC decided not to meet in 2019 and continue coordination telematically. This will save budget to be used for specific activities and products.

2. Science highlights in the 2018-2019 period

2.1. Communications about the GlobalHAB program, from GlobalHAB endorsed projects and other programmes related to GlobalHAB in international scientific events:

* Regional Workshop on Monitoring and Management Strategies for Benthic HABs, Monaco, April 2018 - E. Berdalet, H. Enevoldsen and the GlobalHAB SSC. *The IOC-UNESCO and SCOR programme GlobalHAB: International coordination to advance in the understanding and management of benthic harmful algal blooms impacts.*

* The Effects of Climate Change on the World's Oceans, 4th International Symposium, Washington, DC, US, June 2018 - Raphael Kudela, E. Berdalet, C. Gobler, B. Karlson, N. Banas, E. Bresnan, M. Burford, K. Davidson, Po Teen Lim, L. Mackenzie, M. Montresor, V. Trainer, G. Usup, K. Yin, H. Enevoldsen and Ed Urban. *GlobalHAB: International coordination to ascertain the effects of Climate Change on the occurrence of Harmful Algal Blooms.*

* ICHA2018, Nantes, October 2018 - E. Berdalet, N. Banas, E. Bresnan, M. Burford, K. Davidson, C. Gobler, B. Karlson, R. Kudela, P. T. Lim, L. Mackenzie, M. Montresor, V. Trainer, G. Usup, K. Yin, H. Enevoldsen, E. Urban. *GlobalHAB (IOC-UNESCO and SCOR): International coordination for sound knowledge of HABs to manage their impacts.*

* ICHA2018, Nantes, October 2018 - L. Mackenzie, J. Banks, K. Smith. *Application of gel-formatted qPCR assays for rapid diagnosis of shellfish toxin producing and fish-killing micro-algae in seawater.* Communication of the GlobalHAB endorsed projects of the authors.

* Global Ocean Observing System Bio/Eco Panel Meeting. St Peter's Beach, FL, USA, October 2018 - R.M. Kudela. *An update on development and implementation of the Phytoplankton EOY.*

* PICES2018, Yokohama, Japan October 2018 - V.L. Trainer *Progress of GlobalHAB including Best Practices Manual. PICES Annual Meeting, HAB Section report*, <https://meetings.pices.int/publications/annual-reports/2018/2018-S-HAB.pdf>

* UN DOALAS, Multi-Stakeholder Dialogue and Capacity-Building Partnership Event, New York, January 24-25, 2019. Kedong Yin was invited to give the presentation

Science-Driven Management Decision Making in Formulating Sewage Treatment Strategy.

* UN DOALAS, Regular Process For The Global Reporting and Assessment of the State of the Marine Environment, Including Socioeconomic Aspects. Kedong Yin also participates in writing *Chapter 10. Changes in inputs to the marine environment of nutrients.*

* International Conference on Toxic Cyanobacteria, Krakow, Poland, 2019, Poster presentation on GlobalHAB program and activities associated with cyanobacteria research. Presenter Michele Burford.

2.2. Sessions chaired by GlobalHAB in international meetings:

- International Conference on Harmful Algae, Nantes (France), October 2018. Session "Networking activities around HABs: GlobalHAB, Global HAB Status report, ICES-WGs and other initiatives" chaired by E. Berdalet, A. Zingone and P. Hess.

2.3. GlobalHAB endorsed Workshop funded by EukRef of UniEuk, Roscoff, (France), 5-9 Nov 2018 (<http://eukref.org/roscoff-workshop/>). *EukRef* is a standardized, open-source bioinformatics pipeline that allows taxonomic curation of publicly available phylogenetic marker sequences (starting with 18S rDNA), generating homogeneous sets of curated, aligned sequences and phylogenetic trees. *EukRef* is one of the modules of *UniEuk* (www.unieuk.org), an open, community-based and expert-driven international initiative to build a flexible, adaptive universal taxonomic framework for eukaryotes, focused primarily on protists. E. Berdalet and M. Montresor participated in the organization of the workshop and M. Montresor attended it in quality of advisor, with UniEuk financial support.

The workshop focused on Diatoms, Dinoflagellates, and Green Algae. The working group integrated the curation efforts on individual eukaryotic groups into a biological data warehouse consisting of curated sequences, flexible taxonomy, and phylogenetic trees and their underlying sequence alignment. *EukRef* will integrate with PR2, a reference database for protists, with plans to push forward and expand ongoing curation efforts that are crucial for the interpretation of metabarcoding datasets (<http://eukref.org/eukref-pr2-integration/>).

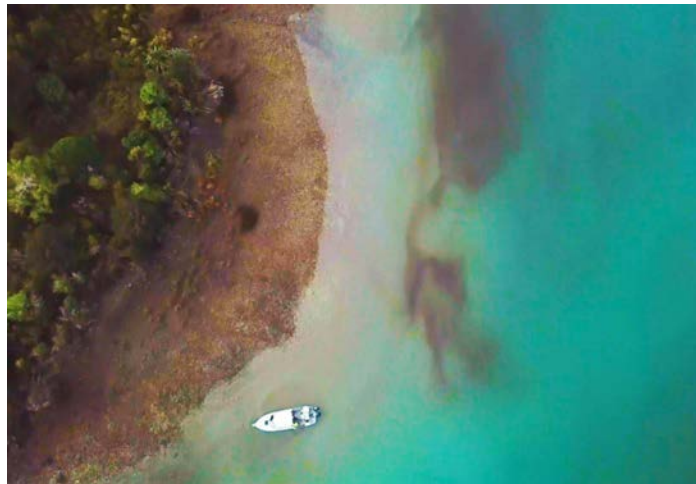
2.4. GlobalHAB endorsed project "International Collaborative Study for the Validation of a HILIC-MS/MS Method for Analysis of Paralytic Shellfish Toxins and Tetrodotoxin in Live Bivalve Molluscs", jointly led by Dr Andrew Turner (Centre for Environment Fisheries and Aquaculture Science -CEFAS-, Weymouth, United Kingdom) and Dr Tim Harwood (Cawthron Institute, Nelson, New Zealand). Twenty-four labs were involved in the inter-laboratory validation study, with support of a private company and participation of independent advisors: Dr Paul McNabb (NZ), Dr Ana Gago Martínez (EURLMB Spain) and Dr Jim Hungerford (FDA USA).

The project is in the final stages of report preparation and publication, and will mark a very important milestone in the global adoption of instrumental method of analysis of marine biotoxins. The validation study will be published in the *Journal of Official Analytical Chemists (JAOAC)* after which it can be formally accepted as the official standard method for the analysis of paralytic shellfish toxins and tetrodotoxins in New Zealand and other jurisdictions that may wish to adopt this method.

2.5. Workshops of GlobalHAB endorsed project “Assessment of the risk of benthic life stages of toxic dinoflagellates to the Seafood Sector of New Zealand and France”, led by Dr Kirsty Smith (Cawthron Institute, Nelson New Zealand) and Dr Kenneth Mertens Ifremer, Concarneau, France). The specific aim of this project was to identify benthic life stages of three high priority toxic dinoflagellate groups, *Alexandrium*, *Azadinium* and *Vulcanodinium*. Two workshops, held in New Zealand (February, 12-14 2018) and France (coinciding with ICHA 2018 in Nantes, October 21-26, 2018) demonstrated morphological and novel molecular methods for cyst identification and provided international training for monitoring programmes.

2.6. GlobalHAB endorsed project “Innovative technologies for the early detection of Harmful Algal Bloom threats”, led by Dr Lincoln MacKenzie (Cawthron Institute, New Zealand) with participation of Drs Kirsty Smith and Jonathan Banks (Cawthron, NZ), Dr Raphael Kudela (University of California Santa Cruz, USA), Mr Mark Vanasten (Diagnostic Technologies, Australia), and Dr Jason Acker (Diagnostic Systems Inc. Edmonton, Canada).

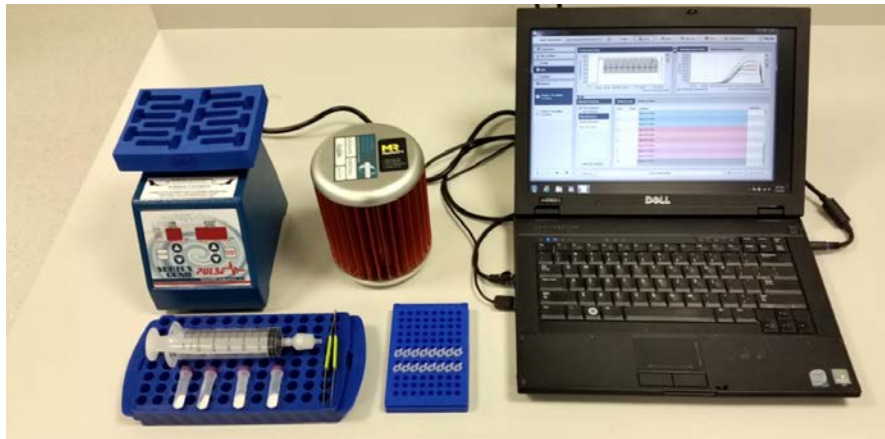
The project aims to apply innovative technologies for detecting harmful phytoplankton species in near real time, thereby enabling rapid response of the aquaculture industry and other stakeholders to the onset of HABs and where possible mitigate their impacts.



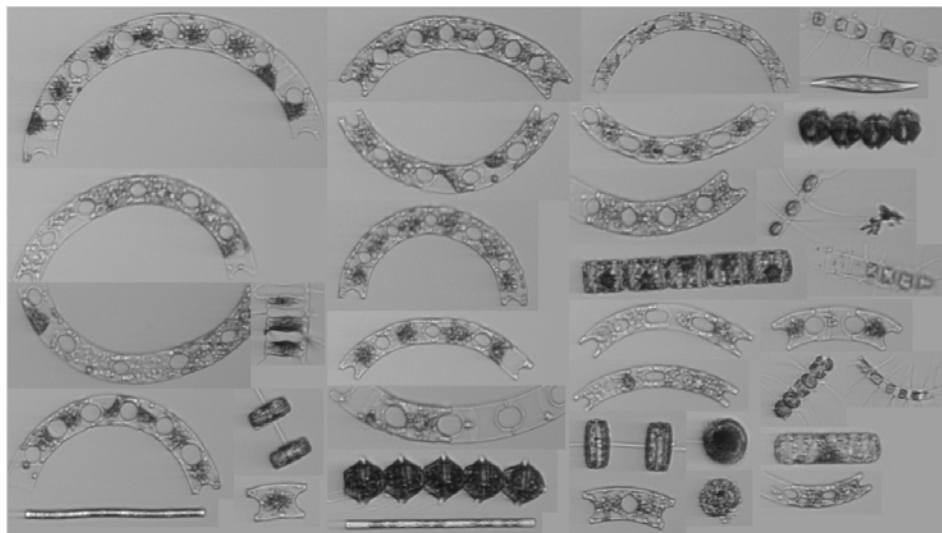
Drone footage of a ‘red-tide’ of *Alexandrium pacificum* in the Marlborough Sounds, New Zealand.

Specifically, the project involves field and laboratory trials of three complementary technologies: the Hydrogel™ qPCR assay, the DinoDTec Saxitoxin gene qPCR assay and the Imaging FlowCytoBot (IFCB) instrument for the detection and monitoring of harmful planktonic micro-algae. This project is applied research aimed at improving the effectiveness, and lowering the cost, of current harmful algae monitoring methods for aquaculture. The Hydrogel™ assay is a field deployable qPCR assay developed by Aquila Diagnostic Systems that can provide a fast and effective screening tool competitive with the current microscopy methods for detecting problem algae species. The assay is sensitive, simple and robust and able to be carried out in a basic laboratory at sea or in an on-shore seafood processing facility. The research involves the transfer of developed qPCR assays to the Hydrogel™ format targeting HAB species most important to the aquaculture industry in New Zealand. The assays specifically target DNA sequences unique to the ichthyotoxic species *Pseudochattonella verruculosa*,

Heterosigma akashiwo and *Karenia brevisulcata*, and the paralytic shellfish toxin producers *Alexandrium pacificum* and *A. minutum*. Parallel trials of the commercially available DinoTec STX gene assay are being carried out alongside the Hydrogel™ assay when screening for toxic *Alexandrium* spp.



Portable equipment required for DNA extraction and the Hydrogel qPCR assay of seawater samples.



IFCB *in situ* imaging of phytoplankton showing two chain forming *Alexandrium* species (*A. pacificum* and *A. fraterculus*) in the assemblage.

The Imaging FlowCytobot (IFCB) is an-autonomous submersible, *in situ* imaging flow cytometer, manufactured by McLane Labs, USA (<http://mclanelabs.com/imaging-flowcytobot/>). It combines flow cytometry and video technology to capture images of individual cells. After training the software, the images can be automatically classified to provide, identification, abundance and bio-volume estimates. Through collaboration with Dr Raphael Kudela the instrument is being evaluated for the detection and quantification of HAB species in aquaculture regions in New Zealand. The IFCB is currently being deployed from

various aquaculture installations (e.g. salmon farms) and on monitoring vessels and its capabilities demonstrated the aquaculture industry.

2.7. Intercomparison of methods to detect harmful species and toxins. Raphe Kudela participated in the [Alliance for Coastal Technologies](#) workshop in Jan 2017 on detection of HABs (see [report](#)). A second workshop and technology demonstration on toxin detection will be conducted soon. This organization is supported by U.S. companies, but is open to any vendor. There are a series of field sites, including Monterey, Lake Erie, and Long Island.

2.8. Paper on HAB Observing System: Scaling Up From Regional Case Studies to a Global Harmful Algal Bloom Observing System. *Clarissa R. Anderson, Elisa Berdalet, Raphael Kudela, Caroline Cusack, Joe Silke, Eleanor O'Rourke, Darcy Dugan, Molly McCammon, Jan Newton, Stephanie K. Moore, Kelli Paige, Steve Ruberg, John R. Morrison, Barbara Kirkpatrick, Katherine Hubbard and Julio Morell.* *Frontiers in Marine Science* May 2019, doi: 10.3389/fmars.2019.00250, <https://www.frontiersin.org/articles/10.3389/fmars.2019.00250/full>

2.9. Inclusion of data on cyanobacterial blooms and toxins in HAEDAT database which presents reporting of HAB blooms globally (<http://haedat.iode.org/index.php>).

3. Implementation activities in the 2018-2019 period

In addition to the Science Highlights in the previous Section 2, other activities have been conducted by GlobalHAB:

- A brochure was produced on October 2018 and distributed at the ICHA2018 and at the *Marine Environmental Science Symposium (XMAS IV)* 6-9 Jan 2019, in the HABs session convened by Po Teen Lim and colleagues from Xiamen, China.

The international community is invited to participate in the GlobalHAB program, through seeking endorsement of relevant research, monitoring, and modelling activities as well as by proposing and taking initiatives for integrating science workshops, publications and capacity building.

<http://www.globalhab.info/about-us/get-involved>





GlobalHAB
www.globalhab.info

Goal
To improve the understanding and prediction of HABs in aquatic ecosystems, and management and mitigation of their impacts.

Mission

- To foster international coordination and cooperative research to address the scientific and societal challenges of HABs, including the environment, human health, and economic impacts, in a rapidly changing world.
- To serve as a liaison between the scientific community, stakeholders, and policy makers, informing science-based decision making.

 **GlobalHAB**
An international program sponsored jointly by the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO




www.globalhab.info

An international science program on HABs building on the foundations of GEOHAB

GlobalHAB


GlobalHAB Endorsed Workshops & Projects
<http://www.globalhab.info/about-us/globalhab-endorsed-projects>

This list will be enhanced with your participation in GlobalHAB!

- EukRef: The 18S Annotation Initiative, 3rd Workshop, November 5-9, 2018
- International Collaborative Study for the Validation of a HILIC-MS/MS Method for Analysis of Paralytic Shellfish Toxins and Tetrodotoxin in Live Molluscs
- Effects of climate changes on harmful algal and cyanobacterial blooms along the South Atlantic Ocean
- Predicting Risk and Impact of Harmful Events on the Aquaculture Sector (PRIMROSE)
- Source and fate of ciguatera fish poisoning-toxins and its implication on coral reef ecosystem health and seafood safety. Training courses and Workshop
- AZTI - EEAcademy Summer School 2019: Does Human health and Wellbeing depend on a Healthy Ocean?
- Assessment of Risk of Benthic Life Stages of Toxic Dinoflagellates to the Seafood Sectors of New Zealand and France (CystRisk)
- Co-development of Climate services for adaptation to changing Marine Ecosystems (COCLIME)
- Innovative technologies for the early detection of Harmful Algal Bloom threats

Science and Implementation Plan 2018
<http://www.globalhab.info/files/Science-and-implementation-plan-final5.pdf>

GlobalHAB Themes



The themes integrated in GlobalHAB range from cellular to ecosystem- and climate-based processes. GlobalHAB's perspective is multidisciplinary, integrating physics, chemistry, and biology and addressing the impacts of HABs on the environment and humans. Terms shown in italics are not established as individual GlobalHAB themes, but are intrinsically integrated into HAB research.

Coordination with International and Regional Programs on HABs, such as

- ISSHA, ICES, PICES, IAEA, CIESM, POGO, WHO, FAO, IWC, IOC-IPHAB, IOC Regional Groups, SCOR Working Groups
- GOOS Bio/Eco – HABs are a major component of the Phytoplankton EOY
- IOC-NOAA-FAO-WHO to implement the Global Ciguatera Strategy
- OceanObs19 – GlobalHAB will foster HAB multidisciplinary and innovative observation systems

Opportunities & Outcomes

- GEOHAB final product: Oceanography special issue (2017)
- Harmful Algae special issue "Harmful Algae and Climate Change" (2019) M. Wells & C. Gobler, Editors
- Global Harmful Blooms Status Report
- "Best Practice Guidelines for the Study of HABs and Climate Change" (2019) M. Wells, M. Burford, A. Kremp, M. Montresor, G. Pitcher, G. Usup, Editors
- GlobalHAB participates as External Advisor in the EU H2020 SOPHIE project aimed at Linking Oceans and Human Health (2018-2020)
- Workshop on the economic impacts of HABs coordinated with PICES (2019)
- A Webinar series on cyanobacterial HABs for water managers and maps of cyanobacterial species occurrence
- Open Science Meeting on HABs and deoxygenation in coordination with IOC-GO2NE
- Open Science Meetings, Workshops and Summer Schools focused on HAB related topics

Acronyms

- HAB: Harmful Algal Bloom
- EOY: Essential Ocean Variable
- GO2NE: Global Ocean Oxygen Network
- PICES: North Pacific Marine Science Organization

- Coordination between GlobalHAB and TrendsPO (IOC) to analyse occurrence of HABs in response to climate change and global change, TrendsPO meeting (November 12-16, 2018, UCSC, US). Efforts are underway to conduct a comparative analysis across multiple ecosystems of trends in HAB organisms. Following from this analysis would be exploration of the underlying drivers (i.e. if a trend exists, is it clearly linked to climate change?). Comparative work on different environments and harmful events is also conducted by PICES and NOAA. As part of this effort a manuscript describing the link between climate change and HAB events has been submitted to *Harmful Algae* (Trainer et al., 2018).

- A workshop was organized by IOC WESTPAC-HAB at Chulalongkorn University from 25-27 February 2019 to review the status of fish-killing Raphidophytes species in Western Pacific region. A review paper on Raphidophyte species and its impacts in the region is expected from this activity.

- A session on HABs will be conducted within the 7th European Phycological Conference (<http://epcseven.biol.pmf.hr/>) to be held in Zagreb (Croatia) from 25-30 August 2019. The session is by S. Accoroni and P.M. Visser, and M. Montresor is member of the Organizing Committee.

4. New implementation activities in the 2019-2021 period

4.1. Ongoing and confirmed activities

- **June 5-7, 2019.** AZTI-SOPHIE project Summer School: "Does human health and Wellbeing depend on a healthy Ocean?" Aquarium of San Sebastian (Spain). This is a GlobalHAB endorsed project. **Elisa Berdalet will give a lecture, representing GlobalHAB** (<https://www.azti.es/eventos/azti-sophie-project-summer-school-2019-does-human-health-and-wellbeing-depend-on-a-healthy-ocean/>). The activity is linked to the World Oceans Day (<http://www.worldoceansday.org/Default.aspx?CCID=31759&FID=343862&ExcludeBooI=False&PageID=17466397>).

- **June 10-11, 2019.** As already initiated within GEOHAB (lead by Grant Pitcher and Raphe Kudela) GlobalHAB included fostering research on the potential links between ocean deoxygenation and HABS through interaction with IOC GO2NE (Global Ocean Oxygen Network, <http://www.unesco.org/new/en/natural-sciences/ioc-oceans/sections-and-programmes/ocean-sciences/global-ocean-oxygen-network/>). **A joint GO2NE - GlobalHAB workshop is being organized** to identify potential research on this topic in 2019, to be held in Paris immediately prior to the next GO2NE workshop (http://hab.ioc-unesco.org/index.php?option=com_oe&task=viewEventRecord&eventID=2469).

- **October 17-19, 2019.** An international workshop, "Evaluating, reducing and mitigating the cost of harmful algal blooms: a compendium of case studies", which will be held in Victoria, British Columbia, Canada as part of the Annual Meeting of the North Pacific Marine Science Organization (PICES). The workshop co-convenors are Drs Vera Trainer (USA), Keith Davidson (UK) and Kazumi Wakita (Japan) and **it is jointly sponsored by GlobalHAB (SCOR and IOC), PICES, NOWPAP, ISSHA, NOAA, FAO and private companies.** The goal of the 2.5-day workshop is to bring together international experts in economics, social sciences, and the study of harmful algal blooms (HABs) to develop a compendium of case studies to guide future research on the economic and social costs of HABs. The intent is that this compendium will identify priorities and unify methods for future collaborative assessments of HAB impacts. More information can be found at <https://meetings.pices.int/meetings/annual/2019/PICES/Program>

- **October, 2019.** A fish-killing HABs workshop is planned, **co-funded by GlobalHAB, IOC UNESCO and the government of Chile.** The activity is coordinated by Leonardo Guzmán and the IOC/IPHAB Task Team on Fish-killing algae. The workshop will include: a) plenary lectures by invited experts to provide a synthesis of current state-of-knowledge and to point the way forward in furthering our understanding of fish-killing HABs phenomena; b) presentation of case studies of particularly dramatic crises in the Chile and other areas; c) participation of Chile national scientists, monitoring and regulatory agencies and the local industry viewpoints; d) laboratory demonstrations (if feasible). The outcomes of the workshop will be published as a ebook. Note: the date has not been confirmed yet, and due to agenda issues it could be delayed for a few weeks.

- **Fall 2019.** *Manual for water managers on mitigation of cyanobacterial HABs* elaborated by Michele Burford and Chris Gobler. The goal is an aesthetically appealing, easy to understand document for drinking and recreational water managers on managing cyanobacterial HABs available in print and on web. First draft already finished. **GlobalHAB is co-funding this product.**

- **March 2018 to October 2019.** E. Berdalet is participating, in representation of GlobalHAB at the CLEFSA project activities "*Emerging threats on human health in Europe due to climate change*". CLEFSA is a project of the European Food Safety Agency (EFSA) that explores the risks of food intoxication in future climate change scenarios. CLEFSA included aquatic biotoxins in the European landscape. E. Berdalet is collaborating in the elaboration of Reports and documents **through online communication and particular meetings (funded by GlobalHAB)**.

- **Fall 2019.** *Special issue on the journal Harmful Algae focused on "Climate Change and HABs"*. The editors of the special issue, Chris Gobler and Mark Wells have solicited 14 articles. Papers were submitted in summer 2018; some are under revision and others will be in press as of April 2019:

1. The Future of HAB Science: Directions and Challenges. *HAB-Climate Change Symposium Organizers and Breakout Discussion Leads.*

2. Projected Latitudinal Changes in Environmental Conditions Influencing HABs. *Fei Chai, Enrique Curchitser, Phil Boyd et al.*

3. Modelling HABs in a changing climate. *Kevin Flynn, Inga Hense, Neil Banas, Dennis McGillicuddy, Stephanie Dutkiewicz.*

4. Dynamic CO₂ and pH levels in coastal, estuarine, and inland waters: theoretical and observed effects on harmful algal blooms. *John Raven, Chris Gobler, Per Juel Hansen.*

5. Progress and promise of omics for predicting the impacts of climate change on harmful algal blooms. *Gwenn Hennon, Sonya Dhyrman.*

6. Advancing the research agenda for improving understanding of cyanobacteria in a future of global change. *M.A. Burford, C.C. Carey, D.P. Hamilton, J. Huisman, H.W. Paerl, S.A. Wood, A. Wulff.*

7. Pelagic harmful algal blooms and climate change: lessons from nature experiments with extremes. *Vera L. Trainer, Stephanie K. Moore, Gustaaf Hallegraeff, Raphael M. Kudela, Alejandro Clement, Jorge Mardones.*

8. Climate change and benthic harmful algae. *Pat Tester, Elisa Berdalet, Wayne Litaker.*

9. Fish-killing HAB and Climate change. *Charles Trick, Gustaaf Hallegraeff, Alan Cembella.*

10. High biomass HAB and Climate change. *Bill Sunda, Grant Pitcher, Chris Gobler.*

11. Future observing systems. *Bengt Karlson, Raphe Kudela, Stewart Bernard*

12. HABs: a climate change co-stressor in marine and freshwater ecosystems. *Andrew Griffith, Chris Gobler*

13. Zooplankton grazing and HABs. *Hans Dam, Susan Menden-Deuer, Diane Stoeker, Matt Johnson.*

14. Harmful algae at the complex nexus of eutrophication and climate change. *Pat Glibert.*

GlobalHAB will support some open access. The main key messages from the special issue will be used to elaborate a Scientific Summary for Policy Makers (SSPM) on HABs and Climate Change. The SSPM could be linked to the two IPCC 1.5C special reports that are coming out this year and next year.

- **May 2020.** Planning is underway for a workshop on "*Modelling and prediction of harmful algal blooms, from event response to multi-decadal projections*" to be held in Glasgow, UK. The organising committee consists of Neil Banas, David McKee, Bingzhang Chen, Paul Udom (University of Strathclyde), Bengt Karlson (Swedish Meteorological and Hydrological Institute), Keith Davidson, Dmitri Aleynik (Scottish Association of Marine Science), Clarissa Anderson (Scripps / SCCOOS), Dennis McGillicuddy (Woods

Hole Oceanographic Institution), Beatrix Siemering (Marine Institute, Galway), and is also coordinating with Katja Fennel and Marion Gehlen, chairs of the Marine Ecosystem Analysis and Prediction Task Team (MEAP-TT) of the GODAE OceanView programme.

The organizers hope to secure enough funds from different institutions, including co-fund from GlobalHAB, to invite a substantial number of early-career and developing-world scientists. A programme of summer-school-like tutorials will be woven into conference-style presentations and discussions. The draft programme is organised into four parts:

- Exploring the diversity of HAB modelling approaches
- Emerging technologies and platforms to support HAB monitoring
- Linking models, observations, and stakeholder needs
- Scaling up: the global impact of global change on HABs

- **Summer 2020.** *Symposium on automated in situ observations of plankton.*

In recent years novel in situ instrumentation has been developed for automated high frequency HAB detection in near real time. Also instruments for observing grazers, e.g. microzooplankton and multicellular zooplankton are becoming available commercially. These instruments are now being adopted in research and also in monitoring programmes. The aim of the mini-symposium is to bring together experts on, and users of, in automated in situ imaging systems, novel sampling equipment etc. to present methods, recent results and to share experiences. Another aim is to carry out a comparison of results when analysing plankton communities quantitatively. Young scientists is one target group of the symposium. After the main symposium a young scientist's data workshop for data processing and report/article writing is planned. The symposium is planned on summer 2020, **pending the results of several applications for funds** (e.g. recently sent to the European network EuroMarine www.euromarinenetwork.eu), **besides some potential support from GlobalHAB.**

- **2020.** A "*Best Practice Guidelines for the Study of HABs and Climate Change*", editorial team constituted by Mark Wells (chair), Michele Burford, Anke Kremp, Marina Montresor, Grant Pitcher and Gires Usup started on March 2018 with a tentative deadline for the submission of the draft chapters was the month of May 2019.

The Manual includes the following chapters:

Overview (Editorial Board)

Chapter 1 - Rationale and Introduction (Editorial Board)

Chapter 2 - Observing changes in HABs over time — Long Term Observations (Richardson AJ, Eriksen R, Hallegraeff GM, Rochester W, Pitcher G, Burford M)

Chapter 3 - Understanding Responses of HAB Species to climate change through experimentation

A) General Recommendations (Burford M)

B) Culture Experiments (van der Waal D, Kremp A)

C) Acclimation and Adaptation (Dyhrman S, Godhe A, Hennon G, Seibom J)

D) Toxin Measurements (McCarron P, Deeds J)

Chapter 4 - Databases (Zingone A, O'Brien T, Enevoldsen H, Provoost P, Lorenzoni L, Yin K, Bresnan E, Richardson A, Kruck A, Hallegraeff G)

Chapter 5 - HAB modelling and forecasting chapter (Hense I)

Funds for the first working meeting of the editorial team were provided by GlobalHAB. *The initiative of the Best Practices Manual for HAB and Climate Change is in line with the activities of SCOR WG149 that is focusing on Changing Ocean Biological Systems (COBS) and particularly on "How will biota respond to a changing ocean?" ([11](https://scor149-</i></p></div><div data-bbox=)*

ocean.com/). A second writing - editorial meeting could be necessary to finish the Manual.

4.2. Other potential activities ongoing and under exploration by the GlobalHAB SSC members and other collaborators:

*** Global Harmful Algal Bloom Status Report**

The first Global HAB Status Report is an initiative of IOC UNESCO with the support of IAEA, ICES, PICES and ISSHA. The GlobalHAB SSC is following and supporting the initiative where it can. In order to develop and launch the first Global HAB Status Report a network of data providers for OBIS-HAB and HAEDAT has been established and an Editorial Team for the First Global HAB Status Report was established together with a data flow structure. A data compilation template for HAB data in OBIS has been developed and reviewed and is in use (https://github.com/iobis/habtemplate/blob/master/habtemplate_a_v4.xlsx). This will allow to complement, and add value to, data already in OBIS with baseline observations recorded in the literature. Focus continues to be on data compilation and upgrades and adjustments to the data systems (HAEDAT as well as the OBIS-HAB data entry template). Additionally, the Editorial Team for the GHSR has developed the outline of the GHSR and chapters are drafted. Regional summaries on HAB based on OBIS, HAEDAT and the literature will constitute a special issue of the Elsevier Journal Harmful Algae late 2019. The planned online tools to create information products have yet to be developed and will focus on creating the products for the GHSR. Currently, a new data portal for HAEDAT is in development (<http://dev.iobis.org/haedat/>). The GHSR is foreseen to be complete by end 2019/early 2020.

*** New GlobalHAB Theme: *Sargassum* Blooms.** The GlobalHAB Science and Implementation Plan identifies that new emerging HAB related issues can be incorporated into the program after its launch. This is the case of the blooms of green macroalgae and *Sargassum*. **Elisa Berdalet** and **Henrik Enevoldsen** have been in touch with several researchers about this topic since 2016. The SSC have with Brian Lapointe (US) developed a short overview paper and the GESAMP Group of Experts have prepared a longer scoping paper on the *Sargassum* issue. The SSC proposed to GESAMP at its 2018 session to organize a joint open science meeting to identify the main research questions to understand the population dynamics of *Sargassum*. Several of the GESAMP sponsoring agencies have shown interests in the topic. **The GlobalHAB SSC will work during the coming months to progress in the organization of this theme jointly with GESAMP**, herein included to identify and engage additional experts with experience on *Sargassum*.

*** Workshop and a Summer school on analysis and interpretation of genetic data on HABs.** The activity is followed by Po Teen Lim who hosted regional workshops/training courses on HABs species and detection using molecular techniques for Southeast Asia in 2017 and 2018. More details of these activities are available in Harmful Algae News 58 and 61 (http://hab.ioc-unesco.org/index.php?option=com_content&view=article&id=22&Itemid=0). **National and regional workshop will be planned in collaboration with other international and regional agencies interested in HABs.**

***Workshop and Summer school on analysis and interpretation of genetic data relevant to HAB toxicity.** The activity is followed by Po Teen Lim, who is hosting a

regional workshop on toxins for Southeast Asia, as well as the Xiamen Marine Environment Meeting.

* A PCR/qPCR *Gambierdiscus* identification workshop.

* A 2nd International Conference on *Ostreopsis* Development, including ecology, toxicology, health and economy issues.

* A harmful species (*Gambierdiscus*, *Ostreopsis*, *Prorocentrum*, cyanobacteria) sampling workshop is under exploration with different Spanish institutions in the Canary Islands in 2020 - early 2021.

5. Representation of GlobalHAB at the Fourteenth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB)

The session was conducted in Paris, UNESCO Headquarters, Paris, 24-26 April 2019. SSC Chair, Elisa Berdalet, presented the Report on the activities contributing to the GlobalHAB Implementation Plan between May 2017 (XII IPHAB session) and April 2019. The IPHAB is the IOC governing body to which the SSC reports for IOC. The IPHAB welcomed the developments and had a discussion on how to ensure broader engagement geographically in as many of the GlobalHAB activities as possible. The Panel also discussed strategies and means for announcing GlobalHAB events, for engaging younger scientists and to strengthen the perception of ownership to GlobalHAB in the scientific HAB community. IPHAB recommended broader, wider and earlier communication of all events and developments, even in cases where there may be few seats available, as it is a way to make visible what GlobalHAB does and how it contributes to advance science. The IPHAB recognized that IPHAB members can serve an important role in doing so.

6. Funding considerations and future funding plans

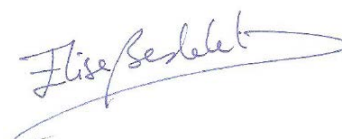
The scientific meetings of the GlobalHAB SSC have been supported by IOC UNESCO and SCOR (with funding from the U.S. National Science Foundation), and by in-kind contributions from ICES, PICES and SAMS. Additional funds have been received from other institutions to conduct the specific activities indicated previously.

As it is shown in this 2019 Report (section 4) some new scientific activities are planned and scheduled for the 2019 - 2021 period. In all cases, scientific outcomes in form of papers, new knowledge, training and coordination will result. The implementation of these activities depends on obtaining the necessary funds. **At present, the SSC members are in contact with interested researchers and institutions to co-organize and co-fund these activities.**

It is also important to note that GlobalHAB has been present in relevant international scientific and stakeholder *fora* where the challenges posed by HABs have been visualized and incorporated in key documents defining the road map of international agencies. **The work of GlobalHAB is becoming increasingly relevant as climate change begins to have worldwide discernible effects on coastal marine ecosystems along with major HAB impacts on resources** (e.g., HAB induced salmon mass mortalities in Chile and Norway in the last three years). **Nowadays, research on HABs goes beyond the traditional HAB arena and is entering into a new era of coordination initiatives. In all these initiatives SCOR has always been visible and acknowledged.**

For all the exposed, both SCOR and IOC members (states) are encouraged to contribute to the operation of the GlobalHAB SSC as well as to the implementation of the specific activities. This is particularly needed as the US NSF earmarked contribution to SCOR will be exhausted on August 31st, 2019. **The GlobalHAB SSC requests that SCOR investigates with NSF all options to extend this deadline** specifically for 18 months, **until February 28th, 2021**. This extension will allow conducting the planned activities and produce the scientific outcomes that implement GlobalHAB goal. As stated in the GlobalHAB webpage, "*In the broader picture GlobalHAB contributes to improved management of HABs as an ocean hazard through improved preparedness and early warning systems contributing to UN Sustainable Development Goal 11, target 11.5 and Priority 4 and Global target 7 of the Sendai Framework on Disaster Risk Reduction (UNISDR) 2015-2030.*" And the GlobalHAB SSC is committed to it.

When closing this Report, I am asking, respectfully, for this consideration to the SCOR President, Executive Director and Committee, on behalf of the GlobalHAB SSC and the international community working on HABs.



Elisa Berdalet, Chair of the GlobalHAB SSC
Barcelona, May 28th, 2019

GlobalHAB Scientific Steering Committee members

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