

Report of the Section on *Ecology of Harmful Algal Blooms in the North Pacific*

The Section on *Ecology of Harmful Algal Blooms in the North Pacific* (S-HAB) met under the chairmanship of Dr. Douding Lu (China), with the assistance of Drs. Charles Trick (Canada) and William P. Cochlan (USA), on September 23, 2017, in Vladivostok, Russia. Dr. Lu welcomed all participants and introductions were made. The meeting was attended by members from all PICES member countries (*S-HAB Endnote 1*). The proposed agenda for the meeting (*S-HAB Endnote 2*) was reviewed and some items were rearranged or taken off the agenda before being approved by the Section.



Participants at the meeting of S-HAB at PICES-2017, Vladivostok, Russia. Back row, from left: Xinfeng Dai, William Cochlan, Melissa Peacock, Tatiana Morozova, Charles Trick, Polina Kameneva, Ryuji Kuwahara, Douding Lu, Mitsunori Iwataki, Toyomitsu Horii; Front row, from left: Zijun Xu, Inna Stonik, Weol-Ae Lim, Setsuko Sakamoto, Lingjuan Wu, Hao Guo, Chuangjiang Guan, Keigo Yamamoto.

AGENDA ITEM 2

IPHAB meeting and Best Practices Manual and GlobalHAB

Drs. Cochlan and Trick reported on behalf of Dr. Mark Wells who was unable to stay for the meeting. They presented an update on the Best Practices Manual for Climate Change and HABs that is strongly aligned with PICES FUTURE project. Dr. Wells attended IPHAB-XIII (May 3–5, 2017, Paris). Dr. Wells is the chair of an editorial board for the manual. Other members, representing regions and various areas of expertise, are Drs. Donald Anderson (USA), Marina Montresor (Italy) and Michele Burford (Australia).

Editorial board terms of reference:

1. Develop outline for the guide;
2. Select authors for the chapters in base of expertise/topics, geographic distribution and gender balance;
3. Develop timeline for production of the guide and encourage chapter authors to stick to the timeline;
4. Oversee review process for draft chapters;
5. Develop a budget for the production and publication and, with GlobalHAB SSC and its sponsors, seek the required funding;
6. Report to the GlobalHAB SSC Chairs by e-mail on progress each quarter.

The editorial board would like to meet in spring 2018 to decide on outlines of each topic and potential authors (*S-HAB Endnote 3*). The manual should be finished by the Fall 2018 PICES meeting Dr. Wells requests PICES funding to attend this meeting as the lead editor.

GlobalHAB status report

HABMAP is an IOC effort to document the occurrence of every toxic HAB species around the world. Contributors are asked to document, with an appropriate reference, 2–3 example records of that harmful species and the level of toxins associated with its presence in their region. The IOC region associated with PICES is region 4 (West Coast of USA, West Coast of Canada, and Alaska) and region 7 (Korea, Japan, China, and Russia). Dr. Vera Trainer is an *ex officio* member of the GlobalHAB SSC.

PICES representatives from each country who have been assigned to enter their country's data into HABMAP by December 2017 are:

Canada – Dr. Nicola Haigh

China – Drs. Chunjiang Guan, Xinfeng Dai

Japan – Dr. Setsuko Sakumoto

Korea – Drs. Woel-Ae Kim, Taegy Park

Russia – Drs. Tatiana Morozova, Tatiana Orlova (possible to add Polina Kameneva?)

USA – Dr. Vera Trainer.

AGENDA ITEM 3

PICES MarWeb project updates

Dr. Trick, on behalf of Dr. Wells, presented updates on Marine Ecosystem Health and Human Well Being (MarWeB) project funded by MAFF (Ministry of Agriculture, Forestry and Fisheries of Japan) that took place in Indonesia and Guatemala (see the [MarWeB website](#) for more details).

- A final report of the MarWeB project has been published in [PICES Scientific Report No. 52](#) (M. Makino and R.I Perry, Eds).
- [Survey data](#) for the comparative well-being analysis in PICES member countries and Indonesia were collected (using the electronic clicker system) as part of the MarWeB project. Chapters written/co-authored by S-HAB members include:
 - Chapter 3, Case study 1. Indonesia – M. Makino, M. Wells, M. Hirota, S. Sachoemar;
 - Chapter 4, Case study 2. Guatemala – V.L. Trainer, C. Trick, W.P. Cochlan, P. Henley, H.L.C. Ovalle.
- A summary article entitled “*PICES.MAFF MarWeb project collaborates with the United Nations in the development of Marine Protected Areas in Guatemala*” by Vera Trainer, William Cochlan, Julian Herndon, and Charles Trick was published in PICES Press (Summer 2017, [Vol. 25, No. 2](#), pp. 31–34).
- A Topic Session ([S8/HD Paper](#)) on “*Marine ecosystem health and human well-being: A social ecological systems approach*” was co-convened by Mark Wells, Keith Criddle, Mitsutaku and Ian Perry at PICES-2017. Charles Trick (S-HAB) and Suhender I Sachoemar (Indonesia) were invited speakers.

AGENDA ITEM 4

Country reports

Japan

Dr. Setsuko Sakamoto reported that total number of HAB events decreased in 2016. *Karenia mikimotoi* and *Chattonella* spp. still occur as major species responsible for fishery damages in Japan. The number of red tide incidences of *K. mikimotoi* decreased in FY 2016 compared with that of FY 2015, but those of *Chattonella* show an increasing trend over the past 3 years. In the summer of 2017, severe fishery damage mainly to cultured puffer fish caused by *K. mikimotoi* red tides occurred at Imari Bay, northern Kyushu. Bivalves showed an accumulation of diarrhetic shellfish poisoning toxins in a limited area of the Northeast Pacific coastal area of Japan and by accumulation of paralytic shellfish poisoning (PSP) toxins in the same Tohoku region and the coast of western Japan, respectively. PSP in bivalves did not exceed the regulatory limit. A new occurrence of *Alexandrium tamivanichi* was observed in Seto Inland Sea.

China

Dr. Hao Guo reported that about 68 red tides events affecting an area of 7,500 km² were registered along Chinese coastal waters in 2016. The main blooming species included: *Aureococcus anophagefferens*, *Prorocentrum donghaiense*, *K. mikimotoi*, *Phaeocystis globosa*, and *Noctiluca scintillans*. The occurrence and affected areas of red tides were markedly increased compared with the previous year. Peak bloom concentrations were from April to August. The waters where the marine red tides frequently occurred were mainly in the East China Sea, with about 37 red tide events affecting an area of 5,700 km². Most cases of blooms were caused by *Noctiluca scintillans*. A new bloom caused by *Gyrodinium impudicum* was recorded in the Bohai Sea from August 27 to September 29, 2016. In addition, a green tide in the area caused by *Enteromorpha prolifera* was the largest observed in the last 5 years.

Canada

Dr. Charles Trick reported on behalf of Dr. Nicola Haigh on the west coast Canada HABs in 2016–2017.

For shellfish toxins: Domoic acid levels and spread were much less in 2016 and 2017 than in 2015 (CFIA data); several samples had low levels of diarrhetic shellfish poisoning (DSP) toxins, but there were no reports of DSP (CFIA and BCCDC data).

Paralytic shellfish toxin (PST) closures were widespread in 2016–2017, especially on the west coast of Vancouver Island (WCVI) in September and October 2016 (max 8500 µg STX-eq/100g, Esperanza Inlet, early October 2016), on the Central Coast area from late June through September 2017, and in the Salish Sea (Patricia Bay 2100 µg/g, June 2017, CFIA data).

For fish killers, *Heterosigma akashiwo* was less prevalent than usual in the last 3 years.

- 2015 – blooms on NE and mid-western Vancouver Island, mortalities in some areas;
- 2016 – bloom in September on SE Vancouver Island, mortalities reported;
- 2017 – very little until early September. It seemed 2017 might be a significant year for *Heterosigma* blooms, especially in the Salish Sea, with high Fraser River freshet due to a large snow pack. However, there were more diatoms than usual in the summer months.

There were significant *Dictyocha* blooms in 2016 and 2017, especially in the Salish Sea. Highest cell counts were dominated by non-skeletal *Dictyocha* and *D. fibula*. We still cannot say definitively how much *Dictyocha* is lethal to finfish and whether it affects shellfish. In 2017 there was extensive monitoring (by Grieg Seafood Canada farm personnel) in Sechelt Inlet and Jervis Inlet of *Dictyocha* cell counts and environmental parameters, and farmed salmon mortality levels – analysis of this data should lead to better understanding of this HAB species.

In June 2016, there was a *Chrysochromulina* sp. bloom with a coccolithophorid bloom on the west coast of Vancouver Island, with farmed salmon mortalities in Clayoquot Sound. Mitigation of this bloom was difficult, as the bloom was throughout the water column, and identification of these species is extremely difficult. Coccolithophorids are not unusual in June on WCVI, but *Chrysochromulina* at the same time is. In 2017 there were less *Chrysochromulina* spp. on WCVI than in 2016, but there were still some mortalities reported. There were no significant coccolithophorid blooms in British Columbia in 2017.

Russia

Polina Kameneva reported on behalf of Dr. Tatiana Orlova events in 2016–2017. In general, the major goals of the Russian monitoring program are to monitor HAB populations (plankton/benthos), reveal new sources of toxicity and early warning/mechanism efforts. Monitoring program consists of microalgae sampling, analysis of environmental parameters, culturing and molecular genetic studies. Over the last 3 decades it is noted that the diatom component of the microalgae community has become less frequent and mostly dinoflagellates prevail during the summer months. In the last 2 years unidentified cyanobacterial blooms have occurred in summer, releasing large amount of cyanobacterial pigments in the coastal area. A

Speletonema spp. bloom was registered in August 2017 with a density 13,913,500 cells/L and a *Noctiluca scintilans* bloom was registered in June with density 37, 000 cells/L.

Korea

Dr. Woel-Ae Lim reported that *Cochlodinium* blooms have occurred since 1995 in Korean coastal waters and have caused fisheries damage. However, a *Cochlodinium* bloom occurred in a very limited small area for a short period in 2016. There was no *Cochlodinium* bloom in 2017. The waters around Korea shared three characteristics in 2016 and 2017:

1. The water temperature was 3–5°C higher than the mean water temperature;
2. *Cochlodinium* free living cells were below 1 cell/mL and the dominant phytoplankton were diatoms;
3. An exceptionally strong Tsushima warm current was prevalent.

These unusual marine environmental characteristics in 2016 and 2017 are speculated to lead to *Karenia mikimotoi* and *Alexandrium affine* blooms in place of *Cochlodinium* blooms.

USA

Dr. William Cochlan presented a video showing that climate change may be linked to HABs which can influence the daily life of people in Alaska. To monitor HAB toxins (saxitoxin) in the area the local population needs to be engaged. He also reported that NOAA is transitioning a number of research projects to operational forecasts over the next several years. The following are the areas of priority for different regions of the U.S.: the Pacific Northwest is the highest priority for transition due to the effects of domoic acid on razor clams, other mollusks, and Dungeness crab. Other regions that ranked highly for transition to operations were:

1. California, for impacts of domoic acid on shellfish including Dungeness crab, and impacts on the health of marine mammals;
2. Gulf of Maine for the impacts of *Alexandrium fundyense* and the toxin, saxitoxin on aquacultured and wild shellfish;
3. Florida, for impacts of brevetoxin, a respiratory hazard on marine fish, wildlife and humans.

Other areas are focusing on improvements of forecasts including: the improvement of the Florida forecast with a transition and expansion to Texas, and freshwater Lake Erie forecasts which includes such improvements as the addition of satellite data and an upgrade to the mixing model.

The NOAA operational forecast has several developing capabilities including Alaska (*Alexandrium*; saxitoxin) and Chesapeake Bay (aquaculture, event response).

AGENDA ITEM 5

Special presentations

Lingjuan Wu presented an analysis of dynamic factors influencing the 2013 giant jellyfish bloom near Qinhuangdao in the Bohai Sea. The explosive growth of *Nemopilema nomurai* occurred near the coastal waters of Qinhuangdao in July 2013. The dynamic factors of wind, ocean currents, and sea temperature on the giant jellyfish bloom in 2013 are analyzed comprehensively than in the past. The jellyfish drift is jointly driven by the surface winds and surface currents. In the northeastern Bohai Bay, the giant jellyfish moved northward in the surface layer with a westward wind and current anomalies during the second half of May 2013. The specified direction of wind and current pattern in the Bohai Sea in the surface layer was important for the initiation of jellyfish bloom near Qinhuangdao than sea temperature in that source region.

Mitsunori Iwataki presented Ultrastructure and phylogenetic position of a karenian dinoflagellate collected from Japanese coast. Morphology and phylogeny of a small unarmored dinoflagellate isolated from Japanese coast, based on SEM, TEM and molecular phylogeny inferred from LSU rDNA sequences.

The species has the small epicone, and chloroplasts mainly situated in the large hypocone. The straight apical groove could be observed under SEM. TEM revealed the typical organelles of dinoflagellates. Molecular phylogeny showed the small species is positioned in the family Kareniaceae, but not closely related to the clades of well-known genera, *Karenia*, *Karlodinium* and *Takayama*.

AGENDA ITEM 6

FUTURE linkages and ideas for collaboration with S-HAB

Dr. Toyomitsu Horii, FUTURE SSC liaison to S-HAB, discussed possible linkages and ideas for FUTURE collaboration with S-HAB. HABs can be linked with FUTURE by contributing to marine ecosystem and human dimensions system.

S-HAB contributions to the FUTURE Science Plan as follows:

- HABs are a coastal pressure that generate substantial environmental, human health and economic impacts;
- HABs are driven by environmental conditions, some of which are well understood, and can be strongly influenced by anthropogenic pressures;
- S-HAB is working towards developing outlooks, and ultimately forecasts, of HAB events to aid society;
- S-HAB contributes directly to better understanding anthropogenic impacts on coastal ecosystems and the effects of climate effects on ocean ecosystems.

S-HAB noted that its contributions to the FUTURE roadmap and FUTURE include the following products (scientific knowledge):

- International cooperation in HAB science – GlobalHAB ([Oceanography 30: 70–81](#));
- HABs and Climate Change “Commentary” in the journal [Harmful Algae 49: 68–93](#);
- A [workshop](#) on East–West comparisons of *Pseudo-nitzschia* at PICES-2016 and a [PICES Scientific Report No. 53](#) resulting from the workshop.

AGENDA ITEM 7

Presentation on a new MAFF project

No information.

AGENDA ITEM 8

Prioritized requests to MEQ

- 1-day proposal for a workshop on “*Emerging blooms of toxic dinoflagellates in the Pacific: Comparative analysis of their prevalence and ecological impacts in the eastern and western regions*” (*S-HAB Endnote 4*). S-HAB requests funding for 1 speaker from the Eastern Pacific (a second speaker, from the western Pacific may be sponsored by NOWPAP);
- 1-day S-HAB business meeting (PICES-2018);
- GlobalHAB meeting, March 2018 (location TBD, for GlobalHAB SSC *ex-officio* member Vera Trainer to attend);
- Best Practices Manual, Editorial Board meeting, March 2018, Naples, Italy, for editorial board Chair, Mark Wells to attend;
- Addition of Dr. Polina Kameneva (Russia) to S-HAB membership.

S-HAB Endnote 1

S-HAB participation list

Members

William Cochlan (USA)
Hao Guo (China)
Chuangjiang Guan (China)
Mitsunori Iwataki (Japan)
Ryuji Kuwahara (Japan)
Weol-Ae Lim (Korea)
Douding Lu (China, Co-Chair)
Setsuko Sakamoto (Japan)
Tatiana Morozova (Russia)
Charles Trick (Canada)

Observers

Xinfeng Dai (China)
Toyomitsu Horii (FUTURE SSC, Japan)
Polina Kamaneva (Russia)
Masaya Katoh (Japan)
Melissa Peacock (USA)
Inna Stonik (Russia)
Lingjuan Wu (China)
Zijun Xu (China)
Keigo Yamamoto (Japan)

Members unable to attend

Canada: Nicola Haigh, Jennifer Martin
China: Chunlei Gao, Qiufen Li, Mengmeng Tong, Naihao Ye
Japan: Ichiro Imai
Korea: Hae Jin Jeong, Kwang Young Kim, Tae Gyu Park
Russia: Olga Lukyanova, Tatiana Orlova, Mikhail Simokon
USA: Vera L. Trainer, Mark L. Wells

S-HAB Endnote 2

S-HAB meeting agenda

1. Welcome, goals of S-HAB meeting (Douding Lu and William P. Cochlan)
2. Global HAB, Best Practices Manual and IPHAB meeting
3. PICES MarWeB project updates
4. Country reports
5. Special presentations
6. FUTURE linkages and ideas for collaboration with S-HAB
7. Presentation on a new MAFF project
8. Prioritized requests to MEQ

S-HAB Endnote 3**Tentative chapter outline for best practices manual for HABs**

1. Field Observations
 - A. In-situ
 - B. Remote Sensing
2. Laboratory/Field Experiments
 - A. Laboratory
 - B. In-situ/deckboard
3. HAB Culturing for CC experiments
 - A. Organism choice/experimental design/axenic (ideal) or not
 - B. General (media, modified nutrient concentrations, nutrient ratios, light (cycle, intensity), continuous vs continuous batch vs batch)
 - C. Acclimation/adaption, choice of start point, choice of endpoint
 - D. Temperature (recommended offset...)
 - E. pCO₂ (recommended levels, adjustment, bubbling, measurement... summary of issues but direct to BP Manual)
 - F. Other CC parameters (list: Salinity, trace elements...)
 - G. Statistical analysis, replication, randomization (e.g., light exposure)
 - H. Model organisms (include in experiments to evaluate general growth conditions)
 - I. Special Considerations
 - a. CyanoHABs
 - b. Toxic HABs
 - c. Fish Killing HABs
 - d. Benthic HABs
4. Toxin Measurements
5. HAB Modelling (adapting laboratory cultures to simulated cultures)
6. Molecular Methods
 - A. Standard Organism/genome approach
7. Long-term Observations and Databases

S-HAB Endnote 4**Proposal for a workshop on**

“Emerging blooms of toxic dinoflagellates in the Pacific: comparative analysis of their prevalence and ecological impacts in the eastern and western regions” at PICES-2018

Duration: 1 day

Convenors: Vera L. Trainer (USA) and Douding Lu (China)

Co-sponsors: NOWPAP, GlobalHAB

Invited speakers: 1 Eastern Pacific, 1 Western Pacific, 1 European

There is clear evidence of contrasting occurrences and impacts of toxin-producing dinoflagellates in the eastern and western North Pacific. In particular, three genera – *Dinophysis*, *Gymnodinium* and *Cochlodinium* – show contrasting historical and habitat preferences, and have potentially distinct consequences to the ecology and downstream health impacts. For example, over the past several decades *Dinophysis* has caused repeated shellfish closures and human illnesses from diarrhetic shellfish poisoning (DSP) in Japan,

China, and Korea. Whereas in the eastern Pacific, *Dinophysis* has been recorded at a high abundance without corresponding DSP events – until 2011. These data will provide a unique opportunity for east–west Pacific comparisons to identify and rank putative environmental factors that promote harmful algal bloom (HAB) success.

The recent PICES-funded workshop on ‘HABs and Climate Change’ emphasized the importance of studying such contrasting events to further our understanding of climate impacts. This workshop will be an extension of the current dataset to the 1990s and earlier where available, with PICES participants pre-submitting available data on: HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, water clarity, nutrients, wind, river flow (flooding), and upwelling indices.

Workshop participants will evaluate the trends and patterns in these data to develop hypotheses for development into outlook products on day 1, and develop a detailed outline for manuscript preparation on day 2, including writing assignments and submission deadlines. The manuscript will be targeted for an appropriate peer-reviewed journal. These goals align closely with those of GlobalHAB and NOWPAP, and the International Society for the Study of Harmful Algae (ISSHA), all seeking to strengthen data collection, analysis and communication of findings on climate change and HABs. Representatives from GlobalHAB, NOWPAP and ISSHA will participate in the workshop, both to contribute to the workshop outcome, and to reinforce ties with other international partners.