

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 chairpersonship of Drs. Vera Trainer and Douding Lu on November 4, 2016, in San Diego, California USA. The meeting was attended by members from Canada, China, Japan, Korea, Russia and USA (*S-HAB Endnote 1*). The proposed agenda for the meeting (*S-HAB Endnote 2*) was reviewed and approved by the Section.

AGENDA ITEM 2

Country reports

Canada

Dr. Nicky Haigh reported that fewer domoic acid events were observed in 2016 compared to 2015. One sample exceeded the regulatory threshold of 20 ppm on the central British Columbia coast. In mid-August 2016, shellfish samples that tested from 2–8 ppm in Clayoquot Sound were concurrent with a bloom of *Pseudo-nitzschia delicatissima* at 10,000 cells/L. The maximum paralytic shellfish toxins observed were at 8500 µg/100g in mid-October 2016 in Esperanza Inlet. *Heterosigma akashiwo* observations were lower than usual in 2015 and 2016. A bloom of *Chrysochromulina* in western Vancouver Island in June 2016 resulted in mortalities at salmon farm sites. These blooms were found throughout the water column, so it was difficult to mitigate these blooms using screens. *Chattonella* was observed in early October 2016 on the northeastern side of Vancouver Island, with no fish kills. A bloom of *Chaetoceros convolutus* in October 2016 on western Vancouver Island resulted in salmon mortalities. An unusual coccolithophorid bloom in August 2016 brought public awareness to phytoplankton in the area and was used as an opportunity for outreach.

China

Dr. Douding Lu reported that 35 HABs occurred in 2015, including blooms of *Aureococcus anophagefferens*, *Prorocentrum donghaiense*, *Cochlodinium polykrikoides*, *Karenia mikimotoi*, *Phaeocystis globosa*, *Noctiluca scintillans*, *Gonyaulax polygramma*, *Heterosigma akashiwo* and *Fibrocapsa japonica*. *Karenia* blooms in Tolo Harbor (Hong Kong) may be linked to a climate change signal. *H. akashiwo* blooms appear to be increasing in China. *Phaeocystis globosa* clogs power intakes for cooling systems. This is a huge problem and clay is being considered as a mitigation tool. Domoic acid has been measured in shellfish. *Pseudo-nitzschia simuloris* has been identified as a DA producer. The scale of green tides in China is larger than in previous years and appears to be having an increasing trend.

Japan

Dr. Setsuko Sakamoto reported that from 2014–2016 there was a dominance of *K. mikimotoi* in Japan and *Chattonella* in western Japan as the major HAB species. Other species included *K. digitate* and *Dictyocha* and there were records also of DSP and PSP closures. From 2013–2015, the number of fish kills caused by *Chattonella* increased, those caused by *H. akashiwo* remained constant, those caused by *K. mikimotoi* increased in both number of occurrences and fish killing events, the number of cases of *Heterocapsa circularisquama* events decreased, and those caused by *C. polykrikoides* increased in number of occurrences and fish killing events.

Korea

Dr. Woel-Ae Lim reported that *Cochlodinium* blooms appear to be increasing over the last few decades while at the same time, diatom abundance is decreasing. The area of blooms has increased from 2012–2015. The Kuroshio Warm Current appears to transport the cells. Blooms occur at the front of the coastal current and the Kuroshio; *Karenia mikimotoi* blooms killed abalone in 2016. The long-term trend is for increasing sea surface temperature by over 1°C. Higher than usual water temperature and deficient seed populations were the reason

for the small *Cochlodinium* bloom in 2016. Low salinity from the Yangtze River also played a role in the inhibition of seed populations as well as a strong Tsushima Warm Current.

Russia

Polina Kameneva reported that very unusual low salinity events were observed in the Vladivostok region in 2016. The following harmful algae were observed in 2015: *Ostreopsis* in August, *Pseudo-nitzschia* in October, prymnesiophytes in February and September (blooms under the ice), *Noctiluca scintillans* in June, *Dinophysis acuminata* on 21 June (an unusual time for a *Dinophysis* bloom). A fish kill (*Osmerus* sp.), not necessarily HAB-related was observed in May.

USA

Dr. Vera Trainer reported on the large-scale, long-lasting *Pseudo-nitzschia* bloom off the U.S. West Coast, beginning in spring 2015. It resulted in closures of the razor clam and Dungeness crab fisheries, resulted in some of the highest toxin levels ever measured in anchovies and seawater, and caused marine mammal mortalities. The bloom impacted many sites along the West Coast, including the U.S. and western Vancouver Island, Canada, in early May 2015. Cruises of opportunity made it possible to sample along the continental shelf from California to Alaska during summer of 2015. These samples will be analyzed for particulate and dissolved domoic acid to determine the spatial distribution of the large HAB event. This event is published in *Geophysical Research Letters* (McCabe *et al.*, 2016 doi:10.1002/2016GL070023).

AGENDA ITEM 3

Scientific presentations

Joo-Hwan Kim reported on the first ever occurrence of *Azadinium* in Puget Sound, Washington State, USA. The species observed include *A. poporum*, *A. obesum*, *A. dalianense* and *A. cf. dalianense*. Analysis by LC/MS (collaboration with German colleagues, Dr. Urban Tillman and Dr. Bernd Krock of the Alfred Wegener Institute) has shown that *A. poporum* is producing a unique toxin, now named azaspiracid 59.

Svetlana Esenkulova reported on the Salish Sea Marine Survival Project that uses fishers as volunteers to collect environmental and phytoplankton samples in the Straits of Georgia, British Columbia in her presentation on “*A review of unusual phytoplankton dynamics and oceanographic conditions favoring diatom growth in the Strait of Georgia, Canada 2015*”.

Dr. Clarissa Anderson presented results of a *Pseudo-nitzschia* and domoic acid forecasting system called C-HARM (California Harmful Algae Risk Mapping). A suite of environmental factors, including temperature and salinity (from ROMS) and ocean color parameters (from MODIS), are used to create spatially explicit nowcasts and 3-day forecasts at a 3-km horizontal resolution. The domoic acid risk mapping shows greater predictive skill than the *Pseudo-nitzschia* risk mapping, presumably due to the high variability of toxin production by the many species of *Pseudo-nitzschia* and also the tendency of the optical model to conflate terrigenous runoff with *Pseudo-nitzschia* biomass. Domoic acid also provides a useful lead time relative to marine mammal strandings from DA toxicosis in central California and proxies for shellfish toxicity.

AGENDA ITEM 4

Marine Ecosystem Health and Human Well-Being (MarWeB) project

Dr. Vera Trainer provided an update on the 5-year PICES project on “*Marine ecosystem health and human well-being*” funded by Japan’s Ministry of Agriculture, Forestry and Fisheries (MAFF), through the Fisheries Agency of Japan. MarWeB will end in March 2017. Drs. Charles Trick, Mark Wells and Trainer are part of the project science team (PST) representing S-HAB. Dr. Wells has been involved in the Indonesia case study, developing a multi-trophic aquaculture and pond experiment with Indonesian partners and Drs. Trainer and Trick have worked with the locals in two coastal villages to explore alternatives to wild fishing to sustain their

communities. Articles on the progress for the Indonesian study can be found in [PICES Press Vol. 24, No. 1](#), pp. 29–30 and for the Guatemala study in [PICES Press Vol. 24 No. 2](#), pp. 28–31.

AGENDA ITEM 5

Update on HABs and climate

Dr. Mark Wells discussed the need for new research strategies to better understand the linkages between HABs and climate change. Climate change is a statistical change in global or climate research patterns whereas global change includes human factors such as population, economies, *etc.* For example, high biomass HABs is not a climate change issue but if changes in high biomass HABs are caused by shifts in global climate patterns (*e.g.*, precipitation), then they are a climate change issue. “Climate HABs” are the result of long-term changes whereas “Weather HABs” are a result in short term, more local changes. Dr. Wells stressed that the HABs community needed to develop evidence that climate-driven environmental change will alter HAB frequency, distribution and intensity. This could be achieved by: (1) studying HAB weather (using the natural lab to study extreme events such as the large-scale *Pseudo-nitzschia* bloom on the north American west coast in 2015), (2) using IPCC regional end-of-century climate forecasts to hypothesize how regional HABs would respond, and (3) using new investigative approaches to strengthen our understanding (change how we are doing things). Decadal geographic HAB forecasts, select species for focused molecular campaigns and develop a “best practices manual” needed to be developed. The best practices manual would standardize culturing methods, select recommended stress levels and use certifies growth standards (cosmopolitan non-HAB species).

AGENDA ITEM 6

Joint Harmful Algal Programme and International Oceanographic Data and Information Exchange Harmful Algae Information System: An update and country maps

Dr. Trainer will review the country point people to see if there were any changes. Any new point people who are not familiar with HAE-DAT data entry protocols will be put in touch with Dr. Henrik Enevoldsen (Head, IOC Science and Communication Centre on Harmful Algae) who can provide instruction. The current focal points are:

Canada – Dr. Jennifer Martin, Nicky Haigh,

China – Dr. Chunjiang Guan,

Japan – Dr. Setsuko Sakumoto,

Korea – Drs. Woel-Ae Kim, Taegy Park,

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

USA – Dr. Don Anderson (Vera Trainer to replace Rita Horner)

AGENDA ITEM 7

GlobalHAB (to replace GEOHAB) and IOC/IPHAB global HAB report

Dr. Vera Trainer reviewed Global HAB Status Report Decision IPHAB-XI.2 on the “Development of the Harmful Algal Information System” that describes the resolution to invite PICES’ S-HAB to participate in a project Task Team to develop a periodic Global Harmful Algal Bloom Status Report that shall:

1. Provide a global status and overview of HAB events and their societal impacts;
2. Provide a global overview of the occurrence of toxin producing microalgae;
3. Assess the status and probability of change in HAB frequencies, intensities, and range expansions resulting from global change.

S-HAB-2016

She presented a summary of the GlobalHAB terms of reference, established during the March 2016 GlobalHAB Scientific Steering Committee meeting in Oban, Scotland. The GlobalHAB mission is to improve the understanding, prediction, management and mitigation of HABs in aquatic ecosystems. Goals are to:

- Address the scientific and societal challenges of HABs, including the environmental, human health and economic impacts, in a rapidly changing world;
- Involve participants from related fields of natural and social science, and will link with other regional and international organizations and initiatives relevant to HABs;
- Foster intercalibration among existing methods, as well as promoting the development and adoption of new technologies;
- Promote training, capacity building and communication of knowledge about HABs to society;
- Serve as a liaison between the scientific community, stakeholders and policy makers, promoting science-based decision making.

AGENDA ITEM 8

Presentation on NOWPAP

Dr. Takafumi Yoshida gave a presentation on recent accomplishments of NOWPAP. For 2012–2017, strategic goals are to (1) understand climate change impacts on the environment and (2) take regular assessments of the state of the environment. At PICES-2015, the joint PICES-NOWPAP Study Group on Scientific Cooperation in the North Pacific Ocean (SG-SCOOP) developed a Framework for Scientific Cooperation in the North Pacific Ocean. Of the seven priority topics for joint collaboration, HABs received the highest priority.

AGENDA ITEM 9

Presentation on FUTURE

Dr. Toyomitsu Horii, FUTURE SSC liaison with S-HAB, gave a presentation on FUTURE goals and how the S-HAB can continue to contribute to FUTURE's success.

AGENDA ITEM 10

Presentation on new MAFF project

Dr. Masahito Hirota, member of the MarWeB project science team, presented ideas for a new project that will be sponsored by MAFF (Ministry of Agriculture, Forestry and Fisheries of the Government of Japan), tentatively titled "Building capacity for ecosystem based management in small-scale nearshore fisheries impacted by coastal zone development". The project will build capacity for community-scale ecosystem based co-management (EBCM) of fisheries and the coastal zone for small communities in the Pacific region. Emphasis will be placed on well-balanced co-management systems that support sustainable fisheries and sustainable development of the coastal zone through application of PICES's scientific expertise. The project continues the EBFM focus of past PICES MAFF projects, and will use those results to jump-start collaboration between PICES scientists, local stakeholders, and responsible parties in the host countries (Vietnam, Indonesia and Guatemala). Capacity building, as in outreach of the past two PICES MAFF projects, will be stressed. The candidate countries are Vietnam, Indonesia (Year 1) and Guatemala (Year 2). S-HAB members will participate in this new MAFF project.

AGENDA ITEM 11

Prioritized requests with funding implications to MEQ

1. Travel support for 1 PICES member to attend the Global HAB Scientific Steering Committee meeting March 2017 in Naples, Italy. Estimated total: ~\$2500 USD.
2. 1½-day joint S-HAB/NOWPAP/GlobalHAB PICES-2017 workshop on “*Long-term changes in HAB occurrences in PICES nations: the Eastern vs. Western Pacific*” (S-HAB Endnote 3). Funding for 2 invited speakers (Dr. Nick Bond – climatic differences in eastern vs. western Pacific; Dr. T. Nishikawa – long term database on *Chattonella* sp., *Karenia* sp. in the Seto Inland Sea). NOWPAP and GlobalHAB may fund 1 speaker each. Estimated total request to PICES: ~\$5,000 USD.
3. Funds for publication of a “Best Practices Manual” recommended as a priority need at the 2014 PICES/ICES/GEOHAB workshop on “*Harmful algal blooms in a changing world*”. Two PICES S-HAB members to travel to a mini-workshop to discuss manual design in May 2017 in Paris, France. Estimated total: ~\$5000 USD.
4. Addition of Ms. Paolina Kameneva (Russia) to S-HAB membership.

AGENDA ITEM 13

Review of assignments

Dr. Trainer reviewed member assignments before adjourning the meeting.

S-HAB Endnote 1**S-HAB participant list**Members

Hao Guo (China)
 Nicky Haigh (Canada)
 Ichiro Imai (Japan)
 Ryuji Kuwahara (Japan)
 Weol-Ae Lim (Korea)
 Douding Lu (China, Co-Chair)
 Tae Gyu Park (Korea)
 Setsuko Sakumoto (Japan)
 Vera L. Trainer (USA, Co-Chair)
 Mark L. Wells (USA)
 Takufumi Yoshida (*ex officio*, representing
 NOWPAP)

Observers

Clarissa Anderson (SCCOOS)
 Leila Basti (Japan)
 Meredith Elliott (USA)
 Svetlana Esenkulova (Canada)
 Masahito Hirota (Japan)
 Toyomitsu Horii (Japan)
 Devan Johnson (Canada)
 Polina Kameneva (Russia)
 Joo-Hwan Kim (Korea)
 Yuichi Kotaki (Japan)
 Anthony Odell (USA)
 Tamara Russell (Canada)
 Inna Stonik (Russia)

Members unable to attend

Canada: Jennifer Martin, Charles Trick
 China: Chunlei Gao, Chunjiang Guan, Qiufen Li, Mengmeng Tong, Naihao Ye
 Japan: Akira Ishikawa, Shigeru Itakura
 Korea: Hae Jin Jeong, Kwang Young Kim
 Russia: Olga N. Lukyanova, Tatiana V. Morozova, Tatiana Yu. Orlova, Mikhail Simokon
 USA: William P. Cochlan

S-HAB Endnote 2

S-HAB meeting agenda

1. Welcome, goals of HAB Section meeting (Trainer)
2. Country reports and HAE-DAT usage (All)
3. Three special presentations
 - First record of the genus *Azadinium* (Dinophyceae) from the Puget Sound, western Washington State (Joo-Hwan Kim)
 - A review of unusual phytoplankton dynamics and oceanographic conditions favoring diatom growth in the Strait of Georgia, Canada 2015 (Svetlana Esenkulova)
 - Harmful algal bloom warning system for fisheries and marine mammal management (Clarissa Anderson)
4. Update on Marine Ecosystem Health and Human Well-Being (MarWeB) project (Trainer)
5. Update on “HABs and climate”, PICES/ICES/IOC collaboration
6. Joint Harmful Algal Programme and International Oceanographic Data and Information Exchange Harmful Algae Information System: An update and country maps (Enevoldsen, Trainer)
7. IOC/IPHAB Global HAB report (Trainer)
8. NOWPAP (Takafumi Yoshida)
9. FUTURE (Toyomitsu Horii)
10. New MAFF project (Masahito Hirota)
11. Prioritized requests with funding implications to MEQ (all)
12. Review of assignments

S-HAB Endnote 3

**Proposal for a 1½-day Workshop on
“Long-term changes in HAB occurrences in PICES nations: the Eastern vs. Western Pacific”
at PICES-2017**

Convenors: Mark Wells (USA) and Polina Kameneva (Russia)

Proposed invited speakers: Adrianna Zingone (GlobalHAB), Takafumi Yoshida (NOWPAP), Tetsuya Nishikawa (Japan), Nicholas Bond (USA)

Potential Co-sponsor: NOWPAP

The PICES 2016 Workshop on toxic *Pseudo-nitzschia* blooms in the eastern and western Pacific highlighted the stark differences in economic and social impacts of these HABs, and how these effects have been changing over at least the past decade. For example, toxic *Pseudo-nitzschia* blooms have frequent and intense impacts on fisheries and human health in the eastern Pacific, but have not caused any fisheries closures in the western Pacific, despite the widespread presence of toxigenic species in western Pacific waters. Moreover, in some eastern regions these HABs are increasing in frequency, intensity and duration, but it remains unclear whether these changes are linked to climate pressures. There is a strong need to better identify long-term trends in these and other HAB organisms in the context of climate change pressures in PICES nations. We propose a 1.5 day workshop to assemble, present, and analyze long-term datasets on HAB organism abundance and impacts from each nation, along with existing time series data of associated environmental parameters. Key country leads will present trends, HAB distribution maps, and oceanographic, meteorological, and linked terrestrial data (e.g., precipitation), including the dynamics of change in these parameters (e.g., pulsed runoff events) and details on monitoring strategies and impacts (e.g., fisheries, human health). Participants will study these trends to identify knowledge gaps, unify methods for data analysis, and propose methods for future data collection to strengthen understanding of climate/HAB linkages. 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.