2025 Report of Section on *Ecology of Harmful Algal Blooms in the North Pacific* (S-HAB)

The 2025 S-HAB annual meeting was co-chaired by Drs. Pengbin Wang (China) and Mark L. Wells (USA), and attended by 13 members on November 11, 2025 in Yokohama, Japan. The meeting was attended by members from five of the six PICES member countries (*S-HAB Endnote 1*). The meeting began with welcoming comments from both co-chairs and, as new members/participants were present, was followed with short introductions by each participating member (**Agenda Item 1**, *Endnote 2*). The provisional agenda was shared among participants ahead of the meeting and was adopted as proposed (**Agenda Item 2**, *Endnote 2*).

Agenda Item 3 — Structural challenges for S-HAB Business meetings

Members were briefed on the challenges introduced by the new schedule for Section submissions requiring reports of S-HAB business meetings to MEQ in the weeks before the Annual Meeting. The central issue is that the time differences among S-HAB members limits the effective duration of on-line meetings, so that multiple on-line meetings will be required to accomplish the discussions normally covered by longer on-site meetings (the country reports alone require 2+ hours for presentations and discussions). Summer and early fall are busy times for HAB monitoring and management, making it almost impossible for full participation at multiple meetings. The consequence of the current reporting/requesting timelines will be a reduced effectiveness for consensus on S-HAB planning and current activities, and thereby accomplishments PICES has come to expect of S-HAB. It was resolved that the co-chairs will draft a letter to Science Board to communicate the situation and request that adjustments be made to the reporting schedule that enable on-site business as in the past.

Agenda Item 4 — Proposals for a Topic Session and Workshop for the PICES 2026 Annual Meeting

Two proposals were drafted by members, one for a topic session addressing how HAB monitoring strategies have evolved and enabled HAB forecasting, and a workshop enabling a hands-on demonstration of the advances in rapid detection technologies for HAB toxins.

Proposal 1: Topic Session on Evolution in the monitoring of Harmful Algal Blooms (HABs) towards improved forecasting

Convenors: Vera Trainer (verat@uw.edu), Misty Peacock (mpeacock@nwic.edu), Pengbin Wang (algae@sio.org.cn), Charles Trick, Canada, (charles.trick@utoronto.ca), and M. Wells, USA (mlwells@maine.edu)

Corresponding Convener: M. Wells (mlwells@maine.edu)

There have been large changes in methods and approaches for the detection, study, and reporting of HABs over the past two decades. In many cases, the evolution of these changes is a result of the synergies from combining classical with modern advances; improvements that span sampling, analyses, forecasting, and the broad communication of these findings. Classical methods include, but are not limited to, microscopy and shore-based sampling of water and organisms, while more modern and continually advancing tools include satellite, autonomous underwater vehicles (AUV), environmental sample processors (ESP), and automated microscopy (Flowcams, Imaging Flow Cytobots). Rapid advances and decreased costs of genomic analyses (e.g., environmental DNA) and toxin testing provide great potential for better characterizing the ecological drivers for HABs. Innovations in metabolomic methods bring the possibility to study the unique chemical markers of specific cellular processes (e.g., toxin production, competitive interactions, etc.). In addition, there has been considerable progress creating databases that enable merging diverse suites of environmental and HAB-focused observations. Combined, these emerging capabilities improve the potential for actionable forecasting of HAB events. The scope of HAB studies also has become more inclusive, with volunteer and community participation. Communicating the findings has broadened to utilize web and app-based tools that are more successful in "getting the message out" to managers and coastal communities. What are the struggles and success stories of how these diverse capabilities work together to provide the best possible actions to protect human health and seafood harvest? How is this evolution the same or different among PICES nations? This topic session is intended to provide a venue for sharing the broad diversity of decadal changes in how we approach detection, study, and reporting of HABs.

Location: TBD

Duration: 1 day

Date: November 2026

Invited Speakers: TBD, but the intention is to have at least one ECOP who can address some of the more modern techniques for detection and study of HABs.

Co-sponsors: MONITOR, Human Dimension, GlobalHAB, IOC UNESCO, ICES WGHABD, ISSHA

The underlying intention of the Topic Session is to bring together HAB and related scientists to begin planning a workshop on HAB forecasting at the 2027 PICES Annual Meeting. We envision that this workshop will result in a series of comparative papers, or a PICES Special Publication, on forecasting systems in PICES member nations.

We note that this session has a very different focus than the workshop proposal submitted. The goal is to share the broad changes in approach to studying, reporting, and forecasting of HAB events. The workshop's focus is on sharing advances in rapid toxin testing methods.

Proposal 2: Workshop on Advances in Rapid Detection Technologies for Harmful Algal Toxins

Conveners: Natsuko Nakayama, Japan (nakayama_natsuko37@fra.go.jp), Misty Peacock, USA (mpeacock@nwic.edu), Andrew RS Ross, Canada (Andrew.Ross@dfo-mpo.gc.ca),

Pengbin Wang, China (algae@sio.org.cn), Vera Trainer, USA (verat@uw.edu), William Cochlan, USA (cochlan@sfsu.edu), Mark Wells (mlwells@maine.edu)

Corresponding Convener: Mark Wells (mlwells@maine.edu)

Regulatory testing of shellfish for toxins is the foundation of safe and secure shellfish sales around the world. However, aquaculture facilities often are far from regulatory testing labs, which leads to expensive delays in analyses and other increased operational costs. Rapid toxin testing that can be performed at hatcheries and harvesting sites enables informed decisions regarding harvesting strategies. Although a limited number of rapid-test technologies have been available for some time, recent scientific and technological progress has led to improvements in near real-time detection of toxins using rapid tests. For example, the enzyme-linked immunosorbent assay (ELISA) has been modified for some toxins to allow for less expensive, single sample quantitative analysis. In other cases, strip tests that are similar to COVID tests now are available to provide qualitative results that allow shellfish farmers to make strategic decisions (e.g., delaying harvest if toxins are detected). Even with these new technologies, challenges remain to implementing them on an effective operational basis, particularly related to different toxin isomers present in shellfish in different geographic regions. Each method also has technical constraints in terms of its efficiency, accuracy, and the needed expertise of operators, along with operational costs. There is a need to share current experiences, advances, and limitations of rapid detection methods for toxins and HAB organisms, including molecular probes, ELISA analysis, quantitative PCR essays, high-throughput sequencing and remote sensing techniques. This workshop will bring together researchers, industry members, and government experts on regulatory limits and associated risks to explore existing and new directions for rapid toxin testing. It will combine focused group discussions, example pilot studies, and hands-on demonstrations towards promoting, adapting, and applying rapid detection technology for toxins. The long-term goal is to improve early warning and effective management of HABs in the North Pacific Region.

Potential Co-sponsors: Human Dimension, Monitor, GlobalHAB, IOC UNESCO, ISSHA, IUCN

Duration: 1 day

Potential Invited speakers: TBD. One possibility is Avery Tatters (University of Washington) who has extensive experience with rapid toxin testing, and another would be an industry person who can speak about the real-world operational experience with current toxin testing kits on the market.

Outputs: Shorter-term goals include using the workshop as a basis for: 1) developing capacity building training courses for rapid assessment of HABs; 2) summary publications in a peer-reviewed journal as well as PICES Press; and 3) identifying the key foci for a future PICES working group proposal to join with WESTPAC to develop joint studies on emerging Rapid Detection Technologies for Harmful Algal Blooms (RDT-HAB).

Why now? Food security in this century increasingly will be dependant on aquaculture resources that, in turn, are increasingly being threatened by HABs. The economic survival of global aquaculture is critically dependent on adequate and affordable insurance backing that has rapidly dwindled due to mounting HAB-related economic losses (PICES Scientific Report No. 59, 2020). Rapid toxin testing is a critically important tool that can help industry adjust their harvesting dynamics to minimize losses; one essential step to enable more responsive aquaculture management practices.

We note that this workshop proposal has a very different focus than the topic session proposal also submitted. This workshop is narrowly focused on advances in algal toxin testing, with hands-on training, in contrast to the topic session which has a broader goal to share the decadal changes in approaches to study, reporting, and forecasting of HAB events.

SB Decisions — With the recent shift in PICES criteria for ranking meeting proposals, lending more weight on broader support within PICES, S-HAB sought input from related PICES Scientific and Technical committees to better reflect their interest prior to submission of these proposals. Due to the US government shutdown, there was delay in response from the US Chair of TCode, which led to both S-HAB proposals being submitted two days after deadline. Unfortunately, Science Board made no allowances for the US Government shutdown and granted neither proposal, meaning that S-HAB will have no effective participation in the 2026 Annual meeting. This will not happen in the future as S-HAB now understands that it must prioritize PICES deadlines over efforts towards collaborative science.

Agenda Item 5 — Output from the S-HAB 2023 Workshop "*International Workshop on Solutions to Control HABs in Marine and Estuarine Waters*"

Vera Trainer presented a summary of the recent scientific publication in *Harmful Algae* presenting the findings of the PICES workshop on HAB control solutions in coastal and estuarine waters. Despite being well beyond the normally accepted length, this publication received strong support from both the reviewers and lead editor of *Harmful Algae* for its depth of coverage on a topic that remains one of the least developed areas of HAB science. The reviewers noted the timeliness of the work given the growing array of impacts is large and varied, threatening human health, marine and freshwater wildlife, and ecosystems upon which many nations rely on for food, recreation, tourism, and a plethora of other goods and services. The disconnect between HAB control needs and solutions among PICES nations and elsewhere stems in part from public, stakeholder, and scientific uncertainties about the balance between benefits and potentially undesirable environmental consequences. Other more practical challenges include substantial regulation of in situ testing, scaling up laboratory-proven technologies to attack widespread blooms that can move in three dimensions in open marine waters, and an immature commercial market. The workshop findings describe the status of control strategies targeting marine coastal and estuarine HABs, particularly those few approaches that have been tested in mesocosm or field applications. We identify the regulatory support, targeted science, investments, and public outreach that will be needed to accelerate the availability of applications for controlling HABs in marine waters worldwide. The workshop and its resultant publication provide examples of the global leadership that PICES can provide.

Agenda Item 6 — Data Input to HAE-DAT

Shortly after creation of HAB Section, PICES member countries began participating in the global Harmful Algal Event Database (HAEDAT) (haedat.iode.org). This database is part of the Harmful Algal Information system (HAIS) within the "International Oceanographic Data and Information Exchange" (IODE) of the "Intergovernmental Oceanographic Commission" (IOC) of UNESCO and is implemented in cooperation with ICES. PICES data submissions have been temporarily suspended while the HAE-DAT online interface is being upgraded. Misty Peacock provided a summary of the current status of these revisions and let us know that input will be possible later in 2026.

Agenda Item 7 — Revision and adoption of new S-HAB Terms of Reference

There was discussion about the longer-term goals of S-HAB; where we have been and where members feel we need to be going over the next 5-10 years. Issues of new importance noted by members included: 1) the accelerating influence of climate change on marine systems leading to the range expansion and altered characteristics of HAB events; 2) the increasing need for HAB control research and implementation; and 3) the development of new technologies that can support studies that improve scientific understanding and advances in both of these areas. The new ToR being submitted for approval are:

1. Provide ongoing deliverables to address the goals of the PICES Science Plan through PICES Press, the peer-reviewed literature, communications geared to management entities and decision-makers, and other venues.
2. Contribute to the development of the PICES North Pacific Ecosystem Status Report by providing information on status and trends of HAB occurrence and impacts in the eastern and western Pacific.
3. Direct understanding, support, and communicate improved actionable HAB prevention, control, and mitigation strategies.
4. Identify the climate-related and regional drivers of change in the magnitude, frequency, and duration of HAB impacts in PICES and other nations.
5. Participate in global HAB research and training activities, including the GlobalHAB status report (ICES, PICES, IOC) and the UN Decade of Ocean Science for Sustainable Development.
6. Continue PICES member country data entry into the joint ICES-PICES Harmful Algal Event database (HAE-DAT) to allow global comparison of changes in harmful algal blooms.

Agenda Item 8 — Elect a new co-chair for S-HAB

The cycling of leadership in PICES committees and sections is an important step to help revitalize and bring new directions to their scientific endeavours. With this in mind, Mark Wells (USA) will be stepping down as co-chair but will remain a member of S-HAB. Members have elected Misty Peacock (USA) as co-chair for the section to work with Pengbin Wang (China), who will remain as co-chair.

Agenda Item 9 — Country Reports

There was insufficient time to present the PICES HAB country reports at the half-day meeting, so they were submitted later and are presented here (from East to West this year). In many cases, these data are for 2024 as the 2025 data were not available in time for the meeting. These presentations keep each PICES nation aware of occurrences across the Pacific region, with the intention of better understanding the broader driving mechanisms underlying these HAB events.

A. USA

PICES S-HAB: Country report for 2023-24, Prepared by: Misty Peacock, Northwest Indian College, Bellingham, WA, USA

Overview – West Coast incidences of HAE produced mostly domoic acid, and PSTs, though there were also reports of DSTs, shellfish killing toxins (yessotoxin), and evidence of freshwater cyanotoxins transferred to marine habitats (including Alaska). There were continued incidences of marine mammal strandings in 2023-2024, with a current HAB event in California that is causing many marine mammal strandings. There was an extreme PSP event extending from Northern California to Washington that closed shellfisheries, caused 20+ human illnesses, and recalled commercial shellfish. In California, Oregon, and the Washington outer coast, closures were due routinely to domoic acid (CA and WA outer coast) and this year, PSTs (CA, OR, WA, and AK). Continued efforts for more offshore HAB sampling, modeling/forecasting of domoic acid, ocean acidification and multi-stressor events, satellite/remote sensing for HABs, identification of new/emerging HABs, and freshwater toxin transfer to the marine environment are areas of interest for academic, governmental, and tribal harmful algae researchers. Use of IFCB technology is a key technology and the US west coast network is expanding, with California's network being a stand-out highlight of monitoring changes in phytoplankton community changes over the course of a major *Pseudo-nitzschia* event. Several NOAA ECOHAB and MERHAB projects were funded in 2024 to address HABs on the west coast, including rapid response funding due to the PSP event.

California – The California coast is monitored by HABMAP, Coastal Ocean Observing System, and multiple state, federal, academic, private, and tribal partners for harmful algae and toxins. There were punctuated *Pseudo-nitzchia* events reported in Southern-Central California, typically in spring, though they continued into fall 2024. There were marine mammal strandings (many) during the early summer in California and currently CA is in the midst of a large DA event, which is causing many mammal strandings. *Alexandrium* incidences were infrequent in southern California but were present above 10,000 cells/L in central and northern California, and Northern

California was closed due to PST toxins in shellfish in July of 2024, with concentrations between 600-800 ug STX eq/100 g shellfish. Closures due to *Dinophysis* and DSP events were not reported, and *Dinophysis* was infrequent in samples. There were multiple ASP commercial and recreational harvest closures throughout California, Southern and Central California being the longest closures and elsewhere, short-lived. California continues to produce a state-wide HAB newsletter (CA HAB Bulletin), weekly updates by email, and use of the C-HARM model for domoic acid forecasting. Central and Southern California have also begun including freshwater toxins found in the marine environment in weekly/monthly updates to the harmful algae community. There is a statewide Imaging FlowCytobot System for harmful algae (accessed at https://ifcb.caloos.org/dashboard)which is now also available in the weekly HAB bulletin.

Oregon – The coastal waters of Oregon are monitored for HA by the ORHAB and SoundToxins monitoring programs, as well as the state of Oregon public health (shellfish). In 2023, from north to south, there were higher cell counts for *Pseudo-nitzschia* (both large and small) and greater concentrations of pDA, with toxic events happening in April-June, and September-November. Throughout 2023, both *Alexandrium* and *Dinophysis* spp. were present periodically at sampled sites. In November 2023, and periodically during May-August 2023, the southern Oregon coast was closed to shellfish harvesting due to domoic acid. There were minimal reported marine mammal strandings due to biotoxins. In May 2024, there was an unprecedented public health emergency for PSP over a 3-day holiday weekend, which closed commercial and recreational shellfish harvests, and had some PSP readings above 5000 ug STX eq/100 g shellfish. Twenty-one people reported falling ill, and commercial product was recalled from 8 states.

Washington – Washington State waters are monitored for harmful algae by the ORHAB, SoundToxins, Washington Dept. of Health programs, and tribal nations. There were PSP events in multiple counties along the entire coast of Washington State, including the inland Salish Sea. The State analyzed ~2500 shellfish samples for PSP, DSP, and/or ASP. There were multiple commercial and recreational closures. ASP events were confined to the southern coast region, though *Pseudo-nitzschia* was seen throughout Washington state sampling locations, including the South and North Salish Sea (Puget Sound) in September. DSP events were mostly confined to inner Puget Sound and closures in southern Washington, including commercial closures. DSP events for recreational shellfish for DSP in northern Washington happened in August 2024. In Northwest Washington, there were more than 50 subsistence harvest closures for PSP and/or DSP events in 2023. Many beaches, including tribally-controlled beaches are currently closed due to PSP in northern Washington. Southern Washington was included in the PSP outbreak in May-July 2024, and the entire coast (to the northern border with Canada) was closed during the first weeks in June because of the PSP event. There were fewer shellfish die-offs compared to 2021. Monitoring efforts to identify other yessotoxin shellfish die-off events are currently ongoing, as is the implementation of an IFCB network. There is also current work being done to monitor DA offshore of the Washington coast using an ESP. DSP, and PSP events did continue into the winter (January and February) in 2023. Several NOAA ECOHAB and MERHAB projects to monitor HABs (using IFCBs, AUVs, ESPs, and more traditional methods) were funded for Washington state, including support to expand data collection through citizen science, tribal, academic, and state partners.

Alaska – Alaska is being monitored by Alaska Harmful Algal Bloom network (AHAB), SoundToxins, Southeast Alaska Tribal Ocean Research (SEATOR), Kachemak Bay National Estuarine Research Reserve (KBNERR), Alaska Sea Grant, Aleutian Pribolof Island Association, NOAA, and other tribal, governmental, and academic groups. There continues to be elevated levels of PSTs found in shellfish throughout the year at various SE Alaska beaches. In SE Alaska, ~ 1000 shellfish and ~500 water samples were monitored for *Alexandrium*, and PSTs, including cysts. A massive offshore *Alexandrium* bloom and PST was documented with an a shipboard IFCB in 2022. Efforts to investigate the Arctic waters for *Alexandrium* are ongoing, and there is an Alaska IFCB network in place. Near commercial and subsistence geoduck beds, an alarming number of *Alexandrium* cysts was present, but there has (of yet) been no correlation between cyst presence and winter geoduck toxicity. Alaska shellfish and fish samples continue to document some of the highest (ever) recorded concentrations of PSTs in seafood. The Aleutian and Pribilof Islands sampled weekly in 2023-24, and, similar to Kodiak sampling, blue mussel samples were sometimes above the regulatory limit for PSTs. The Bering Sea had clams with elevated PSP levels, and both ASP and PSP toxins were found in stranded or harvested marine mammals' stomachs. Similar to other US west coast states, Alaska has newly funded ECOHAB (NOAA) projects to monitor for PSTs and domoic acid by mapping cell densities and health assessments from marine mammals. Alaska has the most extensive network of citizen scientists monitoring for (mainly) PSTs, where 100% of coastal Alaskans subsistence harvest. The AHAB network and website presence has been updated substantially in the last year and facilitates gathering HAB data into one location.

B. Canada

PICES S-HAB: Country report for Canada, 2025 (Oct. 2024-Oct. 2025), Prepared by: Svetlana Esenkulova (Pacific Salmon Foundation) and Andrew Ross (Fisheries & Oceans Canada)

1. Publications

Deeg, C., Tam, C., Esenkulova, S., Wells, A., Soshnina, V., Ens, N., Schulze, A. and Miller, K., 2025. Spatiotemporal patterns of salmon winter habitat usage in the Northeast Pacific uncovered by environmental DNA. *ICES Journal of Marine Science* 82(7), fsaf104.

- The large-scale eDNA survey covered 2.2 million km² of open-ocean North Pacific salmon habitat at the end of winter, offering an unprecedented taxonomic and spatial view of the ecosystem. Multi-amplicon metabarcoding revealed species-specific associations between salmon and their prey, competitors, revealing strong links observed between salmon and certain harmful algae across the surveyed region. These findings highlight rapid ecological transitions associated with the onset of spring blooms and advance understanding of ecosystem interactions in the open ocean.

Ross, A.R.S., Ip, B., Mueller, M., Surridge, B., Hartmann, H., Hundal, N., Matthews, N., Shannon, H., Hennekes, M., Sastri, A. and Perry, R.I., 2025. Seasonal monitoring of dissolved and particulate algal biotoxins in the northern Salish Sea using high performance liquid chromatography and tandem mass spectrometry. *Harmful Algae*, *145*, 102854.

- A method was developed and applied to profile dissolved and particulate algal biotoxins in seawater from the northern Salish Sea, capturing ASP, PSP, and DSP toxins. Particulate biotoxins related to harmful algae peaked in summer, while dissolved biotoxins persisted into fall and spring when harmful algae were scarce.

Mehdizadeh Allaf, M. and Trick, C.G., 2025. Growth Response and Cell Permeability of the Fish-Killing Phytoflagellate Heterosigma akashiwo Under Projected Climate Conditions. *Toxins*, *17*(5), p.259.

- This study examined how temperature, salinity, and CO_2 interact to influence the growth, yield, and cell membrane permeability of *Heterosigma akashiwo*. Results indicate that future ocean conditions characterized by higher temperature and salinity may promote greater biomass production but potentially reduce cellular permeability and associated toxicity.

McKenzie, C.H., Locke, A., Michaud, S., Peña, M.A., Bates, S.S., Martin, J.L., Poulin, M., Comeau, L., Devred, E., Haigh, N., Howland, K., Moore-Gibbons, C., Perry, R.I., Rochon, A., Scarratt, M.G., Starr, M., and Wells, T., 2025. *Harmful Algal Events in Canadian Marine Ecosystems: Current Status, Impacts, Consequences and Knowledge Gaps*. DFO Can. Sci. Advis. Sec. Res. Doc. 2023/090. Fisheries and Oceans Canada.

- This 2025 report is a revised and expanded version of the 2021 DFO Technical Report, providing a comprehensive review of harmful algal events across Canada's three coasts. It highlights species diversity, impacts, and regional occurrences, identifies key knowledge gaps, and recommends actions to improve monitoring and predictive capabilities.

Schiffrine, N., Dhifallah, F., Dionne, K., Poulin, M., Lessard, S., Rochon, A. and Gosselin, M., 2024. Microbial plankton occurrence database in the North American Arctic region: synthesis of recent diversity of potentially toxic and harmful algae. *Earth System Science Data Discussions*, *2024*, pp.1-33.

- A synthesis of over 18 000 sampling events across the North American Arctic revealed distinct spatial patterns in microbial plankton diversity, including harmful algal (HA) species. HA taxa were present and their recorded northern range has increased since the 1990s, this trend likely reflects expanded sampling rather than true poleward expansion, underscoring the need for sustained monitoring to assess ecological impacts under climate change.

Fajei, E., Whyte, S., Soto-Davila, M., Eslamloo, K., Groves, L., Storey, K., Ghanei-Motlagh, R., GRoman, D., Purcell, S.L. and Fast, M., Impact of Co-Exposure to Chaetoceros Spp. And Tenacibaculum Maritimum on Atlantic Salmon (Salmo Salar) Gills. *And Tenacibaculum Maritimum on Atlantic Salmon (Salmo Salar) Gills*.

- This study examined how exposure to *Chaetoceros* spp. affects gill health and immune responses in Atlantic salmon, particularly in relation to *Tenacibaculum maritimum* infections. Results showed minimal gill pathology and limited immunological responses despite confirmed infections and moderate mortality, suggesting that *Chaetoceros* exposure alone causes only mild stress and damage under the tested conditions.

Jyoti, S., Jia, B., Saksida, S., Stryhn, H., Price, D., Revie, C.W. and Thakur, K.K., 2024. Spatiotemporal patterns of mortality events in farmed Atlantic salmon in British Columbia, Canada, using publicly available data. *Scientific Reports*, *14*(1), p.32122.

- Analysis of over a decade of mortality events from British Columbia finfish farms showed a marked rise in total events, with harmful algal blooms (HABs) cited as a major cause alongside low dissolved oxygen and treatment-related stress. HAB-related mortalities peaked in 2019 and were most frequent on the west coast of Vancouver Island, reflecting vulnerability to ocean warming and changing environmental conditions.

Bi, C., Pan, Y. and Zhang, X., Paralytic Shellfish Poisoning Risk Assessment in the West Coast of Canada. 2025 *Available at SSRN 5347364*.

- A two-decade analysis of paralytic shellfish poisoning (PSP) risk in blue mussels along Canada's west coast tested 11 modelling approaches to enhance early warning and monitoring systems. Tree-based and ensemble machine learning models showed the highest predictive accuracy, providing a robust framework for forecasting PSP events and improving public health protection.

2. Reports

Ross, A.R.S., Mueller, M., Ip, B., Hundal, N., Matthews, N., Surridge, B., Hartmann, H., Nesbitt, B., McKenzie, P., Frederickson, N., Esenkulova, S., Pearsall, I., Sastri, A., Hennekes, M., Galbraith, M., Young, K., Taves, R., Raftery, E., Kafrissen, S., Loro, F. and Perry, R.I. (2025) 'Marine biotoxin monitoring in B.C. coastal waters', in Boldt, J.L., Joyce, E., Tucker, S., Gauthier, S. and Jackson, J. (eds.) *State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2024*. Can. Tech. Rep. Fish. Aquat. Sci. 3687. Nanaimo, B.C.: Fisheries and Oceans Canada, pp. 337. https://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2024/pac-technical-report-rapport-technique-eng.html

Esenkulova, S., Pawlowicz, R. and Frederickson, N. (2025) 'Oceanographic conditions and harmful algal blooms in the Strait of Georgia 2024', in Boldt, J.L., Joyce, E., Tucker, S., Gauthier, S. and Jackson, J. (eds.) *State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2024*. Can. Tech. Rep. Fish. Aquat. Sci. 3687. Nanaimo, B.C.: Fisheries and Oceans Canada, pp. 337. https://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2024/pac-technical-report-rapport-technique-eng.html

Esenkulova, S. and Tomlin, H., 2025. Data Democracy-The Power of Community in Environmental Monitoring. *PICES Press*, *33*(2), pp.25-29. https://meetings.pices.int/publications/pices-press/PICES-Press-2025-Vol33No2.pdf

Pacific Salmon Foundation (2025) PSF Citizen Science Newsletter, Vol. 8, October 2025. Available at: https://marinescience.psf.ca/wp-content/uploads/2025/10/2025PSF-CitizenScienceNewsletter-Vol8-Oct2025-Screen.pdf

Fisheries and Oceans Canada (2025) Follow the Fish Program Newsletter, Vol. 3, September 2025. Monitoring Biotoxins and Contaminants and their Impacts on WCVI Chinook Salmon. Available at: https://publications.gc.ca/collections/collection_2025/mpo-dfo/Fs141-15-2025-3-eng.pdf

Esenkulova, S., 2025. A decade of Pacific Salmon Foundation (PSF) Citizen Oceanography Monitoring Program. Harmful Algae Newsletter. No 79. https://www.e-pages.dk/ku/1596/

2. Harmful Algal Blooms (HABs) on the Canadian West Coast

2024 — The Pacific Salmon Foundation's (PSF) Citizen Science Oceanography Program (Esenkulova et al., 2025) provided a final season of monitoring data on the physical and biological state of the Salish Sea. Analysis of the 2024 chlorophyll fluorescence data revealed a distinctive "double" spring bloom occurring in March and May. Critically, the first bloom did not lead to nutrient depletion, but surface nitrate levels were depleted in June following the second bloom. Throughout the summer, nitrate levels remained low but did not reach the extreme exhaustion seen in the 2016-2019 period, while silicate levels remained relatively high. Initial analysis of approximately one-third of the collected plankton samples indicated that the spring bloom was dominated by chain-forming diatoms (*Thalassiosira*, *Chaetoceros*, *Skeletonema*), with *Pseudo-nitzschia* becoming abundant in May. There were thick blooms of Noctiluca scintillans (Fig. 1) in April, May, and July. *Rhizosolenia setigera* and *Heterosigma akashiwo* cells were also detected in some areas during the summer.

Figure 1. Noctiluca bloom in Sechelt Inlet, April, 2024. Photo by Nicole Frederickson, PSF (left panel). Noctiluca bloom in Wilson Inlet, July 27, 2024. Photo by Ginny Sherrow (right panel).

2025 — Samples from 2025 have not yet been analyzed. Thick blooms of *Noctiluca scintillans* (Fig. 2) were observed in April in the southern Strait of Georgia. At the end of June, a bloom occurred in the inlets of the central Strait of Georgia, where additional samples were collected by Dr. Ross in Malaspina Inlet for biotoxin analysis. During the DFO Juvenile Salmon Survey in Toba Inlet, a similarly intense bloom was observed. The bloom (~30 mg Chl m^{-3}) was widespread throughout the area (Fig. 2), though more intense coloration was noted near the stern, where the ship's movement brought subsurface bloom water to the surface. A surface sample collected near the bloom contained approximately 8 *Protoceratium reticulatum*, 1 *Alexandrium* spp., and 4 *Mesodinium rubrum* cells/mL.

3. Harmful Algal Biotoxins on the Canadian West Coast

2024 — The Fisheries and Oceans Canada (DFO)-led Marine Biotoxin Monitoring Program

(Ross and Mueller, 2024), in collaboration with the Pacific Salmon Foundation (PSF) and B.C. salmon farmers, delivered key insights into the 2024 distribution of harmful algal bloom (HAB) biotoxins across B.C. coastal waters (Fig. 3a). Monitoring at long-term sites in the Salish Sea (Malaspina Strait, IS-2) and the West Coast of Vancouver Island (Clayoquot Sound, Farm A) revealed significant deviations from historical seasonal trends in 2024 (Fig. 3b).

Figure 2. Noctiluca bloom in Brentwood Bay, April, 2025. Photo by Michel Grant (left panel). Bloom in Tobe Inlet, June 27, 2025. Photo by Svetlana Esenkulova (right panel).

a) b)

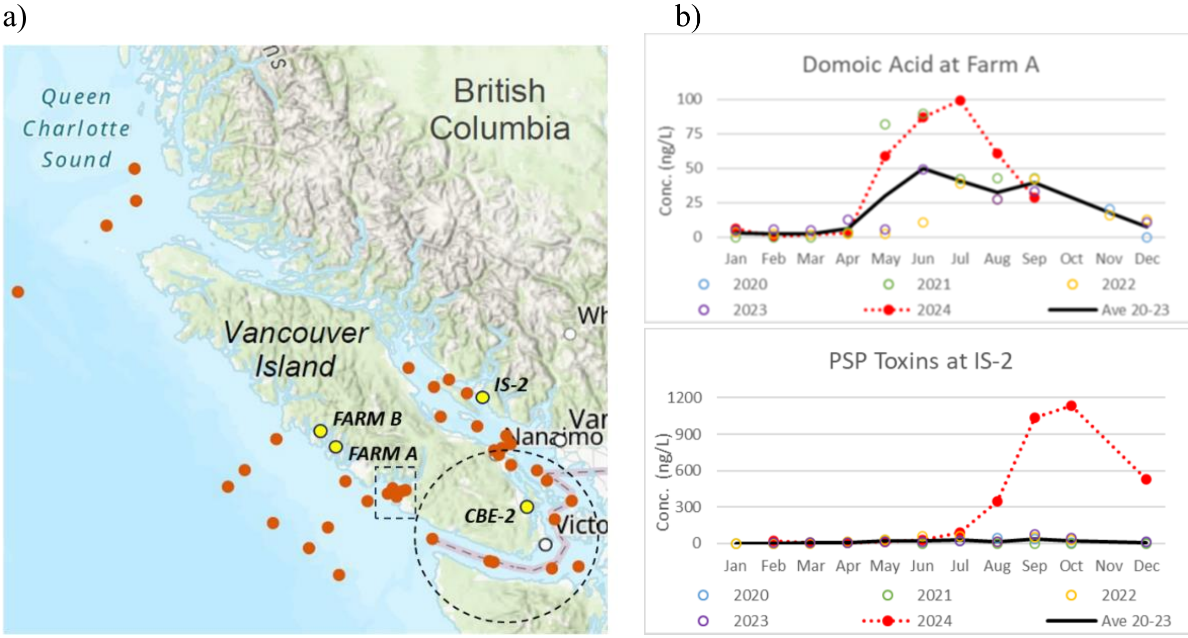

Figure 3. a) Long-term biotoxin monitoring sites in Malaspina Strait (IS-2), b) Time-series of total domoic acid concentration in Cowichan Bay (CBE-2) and Clayoquot Sound (Farms A and B) are high- Clayoquot Sound (Farm A) and total PSP Toxin concentration in lighted in yellow. Barkley Sound is shown by the dashed box and Malaspina Strait (IS-2), both of which were significantly higher than average in 2024.. Southern Resident Killer Whale critical habitat by the dashed circle.

Most notably, domoic acid (DA) peaked at higher-than-average concentrations (~100 ng/L) at the WCVI site (Farm A) in June/July, approaching levels associated with DA accumulation in shellfish. Paralytic Shellfish Poisoning (PSP) toxins at the Salish Sea site (IS-2) also peaked at concentrations significantly higher than average (~1,200 ng/L) in September/October, at levels typically only seen on the exposed WCVI.

Monitoring confirmed that PSP toxins remain the dominant biotoxin concern, showing a consistent pattern of peaking in the late summer/early fall and reaching significantly higher concentrations (up to 4,000 ng/L) on the WCVI, including in Barkley Sound (Fisheries and Oceans Canada 2025) where periodic upwelling occurs. Analysis of samples from the Strait of Georgia suggests that elevated biotoxin concentrations, particularly DA and PSP toxins, are correlated with lower surface salinity, higher water temperature, and greater abundance of harmful algae during summer, as reflected in the higher proportion of particulate biotoxins (Ross et al. 2025). Of particular concern is the finding that DA and PSP toxins were elevated near the Victoria Sill, an area within critical habitat for Southern Resident Killer Whales (SRKW). Other lipophilic toxins, including yessotoxin and DSP toxins (PTX2 and DTX1), were generally present at below-average concentrations in the Salish Sea in 2024.

The findings have important implications for managing at-risk marine life, informing conservation efforts, and supporting aquaculture. The detection of DA in SRKW critical habitat suggests a potential exposure risk for this endangered marine mammal population. Furthermore, the high concentrations of PSP toxins in Barkley Sound during the fall may pose a threat to local at-risk WCVI Chinook Salmon populations, as these toxins are known to harm fish. The program's data, including the strong positive correlation found between yessotoxin in wild mussels and in the surrounding water (a collaboration on Sea Gardens with Parks Canada and the Canadian Food Inspection Agency), are essential for assessing human and ecosystem health risks and for making informed decisions on issues like the timing of salmon hatchery releases to minimize exposure to harmful biotoxins.

2025 — Samples collected in B.C. coastal waters during 2025 are currently being analyzed to see if the elevated concentrations of DA and PSP toxins observed in 2024 are continuing to increase, and whether these trends are related to changes in environmental conditions such as water temperature and nutrient concentrations. In addition, the discovery by US researchers (Anderson et al. 2022) that dormant cysts formed by a PSP-producing *Alexandrium* species in the North Pacific have been accumulating in benthic sediments along the Alaskan coast prompted DFO investigators Andrew Ross and Mackenzie Mueller to start monitoring harmful algal biotoxins in the Beaufort Sea during the Joint Ocean Ice Study (JOIS) surveys in September 2024 and October 2025. Preliminary data indicates that yessotoxin and pectenotoxin 2 were present mainly in surface waters along the Alaskan Beaufort Sea shelf in September 2024 whereas PSP toxins were present mainly in bottom waters, which implies a benthic source consistent with the presence of *A. catenella* cyst beds. Samples from October 2025 will be analyzed in due course.

Other notes — The Pacific Salmon Foundation (PSF) Citizen Science Oceanography Monitoring Program is in its final year of operation. In 2025, the program is supported through the DFO Oceans Management Contribution Program, which funds projects that strengthen oceans governance, co-management of marine spaces, and marine conservation through engagement and science-based evidence. The 2025 funding supports PSF's field operations in three coastal areas. This year marks the conclusion of the program.

The DFO Pacific Salmon Strategy Initiative (PSSI) project known as 'Follow the Fish' is also in its final year. However, discoveries made during this project include detection of harmful algal biotoxins in the tissues of juvenile WCVI Chinook salmon in Barkley Sound (Fig. 3). Furthermore, levels of domoic acid in gill tissue and yessotoxin in liver were found to correlate with concentrations in the surrounding sea water (Fisheries and Oceans 2025), confirming that juvenile Chinook are being exposed to these biotoxins in their critical habitat but also that measurements of biotoxins in sea water can be used to predict when and where exposure might occur.

In 2025, the We All Take Care of the Harvest (WATCH) program completed its pilot phase under the leadership of the First Nations Health Authority (FNHA). On July 1, 2025, WATCH was transferred to the Island Marine Aquatic Working Group (IMAWG), supported by an Interim Steering Committee that includes FNHA and WATCH partners. This transition concludes nearly five years of collaborative work aimed at improving marine food safety, security, and sovereignty in a changing climate. The program's future direction will depend on the availability of new funding and partner support.

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C. Russia

The Annual Report on HABs in the Russian Far East seas was not available at the time of this report.

D. Japan

PICES S-HAB: Country report for Japan for 2023 and preliminary data for 2024, Prepared by: Natsuko Nakayama, Setsuko Sakamoto and Masashi Kodama (Japan Fisheries Research and Education Agency), and Mitunori Iwataki (University of Tokyo)

Long-term and recent trends of HAB events

Interannual variations in blooms and the resulting economic losses caused by HAB events have been documented over the past few decades in western Japan, particularly in the Seto Inland Sea and the Kyushu area. In the Seto Inland Sea, the number of blooms decreased during the 1970s–1980s and has continued to decline gradually in recent decades. In contrast, the Kyushu area has shown an overall increasing trend. Recently, HABs have also begun to appear in central and northern coastal regions of Japan, suggesting a possible expansion of their geographic range beyond traditional western areas.

1. HABs and Their Impacts on Fisheries in 2023–2024

HABs in Japan mainly occur in its western regions, such as the Seto Inland Sea and Kyushu area. The major HAB species in Japan include *Karenia mikimotoi*, *Chattonella spp*., *Margalefidinium polykrikoides*, *Heterocapsa circularisquama*, and *Heterosigma akashiwo*.

Seto Inland Sea

- In 2023, there were 96 HAB events in the Seto Inland Sea (including Tosa Bay and Kumanonada), an increase from 70 events in the previous year. Among these, nine cases caused fisheries damage, mainly due to *K. mikimotoi*.
- Notably, in July, a bloom of *K. mikimotoi* in the Bungo Channel resulted in the mortality of approximately 47 000 cultured red sea bream, causing an estimated loss of JPY 52.7 million.
- For 2024, data are still being compiled, but preliminary reports indicate approximately 91 HAB events, showing a sharp decline compared with the previous year, with 14 cases of reported damage.

Kyushu Area

- In 2024, there were 76 HAB events, similar to 2023. More than half (40 cases) occurred in the Ariake Sea and the Yatsushiro Sea.
- Fisheries damage was reported in 26 cases, mainly caused by *Chattonella* spp., *K. mikimotoi*, and *M. polykrikoides*.
- The estimated total economic loss was JPY 3.3 billion, indicating that severe impacts have persisted for three consecutive years.

- A notable feature in the Yatsushiro Sea was the occurrence of blooms of three species (*Chattonella* spp., *M. polykrikoides*, and *K. mikimotoi*), sometimes simultaneously.
- Affected cultured species included yellowtail (*Seriola quinqueradiata*), striped jack (*Pseudocaranx dentex*), greater amberjack (*Seriola dumerili*), and tiger puffer (*Takifugu rubripes*).

2. Shellfish ban due to the PST & DST accumulation

Most shellfish closures caused by the accumulation of paralytic shellfish toxins (PSTs) and diarrhetic shellfish toxins (DSTs) occur in southwestern Japan (Seto Inland Sea and Kyushu area) and along the northern Pacific coast (Tohoku and Hokkaido).

PST

- In 2024, there were 52 cases of shellfish bans due to PSTs, a decrease from 73 cases in the previous year.
- Affected species included scallops, oysters, sea squirts, and helmet crabs. Causative species were mainly *Alexandrium catenella*, *A. pacificum*, and *Gymnodinium catenatum*, observed from March to May.

DST

- There were two cases of shellfish bans due to DSTs in 2024, significantly fewer than 26 cases in the previous year.
- Affected species included scallops and blue mussels. Causative species were *Dinophysis fortii* and *D. acuminata,* observed from May to September.
- Okadaic acid equivalents (OA) were detected in western Japan for the second consecutive year (first detected in 2023), affecting cultured Japanese egg cockles. Before 2022, shellfish poisoning in western Japan had not been reported; historically, PST and DST events were mainly observed in northern Japan (Hokkaido and Tohoku).

E. <u>Korea</u>

PICES S-HAB: Country report for Korea, 2025, Prepared by: Taegyu Park, Moonho Son, Minji Lee, Seokhyun Yoon, National Institute of Fisheries Science, Korea

1. Status of non-Harmful algal bloom events in 2025

A total of 13 non-harmful algal blooms occurred this year, primarily involving *Akashiwo sanguinea, Scrippsiella* spp*, Heterosigma akashiwo, Noctiluca, Prorocentrum, Chaetoceros* spp*, Skeletonema costatum*, and *Mesodinium rubrum* as dominant taxa. Blooms were observed along the southern coast from May to August, with cell densities ranging from 100 to 7000 cells/mL. Water temperature and salinity during bloom occurrences ranged from 16–26 °C and 30–32, respectively.

2. Characteristics and causes of harmful *M. polykrikoides* blooms in 2025

Occurrence — Early-warning qPCR monitoring initiated in early June confirmed the first appearance of *M. polykrikoides* at low density (<0.07 cells/mL) from June 23 in the waters of

Goheung–Yeosu–Namhaedo–Tongyeong. Cell density began to increase above 1 cell/mL in early August and reached >3,000 cells/mL by late August, particularly around Namhaedo.

Characteristics — *M. polykrikoides* is an oceanic red-tide species that historically originates offshore and spreads inward. However, this year it appeared first in inner coastal waters and subsequently expanded outward. A preliminary advisory was first issued on August 25 for Namhae, followed by bloom events extending from Geoje (Gyeongnam) to Wando (Jeonnam). The maximum density (7700 cells/mL) was recorded in Tongyeong on September 1. The bloom gradually declined thereafter and dissipated by October 1.

Causes — Due to extreme fluctuations in water temperature and rainfall patterns along the southern coast, blooms initiated unusually in inner coastal waters. Heavy rainfall events in early–mid August supplied large amounts of land-derived nutrients, while an anomalously persistent cold-water mass in the southeastern East Sea kept inner-coastal waters within an optimal temperature range (24–27 °C) for bloom development. In contrast, offshore waters maintained higher temperatures (28–31 °C), creating unfavorable conditions for bloom formation (Fig. 4).

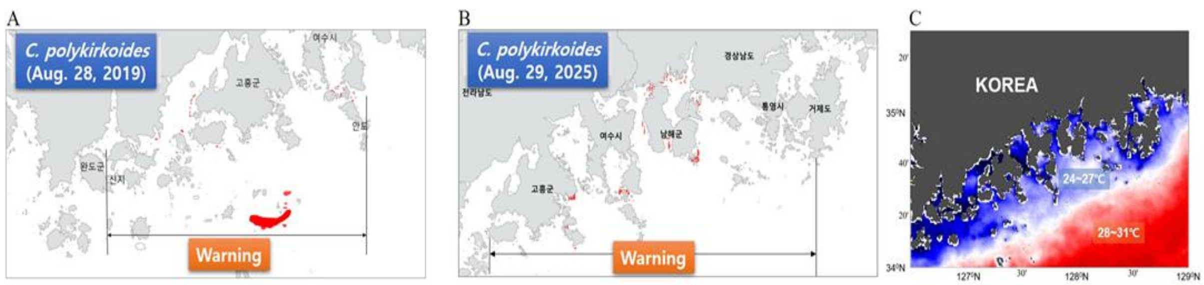

Figure 4. Comparison of M. polykrikoides bloom distribution in 2019 and 2025 (A, B) and satellite-derived sea surface temperature on 29 August 2025 (C)

3. Occurrence of toxic species in Southern Korean coastal waters in 2025

Distribution surveys of seven species showed that *Alexandrium catenella* was frequently detected in semi-enclosed embayments, whereas *A. affine* and *A. fraterculus* were mainly found from Yeosu to Tongyeong. *Dinophysis* species were detected in inner-bay environments. Among two *Azadinium* species, only *A. spinosum* was detected in Korean waters. *A. spinosum* was more common in open coastal waters such as Yeosu–Tongyeong rather than semi-enclosed bays such as Jinhae Bay (Fig. 5).

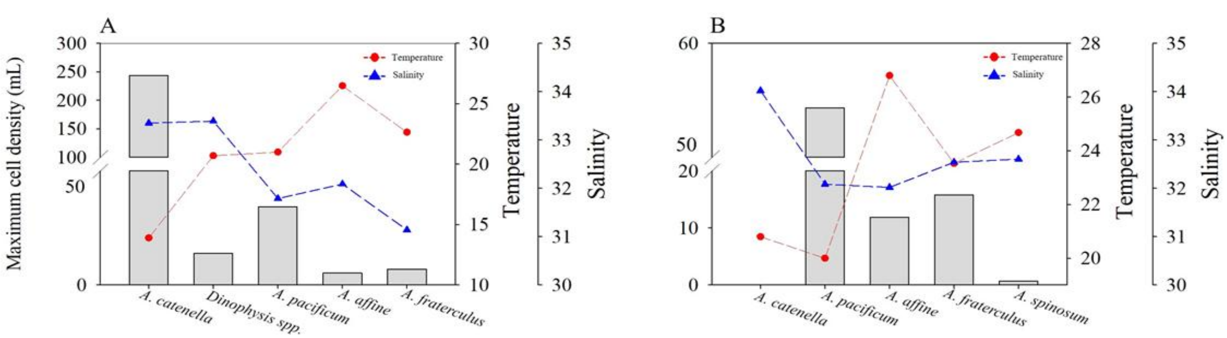

Figure 5. Habitat conditions of toxic species (A: Jinhae Bay, B: Southern coastwide area)

4. Long-term trends in phytoplankton occurrence along Korean coasts (1997–2024)

Overall, phytoplankton abundance has decreased by 79% since 1997. Diatoms, which serve as major food organisms for shellfish and possess broad thermal tolerance ranges, decreased by 62%, whereas fish-killing species sensitive to high temperature *(M. polykrikoides*) decreased sharply by 95%. Toxic species decreased by only 15%, showing a relatively smaller decline (Fig. 6). High-temperature-tolerant toxic species (*G. catenatum*) showed a 60% increase in occurrence frequency, whereas high-temperature-sensitive toxic species (*A. catenella*) decreased by 23%. Due to the marked decline in *M. polykrikoides*, the proportion of diatoms increased from 43% to 87% of total occurrences. Habitat trends show that diatoms and toxic species mainly inhabit waters around 15 m depth, whereas *M. polykrikoides* predominantly inhabits waters around 30 m depth.

Year	Dominant phytoplankton in Korean coastal waters	
In 1990	*M. polykrikoides, Prorocentrum* spp., *Tripos* spp., *Psuedonitzscia* spp., *Heterosigma akashiwo, Alexandrium* spp.	*Skeletonema costatum, Chaetoceros* spp.
In 2000	*M. polykrikoides, Prorocentrum* spp., *Psuedonitzscia* spp., *Heterosigma akashiwo*	*Skeletonema costatum, Chaetoceros* spp., *Leptocylindrus* spp.
In 2010	*M. polykrikoides, Psuedonitzscia* spp., *Heterosigma akashiwo*	*Skeletonema costatum, Chaetoceros* spp., *Leptocylindrus* spp., *Eucampia zodiacus, Thalassiosira* spp.
In 2020	*Psuedonitzscia* spp., *G. catenatum*	*Skeletonema costatum, Chaetoceros* spp., *Leptocylindrus* spp., *Eucampia zodiacus, Thalassiosira* spp., *Guinardia delicatula*

Figure 6. Temporal changes in dominant phytoplankton in Korean coastal waters (red: harmful species, green: diatoms)

F. <u>China</u>

PICES S-HAB: Country report for Korea, 2024, Prepared by: Pengbin Wang and Zihan Sun, The Second Institute of Oceanography, Ministry of Natural Resources, 36 Baochubei Road, Hangzhou, 310012, PR China

1. Red tide

According to China Marine Disaster Bulletin, 66 red tide events were recorded in the coastal waters of China in 2024, covering a total area of 11 731 square kilometers. Among them, 39 were toxic and harmful red tides, covering an accumulated area of 5,424 square kilometers. (Table 1).

Compared with the recent ten years, the number of red tide occurrences increased by 15, and the accumulated area expanded by 5839 square kilometers (Fig.7, Fig.8). In 2024, a total of 27 species of algae were the dominant species that caused HABs in the coastal waters of China. Among them, the dominant species causing toxic and harmful red tides were *Prorocentrum donghaiense*, *Margalefidinium polykrikoides*, and *Phaeocystis globosa*, while *Noctiluca scintillans* was the dominant species responsible for other red tides (Table 2).

Table 1 Statistics of HABs found in various sea areas in China in 2024

Sea area	Number of red tide events	Accumulated area of red tides (Km^2)
Bohai Sea	14	5205
Yellow Sea	7	4617
East China Sea	29	1859
South China Sea	16	50
Total	66	11731

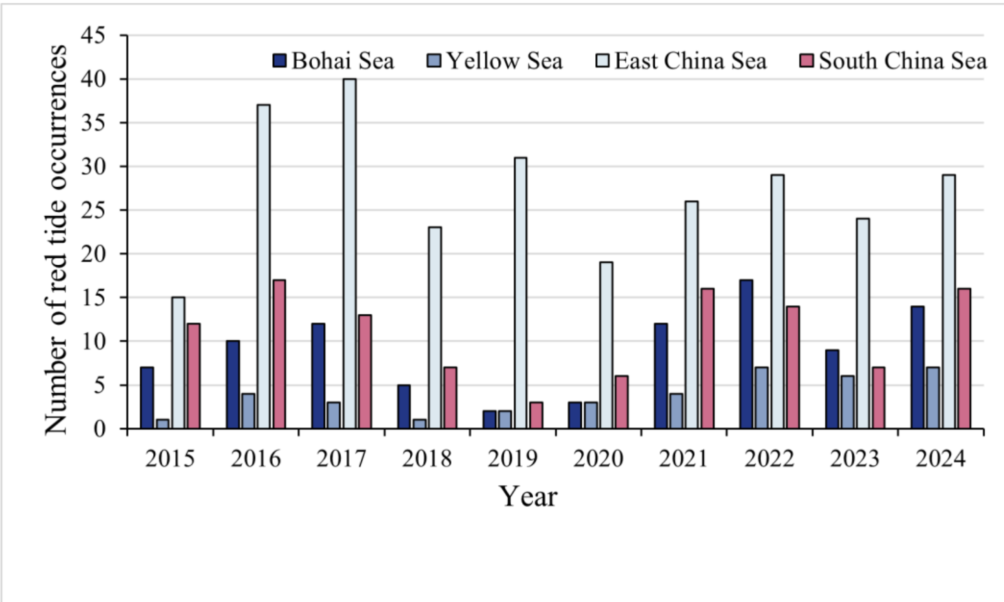

Figure 7 Red tide occurrences in China's sea areas (2015–2024)

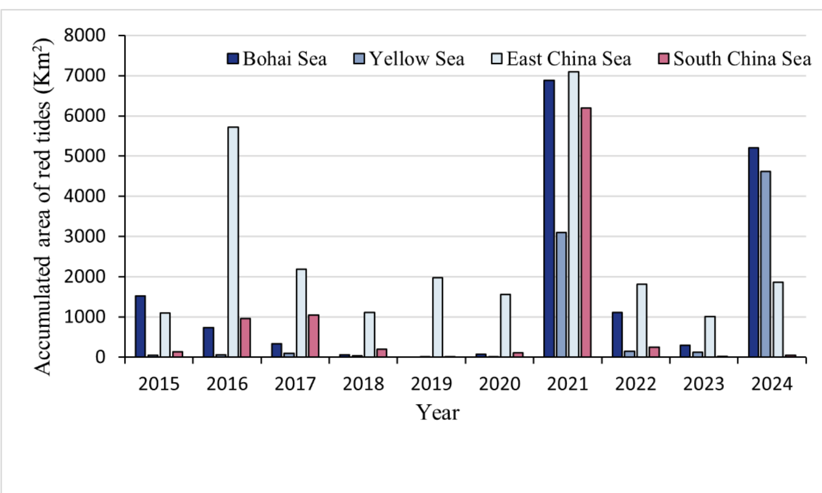

Figure 8 Accumulated area of red tides in China's sea areas (km^2)

Table 2. Statistics of major red tide events in 2024

Province (automomus region, municipality)	Start and end time	Discover the sea	Red tide dominant origanisms	Red tide types[12]	Area (Km²)
Liaoning	Apr 25-May 8	Dalian, Changhai County Waters	*Noctiluca scintillans*	Other red tide	587
Liaoning	May 28-31	Southeast Dalian Waters	*Noctiluca scintillans*	Other red tide	835
Liaoning	Jun 3-9	Near Haiyang Island, Dalian, Changhai County	*Noctiluca scintillans*	Other red tide	2740
Zhejiang	Jul17-29	Lvhua Island — Huaniao Island — Shengshan Island Waters	*Skeletonema costatum*	Other red tide	200
Tianjin	Jul 24-Aug 28	Vicinity of the 100,000-tonnage Channel, Tianjin Nangang	*Margalefidinium polykrikoides*, *Noctiluca scintillans*	Harmful red tide	394
Shandong	Aug 21-Sep 22	Yantai Waters	*Takayama acrotrocha*	Harmful red tide	1338
Shandong	Aug 28-Sep 22	Dongying Waters	*Takayama acrotrocha*	Harmful red tide	1700
Jiangsu	Aug 28-30	Waters at the junction of the Yellow Sea and East China Sea	*Pseudo-nitzschia pungens*, *Ceratium furca*, *Coscinodiscus wailesii*	Other red tide	1161
Liaoning	Sep 9-15	Southeast Dalian, Yellow Sea Waters	*Eucampia zoodiacus*	Other red tide	321
Hebei	Sep 12-30	Eastern Cangzhou Waters	*Akashiwo sanguinea*, *Ceratium furca*	Harmful red tide	637
Tianjin	Sep 19-Oct 7	Vicinity of the 100,000-tonnage Channel, Tianjin Nangang	*Ceratium furca*, *Eucampia zoodiacus*, *Pseudo-nitzschia delicatissima*	Other red tide	160
Hebei	Sep 23-30	Southern Qinhuangdao Waters	*Akashiwo sanguinea*, *Ceratium furca*	Harmful red tide	102
Hebei	Oct 7-10	Southeastern Qinhuangdao Waters	*Akashiwo sanguinea*	Harmful red tide	584
Hebei	Oct 8-12	Eastern Cangzhou Waters	*Margalefidinium polykrikoides*	Harmful red tide	209

Note: (1) The area in this table refers to the red tide area in the sea areas under the jurisdiction of the province (autonomous region, municipality directly under the central government).
(2) [12] Harmful red tide: A red tide that poses no direct harm to humans but can cause damage to marine natural resources or the marine economy through physical, chemical, or other pathways. Other red tide: A red tide caused by species that do not produce toxins and have no recorded history of causing damage to marine natural resources or the marine economy but may still have potential impacts on the marine ecosystem.

2. Green tide

From April to August 2024, the green tide affected the Yellow Sea of China, with *Ulva prolifera* as the dominant species. The maximum coverage area reached approximately 591 square kilometers on June 26, while the maximum distribution area reached about 54 119 square kilometers on June 18 (Fig. 9).

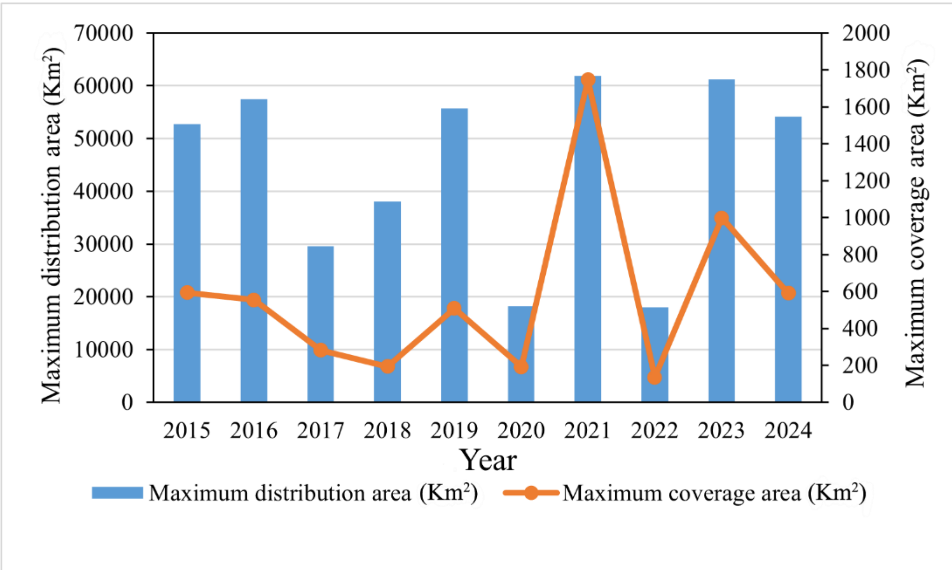

Figure 9. The occurrence of green tide of Ulva prolifera in the Yellow Sea of China in the past decade

S-HAB Endnote 1
S-HAB participation list (both online and in-person meetings)

Members

Mark L. Wells (U.S.A., Co-Chair)
Pengbin Wang (China, Co-Chair)
Andrew RS Ross (Canada)
Charles Trick (Canada)
Natsuko Nakayama (Japan)
Mitsunori Iwataki (Japan)
Takafumi Yoshida (Japan)
Yoichi Miyake (Japan)
Ryoko Yano (Japan)
Seung Ho Baek (Korea)
Misty Peacock (USA)
Vera L. Trainer (USA)
William Cochlan (USA)

Members unable to attend

Canada: Svetlana Esenkulova
China: Chunlei Gao, Chunjiang Guan, Hao Guo, Qiufen Li, Douding Lu, Mengmeng Tong
Korea: Hae Jin Jeong, Kwang Young Kim, Tae Gyu Park, Moonho Son, Minji Lee
Russia: Tatiana V. Morozova, Tatiana Yu. Orlova, Mikhail Simokon,

S-HAB Endnote 2
S-HAB meeting agenda

1. Welcome remarks
2. Discussion and adoption of the agenda
3. Consideration of the structural challenges for S-HAB Business meetings under the new PICES timelines
    a. Expectation that the business meeting report be provided before the Annual Meeting
4. Draft proposals for a Topic Session and Workshop for the PICES 2026 Annual Meeting
    a. Topic Session: *Evolution in the monitoring of Harmful Algal Blooms (HABs)*
    b. Workshop: *Workshop on Rapid Detection Technologies for Harmful Algal Toxins*
5. HAB Control Paper — Output from the S-HAB 2023 Workshop "*International Workshop on Solutions to Control HABs in Marine and Estuarine Waters*" (Vera Trainer)
6. Data Input to HAE-DAT (Misty Peacock)
7. Discussion on the goals for S-HAB over the next 5-10 years
    a. Revision and adoption of new Terms of Reference
8. Election of a new co-Chair
9. Country Reports