



## 2020 inter-sessional Science Board meeting — Note from the Science Board Chair

Vera Trainer



As new Science Board (SB) Chair, I am looking forward to working with all of you to bring PICES science to the forefront of public knowledge. Towards that end, SB has requested that all expert groups think about how their PICES science can be communicated simply, completely and effectively as part of our outreach to the general public and other audiences. This is part of the SB vision to serve people all over the world by clearly communicating the outcomes and recommendations of PICES science. We look forward to creating a new expert group for communications within PICES' Human Dimensions Committee (HD) before the end of 2020. We are excited to hear the voices of early career ocean professionals (ECOP) by more formally incorporating their opinions and strategies into the PICES process. A Workshop, titled "Building a PICES Early Career Professional Network" will be held virtually as part of PICES-2020, to formalize the contributions of ECOP within PICES with a strong emphasis on contributions to the [United Nations Decade of Ocean Science for Sustainable Development \(UNDOS\)](#).

### In this issue:

2020 inter-sessional Science Board meeting — Note from the Science Board Chair .....	1
FUTURE SSC's 6 <sup>th</sup> inter-sessional meeting highlights .....	4
PICES-2020 — See you virtually! .....	6
Reflections on my 28 year journey with PICES.....	7
Robin Brown's legacy — in PICES words.....	10
The role of Early Career Ocean Professionals in PICES.....	16
Pacific Ecology and Evolution Conference (PEEC): 41 years of science and scenery on Canada's West Coast .....	18
PICES TCODE catalog service.....	20
Assessing for paralytic shellfish toxins in Alaskan waters.....	24
Bering Sea: Current status and recent trends.....	29
The western North Pacific during the 2019/2020 cold season.....	33
The Northeast Pacific: Current status and recent trends.....	35
Identifying research priorities for understanding the dynamics of small pelagic fish .....	40
Your PICES science images .....	43
Remembering Paul LeBlond .....	44
PICES by the numbers   About PICES Press.....	46



Six months after the PICES 2019 Annual Meeting in Victoria, British Columbia, Canada, the members of PICES Science Board had planned to convene in Vladivostok, Russia, for the 18th inter-sessional meeting (ISB-2020; from April 29–May 2, 2020). However, quite unexpectedly, recent changes around the world resulted in the need for SB to hold its first ever “virtual” meeting in a record-setting 9 hours! As the new SB Chair, I declared the opening of ISB-2020 with a welcome speech to the members and guests and acknowledgment of their dedication and willingness to participate remotely. SB welcomed four new committee chairs, Jeanette Gann (TCODE), Akash Sastri (BIO), Mitsutaku Makino (HD) and Sung Yong Kim (MONITOR).

At ISB-2020, the Chairs of the five Science (BIO, FIS, HD, MEQ, POC)\* and two Technical Committees (MONITOR, TCODE) reported on progress and planned activities of their respective expert groups since PICES-2019. SB approved the establishment of 2 new joint PICES/ICES Working Groups (WG): Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY) and Ocean Negative Carbon Emissions (ONCE)-From Science to Applications and are encouraging inclusion of ECOP as participants in these new WG.

Prior to ISB-2020, on April 26–28, the FUTURE program Scientific Steering Committee (FUTURE SSC; Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) also held its meeting virtually. We are excited to share with you the approval of FUTURE Phase III as a program focused on the Social-Ecological-Environmental System (SEES) approach, with strong leadership in UNDOS activities (see below). As a high priority activity of PICES, the FUTURE SSC has met inter-sessionally for the past five years during PICES Annual Meetings in order to maintain momentum of this key activity. An exciting new aspect of FUTURE is the establishment of an Early Career Researcher SEES award. Major items discussed at the FUTURE meeting were: 1) strategizing the “ocean we want” as a PICES contribution to UNDOS, 2) incorporating the advice of ECOP in establishing UNDOS activities, 3) leveraging PICES expert group activities for synergy with other organizations and activities. This will include a goal of more fully interacting with under-represented organizations and nations. More details on each of these activities can be found in the article by the FUTURE SSC Co-Chairs on page 4.

UNDOS (2021–2030) is now at the end of its preparation phase (2018–2020) to design the scientific and public activities led by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. PICES has participated in several early-morning virtual meetings with ICES to position joint activities to contribute to UNDOS. SB clearly shared consensus that the Ocean Decade is a great opportunity for PICES scientists and possible partners to do science and contribute to society by disseminating scientific knowledge about the Pacific Ocean. The virtual PICES Annual Meeting in October 2020 will highlight several of the proposed UNDOS collaborative activities and provide PICES scientists with opportunities for engagement.

We look forward to several reports that have received final approval by SB for publication, including the final reports of Working Group 34: Joint PICES/ISC Working Group on Ocean Conditions and the Distribution and Productivity of Highly Migratory Fish and Working Group 32: Biodiversity of Biogenic Habitats. A special issue on North Pacific Climate and Ecosystem Predictability on Seasonal to Decadal Timescales was approved by SB for publication in the journal *Frontiers in Marine Science*. This special issue resulted from a June 2019 inter-sessional workshop held in Qingdao, China (see [PICES Press, 2020, Vol. 28, No. 1, pp. 51-53](#)), and includes papers from PICES-2019.

The final synthesis report from WG35: Working Group on Third North Pacific Ecosystem Status Report (WG-NPESR3) is undergoing its final review. We encourage all authors to finalize their synthesis contributions to ensure that this important report is published in a timely manner. We also expect that regional chapter reports will be available shortly as PDF files on the PICES website.

PICES science interests have expanded in recent years. The HD Committee links natural science and social issues, and the number of social scientists attending PICES Annual Meetings is increasing every year. We encourage participation from scientists with a wide range of interests and expertise in future PICES meetings. We look forward to building upon the recent meeting of the Study Group on Impacts of Mariculture on Coastal Ecosystems (SG-IMCE) to reactivate mariculture and aquaculture interests within PICES and possibly develop a joint WG with ICES to focus on activities related to aquaculture, which is important



The first ever “virtual” Intersessional Science Board meeting, 2020.

for food supply, marine ecosystems and marine planning. Recent collaborations with international organizations such as ICES and several RFMOs (Regional Fisheries Management Organizations) has led PICES to play an important role in the accomplishments of joint expert groups such as the Section on Climate Change Effects on Marine Ecosystems (S-CCME; with ICES), WG 34 on Ocean Conditions and the Distribution and Productivity of Highly Migratory Fish (with ISC), WG 39 on an Integrated Ecosystem Assessment for the Central Arctic Ocean (with PAME and ICES), WG 40 on Climate and Ecosystem Predictability (in collaboration with CLIVAR), WG 43 on Small Pelagic Fish (with ICES) and WG 44 on Integrated Ecosystem Assessment for the Northern Bering and Chukchi Sea (with ICES).

The duration of recent PICES Annual Meetings has been long. We are optimistic that this shorter “virtual” Annual Meeting, planned for October 2020, may encourage many scientists to participate in the videoconferences, allowing all to enjoy these talks together as a community. In recent years, we have received feedback from attendees that the Annual Meeting is too long and the schedule is too full (i.e., too many concurrent sessions). Thus, SB is hoping that fewer sessions will facilitate communication and interaction, perhaps also providing an inspiration for collaboration among expert groups.

Committee Action Plans haven’t been updated since the latest PICES Strategic Plan was launched in 2016, on PICES’ 25<sup>th</sup> Anniversary. SB requested that Committees update their Action Plans to align them with the PICES Strategic Plan and FUTURE activities.

As SB Chair, I sincerely acknowledge the tremendous efforts, dedication and contributions of SB members in steering PICES science activities. We would have preferred to meet in person, however, the dedication and focus shown by SB during our virtual meeting was greatly appreciated.

The next PICES Annual Meeting (PICES-2020, October 26-29 in the Eastern Pacific; October 27-30 in the Western Pacific) will be the first-ever virtual meeting. We anticipate excellent live presentations, with an additional option for presenters to submit previously-recorded presentations and e-posters. This virtual meeting fits well with a SB goal of initiating “green” meetings in the future, with the strategy that a combination of virtual and in-person meetings will allow us to lead the ocean community by promoting exemplary carbon savings through our direct actions. I look forward to working with all of you on these exciting new activities and to “seeing” all of you online at PICES-2020 this October.

Vera Trainer  
SB Chair

\*PICES Standing Committees  
 BIO - Biological Oceanography Committee  
 FIS - Fishery Science Committee  
 HD - Human Dimensions Committee  
 MEQ - Marine Environmental Quality Committee  
 POC - Physical Oceanography and Climate Committee  
 MONITOR - Technical Committee on Monitoring  
 TCODE - Technical Committee on Data Exchange

## FUTURE SSC's 6<sup>th</sup> inter-sessional meeting highlights

*Steven Bograd and Sukyung Kang*

The **FUTURE Scientific Steering Committee** (herein after referred to as "FUTURE") held its 6<sup>th</sup> inter-sessional meeting since 2014. FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) is PICES' second integrative science program, which was launched at PICES-2009. This year's meeting was "virtual" and took place April 26–28<sup>th</sup>, 2020. The 3-day affair was led by Steven Bograd and Sukyung Kang who are the Co-Chairs of the FUTURE SSC. The meeting was attended by all 14 SSC members in addition to seven guests and five representatives from the PICES Secretariat, who hosted the online meeting.

### Review of 2019-20 activities

The SSC reviewed FUTURE activities since its last meeting at PICES-2019 in Victoria, Canada, including changes in membership. Ian Perry (Canada) and Sinjae Yoo (Korea) have stepped down from the FUTURE and were thanked for their excellent service to the program over the past 5 years. Hanna Na (Korea) was introduced as a new FUTURE member replacing Sinjae Yoo. FUTURE revised its liaison table, which provides links of communication between SSC members and PICES expert groups, to reflect both the changes in SSC membership and the addition of new Working Groups and completion of others.

One new development of the FUTURE program is the establishment of an Early Career Scientist Award, designed to both advance the Social-Ecological-Environmental Systems (SEES) approach in PICES, and engage early career researchers in conducting their studies within PICES. The award<sup>1</sup>, originally approved at PICES-2019, provides travel support, an invited speaking slot and a certificate to a young scientist(s) who proposes the best SEES methodology in their work.

The SSC also reviewed the motivation and initial plans to hold a FUTURE Open Science Meeting (OSM). The meeting objective is to highlight and synthesize accomplishments of the FUTURE Phase II (2014-2020) science program and related activities, including from other international organizations. A key theme will include the application of the SEES approach within the framework of UNDOS. Due to travel constraints and delays related to the COVID-19 pandemic, the SSC will continue to plan for this meeting in the coming year, with a target date in 2022 or 2023.

### PICES engagement with the UN Decade of Ocean Science for Sustainable Development

A key objective of this SSC meeting was to discuss ways in

which FUTURE, and PICES more generally, can engage with and provide leadership to the UN Decade of Ocean Science (UNDOS). The discussion began with an introductory presentation on the UNDOS objectives, processes and timeline, given by Dr. Fangli Qiao, who is a member of the UNDOS Executive Planning Group. Dr. Qiao presented the draft Implementation Plan for the decade, which describes the governance structure of UNDOS and the levels of activity and commitment in which the community will engage. The plan is currently undergoing community review and revision. FUTURE presented a number of ideas framing how PICES activities could contribute to UNDOS.

Dr. Bograd briefly described the work of an ad hoc group of ICES and PICES members who have been discussing strategies for joint activities that these organizations can undertake as part of UNDOS. The group met at PICES-2019 and had a series of calls between January and April 2020. Three products have emerged from these meetings:

1. a letter to PICES Governing Council and ICES Science Committee describing a joint UNDOS activities strategy;
2. a draft Strategic Plan of joint PICES-ICES UNDOS activities, still under development;
3. joint comments on UNDOS' draft Implementation Plan.

Drs. Bill Karp and Simon Jennings discussed specific strategies for joint activities from an ICES perspective. One existing activity that has been identified is the Section on Climate Change and Marine Ecosystems (S-CCME), which is supported by both organizations, encompasses many of the strengths of both organizations, and is focused on key UNDOS goals of 'a predictable ocean', 'a productive ocean' and 'a sustainably harvested ocean'.

Dr. Erin Satterthwaite then gave a presentation of Early Career Ocean Professional (ECOP) engagement with UNDOS. She has helped organize a large and diverse informal ECOP Working Group, which facilitates engagement by young professionals in the planning and execution of UNDOS. They recently conducted a survey (responses from >100 countries) to incorporate the views of ECOPs into the UNDOS Implementation Plan, and identified several broad needs of ECOPs: a global network of networks; mentoring and training opportunities; an information portal; a coordination strategy; and funding opportunities. Dr. Satterthwaite is also planning to co-lead a Workshop on "Building a PICES Early Career Professional Network," at PICES-2020.

<sup>1</sup><https://meetings.pices.int/awards/FUTURE-ECS-Award>



FUTURE SSC's "virtual" inter-sessional meeting, 2020.

Following the UNDOS motto of *'The Science We Need for the Ocean We Want'*, SSC members presented ideas on *'the ocean they want'* for the future. Many ideas were expressed, and several key themes emerged from this exercise, including: Climate and Ecosystem Predictability; SEES; Hazards and Extreme Events; Communication; Resilience and Sustainability; Food Security; Human Health; and Equity and Diversity. FUTURE will continue to meet virtually through spring and summer 2020 to further develop these ideas for UNDOS engagement, including new programs to advance FUTURE objectives and PICES-ICES joint activities.

### The next phase of FUTURE

As part of the ongoing discussions on the future of PICES integrative science, the SSC reviewed the recommendations it made to Science Board at ISB-2019 and PICES-2019, i.e. to complete the current Phase II (2014–2020) of FUTURE this year and embark on a FUTURE Phase III with revised Science and Implementation Plans. During Phase II, the SSC implemented a SEES framework to promote multi-disciplinary marine research and facilitate synergies amongst PICES expert groups (see Bograd et al., *PICES Press, 2019, Vol. 27, No. 2, pp. 5–6*). Dr. Bograd reviewed the draft FUTURE Phase III Plans, which build upon the SEES approach, outline significant engagement with UNDOS, and emphasize a renewed commitment to communication and outreach to diverse stakeholders. FUTURE expressed approval of this approach, which includes a completion of the new Science and Implementation Plans by Fall 2020.

Finally, the FUTURE SSC prepared an Action Plan for the coming year, which includes:

1. Finalizing and distributing FUTURE's Phase II product matrix and final report;
2. Completing FUTURE's Phase III Science and Implementation Plans;
3. Continued planning for PICES engagement in UNDOS;
4. Facilitating development of new expert groups to advance FUTURE objectives, including ways to provide greater synergy amongst existing expert groups;
5. Reviewing the NPESR3 synthesis report;
6. Preparing for PICES-2020;
7. Planning for the next FUTURE Open Science Meeting.

### Endnote: FUTURE inter-sessional meeting participants

#### FUTURE Co-Chairs:

Steven Bograd (USA)  
Sukyung Kang (Korea)

#### FUTURE Members:

Emanuele Di Lorenzo (USA)  
Toyomitsu Horii (Japan)  
Oleg Katugin (Russia)  
Jackie King (Canada)  
Vyacheslav Lobanov (Russia)  
Mitsutaku Makino (Japan)  
Guangshui Na (China)  
Hanna Na (Korea)  
Ian Perry (Canada)  
Fangli Qiao (China)  
Ryan Rykaczewski (USA)  
Thomas Therriault (Canada)

#### Guests/Observers:

Chul Park (PICES Chair)  
Vera Trainer (SB Chair)  
Enrique Curchitser (GC, USA)  
Simon Jennings (ICES)  
William Karp (ICES)  
Erin Satterthwaite (NCEAS, Future Earth)  
Sung Yong Kim (MONITOR)

#### PICES Secretariat:

Harold (Hal) Batchelder  
Sonia Batten  
Robin Brown  
Alex Bychkov  
Lori Waters



## PICES-2020, October 26 to 30 — See you virtually!

*Sonia Batten*

When planning for PICES-2020 first began, we could never have envisaged that a virus would shut down world travel almost completely, and make obsolete the detailed timetable that was ready to receive registrations and abstract submissions. It has been a challenging few months as we first delayed making a decision while we waited to see how the pandemic would progress, then took the step (which now feels inevitable) to postpone the next in-person Annual Meeting to 2021, and finally, to plan for what we could do in 2020.

PICES exists to promote the scientific understanding of the North Pacific. The diverse expert groups and Committees are structures necessary to support and further that science, so while their business meetings are an essential part of the Organization, the Annual Meeting is also a chance to showcase the science that they generate. We want to encourage the momentum of the expert groups this year as well as enjoy the products of their hard work so PICES-2020 will be streamlined, but will still contain recognizable elements of previous Annual Meetings.

As other reports in this issue of PICES Press describe, we successfully held two virtual business meetings this spring: the [FUTURE SSC meeting](#) and the [inter-sessional Science Board meeting](#). Although we were apprehensive, both events surpassed our (and the Science Board members) expectations, so we are confident that virtual annual business meetings can be held this autumn and much work can be completed as planned. This may even be the way that PICES does much of its business in the future, as we endeavour to become more environmentally conscious, reduce our carbon toll and shorten the duration of Annual Meetings.

On October 26/27 (for eastern/western Pacific time zones), we will hold a Plenary Opening Ceremony with the usual (though shortened) presentation of awards (Wooster, POMA and Zhu-Peterson awards), the Year in Review by the Science Board Chair, and a reduced Science Board Symposium of three to four talks. This will be followed by three days, October 27/28–29/30, with two concurrent topic sessions, lasting two to three hours each day. The sessions will also have pre-recorded talks and e-posters available to view all week. A few of the planned workshops will go ahead virtually in the weeks leading up to PICES-2020. In this way we can keep the momentum going on current focus issues such as the United Nations Decade of Ocean Science for Sustainable Development, increased involvement of Early Career Ocean Professionals, and joint activities with other groups such as ICES. Please keep checking back to the [PICES-2020 website](#) for the latest information as plans develop. The remainder of the workshops, and the topic sessions that could not be accommodated this year, will take place in 2021.

We will all miss the chance to catch up with old friends, make new ones, and share ideas during coffee breaks, lunches and evening poster sessions and receptions. These opportunities are as much a part of PICES as the science sessions and business meetings, but this is a chance to try new ways of working together. Perhaps future Annual Meetings will be a mixture of the best of the old ways and the new!

## Reflections on my 28 year journey with PICES

*Robin Brown, retiring PICES Executive Secretary*

As I approached the date for my retirement from PICES, I reflected on my history and experiences in the Organization. I attended the first PICES meeting in 1992. More precisely, I didn't attend any of the actual committee meetings but I did participate in the attached Symposium on Climate Change and Northern Fish Populations. Like so many future PICES activities, this resulted in [many papers in a Special Publication in a peer-reviewed journal](#). I have to admit that I wasn't really aware of the significance of what was going on – that a new intergovernmental, multi-disciplinary science organization focused on the North Pacific had been formed. At that point, I was blissfully unaware of the impact that PICES would have on my career and my life, even as the PICES Secretariat was being assembled within the Institute of Ocean Sciences where I worked.

In early 1995, I was quietly going about my normal work as the Oceanographic Data Manager at the Institute of Ocean Sciences when I got a phone call from [Warren Wooster](#). Warren was (and remains) a legendary figure in marine science and guys like me didn't get phone calls from people like him!



He explained that PICES was initiating its first Technical Committee (TCODE - the Technical Committee on Data Exchange) and he wanted me to be the first Chair. We talked about the objectives and the likely workload. We discussed this for a while and then agreed that he would call back in a week, giving me some time to think about the task and opportunity. Sure enough, he called a week later to "land the fish" that he had "hooked" a week earlier. Warren was a very persuasive individual. Once he had determined what he wanted, he was relentless and resistance was futile. I agreed to take on the task and started to make preparations for the first TCODE meeting in 1995 in Qingdao, China.

While this was not my first encounter with international marine science committee work, it was my first in the role of Chair. It was a challenging but very rich experience for me. That first TCODE meeting was my introduction to several TCODE members who became professional colleagues for much the rest of my career, including Tokimasa Kobayashi (Governing Council (GC) Vice-Chair 2002–2004 and GC member 2018–2020), Lev Bocharov (GC member from 1996–2018 and GC Chair from 2010–2012) and William Karp (now 1<sup>st</sup> Vice-President of ICES and Council liaison to PICES).

My appointment as TCODE Chair gave me a seat on the PICES Science Board. This was my personal entry into the "big picture" of PICES science and the interactions of PICES with other scientific programmes and organizations. The breadth is staggering and I encourage all PICES members to think kind thoughts about members of Science Board and particularly the poor Science Board Chair who must coordinate all of this. The position of TCODE Chair also provided me with opportunities to work with the International GLOBEC Program Office and to represent PICES and GLOBEC at some international meetings on marine scientific data management and its many challenges.

I returned to Science Board in 2010 as the Chair of the FUTURE Advisory Panel on Status, Outlooks, Forecasts and Engagement (AP-SOFE). This is one of three advisory panels established to guide the first phase of the FUTURE program. The FUTURE Advisory Panels proved to be an organizational model that was unsuccessful in guiding FUTURE. The management of the FUTURE program was restructured in 2014 and the Advisory Panels were replaced by the FUTURE Scientific Steering Committee.

From 2003–2015, I represented Canada on the Governing Council and Finance and Administration Committee on an intermittent basis as an Advisor, Alternate Delegate and official member (2013–2015). This gave me an inside view of the operations and finances of the Organization and the way the Governing Council functions (warts and all). Over the years, I got to know the PICES staff well at Annual Meetings, Symposia and as co-occupants at DFO's Institute of Ocean Sciences. It was helpful being co-located with the PICES Secretariat but one downside was that Alex Bychkov always knew where to find me. Alex is "cut from the same cloth" as Warren Wooster and is similarly relentless when he wants something from you. My DFO staff became quite skilled at hiding me from Alex when I was too busy to meet with him to receive my long list of instructions! It was also very helpful to be able to consult with Christina and get an "insider's" view of meeting/symposium venues and accommodation options when making travel plans to attend PICES events.



Robin and his cat Chibi, painted by PICES Intern Saeseul Kim, 2020.

I had the opportunity to represent PICES in many meetings, events and activities as an expert group member, committee chair and as Executive Secretary. It has been my experience that PICES is a highly regarded organization in the global marine science community. This favourable view rests on the breadth and depth of the scientific publications that emerge from the various activities of the Organization.

No period of reflection is complete without a reference to my worst day in PICES. Without a doubt, this was during PICES-2013 in Nanaimo where I was Chair of the Local Organizing Committee. Professor Mingyuan Zhu passed away suddenly on the streets of Nanaimo. I had worked with Professor Zhu on an APEC Harmful Algal Bloom Working Group prior to my time in PICES and had worked with him intermittently over the years on PICES science issues. Nothing can really prepare one for this kind of shock.

I believe that PICES is an organization that is successfully working on scientific problems that are both important and challenging. I have always appreciated the fact that PICES was positioned nicely on that all-important third axis – the one labelled “Fun”. I have greatly enjoyed the

international and cross-cultural aspects of PICES. There have been challenges related to culture and language and those of us who are lucky enough to have English as our first language have a special obligation to slow down and make sure that everyone is fully engaged in the discussions. I have always been impressed by how hard PICES scientists work to achieve balance and representation. It isn't always easy and it isn't always successful, but the depth of the commitment is remarkable. The importance of the “social construct” of PICES in encouraging deep scientific collaboration was one of the very strong messages that emerged from the survey done in preparation for the 25<sup>th</sup> anniversary of PICES in 2016, and there are many eloquent comments on this in the [PICES anniversary video](#).

I am quite optimistic about the path forward for PICES. In the early discussions about the United Nations Decade of Ocean Science for Sustainable Development, I did a review of published lists of “grand challenges” in marine science, priorities for the Ocean Decade and the FUTURE program, and other science priorities in PICES. This analysis demonstrated that PICES is fully engaged in most of the important challenges in marine science. The breadth and balance of PICES science activities make PICES unique amongst marine science organizations and a very good fit for the Ocean Decade priorities. I am hopeful that the UN Ocean Decade will provide some new opportunities and resources to bolster some current priorities and elevate some other priorities that have been on our “nice to do but needs more resources” list. This list includes (but is not limited to):

1. Expanded outreach efforts to improve the uptake and impact of PICES research;
2. Expanding the role for early career professionals within PICES;
3. Increasing our contributions to capacity development in non-PICES countries.

All of these present opportunities to expand the network of PICES collaborations. That may make for complicated program delivery, but enhancing and expanding the PICES network will have other benefits as well.

It has been my immense privilege to serve as the Executive Secretary of PICES since February of 2015, and to enjoy the level of support that I have been given from all of you. I think that the Organization is in very good hands. I expect that we will return to a post-COVID-19 world that will require some changes to the way that things are done, but I believe the Organization has both the skill and the will to make these changes to keep the science rolling and the PICES “spirit” vibrant.





Top to Bottom, L-R: Robin Brown and PICES Chair, Chul Park, at PICES-2019; SB 2000: Tsutomu Ikeda, Skip McKinnell, Vyacheslav Lobanov, Doug Hay, John Stein, Pat Livingston, Robin Brown; PICES-1995 Qingdao, Robin Brown, Christie McAlister; PICES Secretariat staff: Christina Chiu, Hal Batchelder, Julia Yazvenko, Robin Brown; Second ADRIFT project meeting, 2015, L-R: Hideaki Maki, Hiroshi Kawai, Peter Murphy, (representing Nancy Wallace), Cathryn Clarke Murray, Thomas Therriault, Alexander Bychkov and Robin Brown; Intern Jinqiu Du and Secretariat staff pose outside the Secretariat, 2019; Roger Griffis, Robin Brown, and Jason Link having important discussions, 2018; Robin enjoying a local delicacy of pigeon head, Qingdao, PICES-2002; Robin and Skip, 2002; Pat Wheeler, Bruce Taft, Robin Brown, PICES-2013; Robin's copepod impression, 2003.

## Robin Brown's legacy — in PICES words

Comments and well-wishes from the PICES Scientific Community

As a long-time member of the PICES HAB Section, I have many memories going back many years of how Robin has been a source of guidance and encouragement, on both personal and professional levels. Much of this was before he took the helm of PICES, and it continued in grander style afterwards. He is a person who always has promoted the best interests of others, and he will be missed dearly. I wish him the very best in his retirement, and hope that our paths will continue to cross.  
~ Mark Wells, School of Marine Sciences, University of Maine

Robin, I hope that you are very happy spending 100% of your time for yourself and your family already, and that you're enjoying your second life. For me, the North Pacific Regional Workshop was my greatest memory of working with you, and I really thank you very much for your very hard work on the North Pacific Regional Workshop for the UN Decade of Ocean Science. You did a great job of collecting many experts from North America to bring to Tokyo, despite the bad climate in the summer of 2019, which caused no one to want to come... I also recall your good leadership coordinating plenary talks. I was impressed and thought "Oh, this is PICES". I hope that you had a very good time during your stay in Tokyo last summer, and hope that I will see you somewhere on earth. Please take care from COVID-19, and have the best time in your life!  
~ Ken Ando, JAMSTEC, and Vice-Chair of IOC/WESTPAC

Robin, You have always been so generous to me as a member of the Delegation of Korea. Sometimes I think what good I did in life to deserve someone like you. Thank you!  
~ Heejin Kim, Deputy Director of International Cooperation, Korea Institute of Ocean Science & Technology

Robin was an excellent skipper of PICES. We really appreciate his experienced skills, rational strategies and charming but strong leadership.  
~ Mitsutaku Makino, Atmosphere and Ocean Research Institute, University of Tokyo

Robin Brown has done an outstanding job for PICES. He was always sympathetic to the varied and sometimes extraordinary requests of its members and his charming personality was ever present. I hold his opinions on international affairs in great respect and wish him all the best in his retirement. We will greatly miss him!  
~ Tim Parsons, Emeritus Scientist, Institute of Ocean Sciences, Fisheries and Oceans Canada

Robin always welcomed us with his smile. Even if facing very difficult issues, he has always shown positive opinions and encouraged us. Robin has really been a pipe connecting PICESians. We much appreciate your buddy-ship. Thank you so much for your devoted contributions for PICESians, Robin.  
~ Shin-ichi Ito, Atmosphere and Ocean Research Institute, University of Tokyo

Robin's retirement will be a big loss to the PICES society, but I hope Robin can still participate in future meetings. As everybody in PICES knows, he is a great happy person to talk with, even for relative newcomers to PICES, like me. Whenever I had issues at the committee or WG meetings, I could always talk with Robin to get his great constructive suggestions, and his offers of support. It was really helpful for me to enjoy the activities in PICES.

I would like to express my deepest gratitude to Robin, for his tremendous efforts on continuous development of PICES through gathering people. Since I've learned a warm heart of PICES activities from people like Robin, I would like to try to preserve this as a great tradition for the future of PICES.  
~ Daisuke Hasegawa, Tohoku National Fisheries Research Institute, FRA, Japan

Robin, Congratulations on your retirement from a long and productive time with PICES, both in the Secretariat and as a (hard working) contributing member when you worked for DFO. I always enjoyed working with you when TCODE and MONITOR had joint business, and while on the Science Board. I think I can remember back to the time when you worked closely with Bern Megrey on several PICES projects (something about federating data from our Far East colleagues), but those memories and the memories of after meeting sessions/dinners at the PICES Annual Science Meeting are foggier still. I hope you have a long, healthy, and happy retirement!  
~ Jeff Napp, Alaska Fisheries Science Center, NOAA Fisheries

I have benefited from knowing Robin for many years, first when he was a Division Head in the Science Branch at Fisheries and Oceans Canada, and then later in his role as PICES Executive Secretary. Robin's ability to motivate people, even when they did not report to him, always impressed me. He never claimed to be a knowledge expert as some senior executives are wont to do, but rather took the time to listen to the real experts. His team building skills led to significant contributions in marine science. I wish Robin and Leslie the best during retirement.  
~ Jim Irvine, Pacific Biological Station, Fisheries and Oceans Canada

My first collaboration with Robin was at PICES WG 13, when I was just a PD and he was data manager of IOS. Since that, he expanded his contribution in many other aspects of PICES business than merely data integration. I also received great support from him through my activities in WG17 and S-CC. For me, like former PICES leaders, he was the embodiment of unselfish volunteer spirits of the Canadian people. It was my fortune to work with him. I hope he has a good life as a great alumnus of PICES. Best Wishes Robin.  
~ Tsuneo Ono, National Research Institute for Far Seas Fisheries, FRA, Japan



"Understanding Changes in Transitional Areas of the Pacific," Symposium group photo, April 2018. Robin is in the center of the action.

*I've been fortunate enough to interact with Robin for many years now. Still, it was in the organization of the International PICES Symposium "Understanding Changes in Transitional Areas of the Pacific," held in La Paz, BCS, Mexico in April 2018, that I experienced his full spectrum of capacity, experience, willingness, and vision. Robin was instrumental for the success of the symposium, and a vital component of the wonderful and efficient PICES Secretariat team.*

*He was (and I'm sure will remain) always kind and helpful, providing wise advice in many different areas. He was also extremely empathic with all sorts of involved people, from students to full professors, from scientists to administration and logistic people, and everyone from the south or the north). My team and I will remain grateful for times to come.*

*Now that I learn he is ending his PICES epoch, two questions assault my mind. The first is, which new adventure will benefit from his experience and overwhelming energy? I just can't picture him sitting in a cabin's shade for more than ten minutes. The second is, how does he look when he gets angry and desperate? That is a face I was never able to see.*

*I wish Robin the best of luck, I send him my gratitude and remind him that he has friends and welcoming homes just south from the PICES region.*

*~ Salvador E. Lluch-Cota, CIBNOR, BCN, Mexico*

*With great pleasure, I congratulate Robin on his retirement from PICES! Although it was not while Robin was at PICES, but during his tenure as a Canadian Representative to NPAFC (2013-2015; North Pacific Anadromous Fish Commission) that I came to be in his sphere of influence. It was always a pleasure to work with Robin. I appreciated his open and positive outlook, and his ability to identify a problem and see a solution. He was one to build connections and provide helpful advice on finding links to experts. And his keen sense of humor—so important to keeping us on track. Robin, Congratulations on your retirement! Wishing you lots o' free time to enjoy your pursuits and having fun with your family. Best wishes!*

*~ Nancy Davis, Washington State Department of Ecology*

*Robin Brown has always been an advocate for PICES and did an excellent job as Executive Secretary over the last five years. Thanks Robin for your efforts for inclusiveness, diplomacy, practicality, and candidness to coordinate and promote ongoing marine ecosystem research in the North Pacific!*

*~ Doug Bertram, Environment Canada*

*Dear Robin, Even though we never got to meet in person, I always enjoyed our interactions and felt that you were someone that I could be completely frank with. You felt a bit like a big brother in a well-oiled, more prosperous project that I looked up to! Thank you for your support over the years, not only for IMBeR, but also for me personally. I really appreciated your support and assistance when we were looking for a new home for IMBeR and am sure that your intervention had something to do with me now being ensconced in Halifax! On that same subject, I was incredibly touched by your email checking that I had made it over here safely and offering to chat on the phone if being isolated became a bit much. I liked knowing that you were there! I wish you so much good health and happiness in your retirement and hope that you will soon be able to do lots of the fun things that you planned to do. All the very best,*

*~ Lisa Maddison, IMBeR International Project Office*

*During my time as the Executive Director of the Scientific Committee on Oceanic Research, I appreciated the positive PICES approach to cooperative work in marine science exemplified by Robin Brown. Robin set the tone for the SCOR-PICES partnership and worked effectively to co-fund a variety of meetings and capacity-development activities. Robin always provided insightful comments about the international ocean science context for our work and how he envisioned PICES and SCOR contributing separately and together. We spent many weeks sitting in the Observer section of IOC annual meetings over recent years. SCOR and PICES were not always placed next to each other alphabetically among observer organizations at IOC meetings, so I sometimes needed to rearrange the acronym placards to make it so. Robin's humor always brightens difficult situations whenever and wherever they occur. Congratulations to Robin for his retirement! It is a most commendable stage of life.*

*~ Edward R. Urban Jr., University of Delaware, USA*

Robin provided great leadership to PICES over many years and served as Executive Secretary with distinction. Robin was a great ambassador for PICES who elevated the Organization's reputation and impact throughout the world. On a personal level, I was always happy to see Robin enter a room where some expert group was meeting. I knew that if any sticky issue arose, Robin would provide a clear and eloquent intervention to keep the discussion moving forward. Robin combined this lucidity with a highly diplomatic and sensitive approach, which made him the ultimate problem solver and earned the respect of the entire PICES community. I certainly wish Robin well in his retirement but hope that he will stay active in PICES for a long time to come.

~ Steven Bograd, Southwest Fisheries Science Center, NMFS, NOAA

Throughout the last 5 years, under Robin's expert management, PICES has been a vital and productive partner in the landscape of global research projects. As the chair of the SOLAS scientific steering committee, I've tremendously enjoyed and benefited from Robin's insights and camaraderie, while we've herded our respective teams of cats through various productive and useful enterprises. I am sorely going to miss our long strategy chats, as well as our commiserations in meeting corners around the world. Thank you, Robin, and congratulations!

~ Lisa A. Miller, Chair, Scientific Steering Committee, The Surface Ocean-Lower Atmosphere Study

I first met Robin soon after I came to Canada late in 2000 (he was my husband's boss in DFO at the time) and he has had a huge influence on my career too. Robin was instrumental in getting DFO support for the Continuous Plankton Recorder Survey that I had started but was trying to secure stability for. He encouraged me to provide the right kind of information to the right people, and found creative ways to maintain that support through PICES. It's in no small part due to Robin's efforts that the survey reached 20 years last year. We idly mentioned me working in DFO a few times over the years, but while we never managed to figure out a way for Robin to be my boss, he has often provided the mentoring and advice that a good boss would have done. And when I learned that he planned to retire from PICES and I expressed an interest, he was encouraging and supportive. It is a real privilege to now take on the Executive Secretary of PICES role after Robin; I'm inheriting an organization in great shape and I will do my best to keep it that way. I hope that his retirement is everything it should be, but that PICES still gets to see him and have the benefit of his insights from time to time over the next year or so before we let him go completely!

~ Sonia D. Batten, Executive Secretary, North Pacific Marine Science Organization (PICES)

Robin has been a wonderful mentor to me during his time at DFO and PICES. He provides honest feedback, is supportive and friendly, and is a good leader and role model. I will miss seeing Robin in the Secretariat's office at PICES Annual Meetings, where his sense of humour was infectious!

~ Jennifer Boldt, Pacific Biological Station, Fisheries and Oceans Canada

I first got to know Robin when I was brought from Newfoundland to Nanaimo in 1990 to be Head of the newly created Marine Fish Division. I expected to have responsibility for the Groundfish, Pelagic Fish, and Invertebrate Sections of DFO Science in Pacific region, but was a little surprised to also have the small Biological Oceanography Group at IOS assigned to the Division as well. I didn't know quite what to expect, because in my years in Newfoundland Region, the "biological oceanographers" were very centered at BIO. The rare interactions I had with them left me with a jaundiced impression that they were obsessed plankton counters who tried to reduce every problem in the ocean to questions that could be answered if they were just given more resources to collect and count more plankton. On the other hand, a close Newfoundland regional colleague Geoff Evans had worked with Dave Mackas, and spoke very highly of him. As I got to know the IOS biological oceanographers, I found I was not dealing with one exception in Dave as an excellent scientist with a broad vision, but with a team of excellent scientists, including Robin Brown, who became an insightful and valued team member for MFD.

Things changed over the 1990s, and by the end of the decade I was in Ottawa, and although Robin was still in IOS, he was deservedly quite a bit higher on the ladder. As I did my part to bring more of an ecosystem approach into DFO science and advice to management, I found Robin one of the most valuable allies in those efforts. And I learned not just more about how broad a vision he brought to our thinking about ocean ecosystem dynamics, I learned how good a hand he had with the "people dynamics" of making change happen. Just a hugely valuable skill, and one that made me realize we had moved some time before from colleagues to friends.

And in due time my role in DFO changed again, and Robin moved to PICES. This time I wasn't surprised at his successes with the science or with the people of PICES. His exceptional performance was nothing more than what I expected from him both as colleague and friend. Which is not to say there were no surprises. This time the surprise was how excellent he is at institutional leadership. PICES has been very fortunate to have him for these last years of his career.

And now he "retires". I have no idea what he will do now. However, the one thing I am certain of is that whatever he chooses to do, he will bring to it all the excellence he has shown in dealing with knowledge, with people, and with organizing what is needed to produce the best outcomes possible. Whatever he does will be better for his engagement. I also expect he might even get some satisfaction from what he does.

And one final message for and about Robin. It's not necessarily something I am sure of, or even expect, but it is certainly something I hope for. It is that Robin and I keep in touch in the years to come, so I can continue to enjoy our occasional but deep discussions of all the problems and opportunities that lie ahead. CONGRATULATIONS, Robin – and thanks for everything over the years.

~ Jake Rice, Emeritus Scientist, Fisheries and Oceans Canada



Photos: Tetsuo Fujii

*Dear Robin-san, I'd like to express my utmost appreciation for your contributions to PICES. When I was appointed to be a member of Governing Council representing Japan, I didn't know anything about PICES. I learned a lot of things from you. I felt as if you were a lighthouse in the storm. Your advice, support, and cheerfulness will be greatly missed. Wishing you a new journey of success and happiness in the new page of your life. I hope our paths cross many times in the future. Best wishes!*

*~ Tetsuo Fujii, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries of Japan*

*The IPHC Secretariat would like to wish Mr. Robin Brown a happy, healthy and well deserved retirement. The IPHC Secretariat would also like to personally thank Robin for his efforts, interest and dedication to help strengthen the working relationship between PICES and the IPHC as contemplated in the recently signed MoU between the two organizations and that has stimulated the active participation of the IPHC in the important scientific activities that PICES undertakes in the North Pacific Ocean.*

*~ David T. Wilson, Executive Director, International Pacific Halibut Commission*

*Dear Robin, It has been a pleasure getting to work with you and know you over the past year within PICES and the Ocean Decade. I am very grateful for your extensive mentorship and support, as it has been vital to my path forward. I appreciate your thoughtful, direct, open-minded, and down-to-earth leadership and nature. I wish you all the best in your next chapter. Thank you!*

*~ Erin V. Satterthwaite, PEGASuS Postdoctoral Researcher, Nat'l. Center for Ecol. Anal. & Synth. (NCEAS) & Future Earth*

*I have not been in PICES for very long, but Robin stood out from the beginning as someone who immediately made me feel welcomed and at ease in a very new (and sometimes confusing) environment. He clearly cares about this organization and everyone in it. He led with grace and knowledge, and he will be missed!*

*~ Jeanette Cosden Gann, Alaska Fisheries Science Center, NMFS, NOAA*

*It gives me great pleasure to be expressing my kind thoughts regarding Dr. Robin Brown, whom I have known since the PICES 2017 Annual Meeting. He is an enormously talented and wise scientist and a wonderful individual with a unique sense of humor. I admire his spirit and ability to find just and complete solutions to important questions and difficulties. I consider his leadership and his personal significant contribution to the positive achievements of PICES as good example of the sustainable progress in the areas of both human and natural sciences. I am very grateful for his valuable advice and helpful recommendations too. I wish him continued success in his life plans and worthy victories! Sincerely, Amri*  
*~ Amrtatjuti V. Sereda, V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences*

*Robin and I both had a long journey in PICES and as employees in DFO and NMFS, respectively. We became friends and trusted colleagues. Many times one of us would pick up the phone to deal with an issue affecting both of our agencies or PICES. The mutual trust and honesty was a great pleasure and something I treasured.*

*In PICES, I first started to connect with Robin at one of early PICES meetings in Nanaimo, and our connections and professional relationship grew from there to ultimately serving together on the Governing Council and then working with Robin as Executive Secretary to plan and put on the 25th Anniversary of PICES in San Diego, USA; no small task but we helped get it done.*

*Robin has given so much to PICES and to DFO. He will be remembered as a key piece in the formative years of PICES. He truly left his mark, and in such a wonderful Robin manner. And finally, I welcome my friend to the other side; retired life is not bad, and I'm sure you are transitioning well. All the best and hope to connect with you soon.*

*~ John Stein, retired, Northwest Fisheries Science Center, NMFS, NOAA, and past Chair of Science Board*

Many congratulations Robin on your retirement. When I was with NPAFC, I was very happy when you first came into our Commission as a Representative bringing all of your Canadian Federal Government's knowledge and experience. Your advice helped our Secretariat a great deal! Then as the PICES Secretary I was again very happy that we could continue our relationship (professional one, I mean!). Thank you for your support for me practically and emotionally. You were also fun to work with. I am sure NPAFC will miss you while I'm glad I retired before you did! I can vouch for you that retirement life is good. I am entering into my fourth year of retirement, and I would say it took me a while to get used to this new life style, but now I fully, and totally enjoy it, particularly the freedom. I assure you will enjoy it, and you well deserve it. Congratulations and best wishes to you with your new life!! Hope we can keep in touch!!  
~ Wakako Morris, former NPAFC Administrative Officer

Dear Robin, Congratulations on your (second) retirement! It is very well deserved, and you have done an outstanding job as the Executive Secretary of PICES. You had very big shoes to fill, which you did very well. You also made your own mark and took the Organisation in exciting new directions. You were always (or so it seemed to the rest of us) calm and collected, with your finger on the pulse of everything that was going on. And you seemed to know everyone, inside and outside of PICES, treating all with consideration and respect. It has been my great pleasure to have known you and worked with you since our early days sharing a house together while working for CEPEX in the mid-1970s(!). You will be missed. But now you can embark on your third career, one for which there is no retirement: being a doting Grandfather! A great many thanks for all that you have done for us, and for PICES. Enjoy!  
~ Ian Perry, Pacific Biological Station, Fisheries and Oceans Canada

Congratulations to Robin on an outstanding career. I had the honour of supervising him first as a manager for Canada's Department of Fisheries and Oceans and then as PICES Executive Secretary. In both positions, he worked very hard behind the scene completing those thankless tasks so that the scientific work of others could shine. He was exceptional at identifying and sorting out issues before they became problems. He took on the seemingly mundane assignments needed to make PICES a vibrant modern organization. He also just liked to have fun and his sense of humour was infectious. I wish him all the best in his retirement.  
~ Laura Richards, PICES Past Chair and former Regional Director Science for Fisheries and Oceans Canada

Dear Robin, Thank you for your kindness and generosity - you have always offered helpful advice and suggestions. I really enjoyed preparing the science exhibits at the Institute of Ocean Sciences with you and the team, for the visit of the Emperor of Japan. And, while our overlap at PICES wasn't long, I appreciate your wisdom and mentorship, your team-based approach, and your ever-present good humour. I hope you'll write a book! All the best for a wonderful retirement. Enjoy your family time!  
~ Lori Waters, PICES Secretariat

Dear Robin, Thank you very much for all your kindness, your support, and all the nice chats during different events or via video call! When I became interim Executive Director of SOLAS, which happened quite suddenly, you directly offered to have a chat and share some of your wisdom with me. I often think back to this call and how much it helped me!! Your support is greatly appreciated and I feel honoured to have met you!! You will be missed. I wish you all the best for your retirement!  
~ Jessica Gier, Executive Director, SOLAS

Dear Robin! Congratulations on your glorious retirement! Even though there has not been much interaction between you and I, I was able to recognize your great contributions to PICES as well as NPAFC as the Canadian Commissioner. You have been promoted to the retirement stage of your life. I wish you endless days of relaxation with friends and family. Respectfully,  
~ Jeongseok Park, Deputy Director, North Pacific Anadromous Fish Commission

Dear Robin, Thank you very much for your support and leadership as a member and first chairperson of TCODE, and Executive Secretary for the last five years. Your advice and comments were extremely helpful for us. Farewell but not good bye!  
~ Toru Suzuki, Marine Information Research Center, Japan

I met Robin during PICES meetings between 2014 and 2018. During that period I learned from Robin not only his disposition and humbleness to interchange knowledge and experiences but also his compromise with marine sciences and strong working capacity. Thanks Robin for being such a great person, for those involuntary lessons you taught me and for your commitment with PICES. My best wishes for you.  
~ Romeo Saldívar-Lucio, CICESE, BCS, Mexico

Dear Robin-san, Thank you very much for your support and leadership. I always remember the first day we met at Sidney in May of 2018 for the ISB meeting, and also my first experience with the PICES Annual Meeting in Yokohama. All your support for the Japanese Local Organization Committee made me, as a nervous and inexperienced graduate, feel easy and comfortable. You are one of the reasons I have fun working in PICES. Your advice, support, and hospitality will be greatly missed. Wishing you and your family a new wonderful and healthy life. I am looking forward to hearing all about you soon. I want to say again that I really appreciate everything that you have done for us. Best wishes.  
~ Nobuaki Suzuki, Fisheries Agency, Japan



Robin in Yeosu, Korea, after PICES-2014. Photo: Ian Perry



At the Great Wall after PICES-2015 in Qingdao, China. L-R: Alex Bychkov, Olga Kiseleva, Laura Richards, Leslie Brown, Robin Brown.

*Congratulations and Happy Retirement, Robin! You will be missed!*

## The role of Early Career Ocean Professionals in PICES within the context of the UN Decade of Ocean Science for Sustainable Development (2021-2030)

*Aoi Sugimoto, Pengbin Wang, and Erin Satterthwaite*



Intergenerational diversity is vital to ensure a sustainable ocean future, since it requires addressing the pressing needs of the present while sustaining essential resources for future generations. The UN Decade of Ocean Science for Sustainable Development (UNDOS) has identified Early Career Ocean Professional (ECOP) engagement as an important facet of UNDOS to not only secure its immediate success, but its continuation beyond 2030. About a year ago, at the first Global Planning Meeting of the Intergovernmental Oceanic Commission of UNESCO in Copenhagen, Denmark, a self-organized group of ECOPs came together to discuss their vision for the future engagement of ECOPs in the Ocean Decade and beyond. They requested a partnership between ECOPs and many of the current ocean leaders in the preparatory phase of the Ocean Decade which included representation at planning meetings, hiring a consultant to support in leading efforts, creating a diverse ECOP working group, and launching a global survey to integrate the perspectives of ECOPs in the planning phases. The survey received an overwhelming positive response – collecting views from nearly 1500 early career professionals from over 100 countries.

From this survey and global consultations there were a few broad needs identified, which translated into priority areas for ECOP involvement in the Ocean Decade. These include a global ECOP network of networks to ensure broad connectivity and knowledge sharing, mentorship and training opportunities, an information portal specifically tailored for ECOPs, hosting youth engagement and other Ocean Decade events, funding opportunities, and supporting campaigns for ocean literacy.

PICES is well positioned to be a key player in UNDOS, due to its role in generating ocean knowledge over the entire North Pacific, and its demonstrated support of ECOPs. Therefore, it is important to ensure that the PICES ECOP community continues to be cultivated within PICES, bringing fresh ideas to the next chapter of scientific discovery, especially within the context of the Ocean Decade.

To bring the PICES ECOP community together and explore the ways that ECOPs want to participate in PICES, we are planning an online Workshop prior to [PICES-2020](#).





Photo by Houraa Daher

We are especially interested in bringing together a diverse group of ECOPs with more experienced PICES members from different countries, disciplines, sectors of society, and career stages to understand the needs of the PICES ECOP community. Specifically, we would like to gain input from the community on how ECOPs can best engage and contribute to PICES within the context of the Ocean Decade and how to continue to foster active and early participation of ECOPs in PICES.

We are looking forward to further developing the vibrant PICES ECOP and mentor community and hope you will join us!

### **Please join the ECOP Conversation!**

**We are looking forward to further developing the vibrant PICES ECOP and mentor community. We hope you will join us!**

**If you would like to join the conversation regarding early career engagement in PICES, please sign up at:** <http://tiny.cc/picesecop>.

**If you are unable to access the link please email:** [satterthwaite@nceas.ucsb.edu](mailto:satterthwaite@nceas.ucsb.edu).



*Dr. Erin Satterthwaite is a Postdoctoral Scholar at the National Center for Ecological Analysis and Synthesis & Future Earth. Erin is a marine ecologist who works at the interface of applied marine research, policy engagement, and science communication to advance ocean knowledge for sustainability. She is broadly interested in ocean sustainability issues related to marine biodiversity, fisheries and mariculture, social-ecological systems, citizen science, and biological oceanography. She is currently supporting initiatives to: include underrepresented voices – such as early career professionals – into global policy processes; develop a global map of biological ocean observing networks to support coordination of the biological Global Ocean Observing System; and to utilize environmental DNA to better understand biodiversity patterns in the California Current.*



*Dr. Aoi Sugimoto is a Research Fellow at Japan Fisheries Research and Education Agency. As a social scientist, her work focuses on coastal community/island studies, environmental sociology and community-based natural resource management. Her main research interest has been in describing the way local community residents perceive nature, and exploring ways of better managing the natural environment. Aoi is increasingly interested in capturing the dynamic Socio-Ecological Systems which need interdisciplinary work, and also exploring how to achieve successful transdisciplinary work between communities, scientists, governments and business sectors. Reflecting these interests, she strongly hopes the ECOP initiative will engage a wide range of stakeholders for sustainable marine/coastal use, and will develop capacities of early career researchers to successfully collaborate with stakeholders such as citizens, media, policy makers, business managers and artists.*



*Dr. Pengbin Wang is an Associate Professor in the Key Laboratory of Marine Ecosystem Dynamics at the Second Institute of Oceanography of the Ministry of Natural Resources (MNR) of the People's Republic of China, located in Hangzhou, China. He also serves concurrently as Deputy Director of the International Cooperation Department at the Fourth Institute of Oceanography in Beihai, China. He is Co-Chair of PICES Section on Ecology of Harmful Algal Blooms in the North Pacific (S-HAB) and a Scientific Steering Member of WESTPAC-HAB. His research focus spans taxonomy, molecular systematics and evolution of microalgae to algal physiology and marine micro ecology. He promotes international cooperation between scientists, especially early career scientists, and recently joined a number of capacity-building training workshops, serving as a lecturer.*



## Pacific Ecology and Evolution Conference 2020: 41 years of science and scenery on Canada's West Coast

Gwyn Case

For the first time in as long as anyone could remember, the *MV Frances Barkley* left dock early. It was an auspicious sign. As night fell over the water and the lights of Port Alberni slipped away into darkness, 80 of us crammed into the upper lounge of the small ferry to hear the opening speech. It was the start of the forty-first annual [Pacific Ecology and Evolution Conference](#) and we had a feeling it was going to be a good one.

The three-hour ferry ride brought us to the Bamfield Marine Science Centre, a world-class research station tucked into the rugged west coast of Vancouver Island. Organized entirely by students, the conference offers a unique opportunity for early-career scientists to present their work to their peers rather than to their professors. The friendly and collaborative environment fosters confidence among the attendees, most of whom are still pursuing their undergraduate, graduate, or doctoral degrees. The turnout was impressive, with 23 undergraduates, 36 masters candidates, 10 doctoral candidates, 2 postdocs, and 5 recent graduates attending from institutions as far away as Newfoundland. This year the conference extended a special invitation to the nearby community of Bamfield, and an additional 10 people joined us from the town and research station.

By the time we arrived at Bamfield it was pitch black, but the next morning was clear and sunny—unusual for Vancouver Island's notoriously wet climate. After breakfast we gathered in the Rix Centre to listen to Chief Robert Dennis of the Huu-ay-aht First Nation, upon whose traditional and unceded territory Bamfield is located. Generations of Huu-ay-aht people have lived on the bounty of ocean and forest, and Chief Dennis spoke eloquently of the relationship between his people and the land and water. "All are one," he said, and described the Huu-ay-aht as being members of an ecosystem. He went on to relate the story of the removal of First Nations people from their lands and his own childhood in a residential school. Now, he cautioned, "the ecosystem is unbalanced."

His words on interconnectedness and his call for wise stewardship stayed with us throughout the talks that followed, many of which focused on management and conservation. The 15-minute talks and 3-minute blitzes were divided amongst 7 sessions:

### Early Bird Gets the Worm

All things feathered and flying were featured in this avian biology session, from parental care to annual migrations.

### Any-Fin is Possible

Rivaling the avian session for popularity, these fish-focused talks examined life beneath the waves in freshwater, marine, and intertidal habitats.

### Conservation in a Changing World

Climate change dominates biologists' conversations, and this session explored ideas, strategies, and techniques for monitoring, managing, and networking in complex and changing systems.

### This Session Will Grow on You

To complement sessions on fish and birds, this session focused on coral, kelp and the other sessile organisms which form the backbone of their communities.

### Animal Behaviour

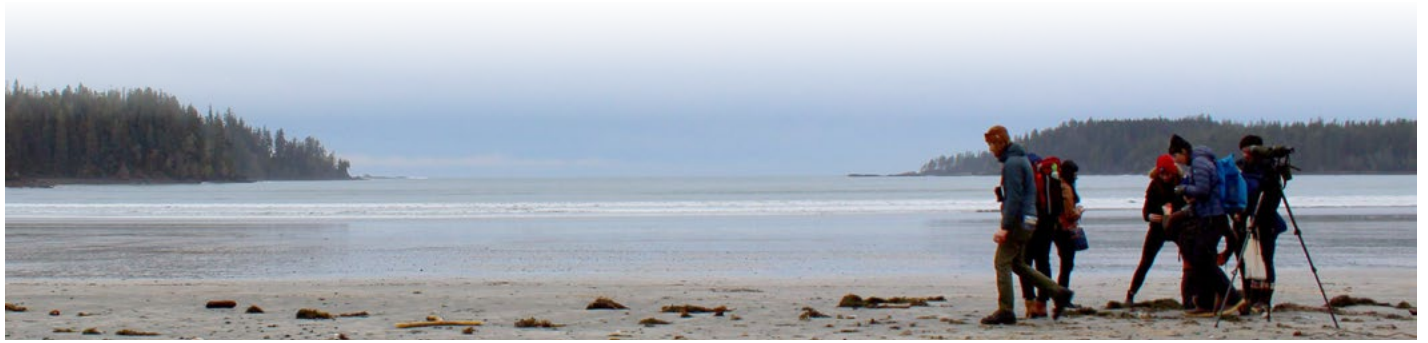
Many different factors can drive animal behavior, from human impacts to nutrient needs, and this session covered them all.

### Ecological Subsidies

Everything is connected. This session highlighted the many ways energy can flow between terrestrial and marine systems.

### Human Impacts & Conservation

From social media to road mortality, inescapable human presence was examined through multiple lenses.



By the afternoon the sky was rapidly clouding over, but the fair weather held for our workshops and field trips. A small group left early to visit the ancient First Nations village site of Kiiḡin on a guided walk with Stella Peters, a Traditional Knowledge Holder of the Huu-ay-aht. The rest of us attended a workshop on iNaturalist hosted by Deborah Obrist and Kelly Fretwell. This citizen science platform has grown rapidly over the past few years and data collected through the app is now widely used by academic researchers and conservation agencies. After learning the basics of the app, how observations are verified, and some of the exciting possible uses for the data, we split up for our field trips. One group took a boat across the Bamfield Inlet to Brady's Beach, while the other drove to Pachena Bay. There we practiced our new iNat skills by photographing and identifying as many lichens, mosses, and seaweeds as we could find. In the evening, we all gathered again in the Rix Centre for the poster session.

The research on display was as widely varied as the earlier talks, including posters on microplastics, First Nations archaeology, and mycorrhizae. Spirited but friendly discussion sprang up around the posters, became friendlier as the evening progressed, and the session transitioned smoothly into the famous costume dance. A conference tradition, this year's costume theme was symbiosis. In groups large and small, attendees demonstrated the closeness of their relationships—for better or worse—with elaborate costumes that ran the gamut from trees to anemones. Sometime around four in the morning, when even the most enthusiastic dancers had called it a night, a violent thunderclap rattled the research station. We woke to dull skies and pouring rain.

Slightly damp, we packed up our luggage and gear for the long ferry ride back and gathered together one last time to listen to our keynote speaker, Dr. Tara Martin from the

University of British Columbia. She described how growing up on Salt Spring Island left her with a profound love of nature and led her to pursue a career in conservation research. "But," she said, "it wasn't enough"—a sentiment that clearly resonated with her audience. Her desire to make a difference led her to become a pioneer in the field of conservation decision science. Although conservation often requires making grim sacrifices, Dr. Martin's talk was optimistic and the conference ended on an upbeat note despite the gloomy weather outside.



There was one last piece of business before we got back on the *Frances Barkley*: prizes! Awards were given for first- and second-place 12-minute and 3-minute talks, as well as the top two posters. Most of the prizes were beautiful paintings, drawings, and prints made and donated by local artists, including Danielle Brufatto, Rosemary Cragg, Sam Coutts, Charlotte Matthews, and Piña Styles. Like an anemone and its anemonefish, the conference depends on these and many other generous donors to thrive. We are particularly grateful to PICES, the Bamfield Marine Science Centre, the University of Alberta Department of Biological Sciences, and the University of Alberta Faculty of Science as our Platinum and Gold Sponsors. Conference information is available at: <https://peec2020.wordpress.com/>



*Gwyn Case is an MSc candidate with the Green lab at Simon Fraser University's Centre for Wildlife Ecology. Her interests lie in avian conservation and management, particularly in temperate rainforests. She is currently researching the foraging ecology of an at-risk forest raptor, the Northern Goshawk, in coastal B.C.*



**PICES TCODE catalog service***Igor Shevchenko*

The **PICES Metadata Federation** (PMF) project was initiated by Bernard A. Megrey and S. Allen Macklin in 2005. This is a very small initiative compared with the European Research and Innovation programme - Horizon 2020<sup>1</sup>. The main goal of the PMF project was to implement and maintain an infrastructure for preparing, publishing, and searching metadata on marine ecosystems of the North Pacific. The targeted living metadatabase was designed as a successor of the PICES Long Term Time Series, the Bering Sea Ecosystem Biophysical Metadatabase, and the North Pacific Ecosystem Metadatabase. In the beginning, implementation of the PMF was fully built on the National Spatial Data Infrastructure (NSDI) which included technologies, policies, and people to promote sharing of geospatial data at all levels of the United States government, the private and non-profit sectors, and the academic community. Among components of the technology were the Federal Geographic Data Committee (FGDC) metadata representation standard, the metadata parser (MP), the Isite software package, the communication protocol Z39.50, and the NSDI Clearinghouse Network<sup>2</sup>.

Initially, only four PICES member countries federated their marine ecosystem metadata holdings: USA (NOAA/AFSC/PMEL), Korea (KODC), Japan (MIRC), and Russia (TINRO-Center). In 2008, PICES rented a server to help consolidate all PICES metadata clearinghouse nodes on one machine. All existing national nodes were duplicated to this new server, and two additional nodes were added – China (NMDIS) and Canada (IOC)<sup>2</sup>.

At the same time, a team from the TINRO-Center was exploring applications of another framework for preparing, publishing and searching metadata based on the free and open-source cataloging application called Geonetwork Opensource<sup>3</sup>. After a positive evaluation of its capabilities, the decision was made to install the Geonetwork software package on the rented server as the PICES TCODE catalog (PTC). All collected holdings were eventually moved to the rented server after the NSDI Clearinghouse Network ceased functioning<sup>2</sup>.

The PTC on the rented server was run under Geonetwork Opensource Version 2. With time it became quite outdated. Newer versions allow more functionality and stability. Therefore, there was urgency to update it. However, the

FGDC format is not supported by the recent Version 3 of the package. Consequently, metadata records in this format must be converted into the ISO 19115/19139 standard. Other methods may be used but result in some loss of information. To access the new features, a copy of Geonetwork Opensource Version 3 was installed on a virtual server in TINRO and run as the PTC-2<sup>4</sup>. All accumulated PMF metadata records from the PTC have now been converted into the ISO format and uploaded there (see Table 1 below), and along with original from the PTC, are available for searching and updating. Original XML files may be found on the PICES TCODE catalog service site<sup>5</sup>. However, all of these records need to be quality controlled and updated if necessary. It seems somewhat unrealistic to have TCODE members undertake this task on a volunteer basis.

Recently, the rented server was attacked with ransomware. The service has become unavailable and PICES TCODE decided not to reinstall the outdated version of Geonetwork Opensource, and to terminate the contract with the provider. In this situation, the PTC-2 became the primary source of collected metadata records including records from the PMF project that were successfully converted and uploaded from the PTC. All these original metadata records are available only as XML files<sup>5</sup>, and may be searched and viewed only with the use of special tools.

**Creating metadata records**

Metadata describe different types of features of some resource (e.g., data, information, service) that are important for discovery, understanding, preliminary evaluation, retrieving, use and management. Metadata are usually structured and may contain different fields, depending on the domain or the type of resource. Metadata may include links to corresponding providers and lead eventually to seeking resources. Standards (represented as schemes) define syntax and semantics of metadata descriptions. By default, the most recent of Geonetwork Opensource (Version 3) allows use of the ISO 19115/11139 standard for spatial resources (e.g., datasets, services, maps), the Dublin Core scheme for referencing publications and reports, and the ISO 19110 standard for the feature cataloging. Other metadata schemes may be added to the dataset (Figure 1).

Metadata records are created by filling screen forms. The editor supports standard templates, multilingual metadata editing, a validation system, and a suggestion system to

<sup>1</sup> Horizon 2020. <https://ec.europa.eu/programmes/horizon2020/en>  
Retrieved 10/11/2019.

<sup>2</sup> Metadata Federation of PICES Member Countries. *PICES Technical Report No. 1, 2007*, Edited by Bernard A. Megrey, S. Allen Macklin, Kimberly Bahl, and P. Daniel Klawitter.

<sup>3</sup> GeoNetwork Opensource. <https://geonetwork-opensource.org/>  
Retrieved 08/20/2019.

<sup>4</sup> PICES TCODE catalog 2: <http://tcode.tinro.ru:8080/geonetwork>  
Retrieved 08/20/2019.

<sup>5</sup> PICES TCODE catalog service: <https://sites.google.com/site/picestcodegeonetwork/>  
Retrieved 08/20/2019.

improve metadata quality, etc. Some fragments (partially filled subtemplates) may be used in different metadata records. External categories (e.g., datasets, maps, PICES-related datasets, etc.) may be assigned to metadata records that are not parts of metadata and used for document grouping, search results filtering, etc. A user can choose terms from one or more thesauri for different fields of knowledge.

### Users

Self-registration is available on the PTC-2 and anyone can create an account (Figure 2). A catalog user may be (self-) registered (Registered User) or may stay non-authenticated (Guest). The Administrator may include a registered user into one or several groups (e.g., TCODE members, by country, by expert group). A user may have different roles in different groups. Assigned roles (User Administrator, Content Reviewer, Editor, Registered User) define the user management or metadata manipulation tasks they can perform.

### Preparing and publishing metadata

Metadata records have a life cycle that typically goes through such states as *Draft*, *Submitted*, *Approved*, *Retired*. To add or edit metadata, a user has to have an editor profile or higher. The user chooses a metadata template and a group, and then fills out the chosen fields. Also, metadata records may be imported from files stored on the workstation or servers. The metadata editor can be configured to analyze metadata and make suggestions to improve it. A record can be associated with different types of resources (e.g., files, weblinks). To help other users identify metadata records, graphic overviews or thumbnails can be attached. A feature catalog describes the data model of a dataset with a list of tables, attributes, definitions, values, etc. Feature catalogs can be described as a linked document (e.g., PDF file) or a record in the ISO19110 standard. The records may be tagged with categories and keywords. Users may identify user groups and the privileges (to view, to download, to edit, etc.) to metadata records and any attached data.

### Searching a catalog

When searching, the user may fill the text search box, define categories of resources, keywords, contacts, specify geographical areas and periods when records were created (Figure 3). Search results present title, abstract, categories, status, overview, and links. More in-depth details about found resources are available under active links (Figure 4). To group a set of records, a general description of the collection may be done in the parent metadata which can then be attached to each dataset of the series. Data discovery is usually done against multiple catalogs. To increase the speed of searching, some metadata records may be harvested (duplicated and stored locally). Automated harvesting may be processed periodically so metadata are kept aligned. The administration panel provides statistics on the search and records in the catalog.

Table 1. Importing statistics.

Origin	Number of stored records in original PTC	Number of successfully converted records (ISO19115)	Number of successfully imported records to the PTC-2
Canada	261	267	232
China	63	58	58
Japan	193	193	122
Korea	27	27	27
Russia	82	93	92
USA	3552	3527	3462
PICES	28	26	26
ALL	4206	4192	4019

Table 2. Harvesting statistics.

Metadata Catalog	Number of harvested records
PICES TCODE	44
KODC	141
TINRO	6

### Status quo

The infrastructure for cataloging has been developed and about 4000 metadata records have been uploaded. Metadata records are harvested from the PICES TCODE, KODC and TINRO catalogs (Table 2; for more details see the project site<sup>5</sup>). TCODE members are supposed to provide services such as maintenance, monitoring, and testing. A metadata contributor can complete all required metadata fields quickly with the use of filled templates and thesauri. Files and links may be attached to metadata records. A peer-review process is supported, and catalogs provide a means for the resource (data/information/service) citation. The catalog resource holders have full control over their metadata records.

### Challenges

To understand at full scale what drives data sharing in a research community, one needs to analyze numerous relations between such categories as<sup>6</sup>:

- Data donor (who is sharing data);
- Research organization (with data sharing and funding policies);
- Research community (standards and sharing culture);
- Norms (legal and ethical codes);

<sup>5</sup> Fecher, B., Friesike, S. and Hebing, M., 2015. What drives academic data sharing? *PLoS ONE*, 10(2), p. e0118053.

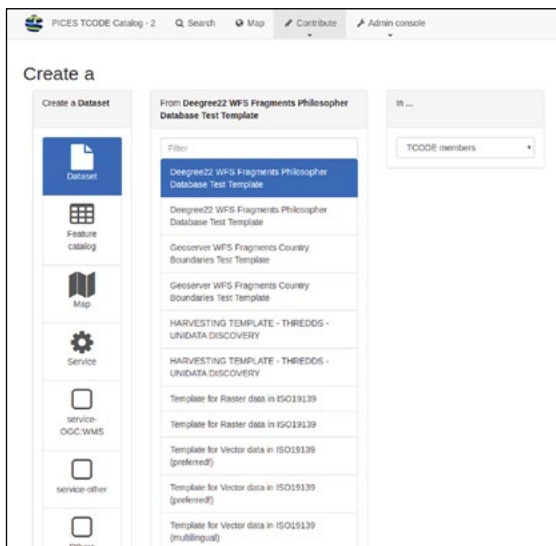


Figure 1. Adding metadata schemes to the dataset.

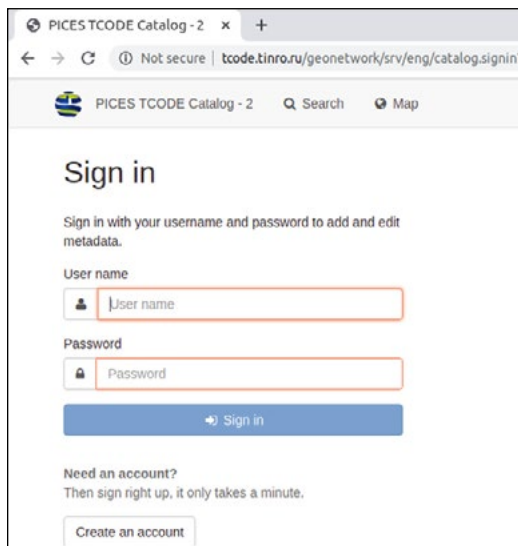


Figure 2. Creating an account.

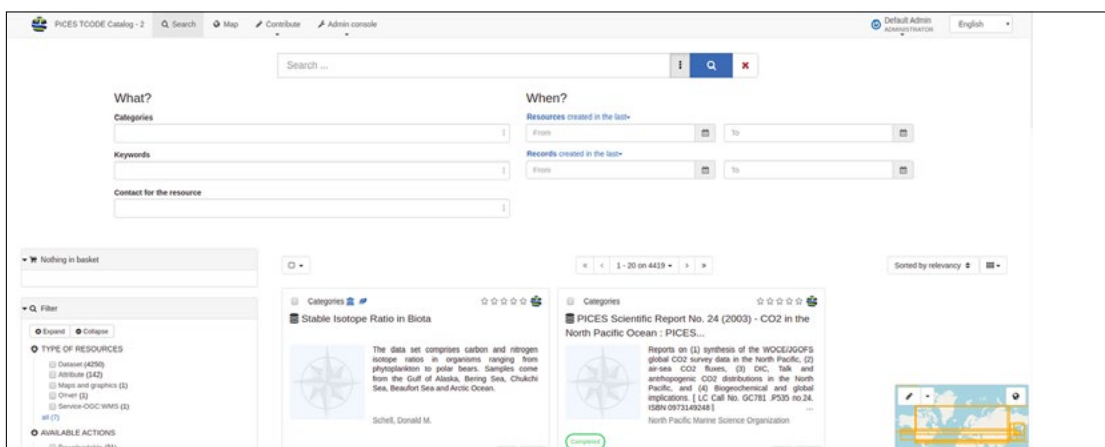


Figure 3. Performing data searches.

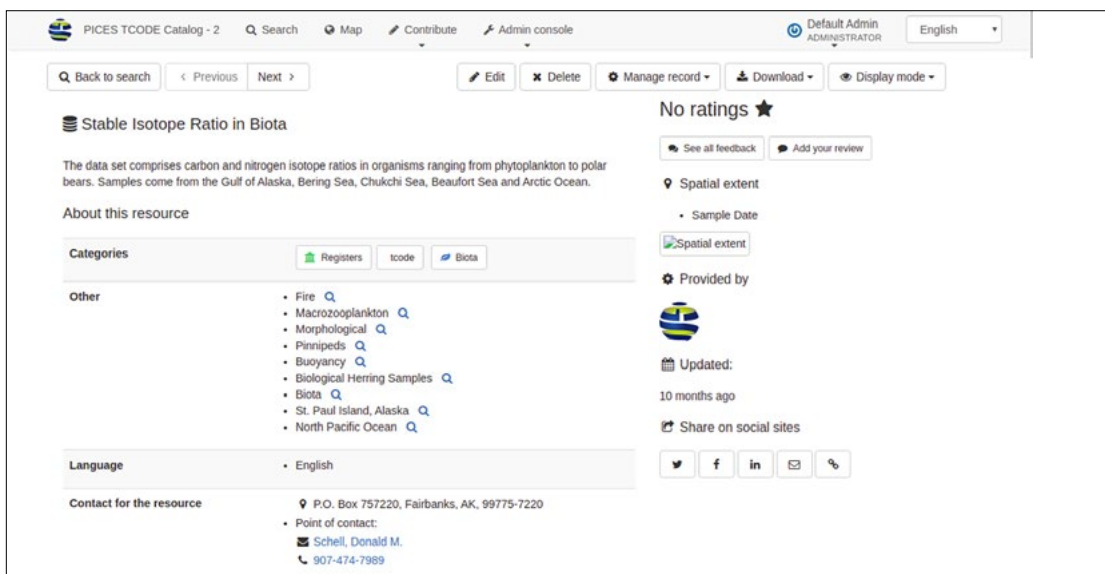


Figure 4. Searches provide in-depth details about found resources.

- Data infrastructure (data management systems and technical support);
- Data recipient (users of shared data).

Traditional Science researchers need to present or publish new results first in order to gain recognition. It is essential to then get tenure, resources, grants, students, etc. This reward system causes scientists to disclose research results as soon as possible, while maintaining control of data (and other intermediate inputs, such as heuristics and problem-solving strategies) to prevent their misuse, monopoly of the area of expertise, or maintain advantage over peers. Moreover, data collection, curation, and management themselves are time-consuming and require skills outside of the expertise domain. This activity is usually badly rewarded under the existing organizing principles. Also, naturally, researchers wish to maintain some degree of control over deposited data (at least knowledge regarding access and use).

For these and many other reasons, research data are not a knowledge commons, in contrast to scientific knowledge. The Open Science movement is a response to the controversial situation when scientists are interested in sharing someone else's resources, but may not be motivated to share their own. New knowledge production models have emerged that support collaborations including for non-scientists. They are referred to by different terms, such as "crowd science", "citizen science", "networked science", "massively-collaborative science", etc.<sup>7</sup>. "Besides science" data refer to data collected by those who generate observational data of scientific value<sup>8</sup>.

PICES science is done by small groups and individuals. Its advancement heavily depends on current and past data collection and management efforts of PICES community members and their willingness to share information resources. PICES science is mostly traditional, with some basic elements of Open Science: final results are openly disclosed in the form of peer-reviewed publications and scientific reports; data collected by expert groups and some other intermediate inputs are open, and there is even some openness in participation. PICES science is "small science" in terms of data collection, curation, management, and sharing (without data centers, standards, open access, managers, etc. as in the case of "big science")<sup>8</sup>.

To foster intermediate sharing among PICES members, and to provide metadata cataloging services, PICES could analyze the situation in different countries and work on such issues as: adequate formal recognition of data products,

mandatory sharing policies, and establishment of an understandable and clear legal basis regarding the rights of use (e.g., what researchers can and cannot do with data, information or services provided by others). In order for catalogs to be relevant to the PICES community, they need to be: visible in terms of citation, current and usable, have appropriate technical support, and have data cataloging of all output products be mandatory for all expert groups.

The PICES TCODE catalog service is not in high demand in the PICES community. To change the situation, several possibilities could be explored. First, according to the PICES data management policy, TCODE is responsible for the management of the PICES data inventory. This inventory also could be implemented in the form of a sub-catalog of the PTC-2 quickly. Second, the FUTURE SSC may create a searchable catalog of all its products as a finalizing task. Lastly, PICES may use this service to enhance implementation of the next integrative program oriented towards the UN Ocean Decade with its objective to provide ocean science, data and information. Then, volunteers from PICES member countries may clean up and update collected records from the MFP as much as desired. Ideally, data/information/services sharing issues should become an essential part of the curriculum for the PICES-sponsored summer schools and training courses and be widely discussed by early career scientists groups.

#### Acknowledgements:

The author is grateful to Jeanette Gann for fruitful discussions and editorial comments, and to all TCODE members for their participation in the project.



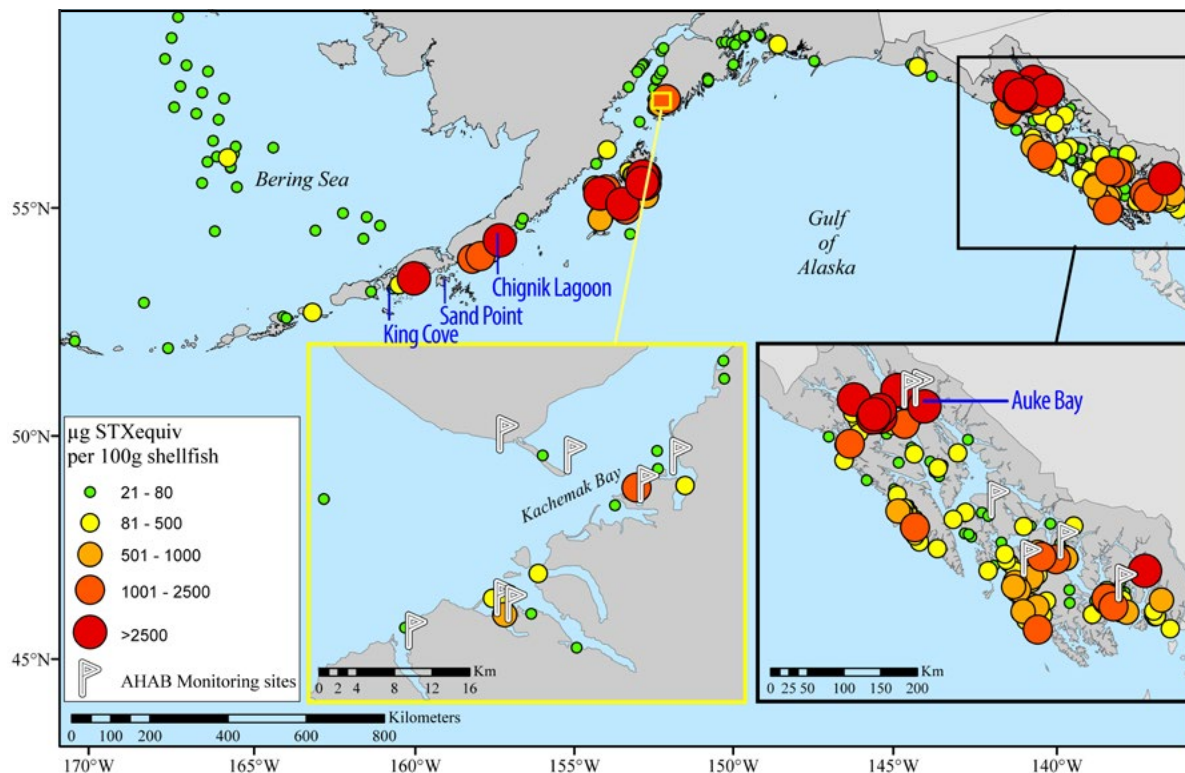
*Dr. Igor Shevchenko is an Advisor to the Head of the Pacific branch of the Russian Institute of Fisheries and Oceanography in Vladivostok. He studies differential games and applications of AI techniques in different fields, such as problem generation or population dynamics. He teaches several courses to students who major in mathematics and programming at the Far Eastern Federal University. He was formerly Head of IT in TINRO-Center and was deeply involved in national and international data/metadata sharing activities. He is a long term PICES member and has served both on TCODE and F&A committees. He currently serves as Vice-Chair of Science Board.*

<sup>7</sup> Franzoni, C., Sauermaun, H., 2014. Crowd science: The organization of scientific research in open collaborative projects. *Research Policy*, 43(1), pp. 1-20.

<sup>8</sup> Onsrud, H., Campbell, J., 2007. Big opportunities in access to "Small Science" data. *Data Science Journal*, 6, pp. OD58-OD66.

## Assessing for paralytic shellfish toxins in Alaskan waters

Bruce Wright



Saxitoxin levels measured in 2018 and 2019 in Alaska marine waters. The US Food and Drug Administration (FDA) limit for paralytic shellfish poisoning (PSP) in bivalves is 80  $\mu\text{g}/100\text{g}$  (green solid circles). Higher PSP levels are depicted by larger circles with the highest levels shown in red. Modified from figure by: National Ocean Service, National Centers for Coastal Ocean Science.

### Introduction

A 2-year Knik Tribal Council project funded by the Bureau of Indian Affairs is a vulnerability assessment for a risk that affects multiple Alaska Tribes and public health agencies including Alaska Department of Environmental Conservation, Division of Environmental Health (ADEC) and Alaska Department of Health and Social Services Division of Public Health (ADHSS). Harmful algal events in Alaska are usually caused by *Alexandrium catenella*, the dinoflagellate causing paralytic shellfish poisoning (PSP), which has sickened many and killed some Alaskans. The current study is investigating the transfer of paralytic shellfish toxins (PSTs) and domoic acid (DA) to shellfish, forage species and commercially important predatory fishes in Alaska's marine ecosystems.

### Objectives

1. Quantify PST concentrations in marine forage species.
2. Quantify anatomical distribution of toxins in salmon and differences among salmon species.

### Results

The 2019 Knik Tribe PSP project sampling began at some locations in the late winter 2018 and early spring 2019 and expanded to additional communities in March 2019 prior to or as spring arrived and PSP blooms began (map above). The Gulf of Alaska marine surface water temperatures were 2–4°C above the long-term average and high enough that the Principle Investigator (PI), Bruce Wright, informed communities inside the study area and outside the study area to expect an earlier and more intense harmful algal bloom (HAB) in spring and summer of 2019. Most study locations began sampling in March in order to note PST levels prior to the algal bloom.

The weekly mussel sampling revealed an early *Alexandrium* bloom in some locations and recorded the third highest PSP levels in Alaska to date. The results from sampling salmon have been very revealing. Some salmon had detectable levels of PSP in their digestive tracts, kidneys and livers, but the eggs and edible meat had very low or no detectable PSP levels were considered safe to eat. The lab results from a shipment of samples of whole small cod, herring and sand lance from a Kodiak to Sand Point survey shows these forage fish species also had detectable levels of PSP.



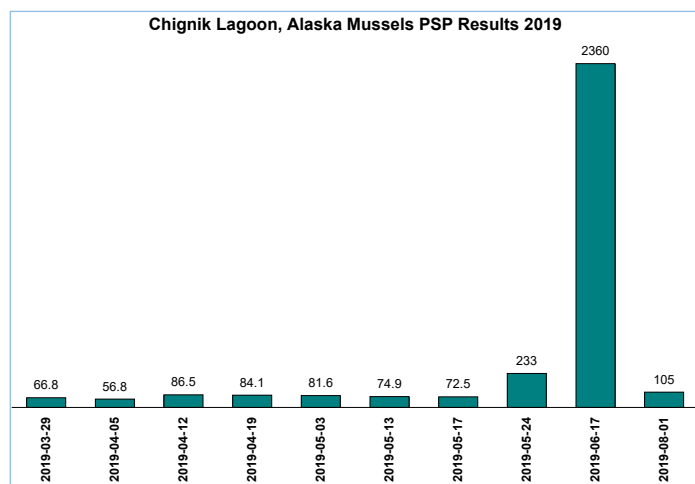


Figure 1. Blue mussel PSP test results for Chignik Lagoon.

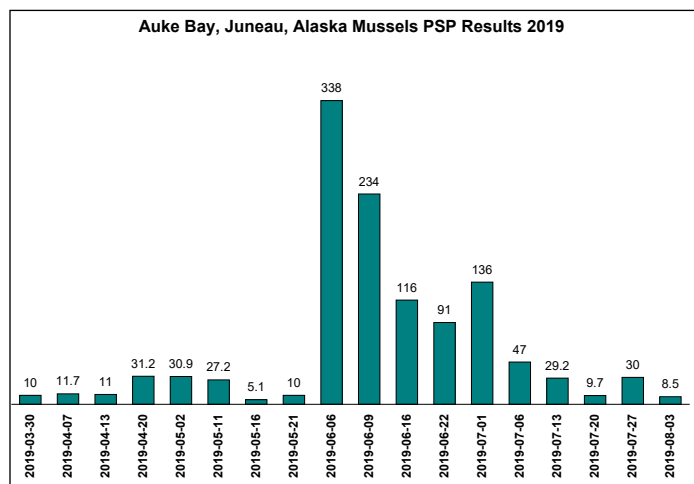


Figure 2. Blue mussel PSP test results for Auke Bay, Juneau.

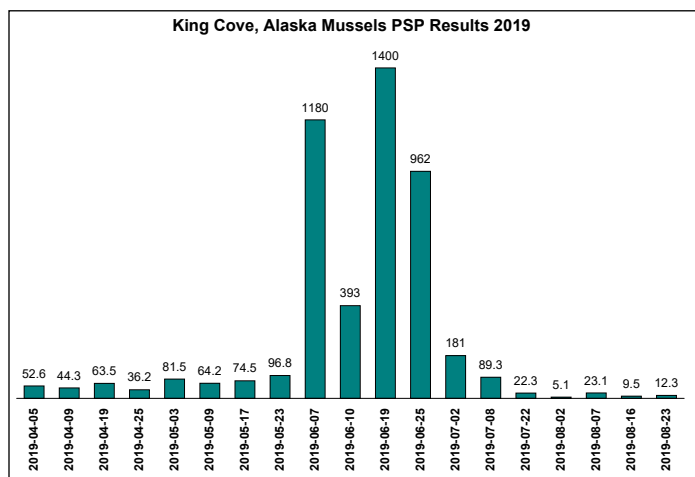


Figure 3. Blue mussel PSP test results for King Cove.

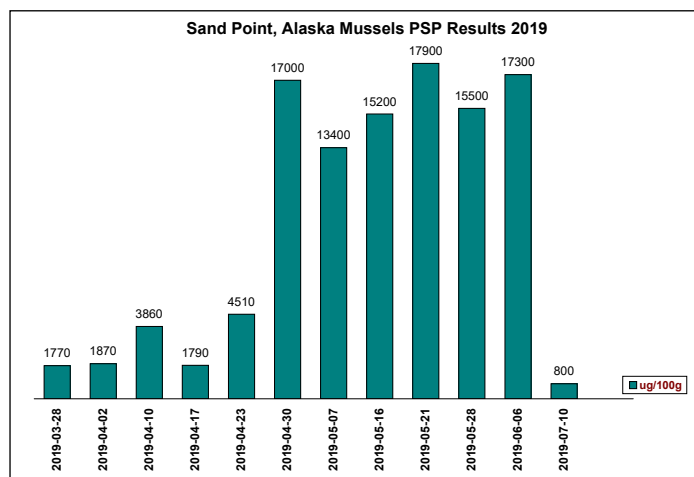


Figure 4. Blue mussel PSP test results for Sand Point.

### Blue mussels

Blue mussels concentrate PSTs rapidly, obtain some of the highest levels but for a short time and can depredate the toxins in weeks. Accordingly, monitoring mussels' toxicity is most valuable for understanding the PSP event timing and toxicity for specific beaches, usually a community's local subsistence beach. The communities collecting weekly blue mussel samples were Akutan, Chignik Lagoon, Juneau, King Cove, Sand Point and Unalaska. Freezers failed in Akutan and Unalaska and months' worth of samples were lost. The Chignik Lagoon mussel data (Figure 1) indicate the end of May for the onset of the *Alexandrium* bloom, but the local technician collected their last sample on June 17, 2019, which prevented a complete characterization of the PSP event. The Knik Tribe Senior Scientist sampled on August 1, 2019 during his site visit.

The Juneau mussel data (Figure 2) show early June 2019 for the onset of the *Alexandrium* bloom, with levels below the Federal Drug Administration (FDA) limit of 80 µg/100g by early July 2019.

The King Cove mussel data (Figure 3) indicate early June 2019 for the onset of the *Alexandrium* bloom, with levels below the FDA limit of 80 µg/100g by early July 2019.

The Sand Point mussel data (Figure 4) reveal early April 2019 for the onset of the *Alexandrium* bloom, and peaking in late April to the third highest PSP levels ever recorded in Alaska with levels still above the FDA limit of 80 µg/100g through early July 2019. These PSP concentrations signify very dangerous toxin levels and support the need for early spring monitoring and extreme caution of personal use of subsistence bivalves for human consumption.

These data were made available to Alaska state regulators because it is imperative to keep them informed, avoid public misconceptions about seafood safety, and for assistance with public engagement. The study results will have applicability to other Alaskan coastal areas and other PSP-endemic portions of North America (British Columbia, Washington, Oregon, Maine, etc.) and other continents where PSP is a problem.

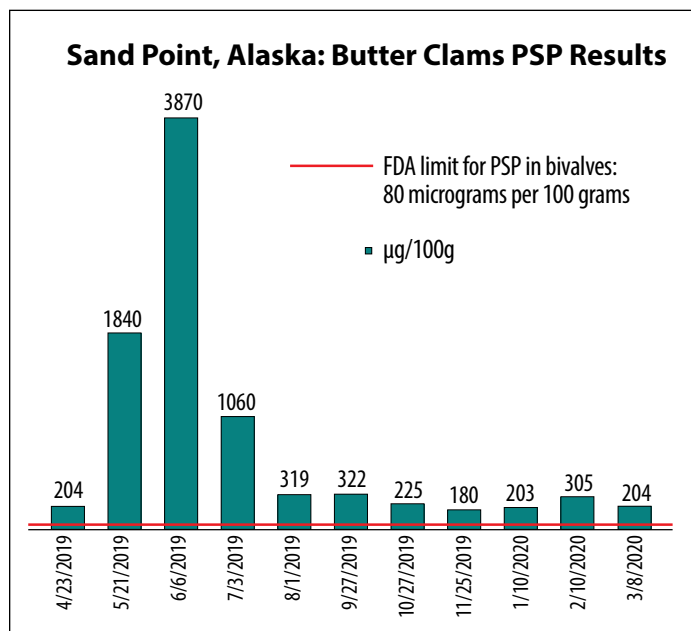


Figure 5. Sand Point PSP test results, March 23, 2019–February 10, 2020. Red line indicates the FDA limit for PSP in bivalves: 80 µg/100 grams.

### Butter clams

Different bivalve species treat PSTs differently. Butter clams, one of the most popular subsistence bivalves in Alaska, concentrate the PSTs and can maintain those toxins at high levels for 2 years.

After communicating with local Tribes and residents, the PI offered to test subsistence shellfish and requested that harvesters wait for the test results before consuming the harvest. Two Chignik Lagoon residents sent in samples from their subsistence harvests. The Butter clams collected on February 9, March 19 and June 6 had PSP levels of 134, 221 and 703 µg/100 g respectively. The PI was able to convince the harvesters to discard the clams and recommended a winter harvest and testing of those clams prior to any consumption. In early August, the PI collected the Chignik Bay and Chignik Lagoon samples in early August when visiting those communities. The PSP levels were still very high, measuring 111 µg/100g in Chignik Bay and 330 µg/100 g in Chignik Lagoon. Similarly, King Cove Butter clam PSP levels, which had been below the FDA limit of 80 µg/100 g for several consecutive years, however in 2019 the levels reached 214 µg/100 g on June 2, 2019, and 320 µg/100 grams on July 3, 2019. Since King Cove is a very important source for subsistence butter clams, monthly sampling and testing continued through the winter.

Sand Point was once an important source of butter clams however it is now not viable, as PSP peaked to 1084 µg/100 g in 2018, and PSP levels have exceeded the FDA limit every month since. With the extremely high PSP levels measured in Sand Point mussels

(exceeding 17,000 µg/100 g), it was expected the butter clams would have also high PSP levels in 2019. The highest PSP levels in butter clams ever seen in Sand Point were 3870 µg/100 g on June 6, 2019. This PSP level greatly exceeds the FDA limit for PSP in bivalves of 80 µg/100 g. In past decades, people have died in Sand Point from eating toxic butter clams, however, they are now are more cautious and patiently wait until clams are again safe to eat. The Sand Point PSP program, which is managed by the Qagan Tayagungin Tribe of Sand Point, has likely been instrumental in saving lives. The Qagan Tayagungin Tribe's latest data can be found at <https://www.qttribe.org/?SEC=12BC3FE9-E8ED-4E09-B3F6-6D6254E121B1> and their most recent data is shown in Figure 5.

### Razor clams, surf clams, cockles

Subsistence razor clams collected in Chignik Bay on June 6, 2019 tested at 988 µg/100 g, so the harvesters cleaned, cooked, and froze the clams for retesting. This time the razor clams tested at 298 µg/100 g, still well above the FDA safe limit. The PI requested the harvesters discard the clams. The same harvesters also collected razor clams south of the Chigniks near Perryville on the Alaska Peninsula. Unbutchered samples had a PSP level of 2140 µg/100 g and clams that were cleaned of their gut ball tested at 1000 µg/100 g. The PI again asked the harvesters to discard the clams and alerted the Tribes and residents of Chignik Lagoon, Chignik Bay and Perryville of the high PSP levels in the region. It was then recommended that people not harvest the bivalves in the region for now. Within a week a woman was medically evacuated from Perryville to Dillingham because she had consumed one small razor clam and nearly died. Chignik Lagoon razor clams are apparently still 'hot,' with some collected on February 10, 2020 still testing at 1342 µg/100 g, which exceeds the FDA limit for PSP in bivalves by more than sixteen times!

The surf clams collected July 6, 2019 near Sand Point had PSP levels of 370 µg/100 g. The primary concern is that walrus, a source of food for some Alaskans, regularly consume surf clams in the Bering, Chukchi and Beaufort seas. Accordingly, Knik Tribe researchers plan to sample clams from walrus stomach contents for testing this year.

PSP-contaminated cockles have sickened and killed many Alaskans over the years. Just a few years ago a person died near Juneau from eating PSP-contaminated cockles. The cockles we collected on August 1, 2019 in Chignik Lagoon had PSP levels of 283 µg/100 g, and those collected on August 3, 2019 in Chignik Bay had PSP levels of 55.6 µg/100 g.

### Fish

Higher PSP levels were also detected in fish species, as shown in Table 1.

Table 1. High PSP levels detected in fish species.

Species	Location	Tissue type	Date collected	PSP level*
Chum salmon	Chignik Bay	guts	8/3/19	27.3
Chum salmon	Chignik Bay	eggs	8/3/19	7.59
Chum salmon	Sand Point	liver	7/7/19	76.8
King salmon	Auke Bay	kidney	7/1/19	128
King salmon	Auke Bay	liver	7/1/19	39
King salmon	Auke Bay	guts	7/1/19	14.8
King salmon	Auke Bay	heart	7/1/19	8.14
Pink salmon	King Cove	liver	6/25/19	73.5
Pink salmon	King Cove	guts	6/25/19	27.4
Red salmon	King Cove	guts	6/25/19	49.4
Red salmon	King Cove	kidneys	6/25/19	64.3
Red salmon	Sand Point	liver	7/7/19	103
Pollock	Sand Point	guts	7/7/19	16.2
Gunnel	Sand Point	whole	7/9/19	113

\*  $\mu\text{g}/100\text{ g}$ .

Some people save and eat salmon livers, yet PSP results indicate eating salmon livers is a risk factor. Additional outreach is needed to inform Alaskans of this risk. So far, the primary salmon tissues eaten by people, muscle and eggs, have low levels of PSTs. Few fish were sampled in this study, so PSP levels in salmon warrant further investigation. Predators that consume salmon, such as bald eagles, bears, wolves, sharks, orca and sealions, may also be at risk for consuming PST-contaminated salmon.

Table 2. PSP levels detected in forage fish species.

Forage Fish Species	Location	Tissue type	Date collected	PSP level*
Pacific cod	Ak Peninsula	whole	7/21/19	32.2
Capelin	Ak Peninsula	whole	7/14/19	20.4
Sand lance	Ak Peninsula	whole	8/7/19	51.0
Pacific herring	Ak Peninsula	whole	8/8/19	22.3

\*  $\mu\text{g}/100\text{ g}$ .

Forage fish are critical for transferring nutrients and energy in the marine food web. Finding levels of PST in forage fish, as is shown in Table 2, is of grave concern for the health of the marine ecosystem and may explain some of the changes and declines in marine top predator populations.

### Cat food

The Knik Tribe presented these data at several venues. During one presentation, someone raised the question if the toxic salmon livers could sicken house pets. Since cats seem to be especially susceptible to PSTs, the Knik Tribe tested canned cat food containing salmon livers and found one had detectable levels of the paralytic shellfish toxins ( $8.39\ \mu\text{g}/100\text{ g}$ ). These levels may be high enough to sicken cats.

### Other invertebrate species

Many Alaska subsistence users consume marine invertebrates such as sea urchins, chitons, limpets, shrimp and octopuses. We found the following PST levels in urchin eggs of  $22.3\ \mu\text{g}/100\text{ g}$  (St. George), in urchin guts of  $66.5\ \mu\text{g}/100\text{ g}$  (St. George), in cooked whole chitons of  $13.2\ \mu\text{g}/100\text{ g}$  (King Cove), in limpets of  $13.6\ \mu\text{g}/100\text{ g}$  (Sand Point), in shrimp of  $5.2\ \mu\text{g}/100\text{ g}$  (Sand Point) and in octopus guts and mantle of  $70.5\ \mu\text{g}/100\text{ g}$  (Chignik Bay). These species need to be monitored and additional samples collected from all coastal Alaska communities.

Past research in the Haines, Alaska, area has shown that crab viscera (also known as guts or crab butter) can become very toxic with PSP. We found PSP levels of  $119\ \mu\text{g}/100\text{ g}$  in Dungeness crab guts collected from Sand Point, and  $9.94\ \mu\text{g}/100\text{ g}$  in hair crab guts from St. George. We recommend cleaning crab by removing the carapace and discarding the guts before cooking. We did not find high PSP levels in crab meat tissue.

Not many Alaskans consume marine snails, but if they do, it's very risky. We found Triton snails in Chignik Bay with PSP levels of  $160\ \mu\text{g}/100\text{ g}$ , and Chignik Lagoon with PSP levels of  $483\ \mu\text{g}/100\text{ g}$ . One Drill (a snail in the *Nucella* genus) tested from St. George had PSP levels of  $9.69\ \mu\text{g}/100\text{ g}$ .

We also tested sand dollars from Sand Point which had no detectable PSP and the sunflower sea star from the same area with a PSP level of  $9.94\ \mu\text{g}/100\text{ g}$ . The sea star from St. George had PSP levels of  $33.6\ \mu\text{g}/100\text{ g}$  and the sea squirt, also from St. George, had PSP levels of  $38.2\ \mu\text{g}/100\text{ g}$ .

Amphipods are very common in the intertidal zone and may be useful in monitoring for PSP where bivalves are scoured from the beaches by sea ice, such as in the Bering, Chukchi and Beaufort seas. The amphipods from St. George sampled on June 24, 2019 had PSP levels of  $16.5\ \mu\text{g}/100\text{ g}$  and  $17.7\ \mu\text{g}/100\text{ g}$  sampled on July 28, 2019.

The Knik Tribe was informed by the ADEC Environmental Health Lab that the Liquid Chromatography Mass Spectrometry (LC/MS/MS) was rerun for several species (Table 3). The PST LC/MS/MS method confirmed that the PST PCOX HPLC method is not suitable for determination of GTX1 and GTX4 due to an unknown matrix interference. The method can be used to measure other PSTs and can be used to determine total toxicity if an alternate method, such as LC-MS/MS, Q-TOF, or LC-HRMS, is used to determine the concentration of GTX1 and GTX4 in the sample. For the species listed in the table, there are inferences at GTX4 and GTX1. For these species in the future, GTX4 and GTX1 will be reported as zero with a qualifier when a peak is observed in the chromatogram unless analyzed

Table 3. List of non-bivalve species tested.

• Pacific cod ( <i>whole</i> )	• Crab: Decorator, Hermit, Dungeness ( <i>whole</i> )
• Chum salmon ( <i>stomach contents, kidney, liver</i> )	• Octopus ( <i>whole</i> )
• Coho salmon ( <i>stomach contents, guts, kidney, Liver</i> )	• Sand Dollar ( <i>whole</i> )
• King salmon ( <i>guts, muscle, liver, kidney</i> )	• Amphipods ( <i>whole</i> )
• Red salmon ( <i>kidney, liver, guts</i> )	
• Dolly Varden ( <i>whole</i> )	
• Herring ( <i>whole</i> )	

by an alternate method. Regardless, data for species other than shellfish should be used for information only.

Accordingly, the Knik Tribe has reached out to SEATOR<sup>1</sup> to analyze samples using ELISA to derive total toxicity for small samples for species other than bivalves.

### Domoic Acid (DA)

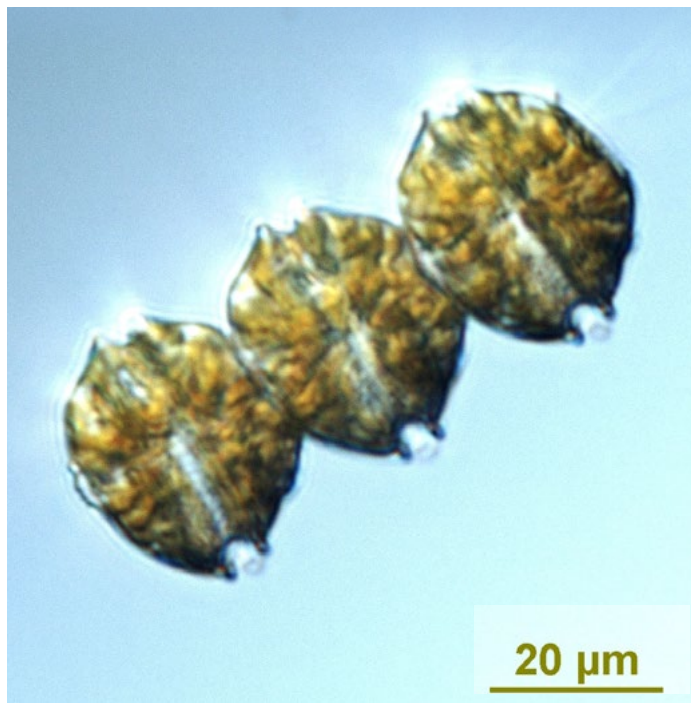
We tested a randomized selection of the archived samples from the study. The archived samples were/are in the ADEC Environmental Health Lab's freezer at -40°F. A total of 181 DA tests were run with 180 non-detects for DA and one detection from Auke Bay (Juneau) with a DA level of 2.2 µg/kg where the FDA limit for DA is 20 µg/kg.

### Outreach

In addition to coordinating the collection of samples, the PI held public meetings and/or telephonic meetings to inform residents of the study objectives and risks from PSP. The PI described safe measures for consuming subsistence shellfish following the protocols established by the ADEC of harvest, hold and test. Outreach and site investigation started in St. George. The PI collected samples from St. George in April 2019. Additional field trips were made to King Cove in late June, Sand Point in early July, Chignik Lagoon and Chignik Bay in August.

Knik Tribe presented the project results at several meetings including the Alaska Tribal Conference on Environmental Management, MatSu Salmon Conference, the Alaska Marine Science Symposium and the Alaska Forum on the Environment. In addition, the PI was a co-author on a PSP research paper in *Nature*, entitled "Saxitoxin and tetrodotoxin bioavailability increases in future oceans."

The paper is published online at the following URL: <https://www.nature.com/articles/s41558-019-0589-3>, and an article describing this work is available at: <https://www.theatlantic.com/science/archive/2019/10/plague-toxic-algae-making-shellfish-deadly/600406/>.



Microscopy image of *Alexandrium catenella*. Credit: NOAA.



Bruce Wright began working on paralytic shellfish poisoning in geoducks in 1978 for the Alaska Department of Fish and Game. He was a University of Alaska professor for ten years, Chief of NOAA's Office of Oil Spill Damage Assessment and Restoration after the Exxon Valdez Oil Spill, also for ten years,

and continued work on climate change, harmful algal blooms, contaminants, environmental remediation, and energy projects as the senior scientist of the Aleutian Pribilof Islands Association and now with the Knik Tribe of Alaska. Wright most enjoys working with top predators and has published several books on Alaska's predators. His work as Alaska Governor Knowles' science advisor to the PEW Ocean Commission was very interesting. Wright has been spending some time, mostly during the summer, investigating the Lake Iliamna monster, and yes, it's for real.

<sup>1</sup> Southeast Alaska Tribal Ocean Research, <http://www.seator.org/>

## Bering Sea: Current status and recent trends

Lisa Eisner

### Climate and oceanography

The Bering Sea experienced less extreme weather during the period October 2019 through March 2020 than during the previous two years. It was again mostly warmer than average, but with the exception of the northwestern portion in the vicinity of the Gulf of Anadyr where positive anomalies exceeded 3°C, the temperatures were not extreme (Figure 1). The overall wind anomalies were from the southwest, as implied by a sea level pressure anomaly pattern with lower than normal pressure north of the far eastern portion of Siberia and higher than normal pressure over the Gulf of Alaska (Figure 2).

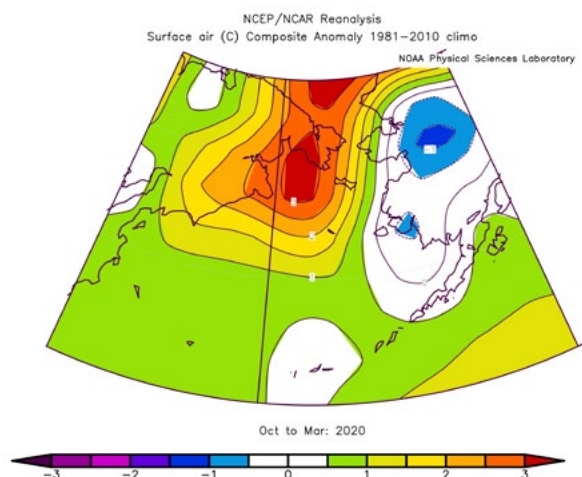


Figure 1. Mean surface air temperature anomalies (°C) from the NCEP/NCAR Reanalysis for October 2019 through March 2020. Figure courtesy of Nick Bond, NOAA Pacific Marine Environmental Lab (PMEL).

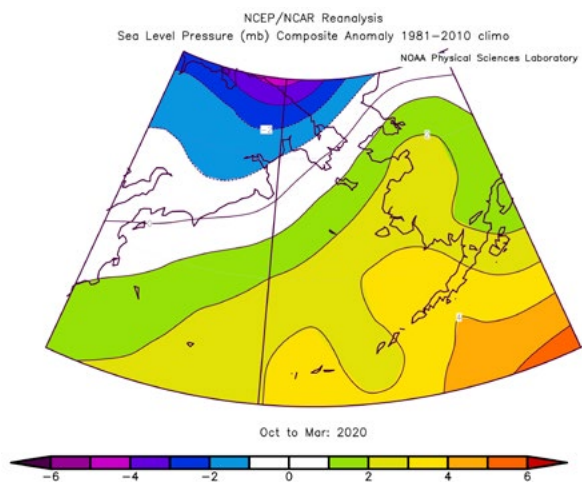


Figure 2. Mean sea level pressure (SLP) anomalies (mb) from the NCEP/NCAR Reanalysis for October 2019 through March 2020. Figure courtesy of Nick Bond, NOAA PMEL.

While the sense of this pattern during the 6-month period resembled that during the previous two years, the strength of the pressure dipole was less. As a result, mean wind anomalies were typically 1–2 m s<sup>-1</sup> in magnitude or roughly half of what was observed during the same periods of 2017–18 and 2018–19. As is always the case, the 6-month period included substantial sub-seasonal variability. More specifically, the interval from the first of October until the latter part of December 2019 was quite warm for the time of year, in part because of winds more from the south than usual and also due to the warm upper ocean temperatures, particularly on the SE Bering Sea shelf. These two factors, in combination with warm ocean temperatures that delayed the onset of sea ice in the Chukchi Sea, led to another late start to the development of sea ice in the northern Bering Sea. There was a 2-week long stretch of pronounced cold weather for the Bering Sea from the end of December 2019 into January 2020 with mean winds from the north of 10 m s<sup>-1</sup>, or about twice as strong as the climatological values. The remainder of January through March 2020 featured a series of short periods of relatively cold weather separated by generally longer periods of warm air temperatures, with overall wind anomalies from the south that helped limit the southward extent of sea ice.

The months of April and May 2020 included a SLP anomaly pattern with lower than normal values centered over the central Aleutian Islands and a continuation of high pressure over the Gulf of Alaska (Figure 3). This pattern resulted in wind anomalies from the southeast of about 3 m s<sup>-1</sup> across much of the Bering Sea, with the largest signal over the central Bering. An important consequence was a relatively rapid retreat of the winter sea ice.

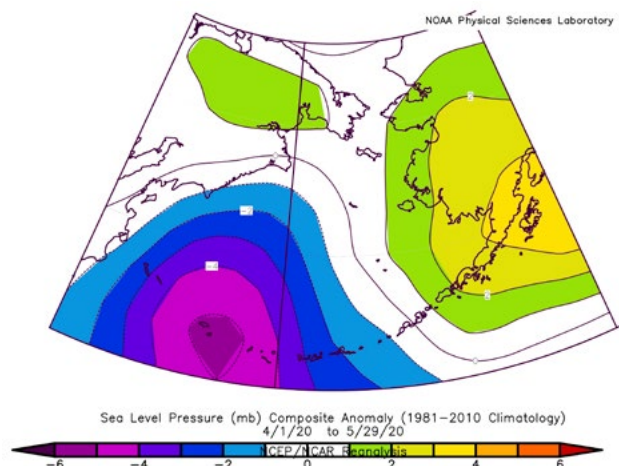


Figure 3. Mean sea level pressure (SLP) anomalies (mb) from the NCEP/NCAR Reanalysis for 1 April through 29 May 2020. Figure courtesy of Nick Bond, NOAA PMEL.

Regional illustrations of satellite-derived sea surface temperature (SST) data for the eastern and northern Bering Sea are shown in Figure 4. Data were downloaded daily and averaged for each of the Alaska Department of Fish and Game statistical management areas (Watson 2019; <https://psesv.psmfc.org/PSESV3.html>). Daily data for each of these statistical areas were then averaged within each region (northern or eastern Bering Sea shelf) from June 2002 to present (the temporal extent of the JPL Multi-scale Ultra-high Resolution (MUR) SST dataset). Notably, most of 2020 has been much more similar to the longer term average temperatures in both the northern and eastern Bering Sea than 2019 (as described in the section above). The 2020 time series began with warmer than average temperatures, cooling off near the start of January.

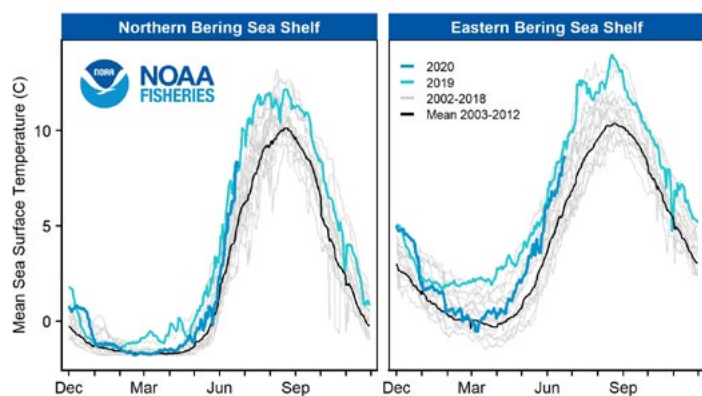


Figure 4. Satellite-derived SST data for the eastern and northern Bering Sea shelf (10–200 m). The northern Bering area is from 60–65° N and the eastern Bering is from the Alaska Peninsula to 60° N. Background grey lines include daily temperatures for each year with the 2003–2012 mean overlain in black. December data are plotted as part of the subsequent year (e.g., dark blue 2020 line includes December 2019). Figure courtesy of Jordan Watson, NOAA Alaska Fisheries Science Center (AFSC).

The time series can be updated daily using code available at GitHub<sup>1</sup>, which also provides a comparison of temperatures across the Gulf of Alaska.

### Sea ice extent

Sea ice extent in the Bering Sea was closer to the long-term average for winter 2019–20 (compared to the two prior winters), although there was a very rapid decrease in March and to a lesser extent in January (Figure 5). The dramatic drop in March was proximally the result of a series of storms that moved across the area. That in itself is not unusual, but it was acting on what must have been quite young and thin ice. The thin ice was related to the residual underlying warm water; 2019 was the warmest year on record in the eastern Bering Sea. Note that ice extent was near record low levels into mid-December before expanding as the weather turned colder. The drop

in January of 20% in extent was the result of just two storms. The 2019–20 ice season is a good example of the importance of ice thickness, both in the rapid January and March decline and the comparatively slow decline since April.

### Satellite estimates of spring Chlorophyll-a in eastern Bering Sea

Satellite Chlorophyll-a (Chl-*a*), used as a proxy for phytoplankton biomass, allows the analysis of large-scale patterns in phytoplankton dynamics. Moderate Resolution Imaging Spectroradiometer (MODIS) satellite Chl-*a* data (<https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamdap.html>) for the month of April show noticeable open water phytoplankton blooms in the southeastern Bering Sea with levels above the long-term mean, 2003–2019, (Figure 6). April 2020 levels were also higher compared to April 2018–19 in many areas. At the time of writing, it is unclear whether these changes in Chl-*a* dynamics are due to overall higher levels in 2020 or if the pelagic bloom began earlier compared to past years. In the northern Bering Sea Chl-*a* levels were generally below the long-term average, potentially due to delay in bloom initiation. This delay may be due in part to the larger and more normal ice coverage in the Bering Sea during 2019 and 2020 compared to the previous couple of years, which had historical low ice levels (Figure 5). It is important to realize that while satellite data provide very high spatial coverage of Chl-*a* dynamics, these products are also limited to measurements within the surface ocean and have many missing data due to ice and cloud cover (typical for high latitude systems such as the Bering Sea). Yet, satellite Chl-*a* data provide useful information for capturing large scale patterns, particularly for the summer months.

The timing and magnitude of the phytoplankton bloom have large and long-lasting effects on biological production, and impact higher trophic level species, including commercial fish stocks and benthic invertebrates in the Bering Sea. Preliminary analysis of spatial difference in bloom formation, using 8-day MODIS satellite products from 2019 indicated that the pelagic spring bloom peak in the Bering Sea first occurs in areas closer to shore, with an increased delay in peak timing in westward and deeper shelf waters. How consistent this pattern is, how much this varies among years, and how this may link to distribution, growth and survival of higher trophic level species is currently under investigation.

### Preview of Ecosystem and Economic Conditions (PEEC)

The NOAA Alaska Fisheries Science Center (AFSC), in partnership with the Alaska Integrated Ecosystem Assessment Program, held a 2-day virtual workshop May 19–20, 2020. Over 90 researchers and stakeholders met to exchange information on early physical, biological,

<sup>1</sup> [https://github.com/jordanwatson/EcosystemStatusReports/blob/master/Daily\\_SST/SST\\_API\\_no\\_logo.R](https://github.com/jordanwatson/EcosystemStatusReports/blob/master/Daily_SST/SST_API_no_logo.R)

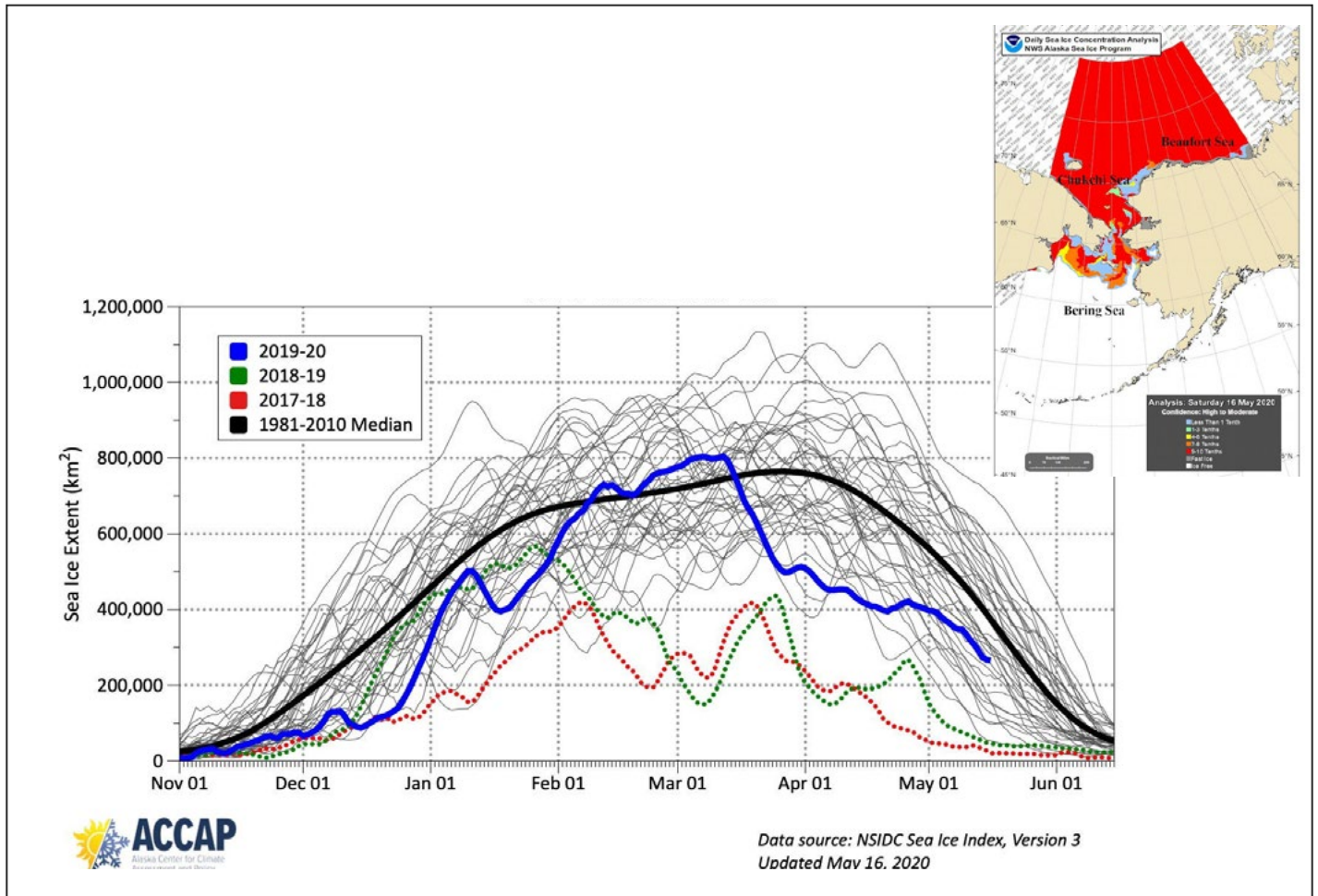


Figure 5. Bering Sea daily sea ice extent for winter 2019–20 (blue), 2018–19 (green), and 2017–18 (red) compared to prior winters, 1978–79 to present. Area includes the eastern and western Bering Sea. Sea ice concentration (inset) for May 16, 2020. Plots available at <https://uaf-accap.org/>.

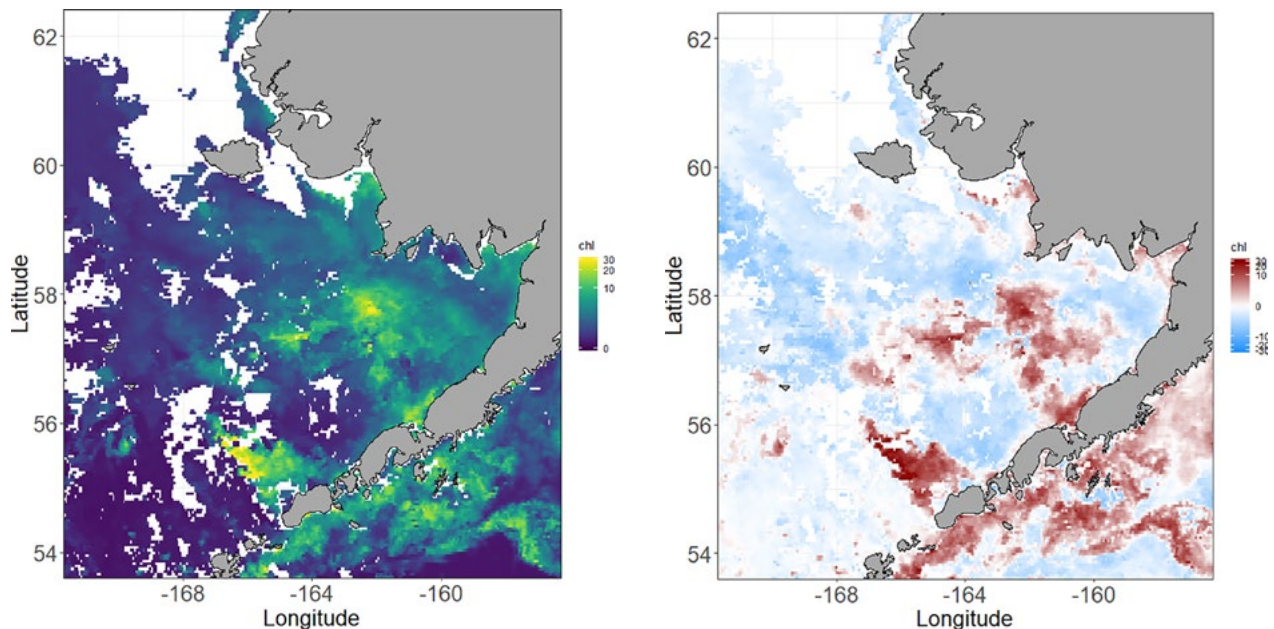


Figure 6. Monthly composite of Moderate Resolution Imaging Spectroradiometer (MODIS) Chl- $a$  ( $\mu\text{g}^{-1}$ ) in the Bering Sea for April 2020 (left), and April 2020 compared to the average April Chl- $a$ , 2003–2019 (right). Figure courtesy of Jens Nielsen, NOAA AFSC.

and economic conditions to inform the fall fisheries stock assessment cycle. The main objective was to identify any areas of concern or unusual conditions that may be relevant to stock and ecosystem assessments. These warning signals will be tracked through the summer. Those that continue to be of concern will be presented to the North Pacific Fisheries Management Council in October, when it begins to review the science supporting the annual groundfish stock assessments. The early warning and final ecosystem assessments will be included in the Ecosystem Status Reports of the eastern Bering Sea, Gulf of Alaska, and Aleutian Islands, which will be available publicly in December 2020. This workshop was a great success, and annual meetings are planned for the future.

### Northern Bering/Chukchi Integrated Ecosystem Assessment Working Group

Working Group 44 is a new joint PICES/ICES Working Group whose goal is to conduct an Integrated Ecosystem Assessment (IEA) of the Northern Bering-Chukchi Sea Large Marine Ecosystem. Over the course of its 3-year life span (November 2019–2022), the WG will inventory existing information, develop an ecosystem description including both indigenous and scientific knowledge, and report on ecological objectives and values. These activities will culminate in the development of the first IEA of this Large Marine Ecosystem. Reports, journal articles and outreach activities will communicate the results to scientists, the public and stakeholders. For details see: <https://meetings.pices.int/members/working-groups/wg44>

### 2020 Bering and Chukchi seas summer and fall surveys

- NOAA summer bottom trawl, acoustic trawl, and ecosystem surveys in the eastern Bering Sea have been canceled due to COVID-19. In July, saildrones equipped with acoustic sensors will collect data for pollock abundance estimates in the eastern Bering Sea. For more information, see: <https://www.saildrone.com/news>.
- The Russian Fishery Agency intends to survey the Russian EEZ of the Bering Sea and possibly the southern Chukchi Sea in August-September 2020. Fisheries bottom and midwater trawling, and oceanographic measurements will be conducted on three research vessels (RVs *Dmitry Peskov*, *TINRO*, and *Professor Kaganovsky*).

### Acknowledgements

*Many thanks to the scientists who helped create this report: Dr. Nicholas Bond at NOAA PMEL provided information on climate and oceanography; Dr. Rick Thoman at the Alaska Center for Climate Assessment and Policy provided information on sea ice; Dr. Yury Zuenko at TINRO-Center, Russia provided information on Western Bering surveys; Drs. Jordan Watson, Jens Nielsen, Elizabeth Siddon, and Libby Logerwell at NOAA AFSC provided information on satellite SST, satellite Chl-a, the PEEC meeting, and the working group on IEA, respectively.*



*Dr. Lisa Eisner is a Biological/Fisheries Oceanographer at the Alaska Fisheries Science Center of NOAA Fisheries. Her research focuses on oceanographic processes that influence phytoplankton and zooplankton dynamics and fisheries in the eastern Bering and Chukchi seas. She has been the lead oceanographer for the U.S. component of the BASIS program (Bering Aleutian Salmon International Surveys). She is the lead/co-PI on current (and past) eastern Bering Sea and Chukchi Sea research programs. In PICES she is Vice-Chair of the Technical Committee on Monitoring and a member of the joint PICES/ICES Working Group on Integrated Ecosystem Assessment for the Northern Bering Sea–Chukchi Sea (WG 44).*



## The western North Pacific during the 2019/2020 cold season

*Naotaka Hiraishi*

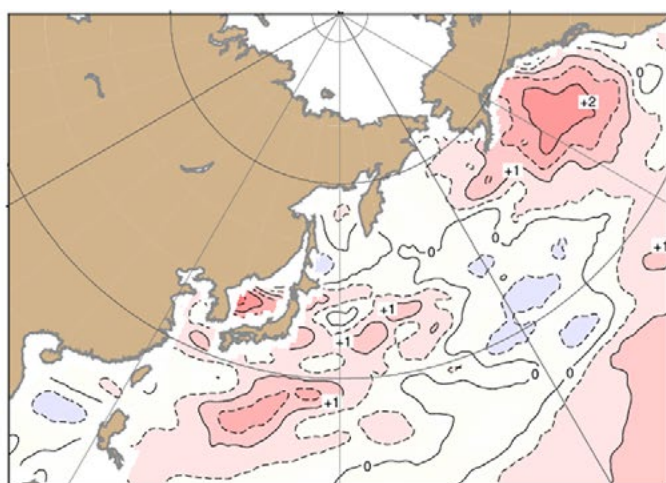
The western North Pacific was characterized by positive anomalies of sea surface temperature (SST) in almost all of this area, throughout the 2019/2020 cold season (Figure 1). In particular, large positive anomalies were observed along the Kuroshio Extension and in the Sea of Japan because the southward cold-air flow around Japan was weaker than normal, as well as the Kuroshio extension path shifted northward.

The winter maximum sea ice extent in the Sea of Okhotsk was 1.06 million km<sup>2</sup> in late February, which was around 90% of the 30-year average of 1.17 million km<sup>2</sup>, although this was larger than the long-term linear trend. The seasonal maximum exhibits a long-term decreasing trend of 0.061 million km<sup>2</sup> per decade, which corresponds to 3.9% of the Sea of Okhotsk's total area (Figure 2).

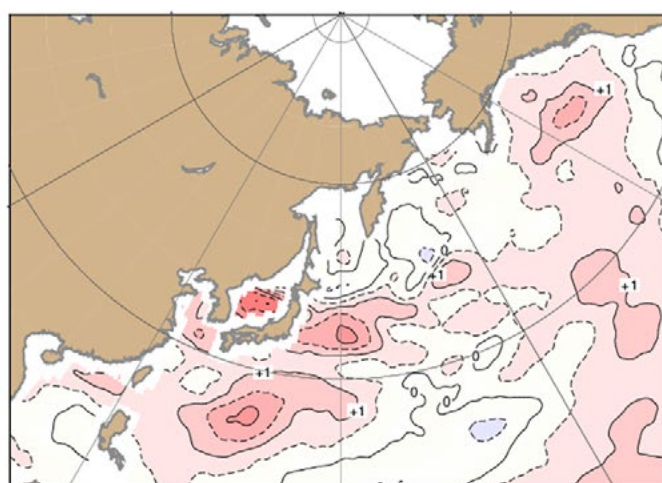
The Kuroshio has followed a large meander (LM) path since the summer of 2017. By March of 2020, the duration of this LM event was 2 years and 8 months, which is the second longest since records began in 1965 (Figure 3 and Table 1). As of May 2020, the LM event persists.

Table 1. Historical Kuroshio large-meander periods since 1965.

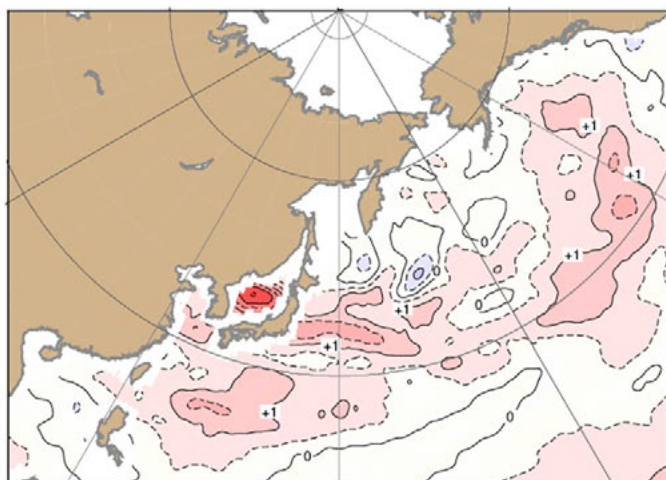
Period	Duration
Aug. 1975 – Mar. 1980	4 years, 8 months
Nov. 1981 – May 1984	2 years, 7 months
Dec. 1986 – Jul. 1988	1 year, 8 months
Dec. 1989 – Dec. 1990	1 year, 1 month
Jul. 2004 – Aug. 2005	1 year, 2 months
Aug. 2017 – Ongoing	2 years, 10 months (as of May 2020)



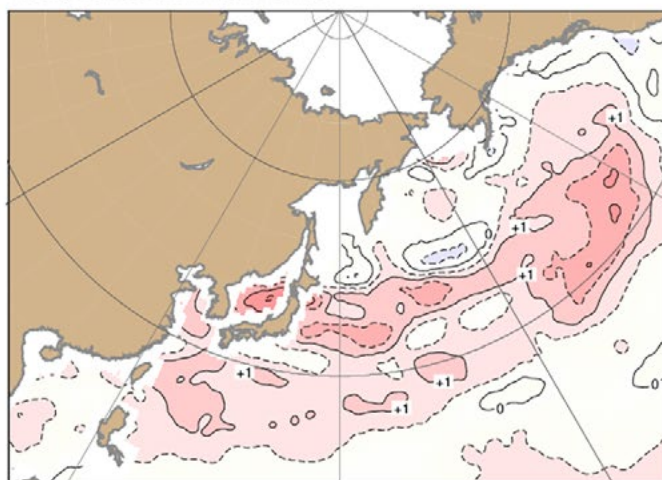
Monthly mean SST anomalies for Dec.2019



Monthly mean SST anomalies for Jan.2020



Monthly mean SST anomalies for Feb.2020



Monthly mean SST anomalies for Mar.2020



Figure 1. Monthly mean sea surface temperature anomalies from December 2019 to March 2020. Monthly mean SSTs are based on JMA's COBE-SST (centennial in-situ observation-based estimates of variability for SST). Anomalies are deviations from the 1981–2010 climatology.

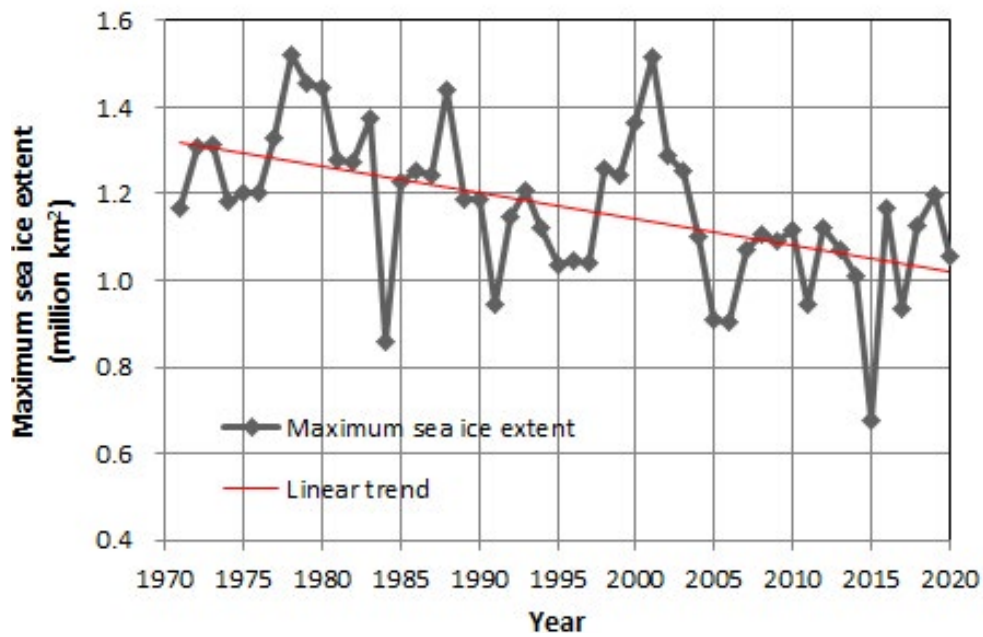


Figure 2. Winter maximum sea ice extent Time series, Sea of Okhotsk, from 1971 to 2020. The red line denotes the long-term linear trend.

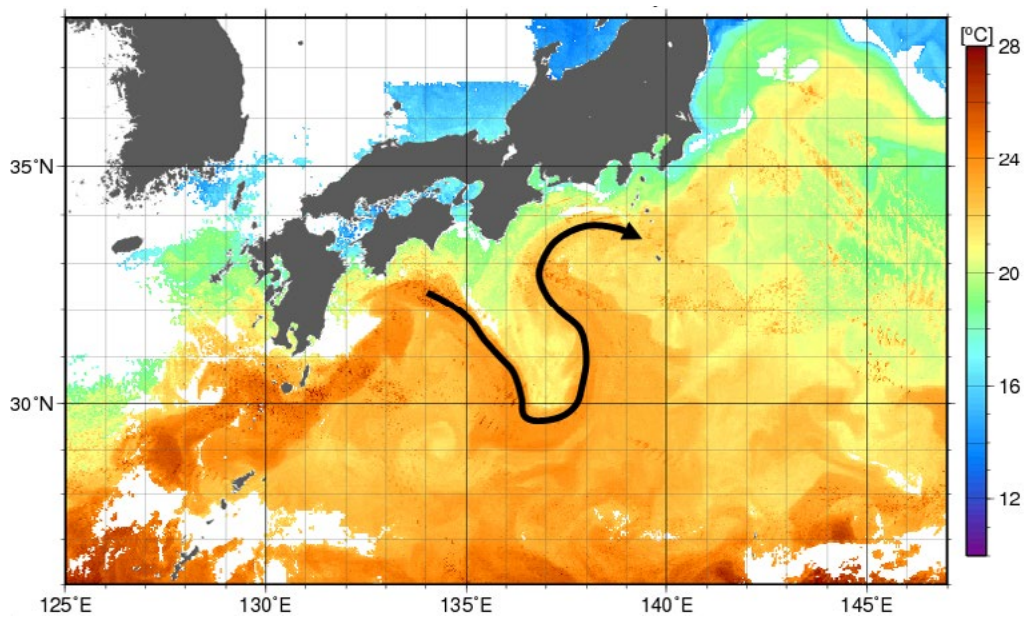


Figure 3. Composite of sea surface temperature, May 14, 2020 (12–23 UTC), as observed by Himawari-8. Black line denotes estimated Kuroshio path.



*Mr. Naotaka Hiraishi is the Head of the Marine Environment Monitoring and Analysis Center, Marine Division of the Global Environment and Marine Department of the Japan Meteorological Agency, in Tokyo, Japan.*

## The Northeast Pacific: Current status and recent trends

Tetjana Ross, Angelica Peña, Frank Whitney, Moira Galbraith, Ian Perry and Andrew Ross

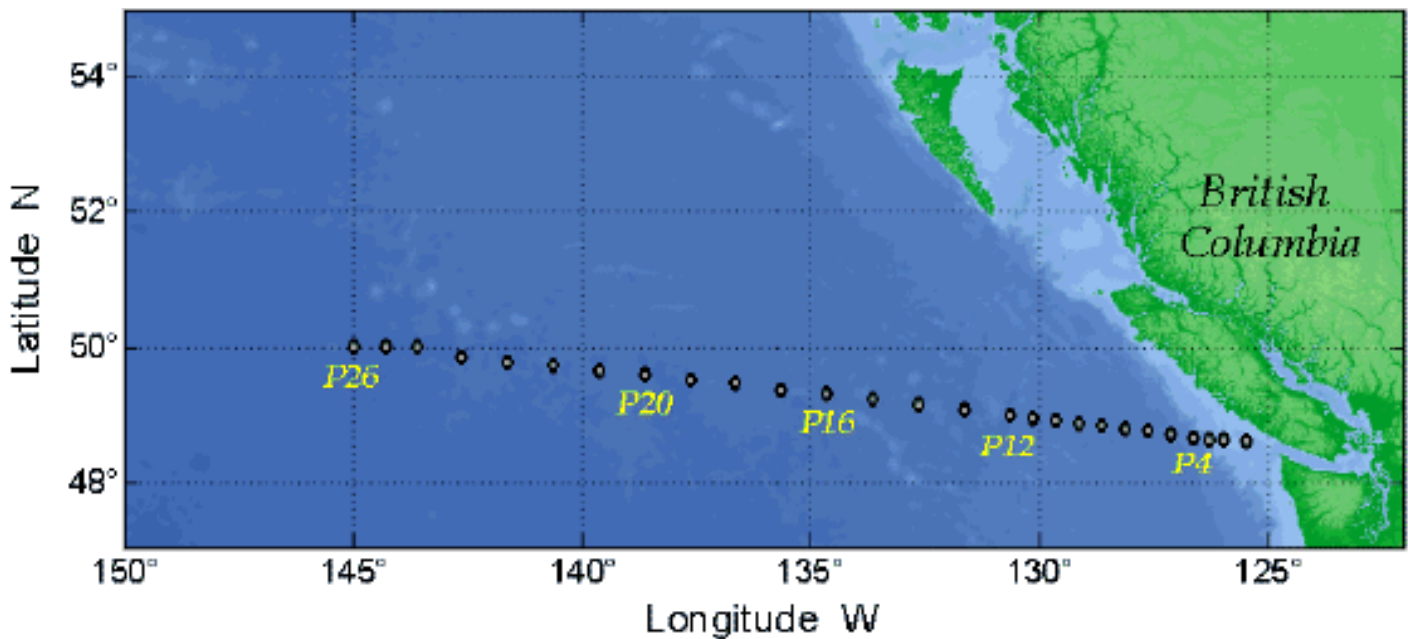


Figure 1. Location of sampling stations along Line P (<http://www.waterproperties.ca/linep/>).

In 2019, evidence from the Line P monitoring program (Figure 1) points to the Northeast Pacific (NEP) behaving more like a spring bloom system than a High Nutrient Low Chlorophyll (HNLC) region for the first time in the 60-year time series. Along Line P, summer nutrients in 2019 were depleted at stations beyond the range of coastal influences (Figure 2). Nitrate and silicate levels this low have never been seen so far offshore; summer mixed layer nitrate was depleted at Ocean Station Papa (OSP) for the first time in 60 years of observations (most recent 30 years shown in Figure 3).

Phytoplankton community composition along Line P in spring of 2019 was similar to that in 2018 but differed from previous years, with diatoms dominating phytoplankton biomass at several open-ocean stations (Figure 4). Additionally, and unusually, the diatom dominance of the phytoplankton community persisted at the offshore (Gulf of Alaska) stations into the summer and chlorophyll remained high (Peña and Nemcek, *In press*).

Although dissolved iron samples from summer 2019 have yet to be analyzed, the lack of coastal eddy presence in satellite sea surface height anomaly data or of a reported volcanic eruption in the area suggests that iron fertilization was not responsible for this nutrient depletion anomaly. Argo density analysis at OSP (P26) suggests that there was less winter mixing in 2019 (Figure 5). This is likely related to the marine heatwave

conditions that were present throughout much of 2019, and particularly those during the fall of 2018 (Figure 5; Ross et al., 2019; Amaya et al., 2020). Winter surface density (higher in winters with strong mixing) remained quite low in the winter of 2019, indicating that stratification remained between the surface and the permanent pycnocline at about 150 m depth. As the main source of nutrient replenishment is from below the main pycnocline, this weak mixing is implicated in the low surface nutrient values (Figure 2). Similar conditions were associated with low concentrations of major nutrients and micronutrient trace metals in Line P surface waters during the 2014 NEP marine heatwave (Peña et al., 2018; Ross et al., 2018). However, while the winter macro-nutrient values were on the low side, they were not anomalous like the summer values; simply on the low end of the previously observed distribution. This suggests that while there was some preconditioning in the physical oceanographic situation towards lower nutrients, the complete drawdown in summer is likely of biological origin and may be related to the high diatom contribution to the phytoplankton assemblage (which tend to be associated with bloom conditions).

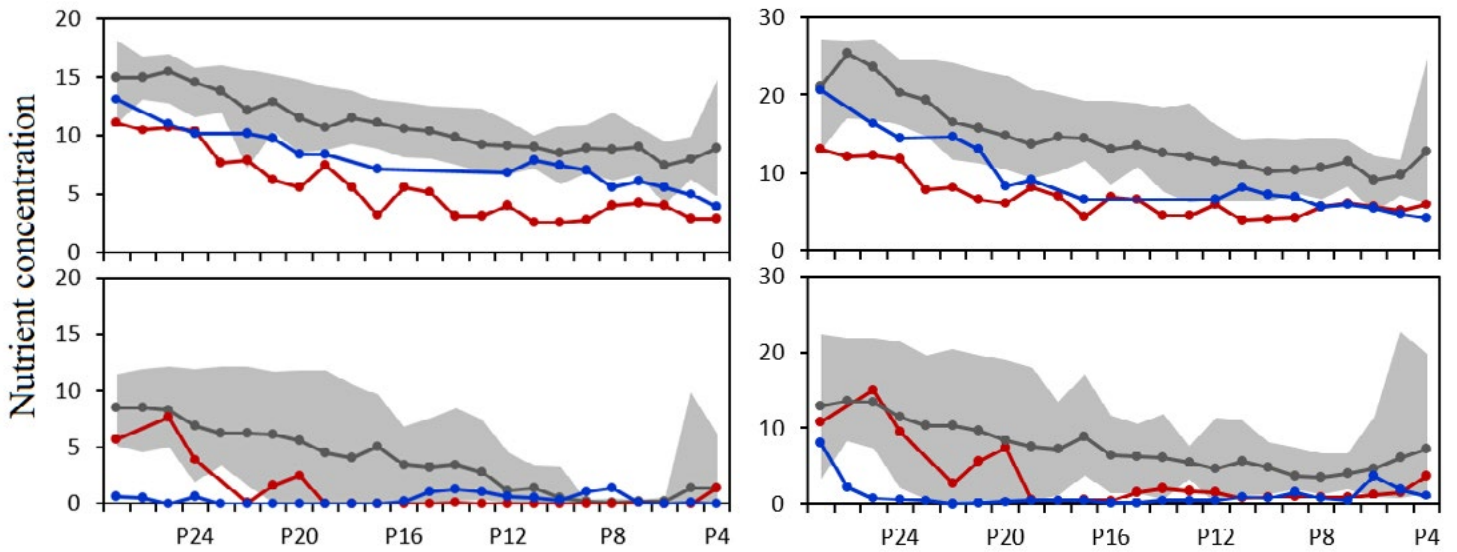


Figure 2. Nitrate (left panels,  $\text{mmol m}^{-3}$ ) and silicate (right panels,  $\text{mmol m}^{-3}$ ) in surface waters along Line P from P4 to OSP (P26) in winter (top panels) and summer (bottom panels) 2019. Panels show the average (grey line) and range (shaded area) of nutrient concentrations in 2000–2014. Data for 2019 are shown in blue and for 2015 in red. Figure modified from Peña and Nemcek (In press).

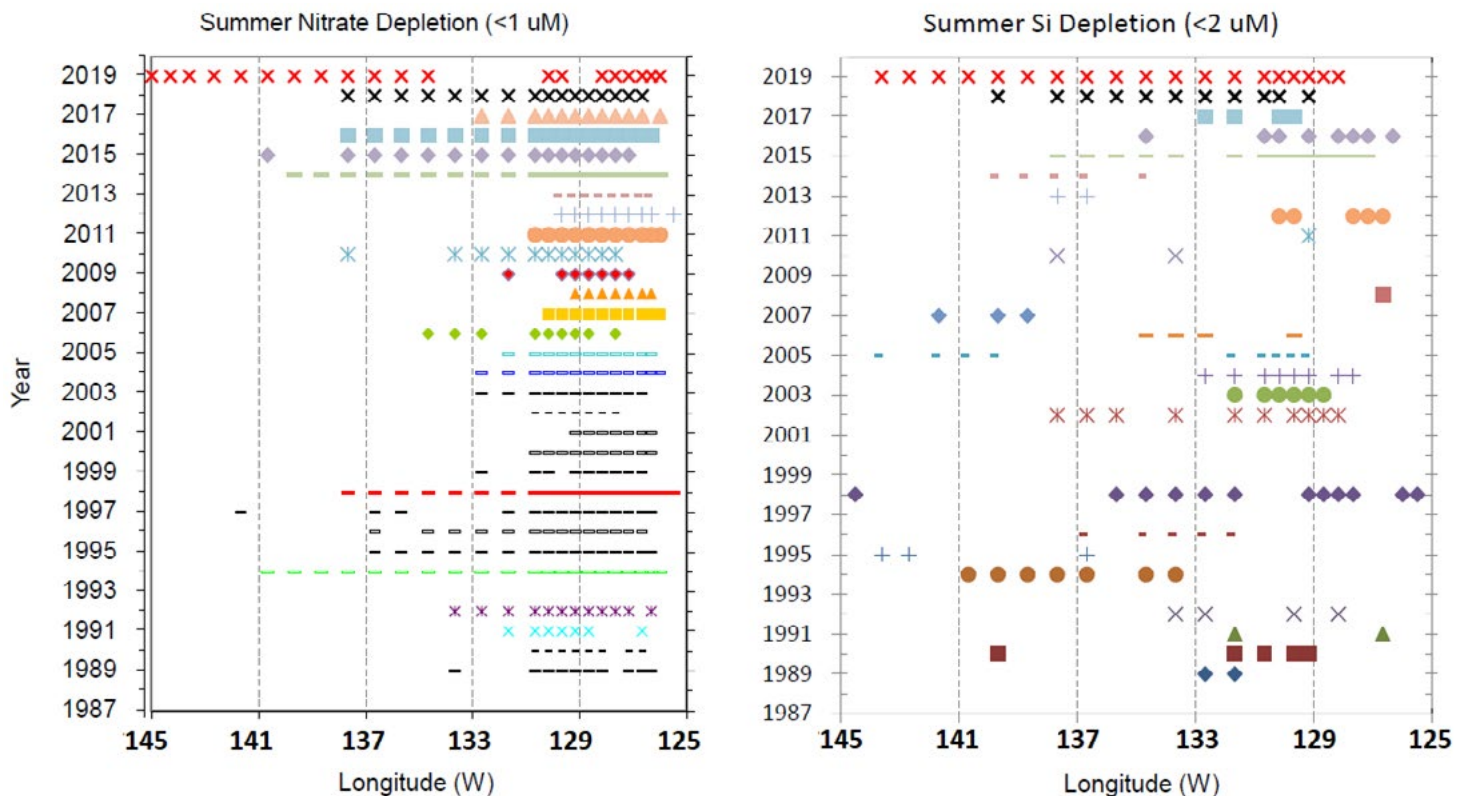


Figure 3. Longitudinal locations of stations with low nitrate and silicate levels are indicated for Line P summer surveys. Nutrient depletion is stronger in 2019 than in any previous survey. 1989 survey was done in October, otherwise data come from August and September (as in 2019).

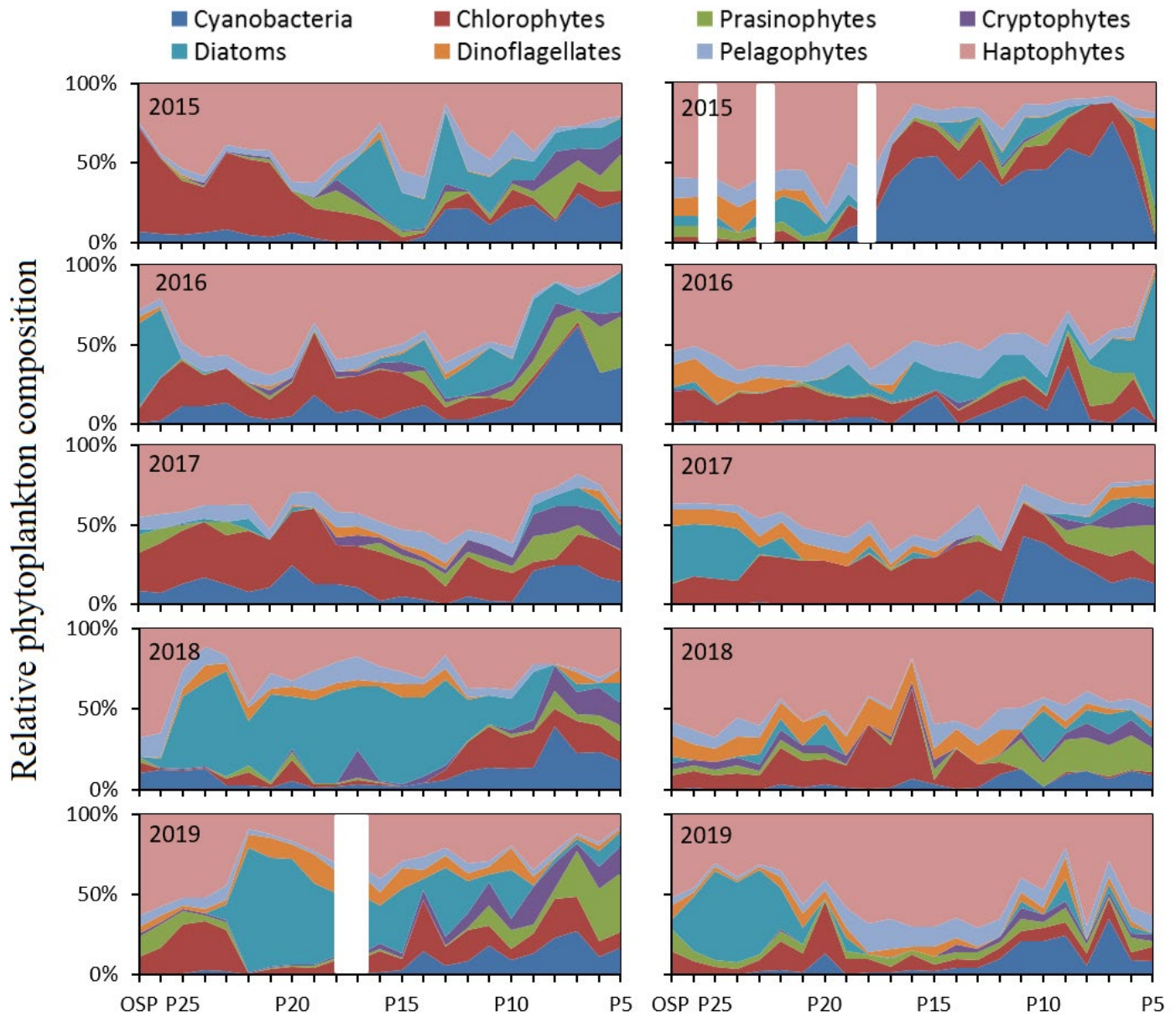


Figure 4. Relative phytoplankton composition in the upper layer at stations along Line P in June (left panels) and August/September (right panels) for 2015 to 2019, from HPLC pigment analysis. Figure from Peña and Nemcek (In press).

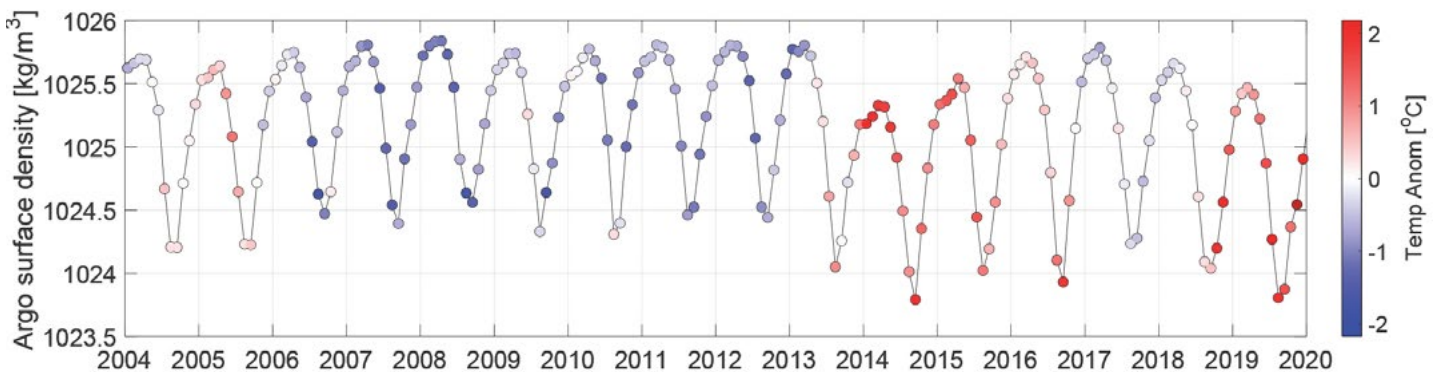


Figure 5. Surface density for each month at OSP (P26) based on analysis of a gridded and interpolated Argo float product (Roemmich and Gilson, 2009). Dots are coloured by temperature anomaly relative to the monthly mean temperature over the Argo record (2004–2020).

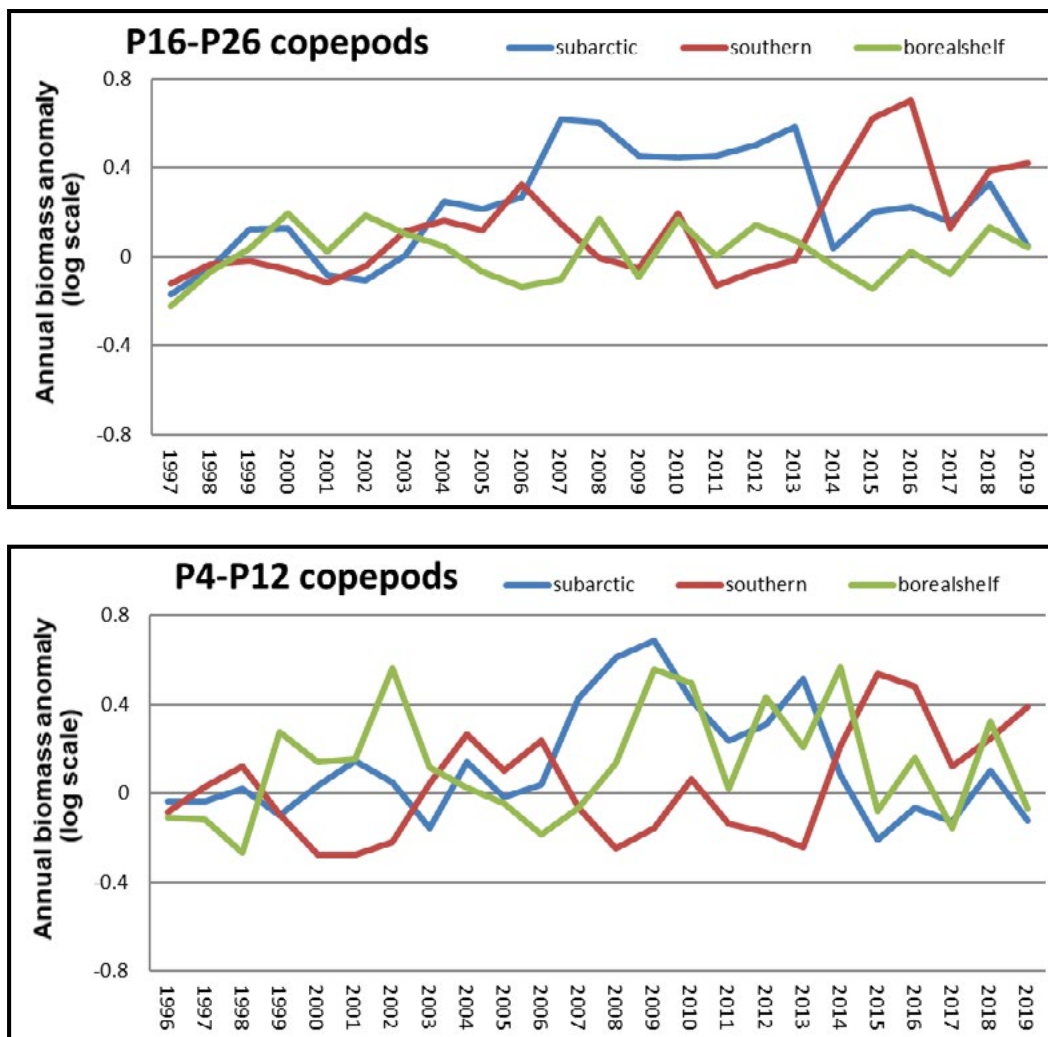


Figure 6. Annual biomass ( $\text{g}/\text{m}^2$ ) anomalies of copepods since 1997 at the oceanic Line P stations (left panel, stations P16 to P26) and along the shelf and shelf break off the west coast of Vancouver Island (right panel, stations P4 to P12). "Subarctic" copepods (blue line) are the typical species found in the deep NE Pacific, such as *Neocalanus* spp.; "Boreal-Shelf" copepods are the typical species found during cooler conditions along the shelf regions west of Vancouver Island; and "Southern" copepods are those species whose centers of distributions are typically further south but occur off Vancouver Island when conditions are warmer. Figure from Galbraith and Young (In press).

In zooplankton data, we continued to see high positive anomalies of southern-origin copepods along both the shelf and oceanic sections of Line P during 2019 (Figure 6). In contrast, copepods of boreal and subarctic origin were about normal for the length of the time series (since 1996). This suggests that the copepod fauna in the NEP is still being affected by recent and current warm conditions, but perhaps not responding to the increased predominance of diatoms. The fact that there are more southern copepods is consistent with trends for individual taxa described by Fisher et al. (2020).

In summary, summer mixed layer nitrate was completely depleted at OSP (and other offshore stations) for the first time in the 60-year Line P time-series. There is some

evidence that this is related to increased diatom presence in the offshore NEP waters in August 2019, suggesting bloom conditions in this normally HNLC region. However, both the causes and biological consequences of this remain puzzling—the causes in that there is no obvious trigger for the change in nutrients and diatoms; the consequences in that despite this highly unusual nutrient event and increase in diatoms, the zooplankton continue to display a pattern of high biomasses of southern copepods, related to the continuing heatwave conditions.

#### Acknowledgements

The Argo data were collected and made freely available by the International Argo Program and the national programs that contribute to it. (<http://argo.jcommops.org>). The Argo Program is part of the Global Ocean Observing System.

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*Dr. Tetjana Ross is a Research Scientist at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in Sidney, BC. She is an ocean physicist who develops new ways to observe the ocean – from observing ocean mixing using sound to taking photographs of zooplankton in turbulence. Nowadays, she rarely goes to sea, sending robots out to do the work for her: both gliders and Argo floats (i.e., she currently leads the Pacific component of DFO's Argo and glider programs). In PICES she is member of the Technical Committee on Monitoring and Working Group on Mesoscale and Submesoscale Processes (WG 38).*



*Dr. Angelica Peña is a Research Scientist at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in Sidney, BC. Her research focuses on processes influencing phytoplankton ecology and biogeochemical cycles. She develops circulation-biogeochemical models and uses long-term observations to study the impacts of natural variability and climate change on ocean productivity and biogeochemistry of the northeast Pacific. In PICES, she is a member of the Biological Oceanography Committee and the Section on Climate Change Effects on Marine Ecosystems.*



*Frank Whitney is a scientist emeritus at the Institute of Ocean Sciences, Fisheries and Oceans Canada. He remains interested in chemical processes impacting ocean productivity, whether it is nutrient supply to surface waters or hypoxia at depth. See papers (*Journal of Oceanography* 67: 481–492; *Geophysical Research Letters* 40: 1–6) summarizing some of the trends he and colleagues observed over 25 years or more in the subarctic Pacific.*



*Moira Galbraith is a Zooplankton Taxonomist who works at the Institute of Ocean Sciences in Sidney, BC. She is a marine biologist who specializes in the identification of zooplankton from the west coast of Canada as well as the Arctic. She has been working, in conjunction with her co-workers, to develop various indices for tracing changes in British Columbia zooplankton community structure and biomass.*



*Dr. Ian Perry is a Research Scientist with Fisheries and Oceans Canada, at the Institute of Ocean Sciences in Sidney and the Pacific Biological Station in Nanaimo, Canada. His research expertise includes environmental influences on the distributions and recruitment of marine organisms and the structure and function of marine ecosystems. He is currently the head of the Plankton Ecology and Ecosystems Oceanography Program for DFO's Pacific Region.*



*Dr. Andrew R.S. Ross is a Research Scientist at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in Sidney, BC. As a marine chemist, he develops and uses analytical methods to study biological and environmental processes that control the availability and distribution of trace elements, marine biotoxins and contaminants. His research involves profiling essential trace metals (micronutrients) and metal-binding compounds (ligands) in the ocean and developing mass spectrometry (MS)-based methods to detect and quantify toxic chemicals in the marine environment. Dr. Ross is a member of the UNESCO-IOC International Group for Marine Ecological Time Series. In PICES, he is current Vice-Chair of the PICES Marine Environmental Quality Committee and a member of the Section on Ecology of Harmful Algal Blooms in the North Pacific.*

## Identifying research priorities for understanding the dynamics of small pelagic fish

Ryan Rykaczewski, Myron Peck, Ignacio A. Catalán, and Akinori Takasuka



Group photo of several members of the Joint PICES/ICES Working Group on Small Pelagic Fish (WG 43; WGSFP) at ICES Headquarters during their workshop in March 2020 in Copenhagen, Denmark. Many participants joined the workshop remotely.

Populations of small pelagic fish (SPF) are highly valued by society, accounting for about 25% of the total landings (by weight) of marine capture fisheries around the world, and are a critical source of animal protein in human diets, particularly in developing countries. The fishmeal and fish oil produced from SPF continue to be critical components of diets used in the rapidly expanding aquaculture sector. These fish are also vital to the diets of higher predators, playing a role in the transfer of energy and organic matter from zooplankton to seabirds, marine mammals, and other piscivores.

SPF exhibit notable temporal variability in the distribution and size of their populations, with spawning stock biomasses that can fluctuate by several orders of magnitude at interannual to multidecadal timescales. In various ecosystems, these fluctuations have been attributed to changes in climate and ocean properties, interactions with predators, shifts in distribution or migration behavior, or variable sensitivity to commercial harvesting. Clear understanding of the mechanisms linking these multifaceted processes to the dynamics of SPF remains elusive. Yet, human society cannot expect to prepare a plan for sustainable utilization of living marine resources unless we improve our understanding of the largest component of ocean fisheries—the SPF.

Consideration of the dynamics of these species, their sensitivity to exploitation and climate change, and the implications of such changes for dependent human communities is essential to promote ocean sustainability and guide adaptation planning. This critical value of SPF to societies around the globe and their hypothesized relationships to climate variability have motivated several international collaborative efforts over recent decades. Like the abundance of the fishes themselves, however, these efforts have been episodic in size and scope. In recognition of the need for continued global exchange of scientific information regarding SPF, the PICES and ICES communities co-sponsored a symposium on “Forage fish interactions: Creating the tools for ecosystem-based management of marine resources” (Nantes, France, November 12–14, 2012) leading to publication of 12 articles in the *ICES Journal of Marine Science* (Peck et al., 2014). Subsequently, in March of 2017, PICES and ICES organized an international symposium on the “Drivers of dynamics of small pelagic fish resources” in Victoria, BC, Canada. This symposium led to special issues in *Deep-Sea Research Part II* (Alheit et al., 2019; 15 articles) and *Marine Ecology Progress Series* (Alheit and Peck, 2019; 22 articles). Discussions at this 2017 symposium and associated workshops highlighted the common sentiment that improved understanding of questions concerning the



dynamics of SPF populations, their role in the structure of marine ecosystems, and the impact of their variability on socioeconomic conditions requires more frequent discourse and closer world-wide collaboration. This need for international cooperation is bolstered by the quickly approaching UN Decade of Ocean Science for Sustainable Development (2021–2030), where SPF will certainly be prominent in the examination of anthropogenic impacts of natural ecosystems, aquaculture development, and conservation of resources.

To harness the enthusiasm following the 2017 symposium and maintain more regular collaborations among SPF researchers, ICES and PICES recently formed a joint working group on Small Pelagic Fish<sup>1</sup>. As co-chairs of this Working Group, we organized an initial meeting in Copenhagen, Denmark (March 9–11, 2020) to identify the focal areas for collaboration, plan for SPF activities at each organization's annual meetings, and discuss the potential convening of another international symposium on SPF in the coming years. At this initial meeting, in-person participation by scientists from the ICES community was strong. Unfortunately, the outbreak of COVID-19 was already complicating international travel for scientists based around the Pacific Rim, and most of the Pacific-focused scientists who could participate did so remotely. This virtual participation, however, was effective. In total, 30 individuals from 19 countries spanning six continents helped shape the initial structure of the joint working group at this workshop.

Over the course of the 2.5-day meeting, the group's framework for collaboration was defined, and strong progress was made in identifying specific goals. We aspire to be comprehensive in our examination of SPF issues, and three broad task forces have been formed to address the range of ecological, management, and socioeconomic questions concerning SPF stocks worldwide. We outlined 11 activities and a greater number of associated research questions that we work toward addressing in the next three years. These activities and task forces are listed below.

#### Task Force on Ecological Process Knowledge

- Activity 1: Critical review, evaluation and testing of classic hypotheses
- Activity 2: Life cycle closures – bottlenecks and gaps in knowledge
- Activity 3: Drivers of spatial distribution and phenology
- Activity 4: Food-web dynamics
- Activity 5: Internal and external drivers of growth, reproduction, and survival

#### Task Force on Translating Process Knowledge

- Activity 6: Survey design and monitoring
- Activity 7: Improving short-term forecasts and/or long-term projections
- Activity 8: Improvements to management

#### Task Force on Social-Ecological Approaches

- Activity 9: Networks, vulnerability, and opportunities of dependent human communities
- Activity 10: Quantifying trade-offs in goods and services
- Activity 11: Bioeconomic modeling

We established a plan for canvassing the rest of the membership with emphasis on forming global collaboration on SPF research, and, since the initial meeting in March, more than 100 scientists have asked to participate in the working group's activities. Given the broad range of interests in this rather large group, we recognized the need to bound the taxa included in future discussions. Following a recommendation, the group narrowed the scope to focus on small-bodied species that are planktivorous throughout their life, including clupeids and engraulids (i.e., anchovies, sardines, sprats and herrings). This will help direct discussions on stocks that exhibit similar life histories, migration capacities, sensitivities to bottom-up forcing by climate processes, and exploitation by commercial fisheries.

The expertise of participants at the initial working group meeting was biased towards ecological topics (particularly Activities 1 through 5 noted above, with some expertise concerning Activities 6, 7, and 8). Activities 9, 10, and 11 concern issues that, though recognized as critical for a comprehensive approach to SPF questions, are not yet well represented by the membership. We are actively seeking recommendations for the recruitment of social scientists to help ensure that those issues receive appropriate attention in this world-wide collaborative effort.

In addition to reviewing global understanding of the drivers of SPF dynamics and re-invigorating international coordination for research spanning the world's oceans, the working group hopes to revisit the numerous hypotheses concerning variability in SPF (Activity 1 above). Hypotheses describing the factors influencing population dynamics of SPF are as old as the field of fisheries oceanography itself. Over the last century, the list of proposed hypotheses has grown steadily. While researchers continue to propose new hypotheses, data available for a single species in an individual ecosystem may be insufficient to definitively reject a hypothesis. The ability to convincingly reject these hypotheses often requires collaboration of scientists who share knowledge and data across species and ecosystems and at varying levels of exploitation. Within this working group, we hope to have expertise that offers opportunities to confront these hypotheses with data from across the

<sup>1</sup> <https://meetings.pices.int/members/working-groups/wg43>

globe. While recognizing that the mechanisms driving variability can change over time and may differ from region to region, we see value in attempting to identify the reasons that dynamics may differ among regions. If we find that we lack sufficient data to test hypotheses across regions, it would be pragmatic to highlight where, when, and what types of new observations are necessary to support future analyses.

Besides coordinating global research and synthesizing recent results, a major activity of the working group is to organize a joint PICES/ICES symposium on SPF that builds upon the 2017 international symposium. We hope that this symposium will showcase the integrative analyses of this working group and help to entrain the participation of scientists from outside of the traditional ICES and PICES regions, and early career researchers from all areas. This symposium is tentatively scheduled for February 2022 in Lisbon, Portugal.

To support the development of session themes for this international symposium, working group members will propose, coordinate, and convene workshops and topic sessions focused on key questions and recent advances in SPF science at PICES Annual Meetings and ICES Annual Science Conferences. The ongoing pandemic poses some challenges to soliciting opinions from the broader community, but we hope that virtual meetings, emails, and newsletters will help to highlight the efforts of the working group as we plan the symposium. Please feel free to reach out to the co-chairs with suggestions concerning SPF research priorities.

The formation of this working group would not have been possible without the guidance of Dr. Alex Bychkov, the PICES Special Projects Coordinator. Alex has been tireless in his support for this group and in facilitating the coordination between PICES and ICES.



*Dr. Ignacio A. Catalán is a Research Scientist of the Spanish National Research Council, at the Mediterranean Institute for Advanced Marine Studies (IMEDEA, CSIC-UIB) in Mallorca, Spain. His research interest is broadly defined by the investigation of the mechanisms behind the population dynamics of marine fish. In the last years, he has focused on: the study of dispersion and connectivity of early stages of fish; the understanding of individual-level responses to intrinsic and extrinsic drivers, including climate change; and, the analysis of coastal recruitment processes.*



*Dr. Myron Peck is a Professor of Biological Oceanography at the Institute of Marine Ecosystems and Fisheries Science, University of Hamburg, Germany. He has a broad range of research interests related to physical and biological processes governing marine and estuarine species and food webs, including coupling species life history and physiology, and translating that knowledge to models to advance predictive capacity in light of climate change, fishing and other drivers.*



*Dr. Akinori Takasuka is a Professor in the Department of Aquatic Bioscience, the University of Tokyo, Japan. His interests are in the fields of Fisheries Biology and Oceanography. His current major research themes include biological mechanisms behind climate impacts on population dynamics of small pelagic fish, growth and survival dynamics during the early life stages of fish, and density-dependent and density-independent processes in the life history of fish.*



*Dr. Ryan Rykaczewski is a Marine Scientist with the Ecosystem Sciences Division at NOAA's Pacific Islands Fisheries Science Center in Honolulu, Hawaii, USA. His research focuses on the sensitivity of marine biogeochemical cycles, ecosystem structure, and fisheries production to changes in ocean climate and physics. Ryan has been active in PICES and ICES for several years and strives to find ways to incorporate knowledge of regional to basin-scale climate processes into the management of living marine resources.*

## Your PICES science images



Moira Galbraith (DFO, Canada) samples hundreds of larval Dungeness crab (*Cancer magister*), aboard the CCGS *Sir Wilfred Laurier* off the coast of Vancouver Island, May 13, 2018, after a horizontal (Neuston) zooplankton net tow. Horizontal zooplankton net tows are used to assess the quality and quantity of food for baleen whales. Photo: Tamara Fraser, DFO Canada.



Moira Galbraith (DFO, Canada) removes a large pyrosome (*Pyrosoma atlanticum*) from a Bongo (zooplankton vertical net tow) stuck in the bottom, or cod end, of a net. (CCGS *John P. Tully*, coast of Vancouver Island, BC, 18 May 2016). Zooplankton vertical net tows are used to geospatially enumerate and identify zooplankton species. Photo: Ian Perry, DFO Canada.

**Call for images**

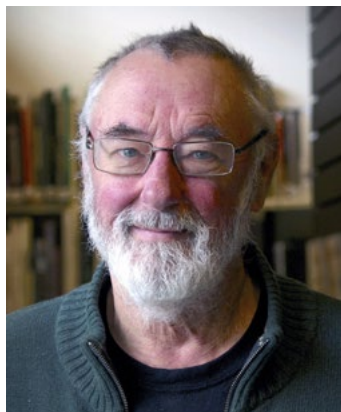
People of PICES: do you have an interesting PICES science image to share in PICES Press?

To have your image(s) considered, please email high-resolution .jpg or .tif files, along with a short caption and image credit to: [Lori.Waters@pices.int](mailto:Lori.Waters@pices.int)

Thank you!

## Remembering Paul LeBlond

Professor Paul Henri LeBlond passed away at his home on Galiano Island, BC, on February 8, 2020 at the age of 81. Paul was one of Canada's leading physical oceanographers and spent his professional career as a professor in the Departments of Physics, and Earth, Ocean and Atmospheric Sciences at the University of British Columbia. His former students contributed to an article "Remembering Paul LeBlond" in the Bulletin of the Canadian Meteorological and Oceanographic Society that remembers and celebrates his many contributions and achievements and readers are encouraged to consult this article<sup>1</sup>.



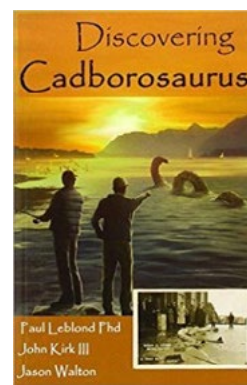
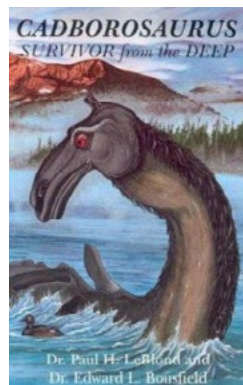
**Paul Henri LeBlond**  
December 30, 1938 –  
February 8, 2020

Paul was very active in PICES from its earliest years. He served as the second Chair of the Physical Oceanography and Climate Committee (POC) from 1995-1998, Chair of WG 7 on Modeling of the Subarctic North Pacific Circulation, and was one of the lead organizers of the 1999 "Beyond El Niño" international conference. Paul was a highly productive and world-renowned scientist, publishing more than 90 peer-reviewed articles on a wide array of oceanographic topics and two books, including the celebrated "Waves in the Ocean". Paul mentored more than 40 graduate students over his career, imparting his great joy and positive outlook on life as well as an intense multi-disciplinary curiosity to a generation of scientists.

As Dr. Warren Wooster remarked when Paul received the Wooster Award, "Paul is a physical oceanographer, a species well known for avoiding involvement in messy fishery questions. But he early recognized that changes in ocean circulation and mixing had an impact on fish populations and therefore has contributed actively to the work of several Canadian fishery conservation organizations. This is exactly the kind of miscegenation PICES has tried to promote!"

As noted above, the list of Paul's contributions to science is quite lengthy, but there are four characteristics that are particularly relevant to PICES — then, now and in the future:

1. Paul recognized the importance of working internationally. This is reflected in his contributions to PICES, but also to the World Ocean Circulation Experiment (WOCE). He was fluent in French and English, but also spoke German, Spanish and Russian. In addition to many Canadian honours, including election by his peers as a Fellow of the Royal Society of Canada, he was a Foreign Member of the Russian Academy of Natural Science.
2. He had an acute interest in expanding his research interests from his "natural habitat" of the physics of wind, waves and currents to the application of science to "messier" problems such as understanding the development of storms at sea and impacts on the safety of mariners, and improving our understanding on the fluctuations in the abundance and distribution of fish and resulting impacts on industries and communities. Paul was an active member of the Pacific Fisheries Resource Conservation Council (PFRCC) and served as Chair from 2005 to 2009.
3. He had a deep commitment to fostering the development of the next generation of marine scientists. He was a wonderful teacher and mentor and treated his students with respect. The success of his approach is exemplified by the contributions of his students, many of whom are well known in PICES as well as in the broader marine science community.
4. His personal conviction was that doing good science should also be fun. Paul's love of science and discovery led him to investigate sightings of unidentified marine animals such as Cadborosaurus, seen many times in the local waters of the Salish Sea. This passion led him to co-found the International Society of Cryptozoology and the BC Scientific Cryptozoology Club (BCSCC). He co-authored and published two books, "Cadborosaurus: Survivor of the Deep" (with Ed Bousfield) and "Discovering Cadborosaurus" (with John Kirk and Jason Walton).



<sup>1</sup> <https://bulletin.cmos.ca/remembering-paul-leblond-1938-2020/>

Paul expressed much of this in own words when receiving the PICES Wooster Award in 2004. He also provided some wonderful guidance which is as pertinent now as it was then:

*"Madame la Presidente, distingues delegues, chers collegues! It is a great honour for me to receive the Wooster Award and to find myself in the company of previous award recipients, Michael Mullin, Yutaka Nagata and Bill Percy, all of whom I met and learned to appreciate at previous PICES meetings. I am also particularly delighted to be more closely associated, through this award, with our founding father, Warren Wooster, who is here with us today. Warren's child, PICES, is now holding its Thirteenth Annual Meeting: PICES is now a teenager! Teenage years are a period of great turmoil in human development. I am happy to say that I can detect no such turmoil in PICES, the institution. More importantly, I detect no evidence of a more common and graver symptom of maturing institutions: the tendency to crystallize into formality, to replace youthful enthusiasm with routine and protocol. One way for an institution to retain its youthful dynamism is to attract young people to its fold, or at least to ensure that its supporters remain young-at-heart. So, in gratitude for this award, I offer two wishes. To all of you as individuals, I wish that you remain young-at-heart and full of joie-de-vivre: may you all follow in the footsteps of our founding father, who was already past usual retirement age when he gave birth to PICES. To PICES as an institution, I offer the wish of continuing youthful and dynamic success for years and years to come."*



Photo: Loren Coleman



Photo: Annette LeBlond



Photo: Vancouver Aquarium



Photo: Sea Monsters: The Definitive Guide

## PICES by the numbers



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**PICES appreciates you sharing your work. Thank you for your contributions!**

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ISSN 1195-2512

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