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Newsletter of the North Pacific Marine Science Organization

PICES science in 2018: Notes from the Science Board Chair

Our Earth System is in transition. In 2000, Nobel Laureate, Paul Crutzen, and Eugene Stoermer proposed a new epoch known as the Anthropocene, the human epoch. They claimed that human activities were having a significant impact on climate, geology and ecosystems of the Earth. However, the scientific evidence to distinguish human activities from natural variation were not fully prepared for some parameters at the end of the 20th century which caused a great deal of heated argument from environmental sceptics. Now, 18 years after this proposal was introduced, there is robust evidence of human-induced changes and, unfortunately, the speed of the changes is faster than previously expected for many parameters. In the North Pacific, the biggest-ever heat wave, the Blob, occupied the eastern North Pacific from 2013 to 2016. The Blob induced not only extreme weather in North America but changes in ecosystem components and production, including a massive *Pyrosoma* bloom (see PICES Press pp. 22–27, Vol. 26, No. 1), mass death of sea birds, and decline in fishery production. In the western North Pacific, geographic-scale coral bleaching occurred repeatedly after 1998 due to high sea surface temperatures. Ocean acidification in parallel with the accumulation of atmospheric CO_2 is the other threat to corals and calcifiers. In the Arctic Sea, the area of sea ice cover is decreasing and it is predicted to be ice-free in summer by the 2030s. Microplastic contamination has spread throughout the World oceans, from the Arctic to Antarctic and from the sea-surface to the bottom of deep-water trenches. Many scientists, including myself, are seriously concerned that the tipping point of climate change is approaching.

These anthropogenic forcings are changing the quality and amount of marine ecosystem services on which our society depends. Finding the best way to adapt and/or mitigate these impacts, as well as decelerate the changes, are the most urgent issues for society in the Anthropocene. Scientific organizations are monitoring the status of and providing forecasts for the future of marine ecosystems for a sustainable society. However, understanding the mechanisms of change and forecasting of the future is quite a difficult task since each marine ecosystem has its own components and intrinsic characteristics to respond to single and multiple stressors. Also, the North Pacific and its marginal seas interact with each other and are influenced by the atmosphere and other oceans. In order to respond to the request from society, it is essential to integrate our understanding under an international collaboration scheme.

Workpia Yokohama.

In This Issue

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Governing Council participants, from left: Sira Hakala (USA), Lesley MacDougall (Canada), Michael Seki (USA), Antao Wang (China), Tomomo Watanabe (Japan), Wonjoon Shim (Korea), Haengnok Oh (Korea), Fangli Qiao (China), Toshiaki Kobayashi (Japan), Cornelius Hammer (ICES), Laura Richards (PICES Past Chair), Cisco Werner (USA), Chul Park (PICES Chair), Enrique Curchitser (USA), Carmel Lowe (Canada), Tetsuo Fujii (Japan), Oleg Bulatov (Russia), Dae-Yeon Moon (NPFC), Vladimir Radchenko (NPAFC), Robin Brown (PICES Executive Secretary), Oleg Katugin (Russia), Aleksai Baitaliuk (Russia).

The 27th PICES Annual Meeting (PICES-2018), entitled "*Toward integrated understanding of ecosystem variability in the North Pacific*" was held from October 25 to November 4, 2018, in Yokohama, Japan. Japan is a leading country in marine sciences and it plays an important role in promoting PICES science with other PICES member countries. However, the history of Japan's marine science is relatively short because of Japan's long (220 years) seclusion policy from foreign influence during the 17th to 19th centuries. In 1859, Yokohama was the first port to be opened to foreign countries. After opening, scientific knowledge as well as goods were transported to Japan through the port, which contributed to the establishment of Japan as a modern state based on science and technology. Holding PICES-2018 in the city of Yokohama is symbolic for PICES to consider how science contributes to develop a society that can adapt to changing marine ecosystems in the Anthropocene. PICES-2018 was extremely successful, having more than 550 attendees, including 140 early career scientists, from 16 countries. Also, representatives of 22 international/regional organizations and programs attended.

Science Board, from left: Jennifer Boldt (MONITOR), Keith Criddle (HD), Igor Shevchenko (representing Russia), Sukyung Kang (FUTURE SSC), Rosalie Rutka (PICES Secretariat), Steven Bograd (FUTURE SSC), Emanuele Di Lorenzo (POC; on screen web remote), Harold (Hal) Batchelder (PICES Secretariat), Hiroaki Saito (Science Board Chair), Chuanlin Huo (MEQ), Xianshi Jin (FIS), Joon-Soo Lee (TCODE), Se-Jong Ju (BIO), Motomitsu Takahashi (representing Japan).

PICES-2018 began with Dr. Tomowo Watanabe giving a keynote talk at the Science Board Symposium on the steep warming trend occurring in the boundary current regions of the western North Pacific. Many studies were focused on changing physical, chemical and biological aspects in North Pacific ecosystems, and their future. The impacts of marine changes on society was another significant theme. It is also worth noting that various new techniques to monitor the changing ecosystems were presented. Prof. Michio Kondoh, an invited speaker in the Science Board Symposium, introduced an environmental DNA (eDNA) technique as an easy and powerful tool for detecting biological diversity spanning from microorganisms to whales. Several presentations demonstrated the power and utility of biogeochemical-Argo floats as remote sensing tools of marine ecosystems. The recipient of the 2018 PICES Ocean Monitoring Service Award (POMA) was the Argo Steering Team (for more details, see next article). Prof. Toshio Suga, Co-Chair of the Argo Steering Team, encouraged PICES member countries and scientists to contribute to and enhance the Biogeochemical-Argo array program in the North Pacific.

Opening Session at PICES-2018. Dr. Chul Park introducing honoured guests at the Opening Ceremony in Yokohama.

During PICES-2018, 29 Committee, Program and expert group meetings, 16 topic sessions and 8 workshops were held. Dr. Vera Trainer (USA) was elected Chair-elect of Science Board. She will take over the task of Science Board Chair at the conclusion of the PICES 2019 Annual Meeting. During the Marine Environmental Quality Committee (MEQ) meeting, Dr. Guangshui Na (China) was elected Chair of MEQ replacing Dr. Chuanlin Huo (China), and Dr. Andrew Ross (Canada) was elected as Vice-Chair replacing Dr. Thomas Therriault (Canada). On behalf of PICES scientists, I acknowledge the long dedication of Drs. Huo and Therriault to MEQ and PICES, and look forward to a seamless transition to the leadership provided by Drs. Na and Ross.

To tackle emerging issues in marine science, PICES established two new expert groups. A Working Group on *Indicators of Marine Plastic Pollution* (WG 42) is based on the recommendations of the Study Group on *Marine Microplastics* (2017–18). The main terms are to review micro- and mesoplastic pollution in the North Pacific, to identify multiple organismal and non-organismal indicators of plastic pollution, and to recommend guidelines for monitoring environmental indicators. The other new group is a Study Group on *Impacts of Mariculture on Coastal Ecosystems* (SG-IMCE). Mariculture is becoming more important for food supply and resultant environmental impacts. The SG-IMCE's motivation is to review recent research related to the effects of pathogenic and harmful organisms derived from mariculture.

From top: Co-Convenor, Anne Hollowed during S-CCME workshop W4, Dr. Jim Christian making a presentation at S-CC Topic Session S10; meetings of SG-PICES-NPFC, and MEQ and FIS committees.

FUTURE, the integrative science program of PICES, is to understand and communicate the future of North Pacific

ecosystems and to disseminate scientific knowledge to stakeholders and the public. The FUTURE Scientific Steering Committee (SSC) held an inter-sessional meeting in April to review activities since PICES-2017 and to complete a draft of a FUTURE synthesis paper. During PICES-2018, Dr. Steven Bograd, Co-Chair of the FUTURE SSC, gave an invited talk explaining the contents of the paper, which includes four case studies of Social-Ecological-Environmental Systems (SEES) that show how the climate system and anthropogenic activities impact ecosystems and how it feeds back to society. Solutions of environmental and/or societal problems obtained by monitoring and analysis of ecosystem change are successful examples of FUTURE.

Dr. Steven Bograd giving an invited talk on FUTURE.

Since many of the scientific issues addressed by PICES are not unique to the North Pacific, PICES engages with other organizations and programs to study marine science issues and share information. One way of doing this is to hold international symposia. In April 2018, many PICES scientists returned to La Paz, Mexico, after a long hiatus to attend a PICES-led international symposium on "*Understanding changes in transitional areas of the North Pacific"*. This was the second symposium focused on Pacific transitional areas (PTAs); the first was organized by PICES in 2002, also in La Paz. More than 140 scientists from 12 countries and 6 international and regional fisheries management organizations attended. They exchanged new findings and discussed emerging as well as current issues on PTAs. A special issue of *Deep-Sea Research II* will be published shortly from papers based on presentations made at the symposium.

Prior to the PTA symposium, a PICES-Mexico Summit was held to introduce the scientific interests and activities of PICES to the Mexican scientific community and *vice versa*. Over 100 attendees, including a large number of postgraduate students and early career scientists, listened to scoping talks by PICES and Mexican scientists. Lively dialogue followed a panel discussion with many questions and comments from the audience regarding PICES-Mexican collaboration. There was common agreement that, independent from what happens in the future regarding formal membership status in PICES, Mexican scientists will continue to collaborate and interact with the PICES community.

Two months after the PTA symposium, PICES organized a second major international symposium on "*The effects of climate change on the world's oceans*" (ECCWO-4), held in Washington DC, USA, in June 2018. Major sponsors in addition to PICES were ICES, FAO and the IOC. Also, the meeting benefited greatly from the funding and strong leadership provided by NOAA as the host of the meeting. The symposium's focus was on: (1) highlighting the latest information on how oceans are changing, what is at risk and how to respond; (2) identifying key knowledge gaps; (3) promoting collaborations; and (4) stimulating the next generation of science and actions. ECCWO-4 enabled more than 600 scientists from over 50 countries to share information, build understanding and advance responses to climate impacts on oceans and the many people, businesses and communities that depend on them. A special issue of the *ICES Journal of Marine Science* resulting from papers based on presentations made at the symposium is now online.

In addition to these two major symposia, PICES was a co-sponsor of two theme sessions at the ICES Annual Science Conference (ASC) in Hamburg, Germany in September 2018, and at PICES-2018, ICES co-sponsored a topic session and a workshop. During the ICES ASC, Dr. Chul Park, PICES Chair, and I attended an ICES Science Committee meeting and discussed the ongoing strategic partnership between the two organizations. Both PICES and ICES agreed to continue on-going collaboration activities and to jointly contribute to the United Nations Decade of Ocean Sciences (2021–2030) and for Sustainable Developmental Goals (SDGs), especially for SDG14 (*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*).

Not withstanding a busy year, PICES was also active in co-sponsoring several international meetings such as the 6th International Marine Debris Conference in San Diego, USA, an NPFC/FAO Workshop on "*Protection of Vulnerable Marine Ecosystems in the North Pacific*" in Yokohama, and the 3rd WGICA Working Group on *Integrated Ecosystem Assessment for the Arctic Ocean* meeting in St. John's, Newfoundland, Canada.

In 2018, PICES received extramural funds from the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan for a capacity building project titled "*Building capacity for coastal monitoring by local small-scale fishers*" (FishGIS). This is a 3-year project that spans 2017–2020 to enhance the capacity of local small-scale fishers to monitor coastal ecosystems and fisheries in a Pacific Rim developing country using smartphone application technology. For more on this project, see the FishGIS article in this issue.

FishGIS Project Science Team MAFF meeting during PICES-2018.

As a science organization, PICES communicates the results of its activities and achievements through a range of publications, such as special issues and a theme section in peer-reviewed journals, FAO Technical Paper, PICES Scientific Reports, and outreach brochures. Links to the reports or journal publications arising from PICES expert groups and symposia/topic sessions can be found on the PICES publication page.

Capacity building was one of the priorities of Dr. Warren Wooster, the founder of PICES, and its first Chairman. Besides co-sponsoring the Pacific Ecology and Evolution Conference, organized and run exclusively by early career scientists in Bamfield, Canada in early 2018, PICES organized a Summer School on "*Coastal ocean observatory science*" hosted in Victoria by Ocean Networks Canada, in July. In October, a practical workshop on "*Production methodologies and measurements for in situ zooplankton*" was held in Yokohama just before PICES-2018. This is an activity of PICES Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions* (WG 37) to disseminate recommended methods and techniques for quantifying zooplankton production. See the following articles on all these events in this issue.

Another way to engage next-generation scientists is to provide travel grants for students and early career scientists to attend PICES Annual Meetings and symposia co-sponsored or organized by PICES. In 2018, PICES funded 20 individuals to attend PICES-2018, and over the course of the year over 80 students/ECS to various PICES co-sponsored events.

Some highlights from PICES-2018

Dr. Tomowo Watanabe, Keynote Speaker

Dr. Michael Jacox, Early Career Scientist, S1

Christina E. Kong, Early Career Scientist, S1

SM Mustafizur, Rahman, Early Career Scientist, S1

Yu-Lin Eda Chang, Early Career Scientist, S5 Plenary

Susan Allen, S7 Plenary

Spirited discussions during coffee break.

PICES scientist-endorsed sweet eats.

Group photo of Yellow Sea Fisheries Research Institute attendees.

Young (potential) scientists had a chance to attend the Welcome Reception with their parents. Left: Midori Sugisaki with dad, Hiroya, and right: Jake with mom, Jackie King.

A large turnout at the Welcome Reception.

Oregon State University members and alumni going through the steps to spell out "OSU" at the Welcome Reception.

Sharing some light moments during the Meeting

Sinjae Yoo and Peter Chandler

Mr. Shigeto Hase, Director-General of the Japan Fisheries Agency and Executive Secretary, Mr. Robin Brown.

Tetsuo Fujii and Christina Chiu.

Ryan Rykaczewski and Jennifer Fisher

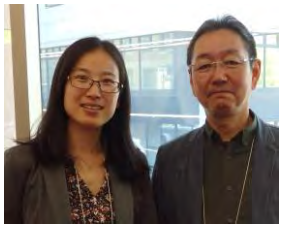
Yury Zuenko and Hiroaki Saito

PICES Chair, Dr. Chul Park

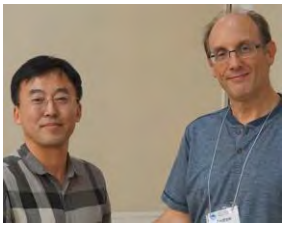
Georgiy Moiseenko and Igor Shevchenko

Chuanlin Huo and Xianshi Jin

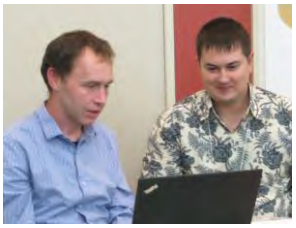
Fei Chai and Hiroaki Saito



Jinqiu Du and Toyomitsu Horii



Newly elected MEQ Chair, Guangshui Na and Vice-Chair, Andrew Ross



Eddy Kennedy and Vladimir Kulik. SG NPFC

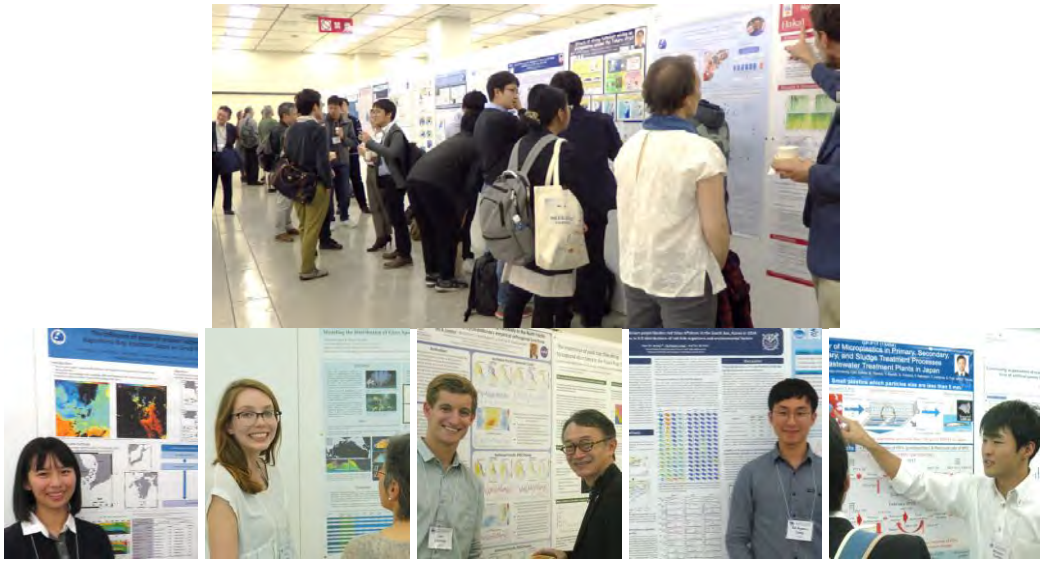
Sukyung Kang and Steven Bograd, FUTURE SSC

Jongseong Ryu, Keun-Hyung Choi and Sung Yong Kim

Hee-Dong Jeong and Joon-Soo Lee

Charles Hannah, S. Kim Juniper and Mei Sato

Poster Session



Early career scientists showing their results at the Poster Session. Bottom panel from left: Kei Nakaya (Japan), Fiona Davidson (Canada), Lev Looney (USA), Se Hyeon Jang (Korea) and Masaki Kakita (Japan).

Sporting Event at PICES-2018

Spectators waiting with bated breath as Kirsten Holsman takes careful aim during the fan tossing competition, sport of the host country for this Annual Meeting (left), a team photo (middle), and audience reaction to Elliott Hazen's kimono modelling (right).

Irina Ishmukova, Olga Bychkova, Vladimir Radchenko, Vyacheslav (Slava) Lobanov and wife Alisa, Alex Bychkov, and Svetlana Radchenko enjoying a glass of wine at the Chairman's Reception.

Yokohama skyline at night.

As mentioned above, two-way communication between scientists and society is essential for making wise decisions for adapting and mitigating the impacts of global changes based on scientific evidence. The title of the 28th PICES Annual Meeting (PICES-2019) is "*Connecting science and communities in a changing North Pacific*", which will be held in Victoria, Canada, this October. I look forward to seeing you in Victoria and at other venues of PICES-hosted events in 2019.

Hiroaki Saito
Science Board Chair

PICES awards in 2018

Presentations of PICES awards took place on October 29, 2018 during the Opening Session at PICES-2018 in Yokohama, Japan.

PICES Chair Award

The establishment of the PICES Chair Award was approved at the 2016 inter-sessional Governing Council (GC) meeting. It is given for sustained contributions to the development of the Organization that have allowed it to meet the purpose as set out in the Convention. The 2018 award presentation ceremony began with Dr. Chul Park (Chair of PICES) introducing the award and announcing the first recipient.

I am pleased to announce that Dr. Tokio Wada is being recognized with the PICES Chair Award for his "sustained contributions to the development of the Organization".

Dr Wada has been involved with PICES since the beginning — he was a founding member of the Fisheries Science Committee (FIS) at the first PICES First Meeting in 1992. He subsequently served PICES in many capacities including: Co-Chair of the Working Group on Dynamics of Small Pelagics in Coastal Ecosystem (WG 3; 1992–1995), Co-Chair of the Regional Experiments Task Team (REX) of the CCCC program), and Co-Chair of the Working Group on Climate Change, Shifts in Fish Production, and Fisheries Management (WG 16; 1999–2001). From 1999 to 2003 he served as an Advisor for the Japanese National Delegates. During 2003–2004 he was a member of the Study Group on Ecosystem-based Management Science and its Application to the North Pacific. At the 2004 Annual Meeting he was an advisor for the Japan Delegation, and was nominated and seconded as Vice-Chairman by the USA and Russia, respectively. Aside from the first Annual Meeting, this might be the only time that a non-delegate was elected to be one of either of the top two positions. This is a testament of the respect that the GC members had for Dr. Wada. He served as Vice-Chairman of GC from 2004 to 2006, and as Chairman from 2006 to 2010. During and after his Chairman duties, he chaired the Study Groups on Restructuring the PICES Annual Meeting and Updating the PICES Strategic Plan, and was a member on two other study groups that looked at PICES Rules of Procedure and Financial Regulations, and the most recent Revision of the Strategic Plan. He led the creation of the PICES Ocean Monitoring Award (POMA), and was important in arranging funds from the Ministry of Agriculture, Forestry and Fisheries of Japan to enable PICES to undertake new activities, and develop scientific capacity for detecting and controlling harmful and invasive organisms in the North Pacific.

After Dr. Wada accepted the Chair Award, Dr. Park continued:

We are not done yet… Council is very pleased to make another award — to Dr. John Stein.

John Stein has held a formidable number of key leadership positions within PICES over the 24 years, from 1993 until 2017, when he retired from NOAA.

He never missed a PICES Annual Meeting during that time. Parenthetically, he was also a regular for the small group that would find a place to swim in salt (and usually very cold) water near the PICES Annual Meeting.

Dr. Stein, during the early years, was an active NOAA scientist working on environmental quality (marine pollution, etc.), and his activities in PICES reflected these science interests. These activities required significant commitment of John's time, which he managed well even as he rose from the science ranks in NOAA Fisheries to becoming director of the Northwest Fisheries Science Center (NWFSC). John's roles in PICES spanned being a member or Co-Chair of working groups, to becoming a member of MEQ (for 11 years), serving as Chair of MEQ, becoming the first Vice-Chair of Science Board, and eventually Science Board Chair. While Science Board Chair, John led the Study Group on Future Integrative Science Programs and was integral to the FUTURE Science Plan Writing Team that outlined the basis of the FUTURE Integrative Program that PICES now has. After "graduating" from Science Board in 2010, he didn't rest on his accomplishments—instead he became the Chair of the Finance and Administration (F&A) Executive Committee and a GC delegate from the USA. At the time of his retirement from NOAA and PICES, he was the Vice-Chair of PICES. In addition to the above-mentioned contributions, one of John's final achievements was as a member of a Study Group that completed an updated PICES 2015 Strategic Plan. He challenged the SG to be aspirational rather than prescriptive by posing broader questions of what the Strategic Plan should be.

Dr. Wada's statement:

> *It was a great honor and pleasure for me that I could receive the PICES Chair Award with Dr. John Stein, my longtime colleague. I would like to express my sincere thanks to all the researchers and administrative officials who worked together with me. I would also*

extend my deepest appreciation to the Ministry of Foreign Affairs, the Fisheries Agency, and the Fisheries Research and Education Agency of Japan which have understood and supported my activities at PICES.

Marine science is a big science, and cooperation between governments and scientific disciplines is necessary to promote it. On the other hand, science is a humanistic activity, so collaboration is possible only when there is mutual understanding and trust among various stakeholders.

In order to establish PICES, a long approach period to overcome the East–West confrontation and conflict on fishery resources was necessary. When thinking about this, I think that the function of PICES to foster human relationships is due to a foresight of the founders of PICES and their legacy to the next generation.

As a person who benefited from this legacy, and if my activities have been of use even a little in passing the legacy to the next generation, it is unexpected pleasure. I sincerely hope that PICES will continue to be a place to foster friendship and develop mutual trust for young people gathering there.

Dr. Stein's remarks:

It is a special honor to receive the PICES Chair Award, and I thank all of the PICES family for this honor. To all of my U.S. colleagues — working with you in PICES is a high point in my career in NOAA.

PICES offered me and offers all of us the great opportunity to make connections and friends with scientists across the North Pacific. I have made many acquaintances and established friendships with colleagues from all the member countries that have lasted for many years and will last for many more.

It is a great pleasure to receive the PICES Chair Award along with Tokio Wada, a good friend and a great leader in PICES. It is particularly an honor that we both receive the award here in Yokohama, Japan, along with the memories of the previous Annual Meeting held here.

There is life after PICES and after NOAA, and I have embarked on doing what I can on a more local regional scale in the Pacific Northwest. While retirement is going well, what I miss a great deal is PICES. The mission and people are what make PICES special. My challenge to all of you is to make the most of your time here, and I predict you will come to treasure it.

A bit of reflection and history. As with any new organization, the early years had their challenges, some quite trying, but we worked through them. By working to build trusting relationships and strong scientific collaboration across PICES we now have connections across the North Pacific that are strong and productive. Recognize the success, build on that success and continue to address the pressing issues through good science.

In closing, the recognition from my PICES family is an immense honor. I'm humbled by it and it truly means a great deal to me.

2018 Chair Award recipients, Dr. Tokio Wada and Dr. John Stein.

PICES Chair Award recipients

2016	Richard Marasco; Alexander Bychkov
2018	Tokio Wada; John Stein

Wooster Award

The Wooster Award presentation ceremony was conducted by Dr. Hiroaki Saito (Chair of Science Board). Dr. Saito announced that the 2018 Wooster Award was being given to Dr. Vyacheslav B. Lobanov (V.I. Il'ichev Pacific Oceanological Institute (POI), FEB RAS), and read the following Science Board citation which was accompanied by a slide show dedicated to Dr. Lobanov:

In 2000, PICES Governing Council approved the establishment of an award named in honour of Professor Warren S. Wooster, a principal founder and the first Chairman of PICES, and a world-renowned researcher and statesman in the area of climate variability and fisheries production. The criteria for selection are: sustained excellence in research, teaching, administration or a

combination of the three in the area of North Pacific marine science. Special consideration is given to individuals who have worked in integrating the disciplines of marine science, and preference is given to individuals who were or are currently actively involved in PICES activities. Please join me in congratulating the recipient of the 2018 Wooster Award, Dr. Vyacheslav (Slava) B. Lobanov.

Dr. Slava Lobanov is the Director of the V.I. Il'ichev Pacific Oceanological Institute (POI), Far Eastern Branch, Russian Academy of Sciences, the leading Russian marine institute for Pacific studies. Slava is a world-renowned oceanographer who has spent a productive career advancing our understanding of North Pacific oceanography and promoting international collaboration in marine science. He has long been a leader in PICES, serving as Chair of POC—the first Russian Chair of a committee. He also is a Co-Chair of AP-CREAMS, a member of the FUTURE Scientific Steering Committee, a member of the MONITOR Committee and a member on several Working Groups. Throughout his 40-year career, Slava has exemplified high standards of scholarship, mentorship of young scientists, and promotion of international collaboration in the marine sciences. We are very pleased to honor Dr. Lobanov with the Wooster Award.

Dr. Slava Lobanov was born in Leningrad, USSR (now St. Petersburg). He has one sibling—a younger sister. As we see [referring to slide]*, Slava had a very loving family, who dressed him appropriately for the Russian weather—shorts for triking with mom, and heavier clothing for skiing with dad. Slava had a happy childhood growing up in Leningrad in the 1950s and 1960s. And he developed an interest in the sea – and the things that lived in it – from an early age. Here* [referring to slide], *a young Slava is conducting ecosystem research on the banks of the Volga River. But Slava had other interests as well. As a young man, Slava dreamed of being a rock musician. And he is still making music. Here* [referring to slide]*, Slava is singing in the Russian chorus at the PICES Annual Meeting in Hakodate.*

In 1980, Slava met the love of his life, Alica, and married her in 1981. Alica is the artistic one in the family, working as an architect and designer. Slava has been known to consult Alica on his oceanographic figures for his presentations. In 1982, two became three when their lovely daughter Polina was born. Slava is a loving husband to Alica and father to Polina ... And is now also a very proud grandfather to little Miloslava.

Slava's love of the ocean led him to the Department of Oceanography at Leningrad State University, where he graduated in 1977. The late 70s was an exciting time to be in oceanography, as it was an era of large-scale field experiments like POLYMODE and POLYGON, and Slava spent many days in the stormy Greenland Sea.

Following his studies, Slava underwent a long migration, all the way out to the new Pacific Oceanological Institute in the Far East, where he was hired as a Junior Researcher. He has remained at POI in Vladivostok ever since, earning a Ph.D. in Oceanography in 1993, and remaining very active in both Russian and international oceanographic expeditions. It was during these years that Slava developed a strong interest, and expertise, in mesoscale features such as Kuroshio warm-core rings and the large anticyclonic eddies around the Kuril Islands, in the water exchange between the Okhotsk Sea and the Pacific, in water mass transformations, and in the dynamics of the East Asian Marginal Seas.

Slava established himself as a premier sea-going oceanographer. He spent many days at sea ... on ships from many nations, with long cruises to exotic seas from Kamchatka to Australia, and from California to the Mediterranean. Although he seems to be a little over-dressed for this cruise! [referring to the presentation slide]

Slava has had a storied career at POI. He worked his way up from Junior Researcher to Researcher to Senior Researcher, and was named Deputy Director in 1995. Since 2015, Slava has been the Director of the POI, the leading oceanographic institute in the Russian Pacific. Some of his more highly cited papers published in English are shown here [presentation slide]*, and reflect the collaborations he has developed with Russian, Korean, and U.S. scientists to study the oceanography of the East Asian Seas.*

Slava's stature as a leading oceanographer is reflected in the many leadership roles he has played, and continues to play, in the international oceanographic community. In addition to his leadership roles in PICES, he is Chairman and National Coordinator of the IOC/WESTPAC Coordinating Committee for NEAR-GOOS, has been on the Board of Directors and is currently President-Elect of the Pacific Congress on Marine Science and Technology, and is on the Steering Committee of the Program of East Asian Seas Collaborative Experiments. He has contributed to many expert groups in PICES.

Dr. Lobanov has shared his expertise as a teacher and mentor to young scientists throughout the Pacific Rim. Here [presentation slide] *he lectures at the Remote Sensing Course held in Vladivostok in 2011. Slava has a faculty appointment at the Far Eastern Federal University, where he advises students and organizes the 'Pacific Floating University' course to give students at-sea experiences. Two of Slava's students have been awarded Best Presentation awards at PICES Annual Meetings.*

Slava has been an active member of PICES since 1993. The next few slides show photos of Dr. Lobanov at several PICES events. Clearly, he is someone who is regularly sought out for scientific discussions, or just to enjoy a drink.

This abstract art is a portrait of Slava created by Prof. Yutaka Nagata. [referring to slides]

For all of his scientific accomplishments, Slava has remained a fun-loving and easy-going friend and colleague. Please join me once again in congratulating Dr. Slava Lobanov as the recipient of the PICES 2018 Warren S. Wooster Award.

A slide show of Dr. Lobanov's Wooster Award nomination can be viewed here.

Dr. Vyacheslav B. Lobanov, 2018 Wooster Award recipient, with Dr. Hiroaki Sato (Science Board Chair).

Dr. Lobanov accepted the award with the following remarks:

I would like to thank PICES for this very important award. I am especially glad to receive it here in Japan, the country where I met PICES for the first time 25 years ago. These two and a half decades are a long and important part of my life. I learned much by being involved in PICES activities. I have always felt strong support from PICES people. We are like a big family. I have enjoyed this time very much.

International collaboration is essential for the progress of oceanography. The ocean has no borders. Since the time of perestroika in Russia I have been supporting various international programs and organizations to make my country an active part of global oceanographic community. This is mutually beneficial.

Prof. Warren Wooster made an outstanding contribution to the development of international marine science by leading IOC-UNESCO, SCOR, ICES and establishing PICES. These organizations created a spirit of trust and understanding between people of different nations even though they speak different languages. This has resulted in a good collaboration and friendship among them.

It is a great honor for me to receive the Wooster Award. I would like to thank PICES, all my friends there, my Russian colleagues and my family for the tremendous support over all these years.

Wooster Award recipients

2001	Michael Mullin (USA)
2002	Yutaka Nagata (Japan)
2003	William Pearcy (USA)
2004	Paul LeBlond (Canada)
2005	Daniel Ware (Canada)
2006	Makoto Kashiwai (Japan)
2007	Kenneth Denman (Canada)
2008	Charles Miller (USA)
2009	Kuh Kim (Korea)
2010	Jeffrey Polovina (USA)
2011	Bernard Megrey (USA)
2012	Richard Beamish (Canada)
2013	Vera Alexander (USA)
2014	Fangli Qiao (China)
2015	Anne B. Hollowed (USA)
2016	Sei-Ichi Saitoh (Japan)
2017	Suam Kim (Korea)
2018	Vyacheslav B. Lobanov (Russia)

PICES Ocean Monitoring Service Award

Progress in many aspects of marine science is based on ocean observations, monitoring, and management and dissemination of data. In 2007, a PICES Ocean Monitoring Service Award (POMA) was established to recognize the sustained accomplishments of those engaged in these activities.

Dr. Saito conducted the POMA presentation ceremony and read the following Science Board citation [reading of the citation was accompanied by a slide show describing the award recipient]:

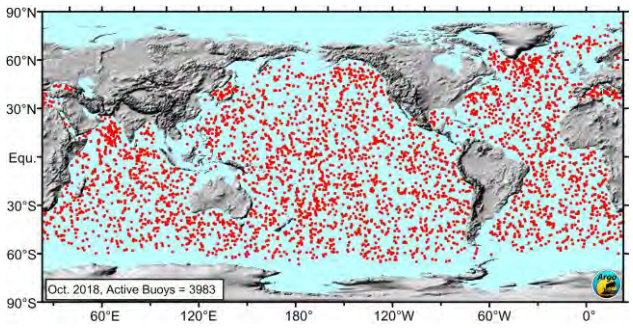
The PICES Ocean Monitoring Service Award (POMA) recognizes organizations, groups and outstanding individuals that have contributed significantly to the advancement of marine science in the North Pacific through long-term ocean monitoring and data management. The award also strives to enlighten the public on the importance of those activities as fundamental to marine science. It draws attention to an important aspect of the PICES Convention

that is less appreciated: "to promote the collection and exchange of information and data related to marine scientific research in the area concerned".

Please join me in congratulating the recipient of the 2018 POMA Award, which is the International Argo Steering Team.

The history of Argo

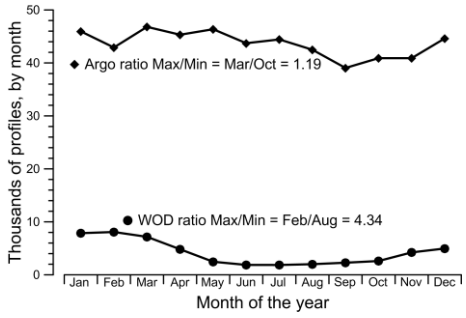
The Argo concept was approved at the OceanObs meeting in 1999, and the Argo Steering Team met for the first time in 2001. Looking at 137 floats in the oceans in January 2001 it was hard to imagine this becoming a global array. The array grew rapidly achieving 1000 operational floats in January 2004. By September 2005 there were more than 2000 floats operating. And in November 2007 the original target of 3000 floats was achieved. At this point growth in the size of the array slowed, but profiles were being gathered at an unprecedented rate. In December 2008 with 3236 floats in the water, the half-millionth profile was acquired. In October 2012, the one-millionth profile was acquired. The array has continued to grow, albeit slowly, and in January 2016 the count of active floats exceeded 4000. Around the 10th of November 2018, the number of profiles acquired will exceed 2 million.



The number of Argo profiles is impressive. But a greater accomplishment is the suppression of the "summer bias" in the Southern Ocean…

Greatly reduced seasonal bias in the Southern Ocean

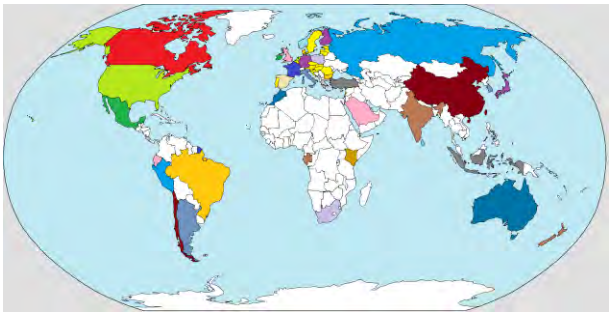
Argo floats do not get sea-sick and last a long time, the most recent versions offering lifetimes exceeding 7 years.



Seasonal variation in the number of profiles divided, for (below) the World Ocean Database compared with (above) Argo, a ratio summer divided by winter ratio of 4.3 is reduced by Argo to 1.2.

International cooperation

Global targets like these by Argo can only be achieved with exemplary international cooperation. So far 30 nations have deployed floats in support of Argo, and that includes all six PICES member countries.



Argo continues to evolve

It has always been seen as a problem that Argo floats sampled only the top 2000 metres of the ocean, but we now have a small, but growing, number of floats capable of sampling much deeper to either 4000 or 6000 meters. The Deep-Argo program is a reality.

Also a reality is the Bio-Geochemical Argo array, which this year received the blessing and approval of the Intergovernmental Oceanographic Commission. All floats still sample temperature and salinity, but many now carry a wide array of BGC sensors—such as pH, nitrate, chlorophyll and oxygen. PICES should note both the under-representation of the North Pacific in the BGC array and the lack of plans to address this deficit.

There is a hopeful sign in an announcement from the Government of Canada to invest heavily in BGC Argo. This is in response to a recent meeting of the G7 Environment Ministers.

Data system

All Argo nations have agreed to a single, uniform data policy. All data are supposed to be delivered in near real-time (in practice, 90% of profiles are delivered within 24 hours of acquisition). All data are available to anyone on the planet in a common data format and with a common approach to real-time and delayed-mode quality control.

Data demand

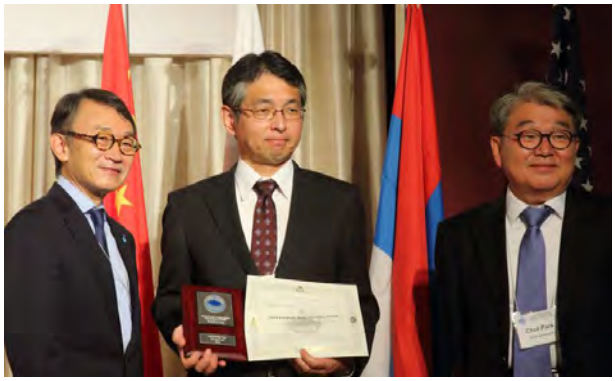
With such extensive coverage of samples and the data readily available, it should come as no surprise that Argo data are heavily used. There are so many scientific accomplishments attributable to Argo that it does not seem realistic to start listing them. We just note that as the array grew, so did the use of Argo data. From 2015 onwards, papers that incorporate Argo data are being published faster than one per day. Next week the 6th Argo Science Workshop will take place in Tokyo, not far from here. There will be an opportunity to celebrate the upcoming 2-millionth profile.

A slide show of the Argo nomination can be viewed here.

Dr. Toshio Suga, Professor of Physical Oceanography at Tohoku University, and Co-Chair of the International Argo Steering Team, accepted the award on behalf of the Steering Team with the following remarks:

I am greatly honored and also humbled to accept the PICES Ocean Monitoring Service Award on behalf of the International Argo Steering Team. Argo is an international program to deploy and maintain the global array of profiling floats and ensure the timely data delivery through its elaborated data system. It would never have been achieved without the continuous efforts by all the Argonauts from about 30 participating countries and their strong international cooperation. Because of that, this award is for the whole Argo community.

This award appears very timely because 2018 will be remembered as a milestone year for the International Argo Program. Argo is reaching 4,000 operational floats and two million profiles will be achieved during this year. Furthermore, the Intergovernmental Oceanographic Commission of UNESCO formally approved the global implementation of Biogeochemical Argo early this year. Such a major extension requires increased engagement with wider communities, including ecosystem science and fisheries science. The Argo program is expecting PICES' leadership in this regard. I believe this award will give momentum to stronger future collaboration between Argo and PICES. Thank you very much.



Dr. Toshio Suga, Co-Chair of the International Argo Steering Team accepting the POMA from Science Board Chair, Dr. Hiroaki Saito (left) and PICES Chair, Dr. Chul Park.

PICES Ocean Monitoring Service Award recipients

2008	T/S *Oshoro-maru* (Japan)
2009	Dr. Bernard Megrey and Mr. Allen Macklin, leaders of the PICES Metadata Federation Project (USA)
2010	Station P/Line P Monitoring Program (Canada)
2011	Network of Serial Oceanographic Observations (Korea)
2012	California Cooperative Fisheries Investigations (USA)
2013	A-line Monitoring Program (Japan)
2014	Trans-Pacific Volunteer Observing Ship (VOS) Survey Program (Japan)
2015	TINRO-Centre Macrofauna Inventory (Russia)
2016	JMA 137°E Repeat Hydrographic Section (Japan)
2017	Newport Hydrographic Line (USA)
2018	International Argo Steering Team

We congratulate the 2018 Award recipients, Dr. Tokio Wada and Dr. John Stein (PICES Chair Award), Dr. Vyacheslav Lobanov (Wooster Award), and Dr. Toshio Suga (POMA) of the International Argo Steering Team.

Call for Wooster Award, POMA, and PICES Chair Award nominations for PICES-2019

We are now soliciting nominations for the Wooster Award and the PICES Ocean Monitoring Service Award. The closing date for Wooster Award and POMA nominations is **March 31, 2019**. Closing date for the PICES Chair Award is **July 30, 2019**. The awards will be presented during the Opening Session of PICES-2019 in Victoria, Canada.

Send your nominations to the PICES Executive Secretary with the following information:
nominee's name and title, institution affiliation and address, CV, and statement of justification for the nomination.

ECCWO-4 Workshop on "*Intercomparison of fisheries and marine ecosystem models*"

by Tyler Eddy, Olivier Maury and Eric Galbraith

A one-day workshop (W10) held June 3, 2018 during the 4th International Symposium on "*The effects of climate change on the world's oceans*" (ECCWO-4) in Washington, DC, USA was convened by the coordinators and members of the Fisheries and Marine Ecosystem Model Intercomparison Project (Fish-MIP), with attendees being made up of existing Fish-MIP members, new members who were added to the group during the workshop–welcome!– as well as interested non-members. The workshop included 10 informal oral presentations and one poster presentation.

The goal of Fish-MIP is to provide a standardized approach for climate change projections for the oceans. Within Fish-MIP, we have 10 different global fisheries and marine ecosystem models, as well as five different regional models for 10 different regions. Different models can give very different projections about the future of fish and fisheries under climate change, and the goal of Fish-MIP is to explore the sources of uncertainty. These sources of uncertainty arise from input data including biogeochemical and ecosystem forcing data such as sea surface temperature and net primary production, socio-economic scenarios of fishing effort or mortality, and emissions scenarios. Fisheries and marine ecosystem models are another key source of uncertainty, as they range greatly in their structure, scale, and assumptions, as the number of size classes/trophic groups/species represented by Fish-MIP models for the global ocean ranges from three to more than one thousand. Due to the large heterogeneity in model structure, models produce very different outputs, and we also had to standardize to the lowest common denominator (three different size classes of fish). From the outset, Fish-MIP has always been an open group, welcoming new members who are interested to participate. All of the input and output data from Fish-MIP are open access and we have published our protocol on our website (https://www.isimip.org/) and in a scientific journal (*Geoscientific Model Development*, Tittensor *et al*., 2018). The goal of W10 was to provide modellers a chance to share their climate change projection results and provide an opportunity for discussion.

Eric Galbraith, one of the Fish-MIP global model coordinators, and developer of the BOATS (BiOeconomic mArine Trophic Size-spectrum) model, gave the opening talk which was an overview of Fish-MIP–now five years old–the key results that we have found so far, and the steps that we are working toward. Andrea Bryndum-Buchholz is a PhD student and has been working with Fish-MIP model output from global models, and gave a talk about climate change projections in different ocean basins. Olivier Maury is a developer of the size-based APECOSM (Apex Predators ECOSystem Model), which is a Fish-MIP participating model, and gave a talk about projections and challenges of using the Fish-MIP protocol. Colleen Petrik has been working with another size-based approach called POEM (Princeton Ocean Ecosystem Model) and presented the model and its potential participation in Fish-MIP. John Pinnegar, the invited speaker, has been involved in a complementary model intercomparison project at the European scale called the CERES (Climate change and European Aquatic Resources) project, and has been working to develop socio-economic scenarios for future fisheries. This approach is roughly analogous to translating the shared socioeconomic pathways to the oceans. Fish-MIP has been interested in incorporating more detailed future fishing scenarios and there was discussion about how to scale up the European-focused scenarios to a global scale. Cheryl Harrison was the next speaker and was one of the new Fish-MIP members who joined the team during the workshop. Cheryl spoke about a method to predict fisheries catch using a metric derived from CMIP (Coupled Model Intercomparison Project) output. We look forward to having Cheryl and her biogeochemical modelling expertise on the team! Next up was Hubert Du Pontavice and Didier Gascuel presenting the EcoTroph trophic level modelling approach. Hubert is a PhD student and both he and Didier joined Fish-MIP during the workshop and are keen to use the Fish-MIP approach with EcoTroph. Ricardo Oliveros-Ramos has been involved with Fish-MIP since the beginning and presented results from his regional OSMOSE size-based model for the Humboldt Current. One issue that we have encountered in Fish-MIP is the poor coastal resolution covered by the one-degree grid from CMIP output, and Ricardo presented a statistical downscaling approach to impute data for the coastal margin.

Dr. Beth Fulton discussing results from Fish-MIP runs.

Next up was Beth Fulton who presented results from Fish-MIP runs for both her Atlantis model and Cathy Bulman's Ecopath with Ecosim model for southeast Australia. Both Beth and Cathy have been active Fish-MIP members from the outset. Thibaut de la Chesnais presented his poster on the role of cephalopods in marine ecosystems. Tyler Eddy presented last about the lack of agreement in projections by regional vs. global models for a given region and provided reasons that might account for these differences. This prompted a discussion about limitations of different types of models, what input data would improve projections and reduce variation in projections among model types, and ways to address these issues. [These topics were taken up at a Fish-MIP workshop that took place at the ICM in Barcelona in early October 2018.]

Overall, the one-day workshop was a great opportunity for existing Fish-MIP members to update with their progress, but also to welcome a number of new members to the group and hear about their research plans.

Attendees at W10 on "Intercomparison of fisheries and marine ecosystem models".

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Dr. Tyler Eddy (tyler.eddy@sc.edu) is a Nippon Foundation Nereus Program research fellow working at the University of South Carolina. His interests include the impacts of coastal resource use on marine ecosystems in the past, present, and future, and he employs a range of ecological and statistical modelling techniques to understand relationships between fishing, climate change, and marine ecosystems. He is currently a visiting scientist at Dalhousie University, Canada, the University of British Columbia, Canada, and the Charles Darwin Foundation, Galápagos, Ecuador, and the founding regional coordinator for Fish-MIP, based at the Potsdam Institute for Climate Impact Research (PIK), Germany.

Dr. Olivier Maury (olivier.maury@ird.fr) is a marine ecologist, population and ecosystem modeler at l'Institut de recherche pour le développement (IRD). Most of his present research time is dedicated to the development of the DEB-based ecosystem model APECOSM, which represents individual-based populations and ecosystems from plankton to fish and fisheries at global and regional scales and includes climate forcing. He is presently an ex officio member of the CLIOTOP Scientific Steering Committee (2013-), a member of the SCOR-France Scientific Committee (2006-) and co-chair of the CLIOTOP-EurOceans Scenarios Working Group, and a member of the Fish-MIP international model inter-comparison project.

Dr. Eric Galbraith (eric.galbraith@icrea.cat) is a Research Professor at Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain. His research is broadly interdisciplinary, and is generally concerned with using numerical models and data analysis to better understand the interactions between climate change, human activities and the marine ecosystem. His current research focuses on methods for including fishing activity as an integral part of marine ecosystem models, to better understand linkages with biogeochemistry and to inform future projections. He is a founding coordinator of the fisheries and marine ecosystem model intercomparison project (Fish-MIP).

The PICES–MAFF-sponsored Project on "*Building capacity for coastal monitoring by local small-scale fishers*" (FishGIS): Mobile phone-based monitoring technology and training workshop

by Shion Takemura, Shigeharu Kogushi, Mark Wells and Mitsutaku Makino

The overall goal of a 3-year (2017–2020) PICES project on "*Building capacity for coastal monitoring by local small-scale fishers"* (FishGIS), funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, is to enhance the capacity of local small-scale fishers to monitor coastal ecosystems and coastal fisheries in Pacific Rim developing countries. Indonesia was chosen as a country to implement the project, and our local counterpart is Prof. Suhendar I. Sachoemar of the Agency for the Assessment and Application of Technology (BPPT) who works in close cooperation with the Ministry of Maritime Affairs and Fisheries (MMAF), Indonesian Institute of Science (LIPI), and local governments of Muara Gembong, Indramayu, and Banten.

Key questions of the project are: a) How do global changes in climate and economy affect coastal ecosystems? and b) How can enhanced capacities for monitoring activities by local fishers help to improve fisheries management in coastal areas? The project is expected to interact with, and support relevant activities of PICES Scientific Committees on Human Dimensions (HD) and Fishery Science (FIS), PICES Technical Committee on Monitoring (MONITOR), and PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Ecosystems) Program (specifically, Research Theme 3 on "How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?"). The project is being directed by the Project Science Team (PST), and all PICES member countries and all above mentioned groups are represented on the PST co-chaired by Drs. Mitsutaku Makino (Fisheries Research and Education Agency, Japan) and Mark Wells (University of Maine, USA).

Mobile-phone-based technology for local fishers

In March 2018, we visited three communities in Indonesia to discuss the concrete design of this project with local people (see Makino and Wells's article, pp. 20–24 in PICES Press, Vol. 26, No. 2, 2018). Based on these discussions, it was decided to introduce new easy-to-use technologies for the local communities to monitor the following 5 items: 1) aspects of water quality (suspended sediments, chlorophyll), 2) phytoplankton community composition, with emphasis on harmful algal bloom (HAB) species, 3) fish landings, 4) illegal fishing vessels, and 5) floating garbage. These items are expected to be monitored by local people (mainly fishers) in close collaboration with Indonesian scientists, as described below.

The water quality assessment application HydroColor (Apple App Store, Google Play Store, Facebook Page) employs a similar methodology as precision radiometers and Ocean Color satellites to estimate three key water quality parameters: turbidity (NTU), suspended particulate matter (g/cm^3), and chlorophyll concentrations (when calibrated). Three images are collected using a smartphone camera (Fig. 1). The first is an 18% photographer's grey card to calibrate the camera, the second is the incoming (sky) radiation, and the third is the light leaving the water surface. The application uses internal GPS, compass, gyroscope, and clock to compute the position of the sun, and with this information it directs the user to hold the smartphone at the correct angles where sun glint off the water surface is minimal and at 135° from the azimuth angle of the sun (Fig. 2). This ensures the image is either taken at 40° (for the water image) or 130° (for the sky image) from nadir.

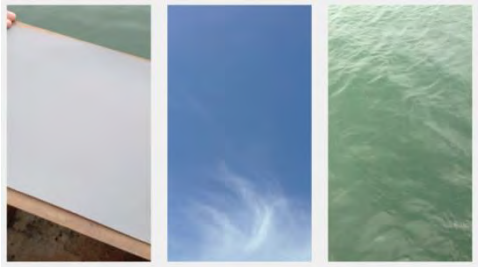

Fig. 1 Example images of the 18% photographer's grey card (left), the sky (middle), and the water surface (right) collected by a HydroColor user for calculating the remote sensing reflectance (http://misclab.umeoce.maine.edu/research/HydroColor.php).

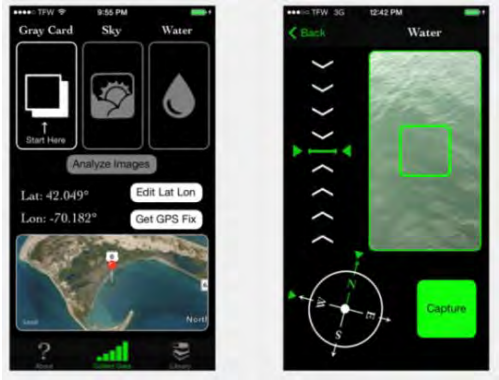

Fig. 2 The HydroColor user interface showing the prompts for the three images: grey card, sky, and water (left). On selecting the image, the screen changes to display the inclinometer and compass to guide the user to the correct smartphone angle to capture the image (right). When the green elements of the compass and inclinometer are properly aligned with the green triangles, the capture button turns green enabling the photo to be taken.

Table 1 The parameters derived by HydroColor along with the estimated uncertainty for each method (http://misclab.umeoce.maine.edu/research/HydroColor.php).

Parameter	Equation	Source	Uncertainty
Remote Sensing Reflectance	$R_{rs} = \frac{L_{water} - 0.028 L_{sky}}{\frac{\pi}{0.18} L_{card}}$	Mobley 1999	±15% (mean absolute relative error from figure 4, for all channels)
Turbidity	$Turbidity = \frac{27.7 R_{rs}(Red)}{0.05 - R_{rs}(Red)}$	Figure 5	±36% (mean absolute relative error from figure 5)
Suspended Particulate Matter	$log_{10}(SPM) = 1.02 log_{10}(Turbidity) - 0.04$	Neukermans et al. 2012	±38% (propagation of error in turbidity and the relationship between turbidity and SPM)
Backscatter Coefficient	$r_{rs} = 0.0949(\frac{b_b}{b_b + a_p + a_w}) + 0.0794(\frac{b_b}{b_b + a_p + a_w})^2$ Solved for b_b assuming constant a_p^*	Gordon et al. 1998	±41% (propagation of error in SPM and R_{rs})

When the incoming radiation is normalized, it is proportional to the water backscattering coefficient and inversely proportional to the water absorption coefficient. Any increase in turbidity then will increase the intensity of light returning from the water. Phytoplankton and other particles containing pigments alter the color emanating from the water, which can be estimated from the ratios of radiance at different wavelengths. Colored dissolved organic matter (CDOM) absorbs light with only negligible scattering, decreasing the intensity of light emanating from water. HydroColor saves the remote sensing reflectance data and estimates of turbidity, suspended particulate matter, and the backscatter coefficient (Table 1) as well as the three images, and these are uploaded to a central server at BPPT when cellphone coverage is strong.

HydroColor provides high technology but simple methodology for accurate measurement of remote sensing reflectance data. It is available for both Android and iPhone products, and has been translated into Indonesian Bahasa for community member use.

The second technology being used in the project aims at collecting phytoplankton community composition data and, in particular, the presence of toxin-producing dinoflagellates. This effort utilizes Foldscopes: origami-based microscopes for the masses (https://www.foldscope.com). Foldscopes are ultra-affordable ($3 USD) durable field microscopes that give remarkably high optical qualities similar to those of standard research microscopes. Foldscopes can provide optical magnifications of 140× with resolutions down to 2 µm. They can be attached to any smartphone, and the camera then can be used to collect still images or videos of swimming phytoplankton, which can be a taxonomic diagnostic. The image quality is remarkably good, and with little training it is possible to obtain high quality images that then are uploaded to a central server. The project is collaborating closely with LIPI which is the central organization responsible for HAB monitoring in Indonesian waters. Initially, images collected by community members will be sent to LIPI staff for manual examination. These communities harvest bivalves from coastal waters for consumption, and LIPI currently lacks the personnel to monitor the presence of toxins or HAB species. The Foldscope program enables LIPI to provide this service to the participating communities.

For monitoring fish landings, the project has developed a new smartphone application software named "FishGIS App" (Fig. 3). Using this software, local fishers can take photos of their catch with additional information such as location, gear used, species, and catch trends (size and amount). This information will be then used for the preliminary stock assessment by local fisheries researchers, and shared with the local community.

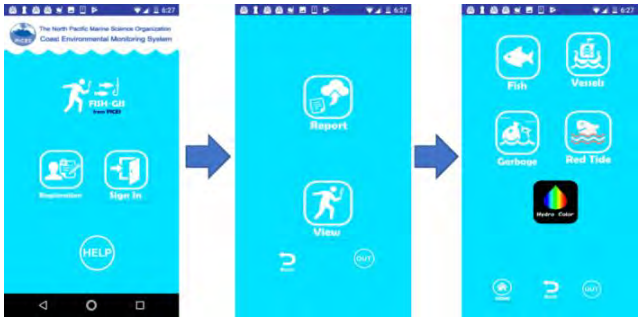

Fig. 3 The FishGIS App user interfaces: user registration (left), top menu (center), and monitoring items (right).

The local fishers follow fisheries rules such as national laws, local regulations, traditional norms, religious taboos, *etc*. However, illegal or unregulated vessels sometimes violate such rules. The FishGIS App can be used to take a photo and record the date and location of such vessels, and share this information with the local community and governmental authorities. Another very serious problem for coastal communities is floating garbage, and the FishGIS App can also be used to record the abundance and location of garbage to enable clean-up as well as to monitor changing community practices.

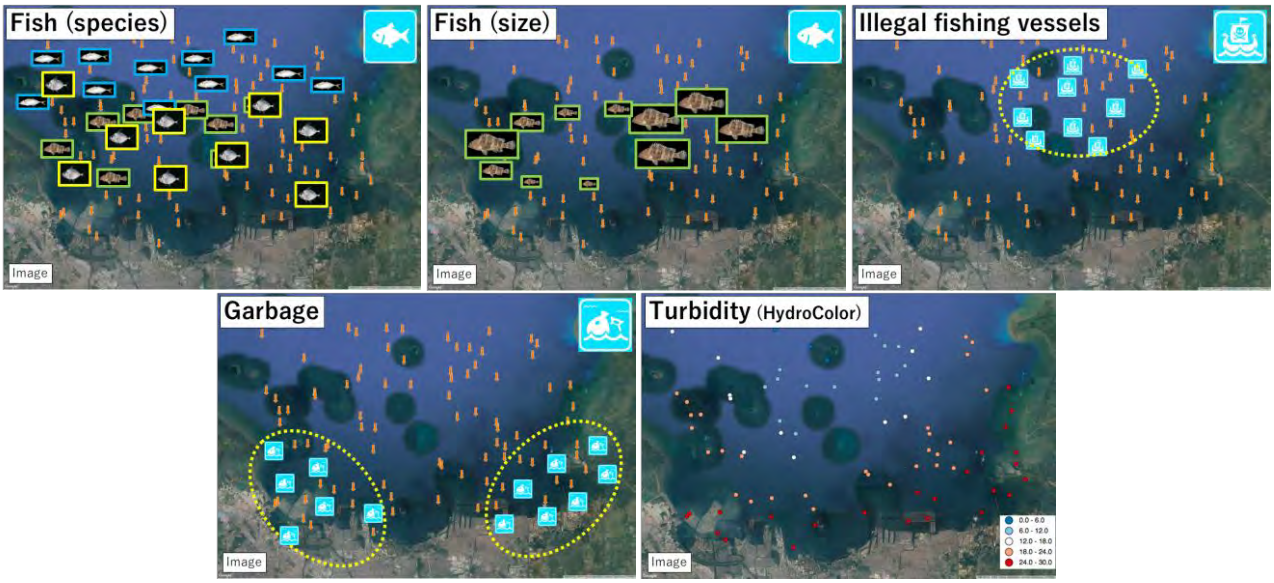

Fig. 4 FishGIS App maps: the fish, catch trends (size and amount), illegal fishing vessels, floating garage, and turbidity by HydroColor.

All the monitoring results, from water quality to garbage, are shown on a map provided by the FishGIS App (Fig. 4). Using this application, local fishers will be able to keep track of the coastal environmental conditions and share that information in their communities.

Training workshop for the community

On July 10–12, 2018, PICES and BPPT, with support from MMAF and LIPI, conducted a training workshop in Jakarta on the new technologies described above (Fig. 5). Overall, more than 100 participants (fishers, community leaders, local government officers, *etc*.) from Muara Gembong, Indramayu, and Banten attended the workshop where they learned how to install and practice HydroColor and FishGIS applications. Also noteworthy is that two scientists from LIPI who gave lectures on HABs at this forum were the trainees of the past PICES MAFF-funded project entitled "*Development of prevention systems for harmful organisms' expansion in the Pacific Rim*" (2007–2012).

We believe the reason the community members showed such strong interest during the 3 days of training was due to us laying the groundwork by holding community meetings in March 2018 to understand the local needs and issues (see Makino and Wells' article, pp. 20–24 in PICES Press, Vol. 26, No. 2, 2018), and then developing a training course based on those needs and issues. We were gratified that they were all very willing and enthusiastic to contribute to the project. The participants were deeply interested and expressed lots of excitement when they were able to view images of phytoplankton on their own mobile phone with Foldscope. Some of them also took additional training on the use of plankton nets.

At the last session of the workshop, very productive discussions were held among community members, central and local government officers, researchers, and PICES experts. For example, it was decided to develop simple guidelines for using the applications in the local languages. Part of the design would be a YouTube movie performed by local community members. It was also found that the OS version of many of participants' mobile phones was too old, and the applications could not be installed. For those phones, down-graded versions of the applications need to be developed. Some people who successfully downloaded

Fig. 5 Training workshop in Jakarta: community members investigate the Foldscope (left) and smartphone applications (middle), and take part in very productive discussions (right).

(continued on page 26)

Northeast Pacific juvenile salmon summer surveys in 2018

by Jackie King, Jennifer Boldt, Brian Burke, Correigh Greene, Jamal Moss and Chrys Neville

PICES has a long history of sponsoring integrated North Pacific marine research linking climate and ocean conditions to fish population dynamics (Beamish, 1995; Hollowed *et al*., 2011; Alheit *et al*. In press). Pacific salmon (*Oncorhynchus* spp.) are a culturally and economically important species in the North Pacific, and their status upon returning to freshwater serves as a useful integrator of ocean conditions over the past few years. Several basin-scale and regional indices, including ecological indices, have been linked to the marine survival of Pacific salmon at the juvenile stage (Mantua *et al*., 1997; Wells *et al*., 2008; Burke *et al*., 2013). Pacific Decadal Oscillation and North Pacific Gyre Oscillation patterns correspond to coastal temperature spatial variability, with cascading impacts on lower trophic level community structure, such as zooplankton composition and abundance (Peterson *et al*., 2014), and coherency to broad-scale patterns in Pacific salmon marine survival (Malick *et al*., 2017). Recent heat wave anomalies in the eastern North Pacific and the concomitant ecological changes may therefore have impacts on Pacific salmon (Morgan *et al*. In Press). Ecosystem dynamics impact the first marine summer growth, migration, and overall survival of juvenile salmon (Burke *et al*., 2016; Burke *et al*., 2013; Freshwater *et al*., 2018; Moss *et al*., 2005). To better understand these ecological dynamics, summer coastal surveys for juvenile salmon are conducted by federal agencies from Canada (Fisheries and Oceans Canada) and the United States (National Marine Fisheries Service). These important surveys provide relevant data on ocean conditions and an early indication of Pacific salmon marine survival, and ultimately inform ecosystem models that support management decisions.

Pacific salmon in the eastern Pacific enter the ocean from several main watersheds, most notably the Columbia River between Oregon and Washington, the Puget Sound and Fraser River basins of the Salish Sea, the Nass and Skeena Rivers in northern British Columbia, and the Kenai and Yukon Rivers in Alaska. Juvenile salmon migrate northwards along the coast towards overwintering grounds in the central Gulf of Alaska. Coastal juvenile salmon surveys are composed of mixed stocks originating from several of these large watersheds. Although variability among stocks or populations exists, collating information from juvenile salmon surveys conducted along the North American coast from Oregon and Washington to the Bering Sea (Fig. 1) provides an indication of broad-scale patterns in salmon marine survival throughout their migratory corridor. By studying these large-scale dynamics, we may be able to better identify the mechanistic drivers of marine growth and survival of these iconic fish.

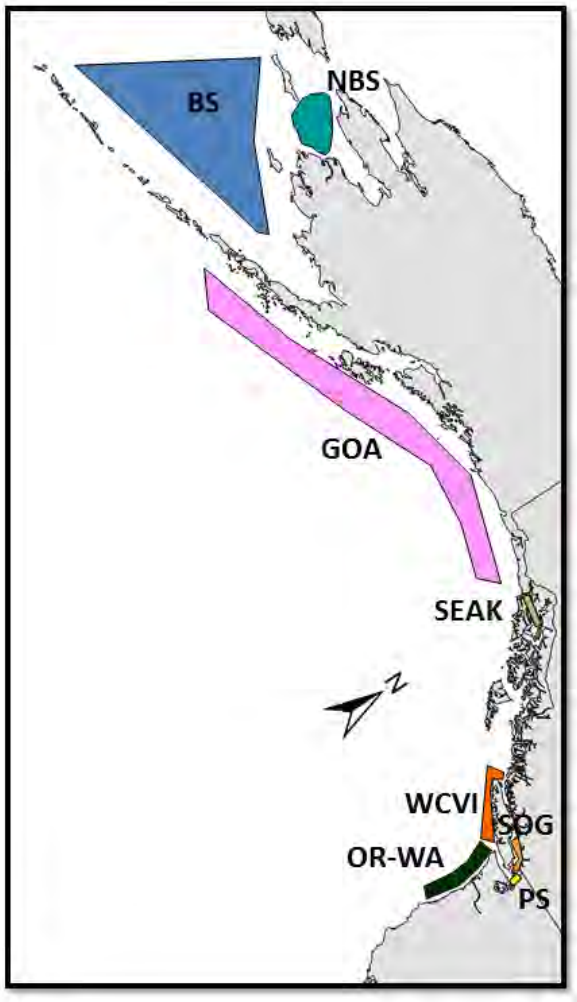

Fig. 1 Summer juvenile salmon surveys are conducted throughout the northeast Pacific and into the Bering Sea by Canada (Fisheries and Oceans Canada) and the USA (National Marine Fisheries Service); general survey areas denoted by polygons. Here we report on the most recent observations off Oregon–Washington (June 19–28, 2018; OR-WA dark green); off the west coast of Vancouver Island (July 5–29, 2018; WCVI dark orange); from Puget Sound (monthly from April–October 2018; PS yellow); from Strait of Georgia (June 17–July 4, 2018; SOG light orange); coastal waters in southeast Alaska (June 18–25, July 26–31, and August 20–25, 2018; SEAK light green); the Gulf of Alaska (July 7–August 16, 2017; GOA pink); southeastern Bering Sea (September 20–October 4, 2018; BS blue); and northern Bering Sea (August 27–September 19, 2018; NBS teal).

Survey time-series

Time-series on relative abundance of juvenile salmon are available from eight long-term surveys conducted in the coastal waters of Oregon–Washington (OR-WA), the west coast of Vancouver Island (WCVI), Skagit Bay in Puget Sound (PS), the inland waters of the Strait of Georgia

(SOG), coastal waters in southeast Alaska (SEAK), in the Gulf of Alaska (GOA), the southeastern Bering Sea (BS) and the northern Bering Sea (NBS) (Fig. 1). Catch per unit effort (CPUE) was calculated for five Pacific Salmon species: Chinook Salmon (*O. tshawytscha*), Chum Salmon (*O. keta*), Coho Salmon (*O. kisutch*), Pink Salmon (*O. gorbuscha*) and Sockeye Salmon (*O. nerka*). Each CPUE series was expressed as a standardized anomaly and natural log transformed for comparison between surveys. Below, we briefly describe each survey.

OR-WA: The Northwest Fisheries Science Center, in conjunction with scientists from Oregon State University's Cooperative Institute of Marine Resources Studies, conducted a surface-water trawl survey from June 19–28, 2018 using a Nordic 264 Rope Trawl (Net Systems, Bainbridge Island, Washington). This survey has been conducted annually since 1998. Forty-four sampling stations were located along 8 transects ranging from the northwest coast of Washington (48° 13.7′ N) to Newport, Oregon (44° 40′ N), including a transect directly south of the mouth of the Columbia River. CPUE was calculated as number of fish per distance trawled (km). CPUE for Chinook Salmon are for yearling-type only; very few Pink Salmon are encountered off OR-WA, and therefore no CPUE was estimated for this species.

WCVI: Summer juvenile salmon surveys have been conducted by Fisheries and Oceans Canada on the continental shelf off the west coast of Vancouver Island since 1999. In 2018, surface trawling was conducted July 5–29 using a LFS 7742 mid-water trawl net (LFS Ltd, Bellingham, Washington); prior to that a CanTrawl 250 mid-water trawl net was used. From 1999–2015, surface trawls (0 and 15 m) were conducted along cross-shelf transects; in 2017 and 2018 surface trawls (0 and 15 m) were conducted with a random stratified survey design (King *et al*. In press). CPUE was calculated as number of fish per distance trawled (km) based on daytime trawling only.

PS: Since 2001, The Northwest Fisheries Science Center has conducted a monthly surface trawl survey in Skagit Bay from April through October using a paired Kodiak trawl (Rice *et al*., 2012; Greene *et al*., 2015). From 2001 to 2005, sampling occurred at index sites, but thereafter the survey design employed stratified random site selection off a 0.5 km grid. CPUE is calculated as number of fish per area trawled (ha) and annual averages are calculated using a space-time model that integrates temporal and spatial autocorrelation (Lindgren and Rue, 2015).

SOG: Fisheries and Oceans Canada conducted an upper-water (0–60 m) trawl survey June 17–July 5, 2018 in the Strait of Georgia using a CanTrawl 250 mid-water net (CanTrawl Ltd., Richmond, BC). These surveys have been conducted since 1998. Fishing occurs along a standard track line with random selection for headrope depths ranging from surface to 60 m, in increments of 15 m with targeted proportional representation (Beamish *et al*., 2000; Sweeting *et al*., 2003). CPUE is calculated as number of fish per trawl duration (hr), based on surface and 15 m trawl depths for Chum, Pink and Sockeye Salmon, 30 m trawl depths for Coho Salmon and 45 m trawl depths for Chinook Salmon (Beamish *et al*., 2000; Sweeting *et al*., 2003).

SEAK: The Alaska Fisheries Science Center has conducted the annual Southeast Coastal Monitoring (SECM) survey designed to study the early marine ecology of Pacific salmon, other epipelagic fishes, plankton, and physical properties in Icy Strait, southeast Alaska, since 1997. In 2018, the survey was conducted monthly from June 18–25, July 26–31, and August 20–25 with a Nordic 264 rope trawl (Net Systems, Bainbridge Island, Washington). CPUE was calculated as number of fish per 20 min tow and averaged as per Wertheimer *et al*. (2010).

GOA: The Gulf of Alaska assessment survey is a fisheries and oceanographic survey conducted in the eastern GOA during the summer season each year since 2010. The survey is designed to characterize ecosystem status and function and is a coordinated research effort among scientists within the Recruitment Processes Alliance at the Alaska Fisheries Science Center. No survey was conducted in 2018, but we report on 2017 results observed from July 7–August 16. Trawling was conducted with a Nordic 264 rope trawl (Net Systems, Bainbridge Island, Washington). CPUE was calculated as number of fish per 20 minute tow and averaged as per Wertheimer *et al*. (2010).

BS: The Bering Sea Subarctic Integrated Surveys (Alaska Fisheries Science Center) are focused on improving and reducing uncertainty in stock assessment models of important commercial fish species through the collection of acoustics information, fish and zooplankton samples, and fisheries oceanographic indices in the southeastern Bering Sea. These surveys were initiated in 1996 and have occurred annually from 2002–2012, and biennially since 2014. In 2018, it was conducted from September 20–October 4 with a CanTrawl 400 rope trawl (CanTrawl Ltd., Richmond, BC). CPUE was calculated as number of fish per 20 minute tow and averaged as per Wertheimer *et al*. (2010).

NBS: The Northern Bering Sea survey provides an integrated ecosystem assessment of the northeastern Bering Sea to support the Alaska Fisheries Science Center's Loss of Sea Ice Program, the Alaska Department of Fish and Game Chinook Initiative research program, and the Distributed Biological Observatory. The Northern Bering Sea survey has occurred annually from 2002, and in 2018 was conducted in August 27–September 19 with a CanTrawl 400 rope trawl (CanTrawl Ltd., Richmond, BC). CPUE was calculated as number of fish per 20 minute tow and averaged as per Wertheimer *et al*. (2010).

Status and trends

Chinook: Juvenile Chinook Salmon relative abundance in coastal waters off OR-WA, WCVI and SEAK remained below average in 2018, although the OR-WA CPUE anomaly was higher compared to the low of 2017 (Fig. 2). In these three areas 2017 and/or 2018 CPUE anomalies denote some of the lowest catch rates of Chinook Salmon in the time series. Similarly in GOA, the lowest catch rate of Chinook Salmon was observed in 2017. In the inland waters of the Salish Sea (PS and SOG), Chinook CPUE anomalies were positive, but still close to the long-term average. Since 2005, Chinook Salmon in PS exhibited a decline, which culminated in one of the lowest abundance years in 2016 during the marine heat wave. The only region with notable positive Chinook CPUE anomalies was the BS, while the catch rates in NBS were near average. Within the most recent 8 years, anomalies have trended upward for northerly areas (Bering Sea), and downward in southern areas.

Chum: For most regions in the northeast Pacific the recent juvenile Chum Salmon CPUE has been near average, albeit with regional differences in whether the anomaly value is positive or negative (Fig. 3). In the inland waters of the Salish Sea (PS and SOG), juvenile Chum Salmon CPUE have been increasing in the last 6 to 7 years. Notable exceptions to average juvenile Chum Salmon abundance are in SEAK and BS where negative and positive CPUE anomalies, respectively, are greater than ±1 standard deviation.

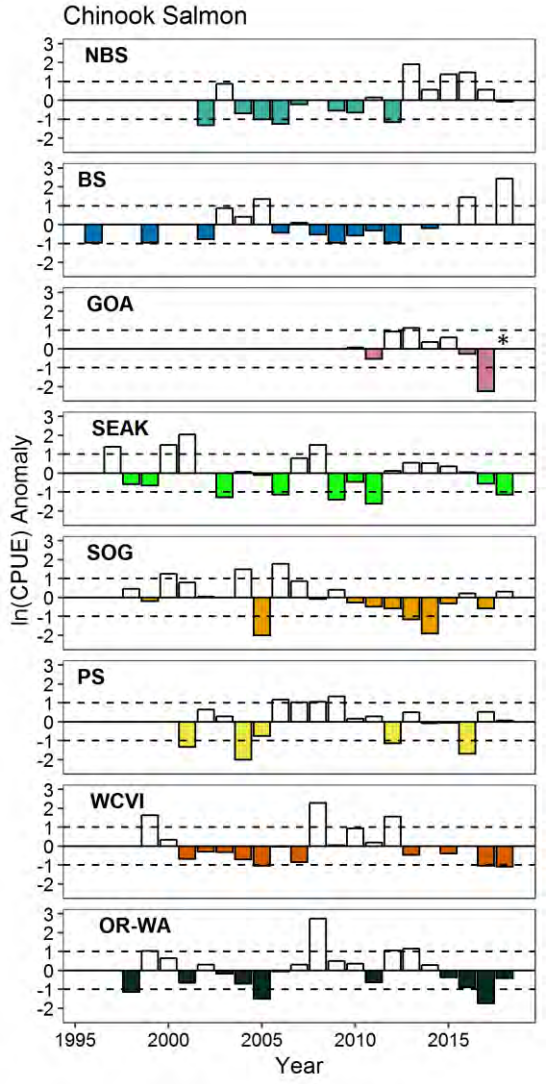

Fig. 2 Standardized CPUE anomalies (mean of zero: solid line; ± 1 standard deviation: dashed lines) for juvenile Chinook Salmon from summer surveys throughout the northeast Pacific. See Figure 1 for region definitions. Asterisk denotes no survey completed in 2018 in GOA.

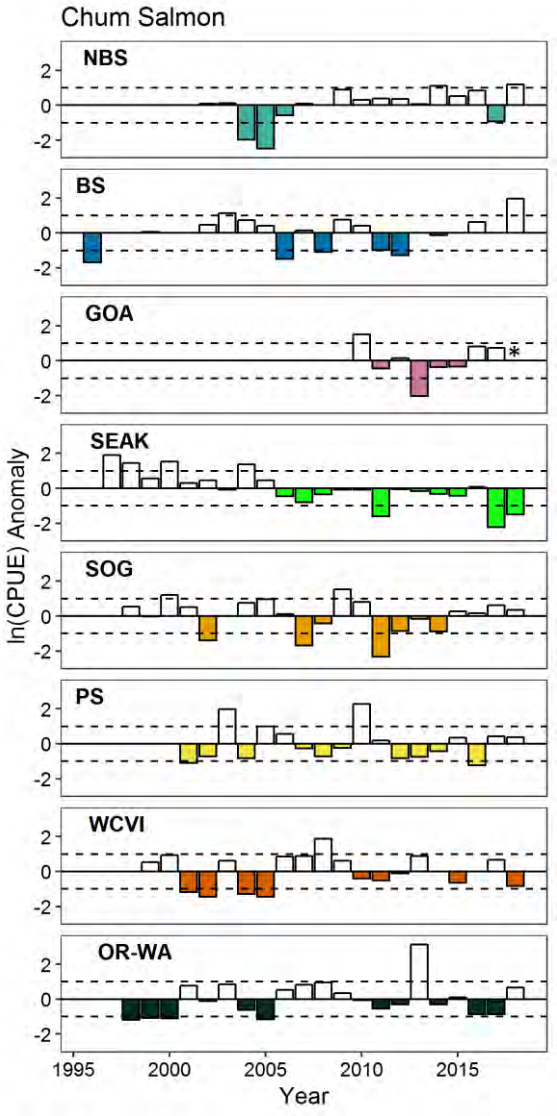

Fig. 3 Standardized CPUE anomalies (mean of zero: solid line; ± 1 standard deviation: dashed lines) for juvenile Chum Salmon from summer surveys throughout the northeast Pacific. See Figure 1 for region definitions of. Asterisk denotes no survey completed in 2018 in GOA.

Coho: The 2018 CPUE anomalies for juvenile Coho Salmon vary greatly across the regions of the northeast Pacific (Fig. 4), but there are three main patterns. The first is observed off OR-WA and SOG, which had some of the lowest CPUE anomalies in 2017, and a complete reversal to some of the highest CPUE anomalies in 2018. Second, the CPUE anomalies in WCVI and PS were low in both 2017 and 2018. SEAK might be included in this, with average CPUE anomalies in 2017, but extremely low anomalies in 2018. Third, in BS and NBS CPUE anomalies have been high in recent years.

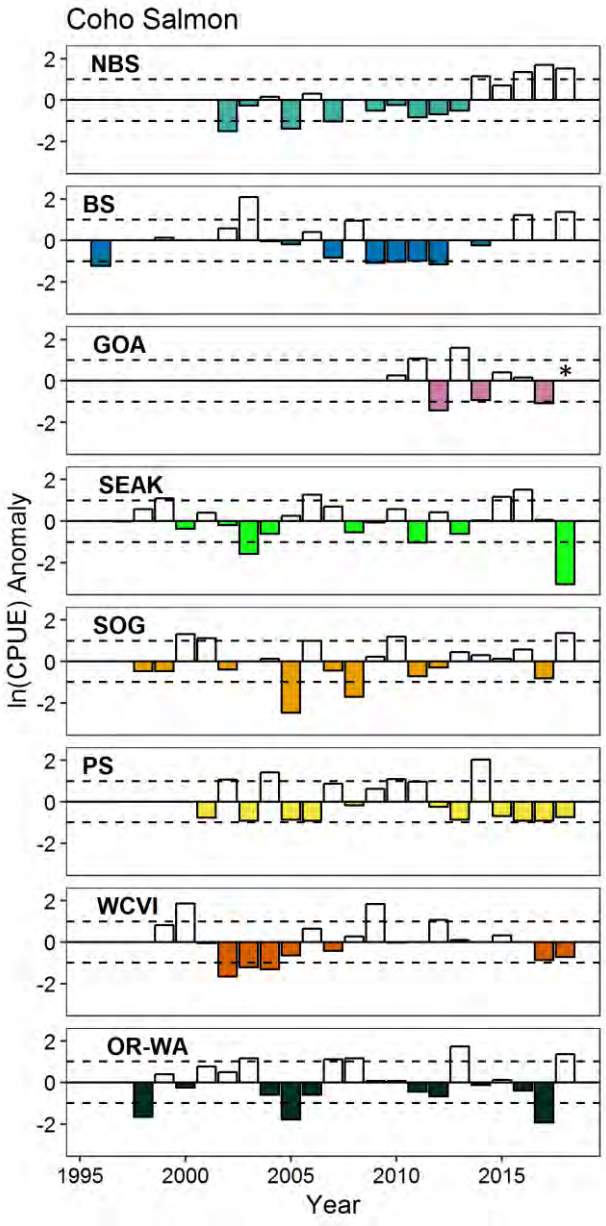

Fig. 4 Standardized CPUE anomalies (mean of zero: solid line; ± 1 standard deviation: dashed lines) for juvenile Coho Salmon from summer surveys throughout the northeast Pacific. See Figure 1 for region definitions. Asterisk denotes no survey completed in 2018 in GOA.

Pink: Juvenile Pink Salmon catches follow the cyclical dominance with high catches in even numbered years. Pink Salmon are rarely encountered in surveys off OR-WA, and are mainly encountered in even numbered years off WCVI (Fig. 5). The WCVI time series is dominated by extremely high catches in 2000, but 2018 is the second highest CPUE anomaly on record. Pink Salmon abundance in the SOG is dominated by Fraser River stocks, and in even numbered years they are either the most or second most abundant salmon species. The SOG time series is overshadowed by a very large catch in 2010. However, if this extreme catch is omitted there has been a general increase in the juvenile Pink Salmon CPUE in even numbered years in SOG since 2008.

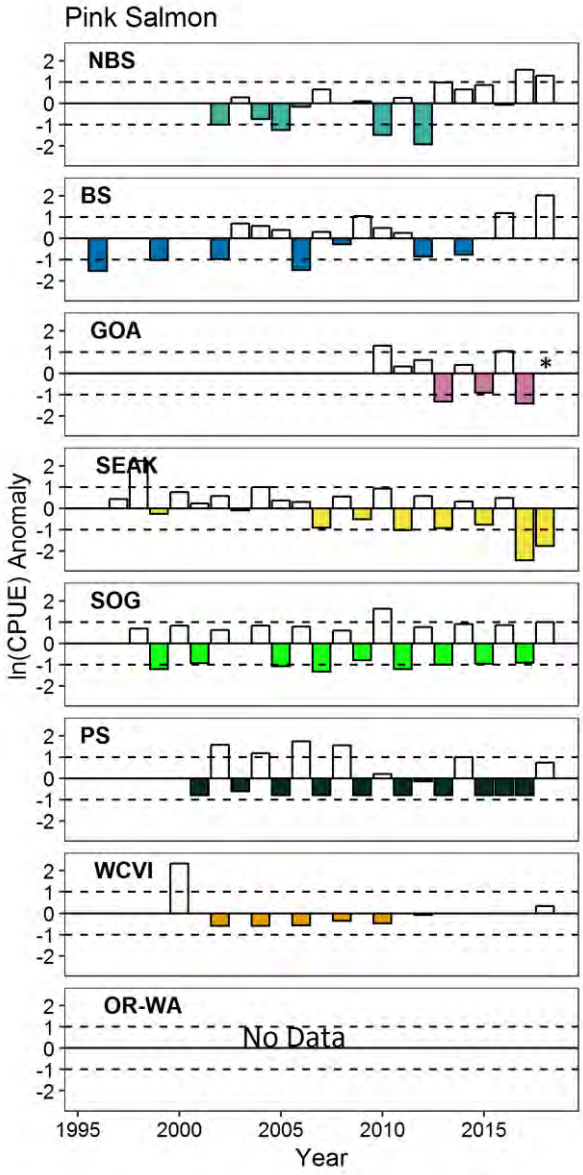

Fig. 5 Standardized CPUE anomalies (mean of zero: solid line; ± 1 standard deviation: dashed lines) for juvenile Pink Salmon from summer surveys throughout the northeast Pacific. See Figure 1 for region definitions. Asterisk denotes no survey completed in 2018 in GOA.

Conversely, in PS juvenile Pink Salmon have stronger evidence for a long-term decline. In SEAK, Juvenile Pink Salmon were not captured during June surveys in 2017 or 2018, whereas they had been captured during June in all prior years. Catch rates of juvenile Pink Salmon in the BS and NBS were anomalously high in 2018.

Sockeye: Juvenile Sockeye Salmon CPUE sockeye were close to the long-term mean in the OR-WA survey (Fig. 6). The below-average CPUE of juvenile Sockeye Salmon observed in 2017 continued in 2018 off WCVI and SEAK. Sockeye salmon appear to migrate extremely quickly through Skagit Bay, as sampling is largely hit-or-miss for this species; catches in 2017 were the highest on record while catches in 2018 returned to the long-term mean. In the SOG, juvenile Sockeye Salmon CPUE have been near the long-term mean since 2015. Finally, the CPUE for Sockeye Salmon was above average in 2018 in the BS and NBS.

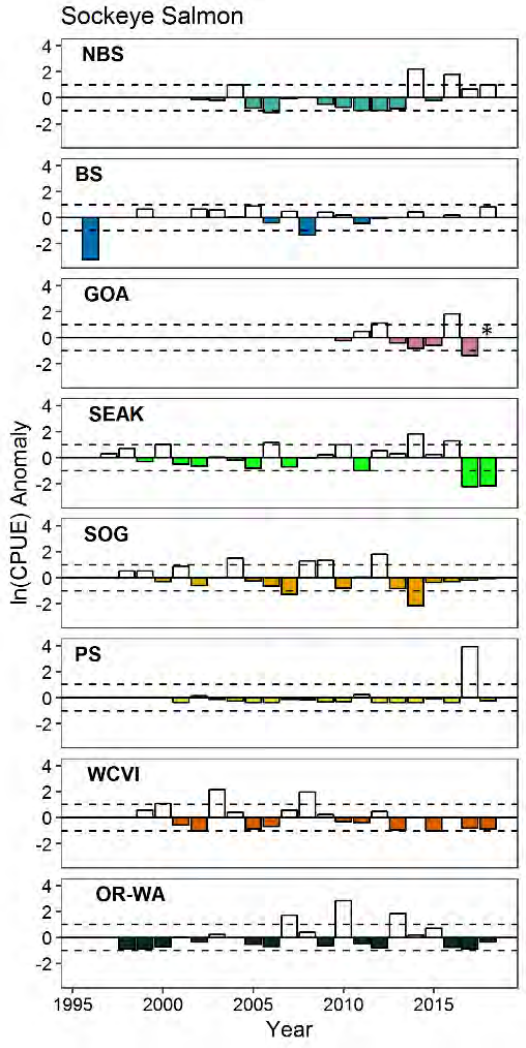

Fig. 6 Standardized CPUE anomalies (mean of zero: solid line; ± 1 standard deviation: dashed lines) for juvenile Sockeye Salmon from summer surveys throughout the northeast Pacific. See Figure 1 for region definitions. Asterisk denotes no survey completed in 2018 in GOA.

It is clear that variability is high among species and across time and space (Figs. 2–6), so we calculated Euclidean distances (Clarke and Warwick, 2001) for each year and region combination based on the CPUE anomaly values of all species. Years in which at least three regions were surveyed are displayed in Figure 7; higher values indicate more dissimilar years, while smaller values exhibit greater similarity among regions. While average Euclidean distance has varied, the recent years since 2015 (the peak of the marine heat wave) have witnessed the greatest swing in similarity. Distance scores were the lowest on record in 2015, consistent with the large-scale nature of the marine heat wave, and were most dissimilar in 2017, indicating highly variable responses of the Pacific salmon community in different regions post-warming. Emerging large-scale warming conditions this winter may provide additional important opportunities for cross-regional comparisons.

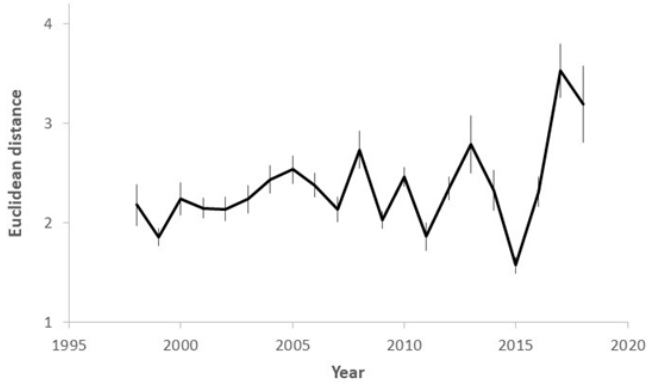

Fig. 7 Average Euclidean distance (± standard error), based on metric multi-dimensional scaling of species anomalies, in each year where at least three regions in Figure 1 were surveyed.

Factors influencing trends

It is important to note that changes in survey design, gear, timing and vessels can influence interannual variability in catch rates, especially for juvenile salmon which can vary in ocean entry time, migration timing and distribution and for some species, such as Sockeye Salmon and Pink Salmon, by dominant stocks and runs. However, comparisons of trends in the northeast Pacific provides a cohesive snapshot of large-scale patterns in juvenile salmon abundance during their migration. Potential mechanisms that may affect salmon abundance trends include prey availability (*i.e.*, bottom-up effects), predation (*i.e.*, top-down effects), or competition, as mediated through climate forcing effects on ocean temperatures, currents, *etc*.

Warm anomalies in ocean temperatures have been associated with decreased marine survival rates in southern stocks (*e.g.*, OR-WA, WCVI, SOG, PS), and with increased survival for northern stocks (*e.g.*, SEAK, GOA, BS, NBS) (Mueter *et al*., 2002). This opposite pattern points to different mechanisms determining survival rates in these

two areas. While the specific mechanisms for early ocean mortality is not yet fully described, Pacific salmon tend to grow well after entering the ocean, suggesting that starvation is not the cause of mortality. In 2018, the mean size and condition of many juvenile salmon species in our surveys were at or above average, supporting the idea that warm ocean temperatures do not reduce growth rates, since larger fish were still observed. Size-dependent predation may be a likely mechanism, but one with still insufficient support. Our 2018 condition data may be observations on survivors only, pointing to a large-scale size-based predation event. Information on predator diets (*e.g.*, fish, seabirds and mammals) or evidence of a specific mortality agent would help to disentangle these complexities.

Adding complexity to our understanding of ocean temperature impacts on juvenile salmon are the occurrences of extreme ocean warming events, *i.e.*, marine heat waves, which correspond to unexpected observations. For example, in SEAK the marine heat wave event of 2015 and 2016 may have resulted in poor ocean survival of juvenile Pink Salmon that entered the GOA, with subsequent poor recruitment evident in the low 2017 and 2018 abundance of juveniles (*i.e.*, low CPUE anomalies). Additionally, low stream flow rates in 2018 may have resulted in late outmigration timing for SEAK Pink Salmon. In 2018, SEAK Pink Salmon had a small body size suggesting that the later outmigration likely resulted in less foraging opportunity in inside marine waters. Additionally, a decrease in typical zooplankton prey coincided with an increase in small copepods, which may have also contributed to small body size. In the BS and NBS, water temperatures were anomalously warm, which likely influenced the northward migration of juvenile Chinook Salmon, the only species not well above average in abundance, as they emigrated from the Yukon River.

Implications

Generally, low abundance of juvenile Pacific salmon in coastal waters has been equated with poor marine survival and subsequent low returns. However, ongoing research indicates a complexity of interactions between abundance along with prey availability, timing of ocean entry and migration which impacts size and condition and in turn, size-based predation and mortality. In SEAK, small body size coupled with low abundance of juvenile Pink Salmon will likely work in concert to result in anomalously low Pink Salmon returns to southeast Alaska in 2019. Added to the complexity of these interactions is the ongoing increase in ocean temperatures. Juvenile Pacific salmon in the northeast Pacific migrate through the Gulf of Alaska to overwinter in the central North Pacific. Surface water temperatures were anomalously warm in the Gulf of Alaska during 2017, which may result in low survival rates of juvenile salmon. Still unknown are the impacts of a potential return of the marine heat wave and high potential for an El Niño this winter.

Notable ecosystem-scale occurrences

Anomalous observations from 2018 include continued observations of warm-water species, such as pyrosomes and Pacific pompano off OR-WA, and high catches of juvenile rockfish off OR-WA and WCVI and market squid off OR-WA. In the SOG, extremely high catches (>10,000 fish) of Northern Anchovy (larval and adults) have continued since 2015, prior to which catches were typically less than 50 fish per survey. Similar observations of Northern Anchovy have been made in PS since 2015, as well as higher catches of jellyfish and post-larval groundfishes. In OR-WA many of the anomalous observations over the past several years (the marine heat wave years) have trended back towards mean levels in 2018 – examples include occurrences of jack mackerel, Pacific chub mackerel, and several jellyfish species.

This comparison of juvenile salmon indicators across areas within their migration corridor will help to elucidate large and local-scale drivers affecting salmon survival. Common trends among regions point to large-scale climate forcing effects on salmon; conversely, variations in trends among regions highlight the importance of regional-scale drivers. To identify mechanisms affecting salmon survival, trends in CPUE need to be considered within the context of the ecosystem, including the physical environment (*e.g.*, temperature and upwelling timing and magnitude), prey availability and timing, and predation and competition. These surveys also provide those ecosystem observations, allowing us to test hypotheses and develop empirical-based mechanisms linking climate forcing to salmon marine survival. Given the interest in this interdisciplinary research within the PICES community, we propose to provide annual updates on our juvenile salmon survey observations.

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the applications found the icons very difficult to understand. Moreover, many community members were uncertain what kind of feedback they would be getting from the data they collect, and how such feedback would contribute to their daily life and well-being. However, overall, participants concluded that the training course was very worthwhile and that the project will make a great contribution to coastal communities in Indonesia. Based on the results from the workshop, we will modify the software and develop guidelines for using the applications. The PST will also act on the feedback we have received from the community. The next training workshop will be organized early 2019.

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Dr. Shigeharu Kogushi (kogushige@gfken.com) is CEO of Greenfront Research Laboratory Co., Ltd. His research interests include landscape ecology, GIS, and citizen science. He is involved in the FishGIS project in order to develop FishGIS App.

Dr. Mark Wells (mlwells@maine.edu) is a Professor of Oceanography in the School of Marine Sciences, University of Maine. His fields and topics of research are marine biogeochemistry, trace metal chemistry, and biological oceanography with emphasis on harmful algal blooms. Within PICES, he is Co-Chair of the Section on Ecology of Harmful Algal Blooms in the North Pacific. Mark was involved in the previous (2012–2017) PICES–MAFF project on "Marine ecosystem health and human well-being (MarWeB)" and now co-chairs the FishGIS project with Dr. Mitsutaku Makino.

Dr. Mitsutaku Makino (mmakino@affrc.go.jp) is Head of the Fisheries Policy Research Group at the National Research Institute of Fisheries Science, Fisheries Research and Education Agency of Japan. He specializes in fisheries and ecosystem-based management analysis. He teaches in several universities in Japan, and currently serves as an Editor of ICES Journal of Marine Science. His book entitled "Fisheries Management in Japan" was published in 2011 by Springer. Within PICES, he is Vice-Chair of the Human Dimensions Committee and a member of the FUTURE Scientific Steering Committee and Working Group on Ecosystem Reference Points across PICES Member Countries. He co-led, with Dr. Ian Perry, the previous (2012–2017) PICES–MAFF project on "Marine ecosystem health and human well-being (MarWeB)" and now co-chairs the FishGIS project with Dr. Mark Wells.

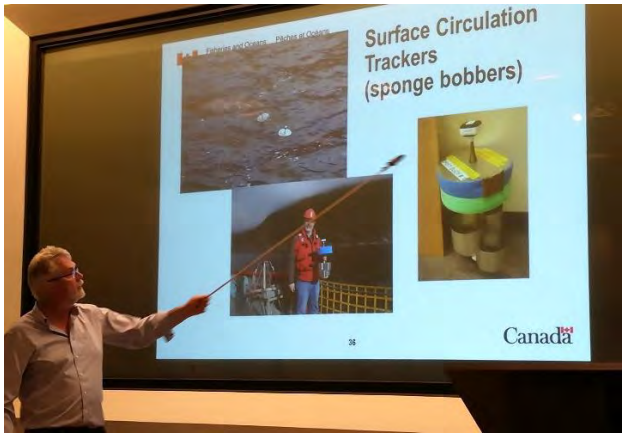
2018 PICES Summer School on "*Coastal ocean observatory science*"

by S. Kim Juniper and Akash Sastri

There is an urgent need to improve our capacity to monitor and manage the coastal ocean. Worldwide, coastal waters are among the most biologically productive areas of the ocean and the most threatened and disturbed by human activities. The coastal zone hosts most of the world's greatest fisheries and most of the world's megacities. Population growth and development are generating pressures on coastal ecosystems and exposing more people and infrastructure to existing marine hazards and future sea level rise. The deployment and maintenance of ocean observing systems is becoming increasingly important to ensuring the long-term sustainability of coastal ecosystems and mitigating coastal hazards. Real-time ocean data support operational now-casting and forecasting, while time-series observations permit the identification and understanding of seasonal and longer-term oceanographic processes. As ocean observing programs and networks expand globally, there is an increasing need to train the next generation of ocean scientists and ocean managers in the analysis, interpretation, and application of data from coastal ocean observing systems.

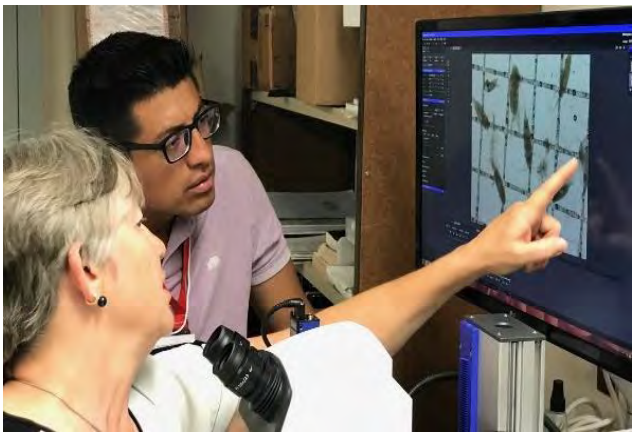
In July 2018, Ocean Networks Canada (ONC) hosted 25 early career scientists from 11 countries, including five PICES member countries, and Australia, Brazil, Switzerland, Ecuador, Germany and Greece for a PICES Summer School on "*Coastal ocean observatory science*" in Victoria, British Columbia, Canada. During this week-long workshop, hands-on activities, lectures, and field trips provided the participants with opportunities to learn about the physical, biological, chemical, and biogeochemical properties of British Columbia's coastal waters, to discover ONC's sophisticated cabled observatory technology, and to learn how to analyze and interpret observatory data.

2018 PICES Summer School participants and instructors at the Vancouver Aquarium.



Dr. Charles Hannah lectures on the use of trackers to study coastal ocean circulation.

PICES Executive Secretary Robin Brown explains the work of the PICES Secretariat.



Visiting the zooplankton laboratory at the Institute of Ocean Sciences.

Local experts lectured on oceanographic time-series analyses and bioacoustics (Dr. Richard Dewey, ONC), coastal oceanography (Dr. Charles Hannah, Fisheries and Oceans Canada), and Image Analysis (Prof. Kim Juniper and Dr. Maia Hoeberechts, ONC). The Summer School also included a facilities and laboratory tour of the Institute of Ocean Sciences, a visit to the PICES Secretariat, and directed tutorials on data set management and QA/QC protocols. The laboratory tour introduced participants to analytical tools and techniques for dissolved oxygen determination, carbon chemistry, plankton identification and enumeration, and passive acoustics.

A field trip onboard the University of Victoria's Research Vessel *John Strickland* provided participants with hands-on experience in sampling coastal waters in Saanich Inlet using standard oceanographic sampling gear/techniques for characterization of physico-chemical water column properties. A mid-week trip across the much-studied Salish Sea, onboard one of the three BC Ferries vessels equipped with ONC sensors, was combined with a visit to the Vancouver Aquarium for special lectures on microplastic pollution research (Dr. Peter Ross, Coastal Ocean Research Institute), and ocean acidification research (Dr. Wiley Evans, Hakai Institute).

Preparing the CTD-rosette for water column sampling in Saanich Inlet.

The busy week ended with participants presenting the results of their analyses of prepared time-series data sets. The data sets included: scalar time series from coastal sea-floor moorings on the west coast of Vancouver Island and the Salish Sea, a mobile (ferry) sea-surface monitoring time series, a multi-frequency echosounder data set from Saanich Inlet, and a benthic video imagery data set.

Summer School participants were invited to complete a course evaluation at the end of the week. The feedback received was very positive, and included comments such as "It was an amazing and very useful experience"; "Such a positive learning environment and great people"; "The Summer School was pretty cool!"; "Well balanced between theory, practice, demonstration and intense personal [work] time"; "Enthusiastic researchers and fellow students".

ONC would like to thank hosting partners: the Institute of Ocean Sciences, Fisheries and Oceans Canada; the Vancouver Aquarium; Hakai Institute; and the University of Victoria for helping to make PICES Summer School 2018 an outstanding success.

(continued on page 32)

Working Group 37 organizes a Practical Workshop on "*Production methodologies and measurements for in situ zooplankton: Phase 1*" in Manazuru, Japan

by Toru Kobari and Akash Sastri

Zooplankton production represents a quantitative proxy for the functional response of marine ecosystems to regional and global climate change. In the last half century, many methodologies for measuring zooplankton production have been developed and reviewed in the ICES Zooplankton Methodology Manual. Unfortunately, the applications to the zooplankton population and community in nature remain limited due to the specific expertise required for these methodologies.

This past fall, the Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions* (WG 37) held a 3-day training workshop to introduce early career scientists and students to information on several traditional methodologies used for estimating zooplankton production and to share the practical tricks for doing so. Drs. Shinji Shimode (Yokohama National University), Koichi Ara (Nihon University) and Toru Kobari (WG 37 Co-Chair) organized a Practical Workshop titled "*Production methodologies and measurements for in situ zooplankton: Phase 1*" which took place October 22 to 24 at the Manazuru Marine Center for Environmental Research and Education (Yokohama National University), just prior to PICES-2018. The Center was located about a 90-minute drive southwest of Yokohama. The workshop was aimed at early arrivals to the Annual Meeting, and was envisioned as the first of two workshops (Phase 2 to take place immediately prior to PICES-2019).

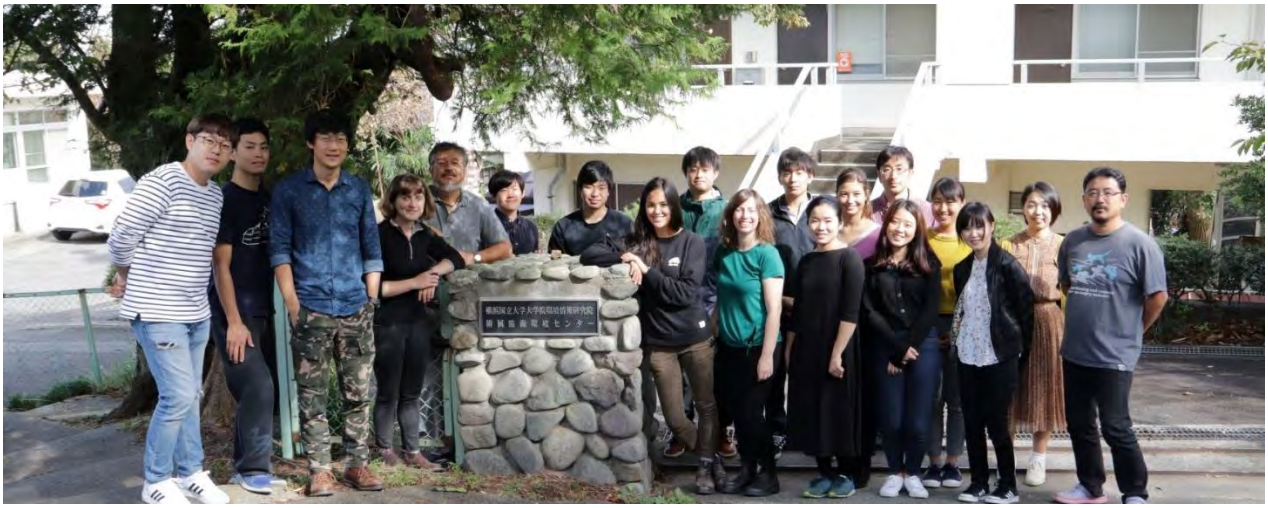
Eleven participants (4 males and 7 females) from 5 PICES member countries (China, Japan, Korea, Canada, USA) registered for this event. The organizers had originally planned for a minimum number of participants, as advertised in the announcement, but due to the exceptional interest the workshop generated, the organizers were able to make arrangements to accommodate twice the number! On the evening of the first day, after a welcome address and description of the workshop by the organizers, all participants introduced themselves during an ice breaker. On the morning of the second day, all participants collected zooplankton samples on board the T/S *Tachibana*, and after lunch listened to lectures on egg production by Dr. Shimode and on empirical models by Dr. Ara. This was immediately followed by laboratory work on identifying, counting and sorting the target species and eggs, and computing their measured data which continued into the morning of the third day.

Participants and two of the organizers, back row: Dr. Shinji Shimode (second from left) and Dr. Koichi Ara (fifth from left) at the ice-breaker.

Sorting adult females of target species for the egg production experiments lectured by Dr. Shimode.

Dr. Ara giving a lecture on sensitivity analysis of zooplankton production estimations among several empirical models.

Dinner and night session on the second day, with everyone enjoying Japanese soul food, "Okonomi-yaki", which was kindly made by Japanese support staff.



Group shot of all participants at the gate of the Manazuru Marine Center for Environmental Research and Education, Yokohama.

Prior to the closing ceremony on Day 3, all participants were asked to complete a questionnaire to evaluate and give their impressions of the workshop. Overwhelmingly, everyone enjoyed the laboratory work, lectures and discussions regarding zooplankton production measurements and methodologies. Such a response indicates that this practical workshop is a good opportunity for making international collaborations and integrating information on zooplankton production measurements. WG 37 will conduct a Phase 2 Practical Workshop on biochemical approaches for measuring zooplankton production just before the PICES-2019 in Victoria, Canada. Stay tuned for a follow-up article in PICES Press.

Dr. Toru Kobari (kobari@fish.kagoshima-u.ac.jp) is Associate Professor of Faculty of Fisheries at Kagoshima University supporting "Biological Oceanography" and "Fisheries Oceanography". He has a background in biological oceanography with a focus on the structural and functional roles of plankton communities on marine ecosystems. Toru completed his undergraduate studies in Faculty of Science at the Yamagata University, Yamagata, and a M.Sc. in Fisheries at the Hokkaido University, Hakodate. His Ph.D. (1999) thesis at Hokkaido University focused on the life cycles and interannual variability of Neocalanus copepods. Within PICES he is co-chairs the Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions.

Dr. Akash Sastri (asastri@uvic.ca) is Ocean Networks Canada's staff scientist supporting interdisciplinary research in the "Plankton Dynamics and Biogeochemistry" research theme. He has a background in biological oceanography with a focus on the roles of marine plankton communities in changing environments. Akash completed his undergraduate studies and a M.Sc. in Zoology at the University of Guelph, Ontario. His Ph.D. (2007) thesis at the University of Victoria focused on the development and application of novel ways to measure zooplankton productivity routinely at sea. Within PICES he is a member of the Biological Oceanography Committee, Advisory Panel on North Pacific Coastal Ocean Observing Systems, and co-chairs the Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions.

PICES in Ireland: ADRIFT marine bioinvasions study presented at NEOBIOTA 2018

by James T. Carlton

The well-known PICES project, **A**ssessing the **D**ebris-**R**elated **I**mpacts **F**rom the **T**sunami, or ADRIFT (https://meetings.pices.int/projects/ADRIFT), came ashore at NEOBIOTA 2018, the 10th International Conference on Biological Invasions, held September 3–7, 2018 near Dublin, Ireland. The conference theme "New Directions in Invasion Biology" was highly relevant to one of the core ADRIFT research areas which focused on the role of rafted objects in the transoceanic dispersal of coastal marine animals and plants.

NEOBIOTA is one of the largest gatherings of invasion biologists, ecologists, and managers in the world. The first conference was held in Berlin, Germany, in 2000. Similar to the International Conference on Marine Bioinvasions (ICMB), meetings are held biennially. The 10th anniversary NEOBIOTA meeting was convened in the beautiful suburban coastal town of Dún Laoghaire, 12 km from the Dublin city center, with more than 300 attendees from 50 countries. Conference themes included the impacts of invasive species on ecosystems and ecosystem services, discussions of universal criteria and biological-ecological characteristics that could be used to predict biological invasions, novel ways of managing invasive species, and the management, use, and accessibility of global alien species data bases.

On the opening day of the conference, at the only special evening session at NEOBIOTA 2018, before a packed auditorium, a summary of the biological aspects of "tsunamigenic megarafting" originating from the Great East Japan Earthquake on March 11, 2011, was presented. As this readership knows, the tsunami triggered by this earthquake launched an extraordinary transoceanic biological rafting event with no known historical precedent. More than 400 living species of Japanese marine animals and plants were documented between 2012 and 2017 as having been transported to North America and Hawai'i on drifting objects that traveled thousands of kilometers across the North Pacific Ocean, often apparently in highly circuitous routes.

At the presentation, given by the author of this article, it was noted that as late as July 2018, Japanese tsunami marine debris (JTMD) with living species had continued to arrive in North America. Debris arrival in the summer and early fall seasons in the American Pacific Northwest, where monitoring of JTMD has been taking place, tends to be lower than in the spring and early summer. It was thus emphasized that we now await landfall arrivals of 2019 to learn whether any coastal species have survived for 8 years drifting in the open ocean.

This astonishing multi-year survival of coastal species at sea is permitted in part by the modern-day non-biodegradable nature of ocean rafts, which by lasting for many years, is in striking contrast to historical rafting on biodegradable materials such as tree limbs and root masses, with much shorter life expectancies at sea. A special focus of the presentation, entitled "*The Age of Plastics meets the Age of Invasions?*," was that the broader global message about ocean rafting, in a world now redubbed as the "plastiphere," is that plastic availability and use increased vastly in the last half of the 20th century at the same time as growing shoreline infrastructure poised these plastics at the land-sea interface. In turn, beyond tsunamis, amplified storm activity due to human-mediated climate change may serve to sweep these plastics in unprecedented quantity into the sea, suggesting that this growing plastisphere may provide greater rafting opportunities for invasive species.

NEOBIOTA is attended largely by invasion scientists working in terrestrial ecosystems, and to a lesser extent in freshwater and marine communities. With the concept of "novel vectors" now getting rapidly greater attention in invasion biology, the NEOBIOTA 2018 attendees were captivated by the JTMD phenomenon and its broader implications. Noting the ADRIFT studies have highlighted that the role of ocean rafting in modern times has been underestimated, a poster presentation at NEOBIOTA 2018 by colleagues from Chile and the U.S. also reported that rafting animal and plant communities had now been detected on anthropogenic marine debris in the South Pacific Ocean gyre.

At the close of Dr. Carlton's talk, he was awarded the first Life Honorary Membership in INVASIVESNET, the International Association for Open Knowledge on Invasive Alien Species.

Dr. Frances Lucy, President of INVASIVESNET, presenting Professor James Carlton with a lifetime Honorary Membership Award.

Further reading

Carlton, J.T., Chapman, J.W., Geller, J.B., Miller, J.A., Carlton, D.A., McCuller, M.I., Treneman, N.C., Steves, B.P., Ruiz, G.M. 2018. Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography. *Science* 357(6358): 1402–1406.

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Clarke Murray, C. Therriault, T.W., Maki, H., Wallace, N., Carlton, J.T., Bychkov, A. 2018. ADRIFT in the North Pacific: The movement, surveillance, and impact of Japanese tsunami debris. *Marine Pollution Bulletin* 132: 1–4.

Dr. James T. Carlton (jcarlton@williams.edu) is Professor Emeritus of Marine Science at Williams College, Williamstown, Massachusetts and Director Emeritus of the Maritime Studies Program of Williams College-Mystic Seaport, Mystic, Connecticut. Having first become interested in marine bioinvasions in 1962 while working in San Francisco Bay (California, USA), his research expanded over the decades to document the diversity and impacts of introduced species throughout North America, in the Hawaiian Islands, South Africa, and elsewhere. His scientific interests focus on the ecology, biogeography, history and management of marine invasions, modern-day extinctions of marine species, and the overall environmental history of estuaries and coastal zones globally. Dr. Carlton was for more than 20 years (1979–2000) a member of the ICES Working Group on Introductions and Transfers of Marine Organisms, including 10 years as Chair. He was one of the lead Principal Investigators in the PICES ADRIFT project to determine the biological consequences of tsunami-rafted materials carried to North America and the Hawaiian Islands. His current work includes continued monitoring of Japanese Tsunami Marine Debris in the North Pacific Ocean, studies on marine bioinvasions in the Galapagos Islands, and the global history and biogeography of introduced barnacles. Dr. Carlton enjoys chocolate as well as a wide variety of other sugar-based foods.

(continued from page 28)

Dr. S. Kim Juniper (kjuniper@uvic.ca) is Chief Scientist for Ocean Networks Canada. He has been a Professor in the School of Earth and Ocean Sciences and the Department of Biology at the University of Victoria, and holder of the British Columbia Leadership Chair in Ocean Ecosystems and Global Change since 2006. He came to the University of Victoria from the Université du Québec à Montréal where he was Professor of Biology and Director of the GEOTOP Research Centre. He received his B.Sc. from the University of Alberta (1976) and a Ph.D. from Canterbury University in Christchurch, New Zealand (1982). The primary focus of his research is the biogeochemistry and ecology of submarine hydrothermal systems. Within PICES he is a member of the Advisory Panel on North Pacific Coastal Ocean Observing Systems.

Dr. Akash Sastri (asastri@uvic.ca) is Ocean Networks Canada's staff scientist supporting interdisciplinary research in the "Plankton Dynamics and Biogeochemistry" research theme. He has a background in biological oceanography with a focus on the roles of marine plankton communities in changing environments. Akash completed his undergraduate studies and a M.Sc. in Zoology at the University of Guelph, Ontario. His Ph.D. (2007) thesis at the University of Victoria focused on the development and application of novel ways to measure zooplankton productivity routinely at sea. Within PICES he is a member of the Biological Oceanography Committee, Advisory Panel on North Pacific Coastal Ocean Observing Systems, and co-chairs the Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions.

The Bering Sea: Current status and recent trends

by Lisa Eisner

Climate and oceanography

During April through September 2018, Bering Sea ocean conditions reflected the unusual climate forcing of the previous winter as well of that of the period of review here. As reported in the previous edition of PICES Press (Vol. 26, No. 2, pp. 57–60), the winter of 2017–2018 was exceptionally warm, with a record low sea ice extent on the eastern shelf north of 60°N. The result was the smallest cold pool (near bottom water <2°C) on the Bering Sea shelf during the summer of 2018 since at least the early 1960s (P. Stabeno, personal communication). A map of the SST anomaly distribution for April–September 2018 (Fig. 1) shows warmer than normal temperatures for the entire region, with particularly high anomalies exceeding 2.5°C in Norton Sound and Kotzebue Sound. The temperatures in the southern portion of the Bering Shelf were not as extreme. Nevertheless, the depth-averaged temperatures at Mooring 2 (near 57°N, 164°W) were the second-highest in the observational record extending back to 1995 (the highest value was in 2016). The upper mixed layer at Mooring 2 during summer 2018 was somewhat deeper than usual, and the temperature difference between this layer and the water near the bottom was reduced (P. Stabeno, personal communication), which may have resulted in enhanced nutrient fluxes into the euphotic zone. Ocean temperature anomalies were greater than 3°C in the northern Bering Sea and southern Chukchi Sea during September 2018; this extra heat has contributed to the delayed onset of sea ice in the vicinity of Bering Strait observed in late 2018.

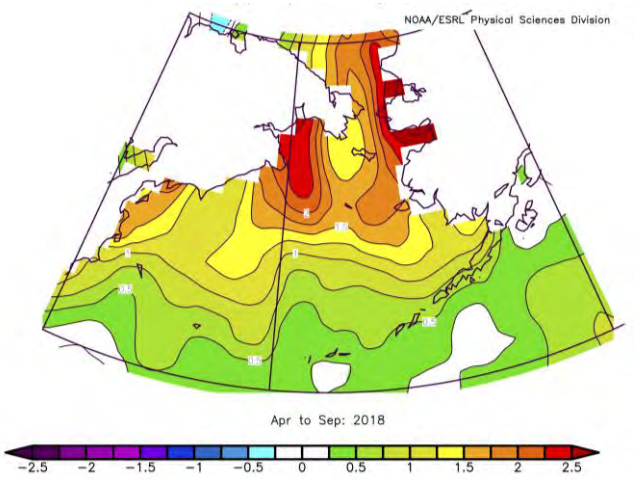

Fig. 1 Mean surface air temperature anomalies (°C) from the NCEP/NCAR Reanalysis for April through September 2018. Figure courtesy of Nick Bond, NOAA Pacific Marine Environmental Lab (PMEL).

The atmospheric forcing during the spring and summer of 2018 is summarized in terms of the mean sea level pressure (SLP) anomaly map (Figure 2). This map indicates a band of lower than normal SLP extending from south of the Kamchatka Peninsula to Cape Romanazof on the west coast of Alaska. This resulted in only a slight shift in the storm track but did bring about wind anomalies of 1 to 1.5 m s^{-1} from the southeast over the southern Bering Sea shelf, and presumably anomalous poleward advection of warmer water in this region. There were some short periods with unusually strong winds for the season, specifically during early June, early July and the second week of August. The latter storm featured sustained winds of greater than 20 m s^{-1}. These events probably were largely responsible for the relatively deep mixed layer observed at Mooring 2 during the summer of 2018.

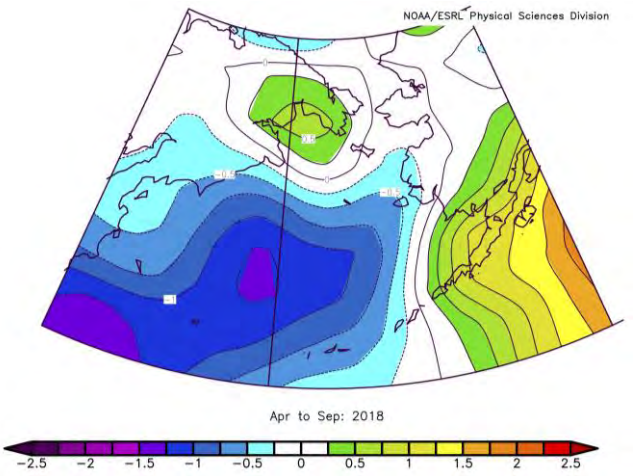

Fig. 2 Mean sea level pressure (mb) anomalies from the NCEP/NCAR Reanalysis for April through September 2018. Figure courtesy of Nick Bond, NOAA, PMEL

At the time of the writing of a similar summary a year ago (December 2017), it appeared that the Bering Sea was liable to be undergoing a transition from a multi-year period of warmth to more normal conditions. With the benefit of a year of hindsight, it now seems that 2017 was a bit of an aberration and that the Bering Sea remains in what can be considered a warm stanza. That being said, it is likely that Bering Sea temperatures will moderate to an extent because the atmospheric forcing during the winter of 2018–2019 probably will not be as unfavorable to the development of sea ice as it was in 2017–2018.

2018 eastern Bering Sea ecosystem status report: In brief

An ecosystem status report brief for the northern and southeastern Bering Sea in 2018 was compiled by

ecosystem scientists at the NOAA Alaska Fisheries Science Center (AFSC), based on NOAA surveys and additional observations (Siddon and Zador, 2018).

Highlights for the northeastern shelf include:

- An unprecedented near-complete lack of sea ice.
- The water column was well-mixed from top to bottom and resulted in a weak and delayed spring bloom (~1 month later than typical).
- Zooplankton abundances and lipid quality were low (lower nutritional value).
- More than 50% of adult Pacific cod biomass in the eastern Bering Sea was found over the northern portion of the shelf. Juvenile forage fish (*e.g.*, pollock, capelin, herring), an important prey resource for birds and mammals, all showed downward trends in abundance.
- Ribbon seals were unusually scarce. Spotted seal pups weighed less and had less blubber than in recent years. Communities reported high numbers of dead seals (primarily young bearded seals) on the north side of St. Lawrence Island in June.
- A seabird die-off event, unprecedented in terms of spatial and temporal scale, occurred. Starvation is the only identified cause of death to date.

Highlights for the southeastern shelf include:

- No sea ice and a greatly reduced cold pool.
- The timing of the spring bloom was a bit late, but otherwise the conditions were typical of a low-ice year.
- In late spring, small copepod abundances were at one of the highest levels recorded, while krill abundances were low. A summer acoustic survey indicated low densities of krill, continuing a trend of low abundance (since 2012) of this important prey resource.
- Larval pollock production was high. However, poor condition and survival is predicted for these fish due to the diminished prey base available. The summer bottom trawl survey indicated that adult Pacific cod and pollock abundances were low (see next section). The condition of adult pollock was the second lowest on record and continued a decreasing trend since 2010.
- Wind and ocean patterns were favorable for winter-spawning flatfish (*e.g.*, Arrowtooth flounder, Northern rock sole) in 2018 indicating that larval fish were carried to nursery areas with optimal conditions for their survival.
- The story was mixed for motile epifauna including crabs, urchins, and sand dollars. The biomass of some species groups (*e.g.*, urchins, sand dollars) continued an increasing trend in 2018 while many commercial crab stocks declined.
- At the Pribilof Islands, seabird reproduction was poor, continuing declining trends seen in recent warm years with little sea ice. On St. George Island, murres experienced the latest mean hatch date ever recorded.
- Northern fur seal pup production declined 4% per year since 1998 at St. Paul Island, but increased by about 5% at St. George Island from 2016 to 2018.

Figure 3 summarizes the 2018 observations for plankton, fish, invertebrates, seabirds, and marine mammals.

Fig. 3 Recent trends for ecosystem components in the northern and southeastern Bering Sea. Figure courtesy of Rebecca White at NOAA, AFSC.

Please see:
https://www.fisheries.noaa.gov/feature-story/bering-sea-ecosystem-status-report-and-brief-now-available-2018 to view the full brief and
https://access.afsc.noaa.gov/reem/ecoweb/ for more detailed information.

Walleye pollock and Pacific cod in the eastern Bering Sea

As mentioned in the prior section, in the southeastern Bering Sea (SEBS), biomass (and abundance) of adult walleye pollock and Pacific cod were low (below average for the 30-year time series) in 2018 (Fig. 4). In the northern Bering Sea (NBS), abundance and biomass of both of these ground fish species was much higher in 2017 and 2018 than in 2010 based on AFSC summer bottom trawl survey data (Figs. 4, 5). The decrease in the SEBS and increase in the NBS in the past two years suggests fish may have moved north in recent years. Trends over time cannot be adequately evaluated due to the lack of extensive sampling in the NBS in prior years.

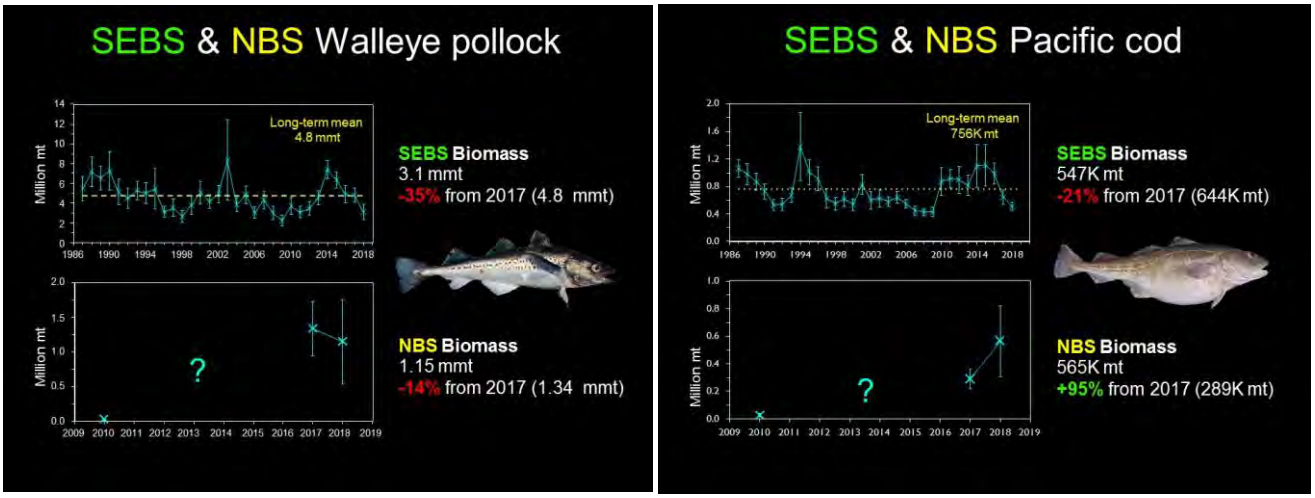

Fig. 4 Biomass (million metric tons) by year in adult walleye pollock (left) and Pacific cod (right) in the northern and southeastern Bering Sea from NOAA AFSC bottom trawl surveys. Figures courtesy of Robert Lauth, NOAA AFSC.

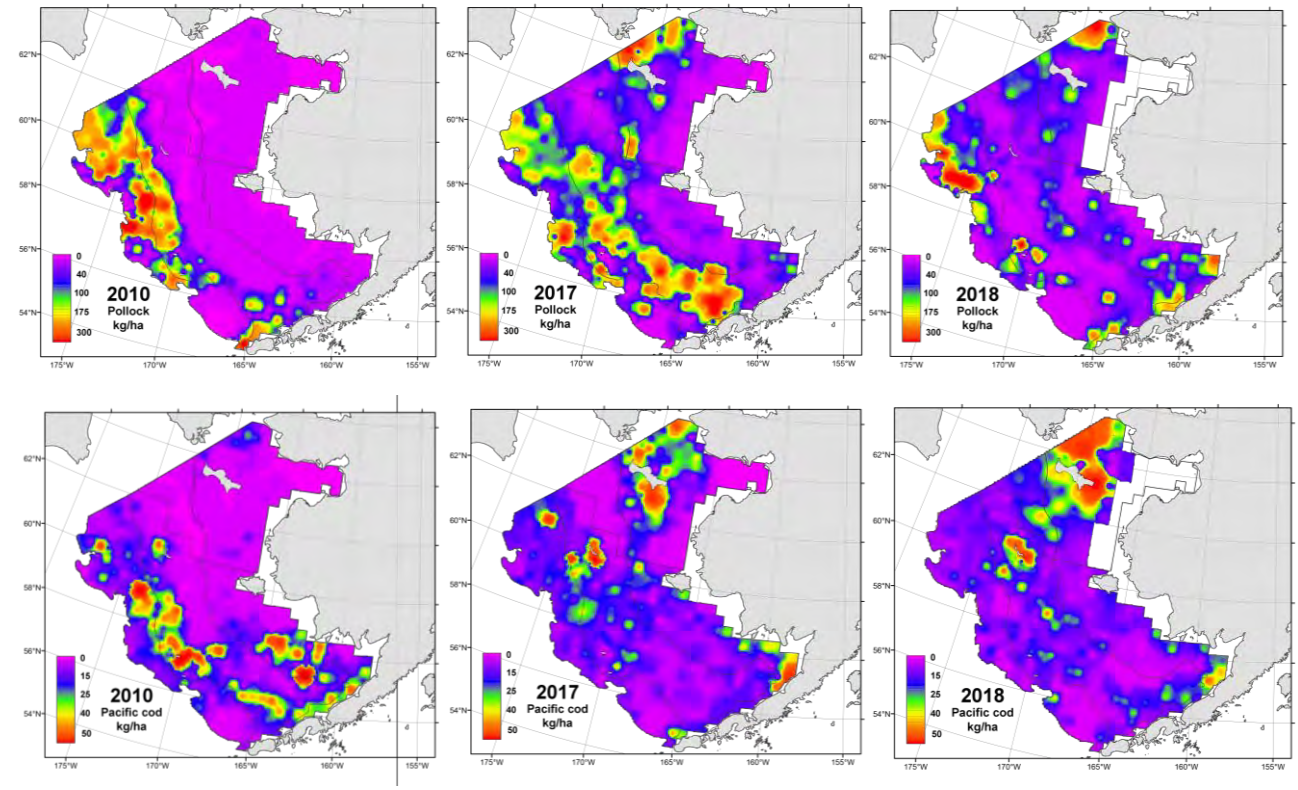

Fig. 5 Distribution of adult walleye pollock (top) and Pacific cod biomass (bottom) in 2010, 2017 and 2018 during July–August on NOAA AFSC bottom trawl surveys. Figures courtesy of Robert Lauth, NOAA, AFSC

Upcoming Bering Sea surveys in 2019

- PMEL and AFSC, NOAA will conduct mooring work, and oceanography and plankton sampling on board the NOAA Ship *Oscar Dyson*, April 19–May 2 and September 18–October 8;
- AFSC, NOAA will conduct bottom trawl surveys in the eastern and northern Bering Sea ~ June to early September;
- AFSC, NOAA will conduct forage fish and oceanography surveys in the northern Bering Sea in August/September.

Upcoming Bering Sea meetings

- Alaska Marine Science Symposium, January 28–February 1, 2019, Anchorage Alaska;
- 2019 Wakefield Fisheries Symposium, *Cooperative Research—strategies for integrating industry perspectives*

(continued on page 39)

The Northeast Pacific: Current status and recent trends

by Tetjana Ross, Jennifer Fisher, Nick Bond, Moira Galbraith and Frank Whitney

A warm sea surface temperature anomaly, with a spatial pattern in the Northeast Pacific (NEP) similar to the "Blob" that first appeared in late 2013 is now present in the NEP. By comparing the sea surface temperatures in Figure 1a (November 2018) to Figure 1b (averaged over the peak "Blob" period of November 2013–May 2014), it is evident that while the bullet shape of 2018 in the NEP is similar in coverage, the entire north Pacific is warmer than average for November. There is no evidence of the PDO-like pattern seen during November 2013–May 2014 time period. Comparing Figure 1a with Figure 1c, showing the SST anomalies averaged over June–November 2018, demonstrates how the recent anomalies in both sides of the North Pacific dominate the average, while the recent positive anomalies near the equator cancel out earlier negative anomalies.

The sustained deep temperature warm anomalies in the Northeast Pacific reported in the last PICES Press update for this region (Ross *et al*., 2018) disappeared in the latter part of 2018 (Fig. 2). At present, the dominant temperature anomaly in the upper 300 m is in the upper 50 m. It appears that this NEP-wide anomaly may be related primarily to the late onset of cooling in the autumn of 2018; the sea surface temperature remained around 14°C until mid-October at Station Papa (Fig. 3).

The development of positive temperature anomalies near the surface in the NEP during the late summer and early fall of 2018 can be attributed to regional atmospheric circulation anomalies that resembled those of the winter of 2013–14 (Bond *et al*., 2015). In particular, a large area of higher than normal sea level pressure was present over the Gulf of Alaska extending into western Canada during the months of August through October of 2018 (not shown); this feature resulted in enhanced insolation and suppressed storminess and ultimately anomalous heat fluxes from the atmosphere into the ocean.

Evidence of anomalous temperatures is not yet evident in the coastal observations from the continental shelf off Newport Oregon (44.6°N) (Fig. 4). The sea surface temperatures at this location are demonstrating the same oscillatory behaviour as in previous years (generally in association with fluctuations between upwelling and downwelling favourable winds) and there is no evidence of the sudden warming that was seen in 2014, when the last major temperature anomaly appeared at the coast.

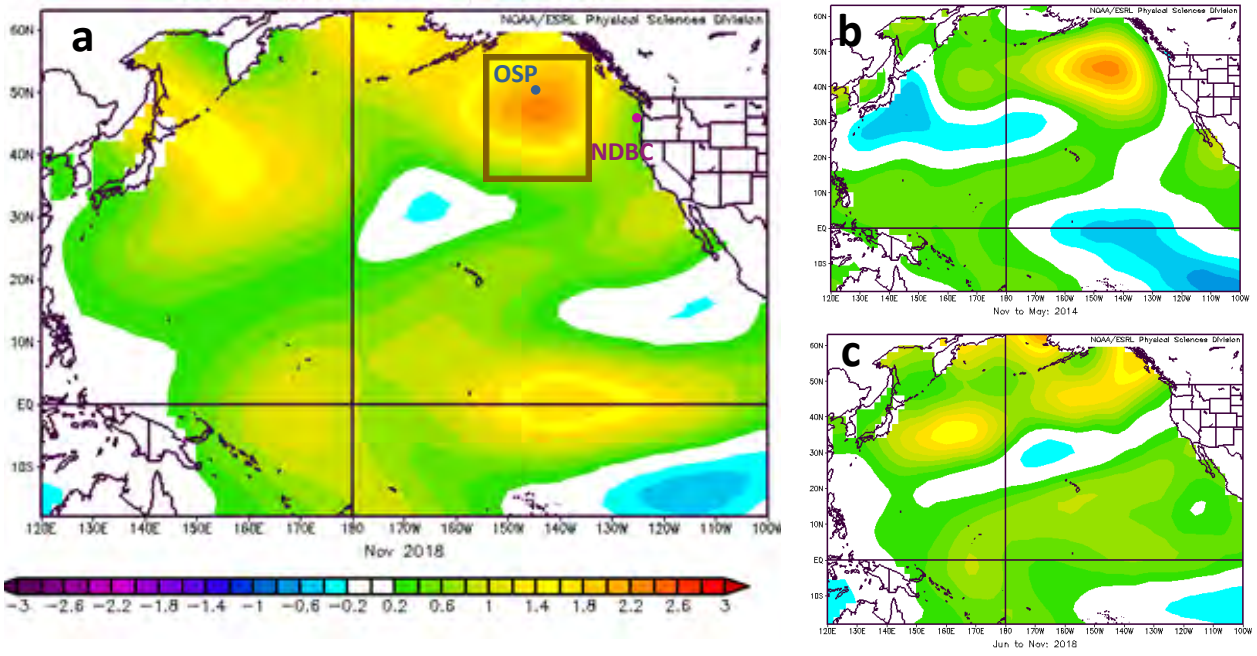

Fig. 1 Maps of temperature anomalies in the Pacific Ocean for November 2018 (panel a), November 2013–May 2014 (panel b) and June–November 2018 (panel c). The colour bar on the bottom, showing the temperature anomaly in °C, applies to all panels. The brown box indicates the area averaged over in Figure 2. The dots indicate Station Papa (OSP; blue) and the NDBC/NOAA Stonewall bank buoy (purple). Source: NOAA Extended SST v4 http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/printpage.pl.

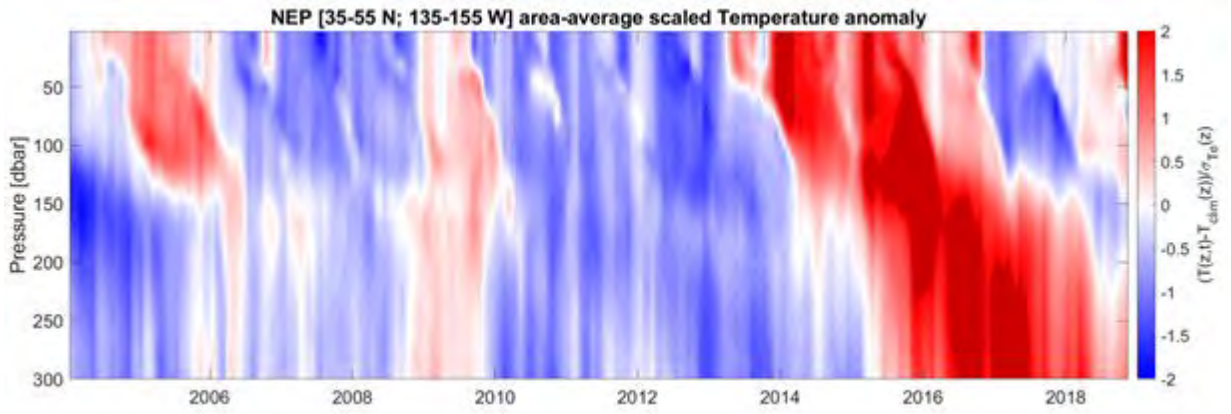

Fig. 2 False colour plot of scaled-temperature anomalies, as observed by Argo floats in the Northeast Pacific. To create the time series, the Roemmich and Gilson (2009) gridded Argo temperature dataset was spatially-averaged over 35–55°N and 135–155°W (box shown in Fig. 1a) and then scaled-temperature anomalies were calculated at each monthly time step by subtracting the 2004–2018 seasonally-corrected mean and then dividing by the 2004–2018 seasonally-corrected standard deviation. The cool colours indicate cooler than average temperatures and warm colours indicate warmer that average temperatures in units of the standard deviation at that depth and in that month.

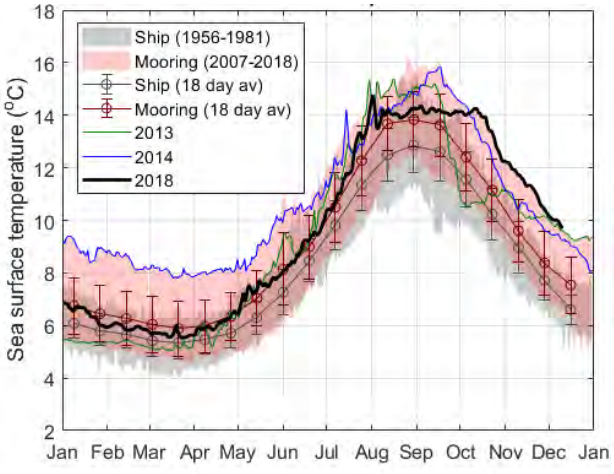

Fig. 3 Surface temperatures at Station Papa (blue dot in Fig. 1a). The two shadings indicate the full range of the data observed either by ship during 1956–1981 (in grey; period when the Weathership program offered excellent temporal coverage at Station Papa) and by the NOAA Mooring during 2007–present (in pink). The circles show the climatology based on the Ship and Mooring data, error bars show the standard deviation. The thick black line shows the daily mooring data for 2018. The green and blue lines show the years 2013 and 2014, respectively.

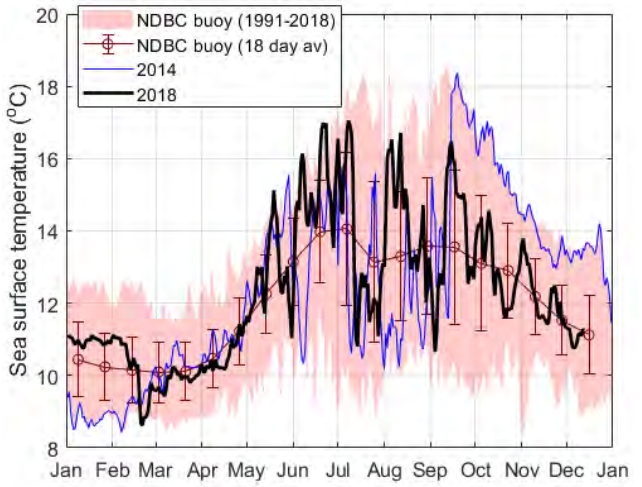

Fig. 4 Surface temperatures from NOAA/NDBC Stonewall Bank buoy (46050) located on the shelf 37 km offshore of Newport, Oregon (44.6°N; purple dot in Fig. 1a). The pink shading indicates the full range of the data from the buoy during 1991–present. The circles show the climatology based on the buoy data, error bars show the standard deviation. The thick black line shows the daily mooring data for 2018. The blue line shows the year 2014 for comparison.

Although the temperature record at the NDBC buoy off Oregon is near normal, the copepod community—as observed nearby at NH-5 (9 km from shore)—still fell below the climatology during 2018, but was more similar to the climatology than in recent years (Fig. 5). During the anomalously warm years in 2015 and 2016, the copepod community remained in a warm state and never transitioned to a cold water (upwelling) community during those years (Peterson *et al*., 2017). During January through May of 2017, the copepod community was still anomalously warm. However, the community did shift to a cold water community in July 2017, three months later than the climatology. In 2018, the community shift from winter to summer occurred on time compared to the climatology. However, the fall transition (the shift from an upwelling to a downwelling copepod community) was delayed two months, presumably from the lack of the onset of winter storms and brief periods of equatorward (upwelling favorable) winds. Recent storms in November finally shifted the community to a winter community.

Using data from the Line P time series, which has only 3-times-per-year temporal resolution, but excellent spatial resolution from the west coast of Vancouver Island (P04) to Ocean Station Papa (P26), we can see that in fall of 2018 the copepod diversity along Line P showed a distinct drop in diversity at all stations compared to the long-term mean post-2009, with the exception of station P26 (Fig. 6). This

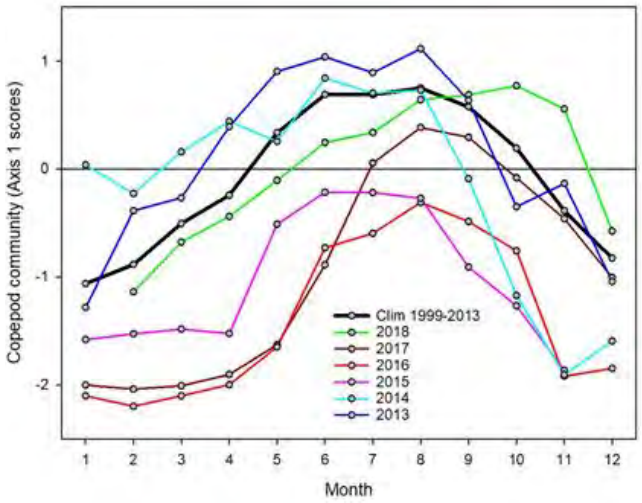

Fig. 5 Copepod community index at the Newport Hydrographic Line station (NH-5) located on the shelf 9 km offshore of Newport, Oregon (44.6°N).

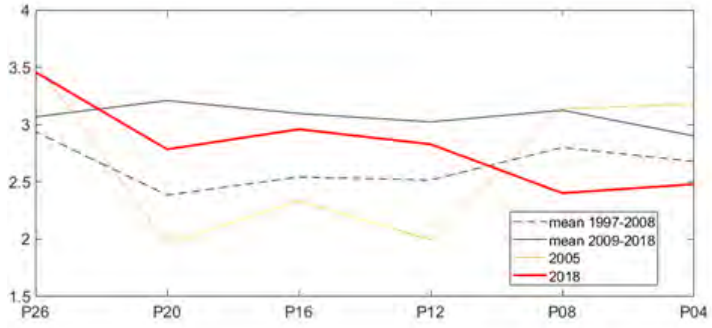

Fig. 6 Copepod diversity index along Line P during the fall of 2018 and 2005, connecting the southern tip of Vancouver Island (P04) to Station Papa (P26; blue dot on Fig. 1a). Means for 1997–2008 and 2009–2018 diversity are plotted for fall samples only.

increase in diversity at P26 during 2018 is very similar to the increase in diversity that occurred only at that station during 2005, another warm event. The 2005 and 2018 September P26 copepod community showed an affinity to open ocean equatorial species rather that southern coastal species. This increase in the copepod diversity suggests an influx of warm water open-ocean species into the late summer copepod community that was already present at P26. An interesting note is that copepod diversity at the outer stations of Line P has followed an increasing trend since about 2003 (see difference between the 1997–2008 and 2009–2018 means in Figure 6).

The emergence of warm water in the NEP has gained quite a bit of attention, and there is considerable interest in how the temperature anomalies are liable to evolve during the winter of 2018–2019. It is increasingly likely that El Niño conditions of weak-to-moderate intensity will develop in the tropical Pacific. The equatorial SST is already approximately 1°C warmer than normal, but the tropical atmospheric response to date has been muted. El Niño winters tend to be accompanied by warmer than normal upper ocean temperatures along the west coast of North America. This expectation is reinforced by the predictions from the global climate models used for seasonal weather prediction as summarized at the following website: http://www.cpc.ncep.noaa.gov/products/NMME/. The seven models used in the National Multi-Model Ensemble (NMME) are unanimous in their projections of positive SST anomalies in the Northeast Pacific Ocean through the spring of 2019. The magnitudes of these anomalies are predicted to be about 1°C, which is significant but not nearly as great as those observed during the marine heat wave of 2014–2017.

Acknowledgements

The long-term oceanographic monitoring programs (see Newport Line, NOAA and Line P Program, DFO for more information, and Ocean Climate Stations, NOAA, see https://www.pmel.noaa.gov/ocs/Papa for more information) were essential to the preparation of this report. 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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Jennifer Fisher (Jennifer.fisher@noaa.gov) is a faculty research assistant with Oregon State University's Cooperative Institute for Marine Resources Studies. She is interested in the physical processes that regulate coastal zooplankton and meroplankton communities. Her current research involves studying the interactions between local and basin-scale physical drivers of copepod communities off Newport, Oregon.

Dr. Nicholas (Nick) Bond (nicholas.bond@noaa.gov) is a principal Research Scientist with the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) of the University of Washington (UW) and he also holds an appointment as an affiliate Associate Professor with the Department of Atmospheric Sciences at the UW. He is the State Climatologist for Washington. His research is on a broad range of topics with a focus on the weather and climate of the Pacific Northwest and the linkages between the climate and marine ecosystems of the North Pacific. He cheerfully admits to being a weather geek. Within PICES he is a member of the Working Group on Third North Pacific Ecosystem Status Report.

Moira Galbraith (Moira.Galbraith@dfo-mpo.gc.ca) is an invertebrate taxonomist specializing in zooplankton, on the west coast Canada, in particular. She works at the Institute of Ocean Sciences in Pat Bay, British Columbia.

Frank Whitney (frank.whitney@outlook.com) is a Scientist Emeritus at the Institute of Ocean Sciences, Fisheries and Oceans Canada. He has remained interested in chemical processes impacting the productivity of the ocean, whether it is nutrient supply to surface waters or hypoxia at depth. See papers (J. Oceanogr. 67: 481–492; Geophys. Res. Lett. 40: 1–6) that have summarized some of the trends he and colleagues observed over a span of 25 years or more in the subarctic Pacific.

(continued from page 35)

and insights in fisheries science, May 7–10, 2019, Anchorage Alaska;

- Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) session on Arctic marine ecosystems in a changing climate as part of the Integrated Marine Biosphere Research project (IMBeR) Open Science Conference, June 17–21, 2019, Brest, France.

Acknowledgements: Many thanks to the scientists who helped create this report: Drs. Nicholas Bond and Phyllis Stabeno at NOAA, PMEL; Lyle Britt, Rebecca White, and Drs. Robert Lauth, Elizabeth Siddon and Stephani Zador at NOAA, AFSC.

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Dr. Lisa Eisner (lisa.eisner@noaa.gov) is a Biological/Fisheries Oceanographer at the Alaska Fisheries Science Center of NOAA-Fisheries in Juneau, Alaska and Seattle, Washington. 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 a member of the PICES Technical Committee on Monitoring and is a co-PI on eastern Bering Sea and Chukchi Sea research programs.

The western North Pacific during the 2018 warm season

by Toshiya Nakano

The western North Pacific was characterized by positive anomalies of sea surface temperatures (SSTs) in a region east of Japan between 30°N and 40°N throughout the 2018 warm season (Figure 1).

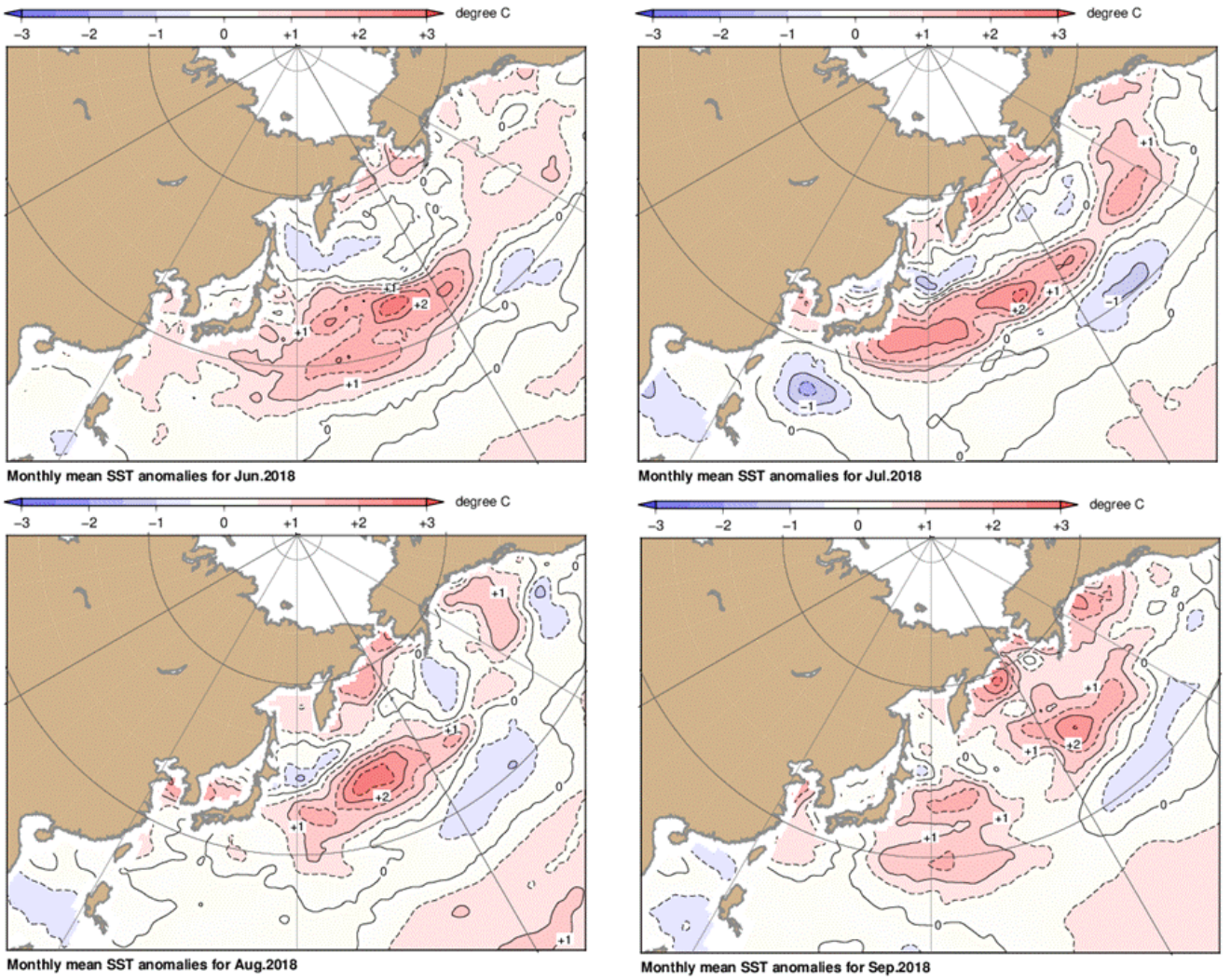


Fig. 1 Monthly mean sea surface temperature (SST) anomalies from June to September 2018. Monthly mean SSTs are based on JMA's COBE-SST (centennial in-situ observation-based estimates of variability for SST and marine meteorological variables). Anomalies are deviations from the 1981–2010 climatology.

The Kuroshio large meander continues for more than a year

In the summer of 2017, a large meander event occurred for the first time in 12 years since 2005, and has continued for one year and four months (as of December 2018; Fig. 2).

A change in the Kuroshio path can influence sea level around Japan's southern coast. When a Kuroshio large meander appears, sea levels from the Tokai region to the Kanto region tend to rise. Sea level becomes highest from summer to autumn throughout the year due to seasonal fluctuations. If sea level rises associated with typhoons or low-pressure areas occur simultaneously for the period, damage caused by inundation in low-lying land areas is expected to be exacerbated by the influence of the meander. The sea level rise in the Kuroshio large meander event is considered to be caused by a cold eddy which appears in the Tokai coast when the Kuroshio large meander is fixing. A Kuroshio large meander generally lasts for a year or more and can influence fishing grounds and economical shipping

routes. For instance, in the Kuroshio large meander event, it was reported that the fishing ground of bonito along the Kuroshio moved offshore of Japan's southern coast and resulted in a decreased catch of bonito in the coastal prefectures of Wakayama and Kochi. Note that shifts in the Kuroshio's path has an effect on different fish species and thus the fisheries that depend on them.

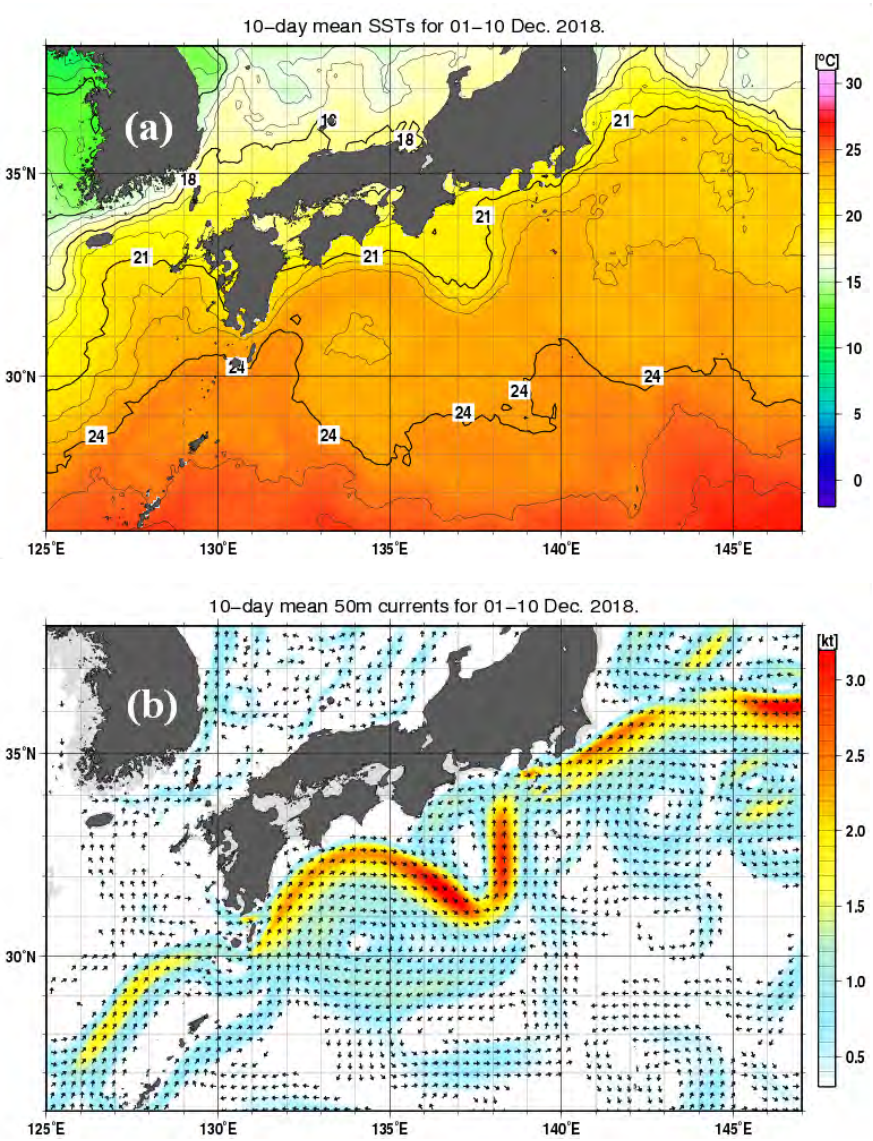


Fig. 2 (a) 10-day mean 100 m temperatures and (b) 10-day mean 50 m currents in the Kuroshio region for December 1–10, 2018.

Oceanographic section time-series dataset for the JMA 137°E repeat hydrographic section now available

The Japan Meteorological Agency (JMA) has conducted ongoing ship-based hydrographic observation along the 137°E meridian across the western North Pacific since 1967 for winter and since 1972 for summer (Fig. 3; Oka *et al*., 2018). In order to facilitate and encourage the wide use of historical long-term observation data for the JMA 137°E repeat hydrographic section, the JMA has released the "Oceanographic Section Time-series Dataset for the 137°E Meridian" in June 2018.

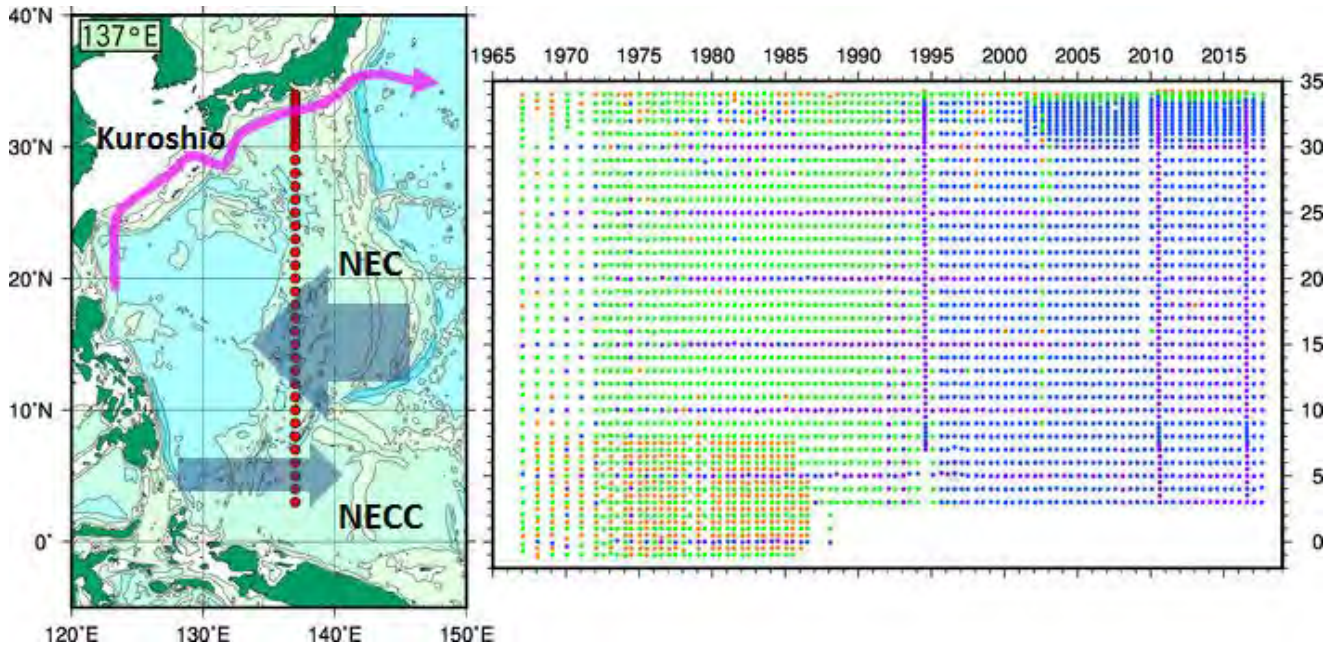


Fig. 3 Stations contributing to the time-series dataset of the 137°E repeat hydrographic section. Left: hydrographic stations (red circles) and the main ocean current system (NEC: North Equatorial Current; NECC: North Equatorial Counter Current). Right: latitudes of hydrographic observations in winter and summer at the 137°E section plotted for 1967–2016. Dot colors indicate the maximum depth of standard layers at each station (orange: <1000 m; green: 1000–2000 m; blue: 2000–4000 m; purple: ≥4000 m).

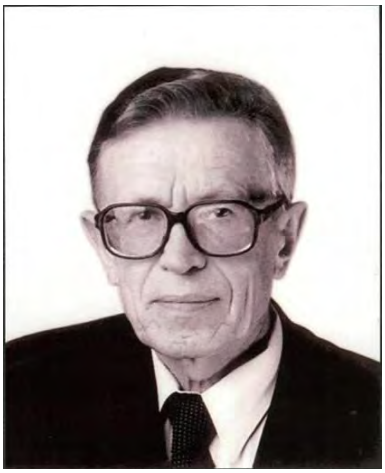
These datasets consist of "Observation Data", "Oceanographic Section Time-series Dataset" and "Sections". Observation Data are raw temperature, salinity, oxygen, nutrients and other materials. The Oceanographic Section Time-series Dataset contains statistically analyzed grid point values based on observation data and other interpolated monitoring information. Sections are vertical section figures based on the Oceanographic Section Time-series Dataset and normals of temperature and salinity. We look forward to your continuous use of our data. If there are any questions, please do not hesitate to contact the Marine Division, Japan Meteorological Agency (e-mail: seadata@met.kishou.go.jp).

Reference

Oka E., M. Ishii, T. Nakano, T. Suga, S. Kouketsu, M. Miyamoto, H. Nakano, B. Qiu, S. Sugimoto, Y. Takatani (2018): Fifty years of the 137°E repeat hydrographic section in the western North Pacific Ocean. J. Oceanogr., 74, 2, 115–145, https://doi.org/10.1007/s10872-017-0461-x.

Dr. Toshiya Nakano (nakano_t@met.kishou.go.jp) is Head of the Marine Environment Monitoring and Analysis Center, Marine Division at the Japan Meteorological Agency. His group is tasked with issuing long-term variations of the marine environment including the state of the ocean climate such as ocean heat content, ocean structure and water properties, and the carbon cycle such as carbon uptake, carbon inventory and ocean acidification.

In memory of Boris Kotenev



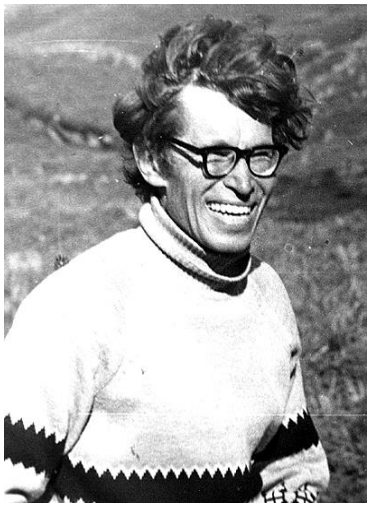
An outstanding Russian scientist, Boris N. Kotenev died on October 26, 2018. He was a man of goodwill who loved life, was creative, tremendously hard working and possessed an exceptionally positive attitude towards people.

Boris Kotenev was born on October 5, 1939 in the town of Ayaguz of the Semipalatinsk region in Kazakhstan (USSR). Since his young years, Boris was fascinated by science, and this led him first to work in the North Kazakhstan Geophysical Expedition after graduating from secondary school, and then to study at the Faculty of Geography of Lomonosov Moscow State University (MSU). During his student years, Boris actively participated in marine expeditions, already then establishing himself as a keen scientist and skilled leader. After graduating from MSU and completing his postgraduate studies, Boris successfully presented his Ph.D. thesis titled "*Geomorphology of continental slope of the Bering Sea*".

Boris' career as an oceanographer was formed in the 1960s. It was time of rapid development and intensification of Soviet marine fisheries when the USSR was organizing numerous scientific expeditions, including those in the most remote parts of the World Ocean. From 1966 to 1971, Boris worked at the Polar Research Institute of Fisheries and Oceanography (PINRO) and led large integrated expeditions in regions of the Svalbard Archipelago, Iceland and Northwest Atlantic. The foundation for Russian fisheries oceanography as a science was laid then and there. Later on, throughout his entire life, Boris was interested in, and attentive to, various fisheries science issues in his beloved Northern Basin.

The scope of his research expanded constantly and included commercial fisheries, studies on fish habitats and status of bioresources, development of new fish stock assessment methods, and medium- and long-term fishery forecasting. As a geomorphologist, he studied topography and bottom sediments of new Russian commercial fishing regions, and participated in the writing of many textbooks on fisheries science. This work was especially pertinent in the 1970s and 1980s when commercial bottom-trawl fisheries were being developed.

At the same time, Boris began studying the regions of oceanic rises and seamounts, including a wide range of issues related to biological productivity formation in the high seas and short- and long-term variability of fishing conditions in frontal zones and local upwellings. During this period, his published works describing the impact of abiotic factors on the processes determining the biological productivity and aggregations of commercial fish. He also contributed to the development of new methods of fishing stock assessment, evaluation of fish habitat conditions and fisheries forecasting. A series of manuals for commercial fishermen was created under his leadership. A two-volume book, "*Description of seamounts and rises of the World Ocean commercial fishery regions*", was the very first publication in the world to summarize all the data known on underwater mountains. Moreover, he also co-authored the "*Commercial description of "horse mackerel zone" of the southern Pacific Ocean*" and the monograph on pollock in the Bering Sea and the Sea of Okhotsk.



Boris Kotenev on South Georgia Island (the UK) during the expedition to the southern Atlantic in 1976.

The most important activity of Boris' career was his participation in (and his leadership of) many integrated fishery science expeditions, both in Russian regional seas and world-wide. His Ph.D. thesis, dedicated to evaluation of trawl fishery bioresources of the Bering Sea continental slope, was based on research cruises conducted in 1961–1965. Using maps of commercial fishing grounds prepared by Boris before 1976, dozens of sites suitable for fishing have been developed in the Bering Sea.

Boris Kotenev (left) during the BIO Committee meeting at the Fourth PICES Annual Meeting (October 1995, Qingdao, China).

As a research scientist with VNIRO (Russian Federal Research Institute of Fisheries and Oceanography), Boris led a number of scientific and commercial fisheries expeditions in the Southwest Atlantic during the 1980s (after the third United Nations Conference on the Law of the Sea adopted the Exclusive Economic Zone concept, a 200-mile economic zone granted to coastal states) where stocks of macrurus fish (grenadiers) were discovered on continental slope of Argentina and the Falkland Islands. He also served as chief scientist of oceanic cruises in the Northwest and Southeast Atlantic, in the western part of the Indian Ocean and in the Antarctic part of the Atlantic and the Pacific Oceans.

Boris Kotenev's administrative career and achievements also deserve the greatest possible respect and admiration: Head of Laboratory at PINRO, then Sector Manager, Deputy Director (1992–1998), and Director (1998–2008) of VNIRO. During his term as a Director, instrumentation and technical base of VNIRO was significantly updated, the Center for Molecular and Genetic Identification (regarded as the best in Europe) was created, sturgeon and crab aquarium complexes were built, and mussel farming and sturgeon breeding in ponds were developed.

Boris was always active in international affairs. His expertise was sought in international negotiations on transboundary fish stocks during UN meetings in 1993–1995. In 1996–2008, he participated, as a member of the Russian delegation, in multilateral and bilateral cooperation negotiations with Japan and the USA on the Convention on Pollock of Central Part of the Bering Sea and in the meetings on the development of the Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean. Since 1998, Boris served as a delegate of the Russian Federation on ICES Council, being a Vice-President of this organization from 2003 to 2006.

Boris was at the forefront in helping to develop a Convention for a North Pacific Marine Science Organization (PICES). In December of 1991, he led the Russian delegation (O.F. Gritsenko, V.I. Radchenko, and M.A. Stepanenko) to attend the first PICES scientific workshop in Seattle, USA. This workshop was convened by Professor Warren Wooster, a principal founder and then the first Chairman of PICES. During that meeting representatives of North Pacific Rim countries exchanged views on the state and problems of ecosystems studies of the North Pacific Ocean and laid the basis for cooperation that led to the creation of PICES in 1992. Boris was an active supporter of the PICES Convention, and eagerly and strongly promoted the joining of the Russian Federation to PICES in 1994. At the Fourth PICES Annual Meeting in Qingdao, China, in October 1995, he was proud to announce that Russian scientists had become a part of the big family of PICES marine science.

Boris worked tirelessly to establish a multidisciplinary national committee for PICES to coordinate scientific research and reporting related to ecosystem studies by Russian fisheries research institutions, hydrometeorological agency, and academia. Despite a formal committee not being established, a spirit of collaboration bound Russian scientists of different institutions and scientific fields together as one team for a long time. From 1996 to the year of his passing Boris was a member of the Biological Oceanography Committee.

During his career, Boris published more than 290 scientific papers, including six monographs and numerous operational editions such as maps, manuals and study guides for the fishing industry. Only a few people know that Boris had prepared a Doctor of Science thesis – a fundamental scientific work encompassing his experience in the field of fisheries. The scientific basis of marine fishing optimization have been formulated and substantiated. Approaches have been developed, potentially allowing improved efficiency in fishing of several commercial fish stocks and, as the end result, an increase in Russian fishery harvest. We believe that this scientific treatise will be published and will become an important parting wish from our colleague to all people who are engaged in fishery science.

The work of Boris Kotenev has been highly appreciated by the Russian State. He was awarded numerous medals and accorded by Presidential Decree the title "The honored worker of fisheries of the Russian Federation" in 2010.

With the passing of Boris, a whole epoch ends. Comrades, colleagues and friends, and all people who knew Boris Kotenev will never forget him – he will remain in our memory forever. A kind and bright man passed away. He was a dedicated scientist and leader, and a modest worker with giant merits in national and world fisheries science.

This article was contributed by friends and colleagues of the late Boris Kotenev.

New leadership in PICES

Marine Environmental Quality Committee

At PICES-2018, Dr. Guangshui Na (China) was elected Chair of the Marine Environmental Quality Committee (MEQ), taking over from Dr. Chuanlin Huo (China) who completed two terms as MEQ Chair. PICES extends its gratitude to Dr. Huo for his dedicated service as MEQ Chair since 2012.

Guangshui Na is a professor with the National Marine Environmental Monitoring Center (NMEMC) of the Ministry of Ecology and Environment (MEE) and is based in Dalian, China, where the 2008 PICES Annual Meeting was held. He has a good scientific background and experience in international collaboration. He knows PICES well, since 2014, when he engaged in PICES work as a member of the Working Group (WG 31) on *Emerging Topics in Marine Pollution*, and then held concurrent posts in the FUTURE Scientific Steering Committee, MEQ, Working Group (WG 35) on the *Third North Pacific Ecosystem Status Report* and joint PICES/ICES/PAME Working Group (WG 39) on an *Integrated Ecosystem Assessment for the Central Arctic Ocean*. As the Secretary-General of PICES–China Committee, he contributes to promoting the participation of Chinese scientists in PICES.

Guangshui received his B.Sc. and M.Sc. in Biochemistry from the Liaoning Medical University, and his Ph.D. in marine pharmacology from the China Pharmaceutical University. His postdoc research was conducted at the Ecological Environment Research Center, Chinese Academy of Sciences. His scientific interests include analysis technology, environmental behavior and toxicology of emerging pollutants in the marine and polar environments. He has authored more than 30 papers, and has trained more than 20 Master's students. In addition, Guangshui has won the Liaoning Provincial Natural Science Achievement Award for three consecutive years, and was one of 100 candidates for the Liaoning Province BaiQianWan talents program of 2017.

Guangshui has been in charge of and involved in many research projects—national and sectional (departmental), fundamental and high-tech, bilateral and regional, including the Special Project on the Comprehensive Survey and Assessment of the Environment of the Arctic and Antarctic, and has participated in the Arctic scientific investigation in 2007, 2014 and 2017, as well as the 26th and 29th Antarctic scientific investigations. He has attended numerous scientific and technical meetings, focusing on the protection and investigation of the marine environment, and participating in discussions on the revision and implementation of the Evaluation Strategy and Monitoring Plan.

Guangshui has a beautiful wife, who is working towards her Ph.D. in the USA. He has a similarly beautiful 4-year-old daughter who always makes his heart full of happiness and pride, and a smart 6-year-old son who is his sunshine and is good at playing the piano and table tennis while his daughter's most favourite passtime is to play with her big brother.

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