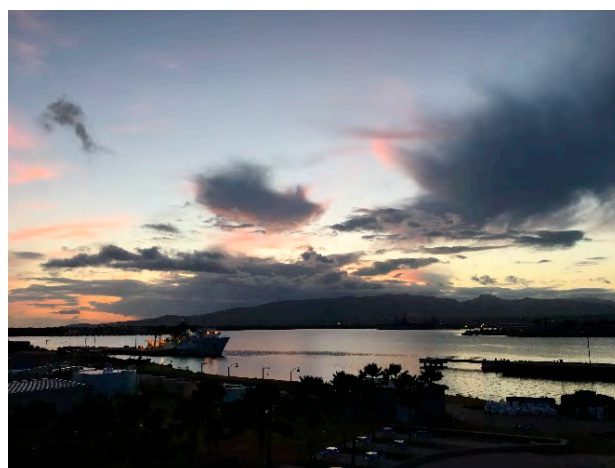


## 2017 Inter-sessional Science Board Meeting: A note from the new Science Board Chair

The 2017 Inter-sessional Science Board Meeting (ISB-2017) was held April 11–13 at the beautiful location of NOAA’s Pacific Islands Fisheries Science Center (PIFSC) in Honolulu, USA. ISB-2017 started with self-introductions, and we welcomed new Science Board members, Keith Criddle (Human Dimensions Committee Chair), Se-Jong Ju (Biological Oceanography Committee Chair), Sukyung Kang (FUTURE Co-Chair), Joon-Soo Lee (Technical Committee on Data Exchange Chair), Emanuele Di Lorenzo (Physical Oceanography and Climate Chair), and Motomitsu Takahashi (representative of Japan).

Prior to ISB-2017, a couple of business meetings were held at PIFSC, which were the FUTURE Scientific Steering Committee meeting and the Working Group on the *Third North Pacific Ecosystem Status Report* (WG-NPESR3/WG 35). We invited the Co-Chairs of WG-NPESR3, Peter Chandler and Sinjae Yoo, to present their report to ISB. The next generation of NPESR will be built on Ecosystem Time Series Observations (ETSOs) of 15 large marine ecosystems of the North Pacific which will be supplied by each PICES member country. The WG laid out the ETSOs

submission process and nominated the lead authors, as well as the contributing authors, for providing regional assessments. The publication of regional assessments is scheduled for mid-2018 and a synthesis paper of NPESR3 will be submitted to a peer-reviewed journal in 2019.



Pearl Harbor from NOAA’s Pacific Island Fisheries Science Center.

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Science Board meeting participants, back row, from left: Igor Shevchenko (representing Russia), Wonjoon Shim (GC), Steven Bograd (FUTURE SSC), Sinjae Yoo (FUTURE SSC), Harold (Hal) Batchelder (Deputy Executive Secretary), Keith Criddle (HD), Chuanlin Huo (MEQ), Joon-Soo Lee (TCODE), Motomitsu Takahashi (representing Japan), Enrique Curchitser (GC), Mike Seki and Jeffrey Polovina (NOAA hosts); middle row, from left: Ken Fujimoto (Adviser, Japan), Elizabeth (Libby) Logerwell (FIS), Sukyung Kang (FUTURE SSC), Peter Chandler (WG 35), Jennifer Boldt (MONITOR), Chieko Kondo (GC), Chika Fujimitsu (Adviser, Japan); front row, from left: Se-Jong Ju (BIO), Hiroaki Saito (Science Board Chair), Chul Park (PICES Chair) Robin Brown (Executive Secretary). Missing: Emanuele di Lorenzo (POC) who participated at the meeting via WebEx.



Top: NOAA PIFSC Director, Dr. Mike Seki (right) taking ISB-2017 participants on a guided tour of the PIFSC facilities. Bottom: beyond the glass wall at far end is the Hawaii Tsunami monitoring facility, with many redundant computers to ensure early warning capability throughout the Pacific region.

The other business meeting was that of the FUTURE SSC. SSC Co-Chairs, Steven Bograd and Sukyung Kang, gave a summary of their meeting’s discussions and decisions. One of the topics the SSC examined was finding gaps in the objectives of FUTURE. The FUTURE SSC used a diagram of Socio-Ecological-Environmental Systems (SEES; see the schematic below) to identify any gaps in the research activities of FUTURE that may need to be addressed by newly developed expert groups (EGs). As PICES has launched several new EGs in the last two years, most parts of SEES diagram are well covered by the past and on-going EGs, so it is essential to review the progress and contribution of on-going EGs to FUTURE science, and to advise and revise them if necessary. The FUTURE SSC is preparing a synthesis paper targeted to scientists who are doing work in interdisciplinary science. The synthesis will describe the FUTURE program and how it has developed an effective way to do cross-disciplinary science in an international environment. The paper will also chronicle the challenges FUTURE has had along the way, and make recommendations.

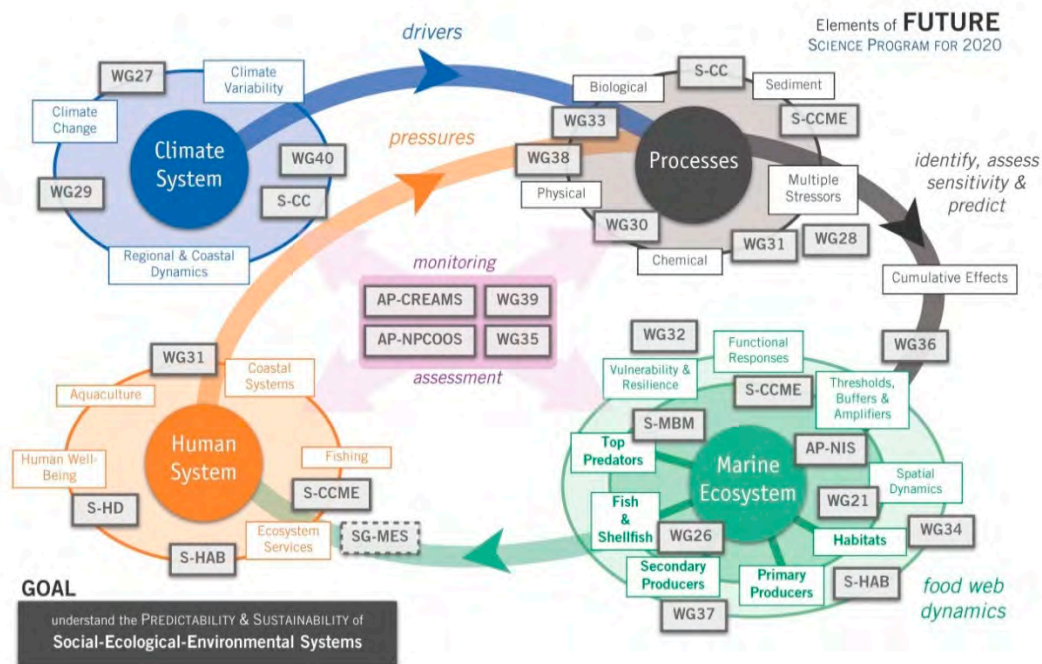
In November 2016, PICES celebrated its 25<sup>th</sup> Annual Meeting in San Diego, USA. The anniversary was a nice opportunity to look at PICES’ past scientific activities and achievements, and to plan its future direction. At the Meeting, Governing Council (GC) made a couple of important decisions. One was to endorse, upon the recommendation of Science Board, a permanent Standing Committee on Human Dimensions (HD), based on the achievements of the Section on *Human Dimensions of Marine Systems* (S-HD). S-HD was an active EG which successfully brought together natural and social scientists in order to better understand and communicate the societal

implications of the conditions and future trends of North Pacific ecosystems. Collaboration between natural and social scientists is often listed in various programs and organizations today. However, it often does not work smoothly because of different scientific approaches and language between disciplines. S-HD scientists overcame this difficult task through convening sessions and workshops, publishing papers, and transferring the knowledge to developing countries. The ICES-organized international symposium, MSEAS 2016—*Understanding marine socio-ecological systems*—is one of the examples where PICES S-HD scientists made significant contributions, and where they are leaders in the science community. The establishment of the HD Committee is a strong message that PICES will promote and coordinate transdisciplinary research that leads to increased understanding of the relationship between North Pacific marine ecosystems and the people, communities, and economies reliant on ocean-derived services. At ISB-2017, Dr. Keith Criddle, Chair of HD, reported on activities since the Committee’s establishment. A major upcoming activity is MSEAS-2, which is a major cross-disciplinary natural science-social science symposium proposed for 2020 in Yokohama, Japan. Science Board agreed that PICES will host the symposium. However, a concern of Science Board was the relatively limited number of HD members from some member countries, so a recommendation was made to GC to appoint more members to help the Committee move this important activity along.

The other important decision made by GC is related to the Arctic Ocean, which is outside of the PICES area of

concern (PICES convention, [Article II](#)). The Arctic Ocean ecosystem is very vulnerable to global warming, as observed in the rapid decline in sea-ice cover, increase in SST, shoaling carbonate compensation depth, and the concern is the potential propagation of these changes to North Pacific ecosystems. At PICES-2016, GC determined the issue to be of high importance, and agreed that PICES would collaborate with ICES on the development of an Integrated Ecosystem Assessment for the Central Arctic Ocean ([PICES2016/S/5](#)). Following the decision, a Joint PICES/ICES/PAME Working Group on an *Integrated Ecosystem Assessment for the Central Arctic Ocean* (WG 39) was established. PAME (Protection of the Arctic Marine Environment) is a working group of the Arctic Council (an intergovernmental forum for Arctic governments and peoples). Since the WG was established after the Science Board meeting and without a recommendation from Science Board, the Executive Secretary, Mr. Robin Brown, and the Science Board Chair explained the rationale for such a decision to the Science Board members. The PICES Co-Chair of WG 39 is Dr. Sei-Ichi Saitoh, and the WG reports directly to Science Board.

ICES is one of PICES’ most important partners. Both organizations have closely collaborated in various activities such as forming joint EGs, e.g., PICES/ICES Section on *Climate Change Effects on Marine Ecosystems*, holding joint international symposiums, e.g., International Symposium on “*Drivers of dynamics of small pelagic fish resources*” and PICES/ICES Early Career Scientist Conference (see articles related to these events in this issue

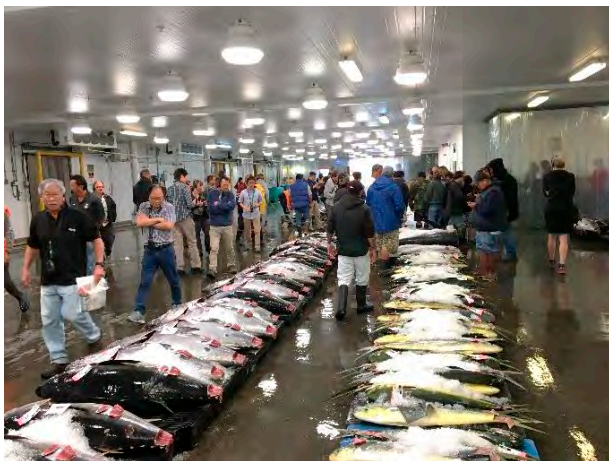


The Social-Ecological-Environmental Systems concept envisioned within FUTURE, and where recent past and present expert groups fit in.

of PICES Press), and the relationship is getting tighter as there is a need to jointly tackle such difficult issues as marine ecosystem change and sustainable use of marine ecosystem services in the Anthropocene. In addition to ongoing collaborative activities, Science Board discussed other potential scientific subjects to be studied through PICES–ICES collaboration such as aquaculture, marine spatial planning, contaminants and plastics, and early career scientists (ECSs) capacity building. Science Board will continue to think about these and other topics when we meet again at PICES-2017.

During ISB-2017, the topic of ECSs came up repeatedly. Science Board recognizes that the recruitment of ECSs to PICES is essential to carry out new innovative science, and to plan for the future. With this in mind, Science Board agreed to nominate more ECSs to the plenary sessions of PICES-2017, and also encourage ECSs to act as session/workshop conveners to lead discussions in PICES sciences. Science Board, as well as the FUTURE SSC, recommended that GC continue to support the attendance of ECSs at PICES Annual Meetings and symposia/workshops as well as to nominate them to EGs and Committees. Science Board will continue to develop a strategy to make PICES more desirable for ECSs and to encourage them to join PICES activities.

ISB-2017 was hosted by NOAA PIFSC. I would like to acknowledge PIFSC Director, Dr. Mike Seki, and staff for their warm hospitality on behalf of the PICES Science Board. Mike kindly arranged for a Honolulu fish auction tour in the morning before the meeting on Day 3. At the market we saw many bigeye tuna, yellowfin tuna, sword fish, marlin, and opah, waiting to be auctioned. Our tour guide, the general manager of the United Fishing Agency, Mr. Brooks Takenaka, was very professional and knew everything about the fisheries in Hawaii from their history, resource management, and marketing issues, through to the best ways of cooking fish. We learned a lot from his



*ISB-2017 participants observing fresh catches, along with distributors and retailers, at Honolulu’s fish auction.*

explanations and thought, “How do we scientists collaborate with people who think seriously about the sustainable use of marine ecosystem services?”



*ISB-2017 participants at the dockyard of the United Fishing Agency fish auction facilities. PIFSC host, Mike Seki (right), and Brooks Takenaka (eighth from the right).*

The next Annual Meeting, PICES-2017, will be held from September 22 to October 1 in Vladivostok, Russia. The theme of PICES-2017 is “*Environmental changes in the North Pacific and impacts on biological resources and ecosystem services*”. PICES-2017 will be an exciting meeting, with many interesting sessions and workshops covering a wide range of topics. After the last Annual Meeting in Vladivostok (2005), the city has changed a lot, with a large investment made towards upgrading and developing the infrastructure, but foods still remain tasty as ever. The venue is the newly developed Far Eastern Federal University facing the beautiful Ussuri Bay. I invite all of you to PICES-2017 in Vladivostok!



*A view of the PIFSC courtyard overlooking Pearl Harbor.*



*Hiroaki Saito  
Science Board Chair*

## Highlights from the FUTURE SSC's 3<sup>rd</sup> Inter-sessional Meeting

by Sukyung Kang and Steven Bograd

FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) is an integrative science program launched during PICES-2009 by the members and affiliates of PICES. The goals of FUTURE are to understand how marine ecosystems in the North Pacific respond to climate change and human activities, to forecast ecosystem status based on a contemporary understanding of how nature functions, and to communicate new insights to its members, governments, stakeholders and the public. To better integrate the activities of FUTURE into PICES Committees and Expert Groups, FUTURE changed its governance structure from 3 Advisory Panels: *Climate, Oceanographic Variability and Ecosystems* (COVE), *Anthropogenic Influences on Coastal Ecosystems* (AICE), and *Status, Outlooks, Forecasts, and Engagement* (SOFE) to a Scientific Steering Committee (SSC) in 2014.

The 3<sup>rd</sup> FUTURE SSC Inter-sessional Meeting was held April 5–7, 2017, at the Pacific Islands Fisheries Science Center (PIFSC), NOAA National Marine Fisheries Service, Honolulu, Hawaii, USA. Co-Chair, Steven Bograd (USA) led the meeting and Co-Chair, Sukyung Kang (Korea) served as rapporteur. The 3-day meeting was very well attended, with 15 participants (12 SSC members and Science Board Chair, PICES Executive Secretary and Deputy Executive Secretary). Two of the SSC members attended through WebEx.

### Review 2016 accomplishments and SSC 2017 Action Plan

One of the first items of the meeting was for the FUTURE SSC to review its activities from the past year. The SSC held its 2<sup>nd</sup> Inter-sessional Meeting in March 2016 to finalize its [Phase II Implementation Plan](#), which is designed to facilitate improved understanding of climate and anthropogenic impacts and consequences on marine ecosystems in the North Pacific. The SSC also began to populate a catalog of FUTURE products and drafted an outline for a peer-reviewed FUTURE synthesis paper (discussed in detail further below). During the 2016 PICES Annual Meeting, the SSC sponsored two events. The first was a FUTURE Mini Symposium where each PICES Expert Group provided an overview of their activities in 2016. The second event was a FUTURE-sponsored Topic Session (S10) on “*The response of marine ecosystems to natural and anthropogenic forcing: Past, present and future*”. This session provided a fascinating and diverse overview of new methods and approaches to investigate the impacts of climate variability and change on marine ecosystems. It was particularly encouraging to see the excellent new science being driven by early career scientists from the PICES community, which bodes well for FUTURE and PICES.



Members of the FUTURE Scientific Steering Committee at their third Inter-sessional Meeting in Honolulu, USA, in April 2017. Back row, from left: Vyacheslav Lobanov (Russia), Steven Bograd (FUTURE SSC Co-Chair/USA), Ian Perry (Canada), Harold (Hal) Batchelder (PICES Deputy Executive Secretary), Jacquelynne King (Canada), Thomas Therriault (Canada), Sukyung Kang (FUTURE SSC Co-Chair/Korea), Toyomitsu Horii (Japan), and Guangshui Na (China). Front row, from left: Sinjae Yoo (Korea), Robin Brown (PICES Executive Secretary), Hiroaki Saito (Science Board Chair), and Mitsutaku Makino (Japan). Emanuele Di Lorenzo (USA) and Ryan Rykaczewski (USA) participated via WebEx. Unable to attend were Fangli Qiao (China), and Oleg Katugin (Russia).

### ***New Expert Groups***

One of the aims of the FUTURE SSC meeting was to review completed Expert Group products by linking each theme to an Expert Group, identifying any gaps the Expert Group was not addressing, and reviewing the activities of new Expert Groups. The FUTURE SSC reviewed the activities of new Expert Groups established in 2016, their Terms of Reference, structure, and member balance. The new Expert Groups are WG 35 on the *Third North Pacific Ecosystem Status Report*, WG 36 on *Common Ecosystem Reference Points across PICES Member Countries*, WG 37 on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions*, WG 38 on *Mesoscale and Submesoscale Processes*, WG 39, Joint PICES/ICES/PAME Working Group on an *Integrated Ecosystem Assessment for the Central Arctic Ocean*, SG-MES (Study Group on *Marine Ecosystem Services*), and AP-NIS (Advisory Panel on *Marine Non-indigenous Species*). Approval of a joint working group with CLIVAR (Climate and Ocean Variability, Predictability and Change) on *Climate and Ecosystem Predictability* (WG 40) was also discussed. The proposed Co-Chair of this Expert Group, Ryan Rykaczewski, clarified the role CLIVAR would have, and submitted a revised working group proposal which the FUTURE SSC fully supported as an important component of the FUTURE program. The SSC also made adjustments to the SSC member liaison-Expert Group list, and reaffirmed the roles of liaisons.

### ***FUTURE activities at PICES-2017 and beyond***

The reorganization of the PICES website was discussed. Although FUTURE is the flagship program of PICES, it does not have a strong presence on the website. An identified task is to work with the Secretariat to give FUTURE a higher visibility and to provide more content.

In recent years, it has become a tradition to have the FUTURE Mini Symposium on Sunday morning prior to the start of the PICES Annual Meeting. The Mini Symposium has proven to be useful for updating the PICES community on FUTURE activities and requirements. However, due to schedule conflicts during PICES-2017, the Mini Symposium will be replaced with a ½-day business meeting combined with a plenary summary talk on FUTURE activities in Topic Session S10. The SSC will also prepare a draft FUTURE product matrix to circulate to Expert Group Chairs and past (Expert Group) product developers to refine the matrix and obtain brief descriptions of how FUTURE objectives are being addressed. Expert Group feedback and updated FUTURE SSC activities will be presented at PICES-2017.

Outreach is a high priority activity of FUTURE. Various suggestions for outreach were discussed, including handouts on FUTURE at the Annual Meetings, a new FUTURE logo, a 5-minute video about the program,

presentations at schools and social media efforts, and a survey of PICES scientists regarding the current FUTURE program and ideas for the next PICES integrative science program. The SSC will continue to pursue these outreach activities this year.

The SSC also proposed new guidelines for PICES workshops. At present, workshops are often qualitatively similar to topic sessions, rather than being focused on development of PICES products. To encourage early career scientists to engage with PICES, the FUTURE SSC recommended longer (2 to 3 days) workshops to facilitate in-depth discussion and output on specific topics. The FUTURE SSC plans a 2-day workshop at PICES-2019 to identify and fill knowledge gaps and to encourage early career scientists to more thoroughly participate in PICES activities.



*FUTURE SSC conducting business at its inter-sessional meeting at the PIFSC facilities, overlooking Pearl Harbor.*

At PICES-2017, FUTURE will sponsor a Topic Session (S10) on “*Emerging issues in understanding, forecasting and communicating climate impacts on North Pacific marine ecosystem*”. Two invited speakers, Drs. Zhongyong Gao (China) and Desiree Tommasi (USA), will provide a fascinating and diverse overview of new methods and approaches to investigate the impacts of climate variability and change on marine ecosystems.

### ***FUTURE synthesis paper***

The SSC is preparing a synthesis paper for a peer-reviewed journal to publicize FUTURE’s achievements and share our research and collaboration structure with other international organizations. The SSC has identified *Progress in Oceanography* as our target journal. The paper will commence with an introduction of the PICES FUTURE program, using a revised FUTURE schematic diagram to illustrate the Expert Group structure and how research is facilitated within the program. This will be followed by a summary of a few outstanding achievements of FUTURE, such as integrated efforts on climate-jellyfish-human dimensions. The final section will cover “lessons learned” to highlight key insights gained during FUTURE’s lifetime.

*(continued on page 15)*

## WG 35 (WG-NPESR3) meets inter-sessionally in Honolulu

by Peter Chandler

Amid the palm trees and warships of Pearl Harbor, Honolulu, the PICES Working Group on the *Third North Pacific Ecosystem Status Report* (WG 35/WG-NPESR3) met at NOAA's Pacific Islands Fisheries Science Center from April 9–10, 2017. This was the first meeting of the group since its transition from a Study Group at the PICES Annual Meeting in November 2016, and provided Co-Chairs, Dr. Sinjae Yoo and Mr. Peter Chandler, the opportunity to discuss with the members how the work of WG 35 will proceed. Of the 28 members appointed to the Working Group, 17 were able to attend (15 present, and Matthew Baker and Vladimir Kulik by WebEx).

The primary objectives of the meeting were to:

1. Review the progress of the implementation plan developed by the NPESR Study Group;
2. Clarify the role and remit of the members involved in the production of the NPESR3;
3. Refine the implementation plan to meet the milestones set for the PICES Annual Meetings in 2017 and 2018;
4. Introduce the naming convention for the North Pacific regions following the Science Board decision to identify by number (Figure 1);
5. Identify and confirm the lead authors for the 15 regional assessments;
6. Determine a format and content structure for each regional assessment;
7. Clarify the procedure for submitting the Ecosystem Time Series Observations (ETSOs) and select a coordinator from each PICES member country to get

these data submitted to the NPESR database *via* the on-line portal.

For the purposes of NPESR3, the North Pacific Ocean has been subdivided into 15 regions, based loosely on the Large Marine Ecosystem boundaries defined by Sherman and Hempel (2009). The naming convention for the NPESR3 regions was established by the PICES Science Board at PICES-2016. Consistent with previous ecosystem status reports produced by PICES, this third edition will consist of chapters for each region and a synthesis report that addresses ecosystem status and trends for the entire North Pacific Ocean. An additional chapter will be included to address Human Dimensions and will be based on national rather than geographic assessments.

An important distinction in the approach used to develop NPESR3 from that of previous reports is the introduction of the ETSO, and the web-based system to manage this information. Time series relevant to assessing the ecosystem status of a region can be submitted by the scientist responsible for that time series *via* the website <https://pices.submittable.com/submit>, which includes a simple interface to accept text, figures, and data. All those contributing ETSOs will be given attribution in the regional assessment reports. At the April meeting it was decided that the coordination of ETSO submissions would be based by country, and a representative from each country on WG 35 was identified to encourage and validate ETSOs submissions.



WG 35 with Science Board members and the Secretariat in Honolulu, Hawaii. Back row from left: Joon-Soo Lee, Steven Bograd, Harold (Hal) Batchelder, Sinjae Yoo, Sukyung Kang, Keith Criddle, Vyacheslav Lobanov, Igor Shevchenko, Peter Chandler, and Stephen Kasperski; front row from left: Guangshui Na, Hiroaki Saito, Robin Brown, Se-Jong Ju, Dong-Jin Kang, Stephani Zador, and Jennifer Boldt.

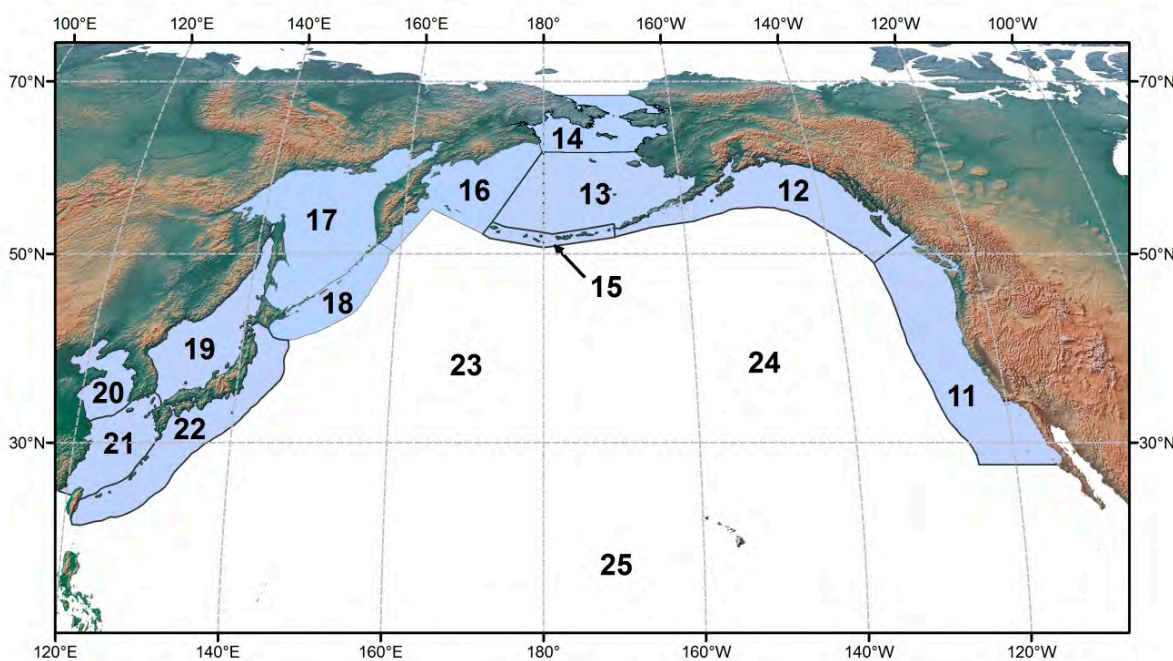


Fig. 1 Large Marine Ecosystems and oceanic areas used to categorize locations of the ETSOs and define boundaries for regional assessment reports.

The identification of regional lead authors is an essential step in the success of NPESR3. PICES is very fortunate to have experts willing to accept this undertaking and lead the work required to develop a regional assessment. A list of the lead authors can be found on WG 35's [homepage](#).

The implementation plan provided by the Study Group was reviewed and adjusted to better reflect the expected timelines required to complete the tasks. Over the next several months it is expected that many more ETSOs will be submitted, and the preliminary writing of the regional assessments will occur. While the completion of all regional assessments will not happen simultaneously, it is expected that by PICES-2017 several will be ready for review by the NPESR3 editorial board, which consists of the Chairs of the PICES Committees, or their designates. By the end of 2017 the completed regional assessments will be provided to the parent committee/program (MONITOR and FUTURE SSC) and then on to the PICES Secretariat for publication by mid-2018. Meanwhile, it is expected that the synthesis report for the North Pacific Ocean will be well underway and ready for editorial board review by PICES-2018. The final NPESR3 report is planned to be published by June 2019.

The North Pacific Ecosystem Status Report is considered a flagship product of PICES and one that serves as an indicator of the Organization's commitment to advance and exchange scientific knowledge about the North Pacific ocean ecosystems, and the impacts of human activities. The use of ETSOs to characterize and understand changes in North Pacific marine ecosystems will benefit not just NPESR3 but the broader marine science community. The

website will remain active and all North Pacific data holders are encouraged to contribute time series as they become available. Please contact Peter Chandler (email below) with any questions.

At the completion of the meeting there was an overall sense of satisfaction that the revised NPESR3 implementation plan presented to Science Board, and the identification of the regional lead authors, were two important accomplishments. It was also agreed that every effort should be made to assemble the entire membership of WG 35 at the business meeting in Vladivostok during PICES-2017.

**Reference**

Sherman, K. and Hempel, G. (Eds.). 2009. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya.



Mr. Peter Chandler (Peter.Chandler@dfo-mpo.gc.ca) is a Physical Oceanographer with Fisheries and Oceans Canada (DFO) at the Institute of Ocean Sciences in North Saanich, British Columbia. His work includes coastal monitoring programs using survey vessels and lighthouses, and the hydrodynamic modelling of coastal waters. Peter is the Co-Chair of DFO's State of the Pacific Ocean report, and in PICES, he serves as Co-Chair of WG 35 and Vice-Chair of TCODE.



## PICES/ICES International Symposium on “Drivers of dynamics of small pelagic fish resources”

by Jürgen Alheit and Yoshioki Oozeki



Populations of small pelagic fish (SPF) such as sardine, anchovy, herring, capelin and mackerel provide about 25% of the total annual yield of capture fisheries, and the well-being of many coastal communities around the world, particularly in developing countries, depends critically on these resources. Small pelagic population sizes exhibit extreme fluctuations in abundance and geographic distribution due to environmental and anthropogenic influences. In spite of many internationally coordinated research efforts, we still do not have sufficient knowledge about the drivers of SPF recruitment and in particular, the interactive effects of environmental and anthropogenic factors.

In 1983, the Fisheries and Agriculture Organization (FAO) and the Intergovernmental Oceanographic Commission (IOC) organized an International Symposium titled “*The expert consultation to examine changes in abundance and species composition of neritic fish resources*” in San José, Costa Rica ([FAO Fisheries Report 291](#), 1983, 3 Volumes). The symposium was a major success and inspired many research efforts on small pelagic fishes for the next three decades. The most memorable presentation in San José was that of Prof. Tsuyoshi Kawasaki on “*Why do some pelagic fishes have wide fluctuations in their numbers? Biological basis of fluctuation from the view point of evolutionary ecology*”. It was the first time many of those attending were confronted with the phenomenon of SPF population abundances varying synchronously in many

unconnected regions of the global ocean. This is an issue that we are still attempting to understand, as the distances between the small pelagic stocks are great, atmospheric and ocean connections weak and unclear, and mechanisms unresolved.

There has been no global symposium on SPF for 30 years, and the exchange of information about SPF globally has declined since the end of the Small Pelagics and Climate Change (SPACC) project of GLOBEC in 2008. The goal of an International Symposium on “*Drivers of dynamics of small pelagic fish resources*”, organized by PICES and ICES from March 6–11, 2017, in Victoria, BC, Canada, was to revitalize global international cooperation on investigations of SPF, and to identify, discuss and develop a framework to address unresolved questions such as the impact of climate and/or fishing pressure on the resilience of small pelagic populations using a comparative approach. Because of the importance of environmental and anthropogenic drivers on small pelagic resources, the participation of experts in the fields of physical oceanography, climate, and socio-economics was strongly encouraged.

The symposium was co-convened by Jürgen Alheit (ICES) and Yoshioki Oozeki (PICES, Japan) and co-ordinated by Alex Bychkov (PICES) and Wojciech Wawrzynski (ICES). They were assisted by the Scientific Steering Committee consisting of Miguel Bernal (FAO, CFCM), Arnaud

Bertrand (IRD, France), Jennifer Boldt (DFO, Canada), Emanuele Di Lorenzo (PICES, USA), Salvador Lluch-Cota (CIBNOR-CONACYT, Mexico), William Peterson (PICES, USA), David Reid (ICES, Ireland), Svein Sundby (ICES, Norway) and Merete Tandstad (FAO). The primary international sponsors were PICES and ICES and the local sponsor was Fisheries and Oceans Canada. In addition, several scientific and institutions co-sponsored the meeting.



The symposium was attended by 237 scientists from 31 countries and 5 international organizations, three of whom were veterans from the 1983 Costa Rica symposium. The 5-day symposium consisted of an Opening Session, morning plenary sessions to provide overarching keynote presentations and to introduce topics of the sessions to be convened on the same day, 6 topic sessions (conducted in parallel as two or three sessions daily), two evening poster presentations, and a plenary summing-up session. It was followed by a day of 6 concurrent post-symposium workshops. There were 15 invited and 148 contributed talks at the plenaries and sessions, 11 invited and 11 contributed talks at the workshops, and 56 posters.

The symposium was opened by the two co-conveners, Yoshioki Oozeki and Jürgen Alheit, who welcomed the participants and pointed out the scientific merits of Prof. Tsuyoshi Kawasaki, who sadly had passed away recently. Short welcoming addresses were given by the representatives of PICES (Chul Park, Chair), ICES (Wojciech Wawrzynski, Deputy Head of the Science Program), FAO (Manuel Barange, Director of Fisheries and Aquaculture Policy and Resources Division), and DFO (Carmel Lowe, Pacific Regional Director of Science).

The opening session was concluded by two plenary lectures on “Progress in small pelagic fish research in the 3½ decades since ‘Costa Rica’” by Andrew Bakun (USA) and “Causality linkages in atmosphere, ocean and marine ecosystems over the North Pacific: Modes, processes and prediction” by Shoshiro Minobe (Japan). In the evening of the first day, PICES hosted its traditional highly popular and always successful Welcome Reception in the Royal BC Museum.



Day 1 general plenary speakers, Drs. Andrew Bakun and Shoshiro Minobe.



Some of the Chilean SPF contingent enjoying the fare at the Welcome Reception at the Royal British Columbia Museum.

Day 3 was marked by third overarching plenary lecture, given by Ryan Rykaczewski who presented an informative talk on “Climate impacts on upwelling and the planktonic prey of anchovy and sardine in eastern boundary currents”.



Former student and mentor meet again: Drs. Yuji Okazaki and Hidaki Nakata sharing a light moment.



Old friends, Salvador Lluch-Cota and Skip McKinnell reconnecting at the SPF symposium.



Lots of enthusiastic discussions were generated during coffee breaks.



Dr. Ian Jones explaining pelagic fish catch in regions adjacent to ocean upwelling fisheries at the Poster Session.

The six Topic Sessions on Days 1–5 were:

- **S1: Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in the ecosystem context.** Conveners: Emanuele Di Lorenzo (USA), Dimitri Gutierrez (Peru), Svein Sundby (Norway), and Yongjun Tian (China); Plenary Speaker: David Field (USA); Invited Speaker: Bryan Black (USA).
- **S2: External drivers of change in early life history, growth and recruitment processes.** Conveners: Dave Checkley (USA), Susanna Garrido (Portugal), Pierre Petitgas (France), and Akinori Takasuka (Japan); Plenary Speaker: Stylianos (Stelios) Somarakis (Greece); Invited Speaker: Dominique Robert (Canada).
- **S3: The role of small pelagic fish in food web dynamics between plankton and top predators.** Conveners: Arnaud Bertrand (France), Salvador Lluich-Cota (Mexico), and Bill Peterson (USA); Plenary Speaker: Sophie Bertrand (France); Invited Speaker: Susana Garrido (Portugal).
- **S4: Comparison of methods for assessment of small pelagic fish populations.** Conveners: Miguel Bernal (GFCM), Jennifer Boldt (Canada), Momoko

Ichinokawa (Japan), and Reidar Toresen (Norway); Plenary Speaker: Reidar Toresen; Invited Speaker: Jim Ianelli (USA).

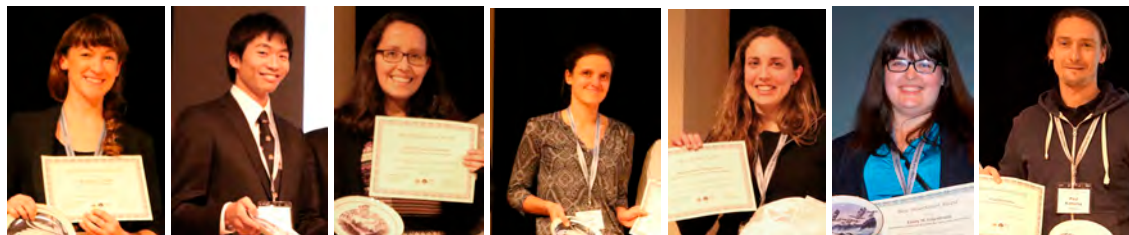
- **S5: Future challenges for ecosystem-based management of highly variable fish populations.** Conveners: Rick Fletcher (Australia), Dave Reid (Ireland), Merete Tandstad (FAO), and Andres Uriarte (Spain); Plenary Speaker: Kwame Koranteng (FAO); Invited Speaker: Verena Trenkel (France).
- **S6: Small pelagic fish and humans – social, economic and institutional dimensions.** Conveners: Manuel Barange (FAO), Marloes Kraan (Netherlands), Mitsutaku Makino (Japan), Jörn Schmidt (Germany), and Rashid Sumaila (Canada); Plenary Speakers: Manuel Barange (FAO) and Ratana Chuenpagdee (Canada).



Plenary S6 speaker, Dr. Ratana Chuenpagdee, addressing a full house.

On the last day, concise and highly informative [session summaries](#) were given by Ryan Rykaczewski (S1), Susana Garrido (S2), Arnaud Bertrand (S3), James Ianelli (S4), Merete Tandstad (S5), and Marloes Kraan and Yoshioki Oozeki (S6).

At the closing ceremony, on the last day of the symposium, awards were given to early career scientists (ECS). The recipients of Best ECS Presentations Awards were Criscely Luján-Paredes (Peru), Claire Saraux (France), Tatsuya Sakamoto (Japan), Paul Kotterba (Germany), Emily Liljestrand (USA), Margaret Siple (USA). The Best ECS Poster Presentation Award was given to Marta Albo-Puigserver (Spain). See their presentations on the [presentations page](#) on the PICES website.



Margaret Siple  
(USA)

Tatsuya Sakamoto  
(Japan)

Criscely Luján-  
Paredes (Peru)

Claire Saraux  
(France)

Marta Albo-  
Puigserver (Spain)

Emily Liljestrand  
(USA)

Paul Kotterba  
(Germany)

Early Career Scientist Best Presentation/Poster Award recipients

At the end of the closing ceremony, Jürgen Alheit thanked all participants for their enthusiastic and active role during the symposium and pointed out again, the very professional efficiency of the PICES team under the guidance of Alex Bychkov in preparing and organizing the symposium. He noticed that quite a few old hands in the field of SPF research have recently retired, or will do so soon, and that it is time to ‘pass on the torches’ to the next generation. He encouraged the audience not to wait again several decades for the next small pelagic fish symposium but to organize such an event on a regular basis to maintain exchange of information and cooperation among scientists in this field, which was successfully re-started during the Victoria event.

The day following the symposium was devoted to six concurrent workshops:

- W1: *Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in the ecosystem context.* Conveners: Jürgen Alheit (ICES), Emanuele Di Lorenzo (USA), Ryan Rykaczewski (USA) and Svein Sundby (Norway); Invited Speaker: Roy Mendelsohn (USA).
- W2: *Methods and techniques for sampling and assessing small pelagic fish populations.* Conveners: Jennifer Boldt (Canada), Matthew Baker (USA), Miguel Bernal (GFCM) and Stylianos Somarakis (Greece); Invited Speaker: Timothy Essington (USA).
- W4: *Modeling migratory fish behavior and distribution.* Conveners: Shin-ichi Ito (Japan) and Enrique Curchitser (USA); Invited Speakers: Geir Huse (Norway) and Akinori Takasuka (Japan).
- W5: *Recent advances in the life stage ecophysiology of small pelagic fish: Linking laboratory, field and modeling studies.* Conveners: Myron Peck (Germany), Kirstin Holsman (USA), Shin-ichi Ito (Japan) and Laure Pecquerie (France); Invited Speaker: Martin Huret (France).
- W6: *Remote sensing and ecology of small pelagics.* Conveners: Shubha Sathyendranath (UK), Grinson George (India), Nandini Menon (India) and Trevor Platt (UK); Invited Speakers: Jose A. Fernandes (UK), Daniel Pauly (Canada) and Renato Quinoñes (Chile).
- W7: *Simulation approaches of forage fish populations for management strategy evaluations.* Conveners: Margarete Siple (USA) and Laura Koehn (USA);

Invited Speakers: Jin Gao (USA), Nis Sand Jacobsen (USA) and André E. Punt (USA).

For more details on these workshops, see the following articles.

Finally, we are happy to announce that numerous papers have been submitted to the convenors for publication. Selected papers from Session 1 will be published in a special issue in *Deep-Sea Research II* (guest edited by Jürgen Alheit, Emanuele Di Lorenzo, Ryan Rykaczewski, and Svein Sundby) and from Sessions 2–6 in a Theme Section in *Marine Ecology Progress Series* (organized by Jürgen Alheit). Anticipated publications dates for both issues will be early 2018.



Dr. Chul Park (PICES Chair) and Dr. Cornelius Hammer (ICES President) toasting ICES–PICES collaboration.



West Coast First Nations carving.



Jürgen Alheit ([juergen.alheit@io-warnemuende.de](mailto:juergen.alheit@io-warnemuende.de)) is a retired fishery biologist from Germany. His main research interest is the impact of climate variability on marine ecosystems.



Yoshioki Oozeki ([oozeki@affrc.go.jp](mailto:oozeki@affrc.go.jp)) serves as the Councillor for the Japan Fisheries Research and Education Agency. His main field is the early life biology of small pelagic fish species such as the Japanese sardine and the Pacific saury. He was recently elected, in 2017, as the President of the Japanese Society of Fisheries Oceanography.

## SPF Workshop on “*Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in an ecosystem context*”

by Ryan Rykaczewski, Jürgen Alheit, Emanuele Di Lorenzo and Svein Sundby



Participants of Workshop 1 at the PICES/ICES symposium on small pelagic fish in March 2017 in Victoria, Canada.

Commercial catches of small pelagic fish have varied substantially through time, and these fluctuations have had dramatic socioeconomic impacts on communities around the globe. Anchovy (family Engraulidae) and sardine (family Clupeidae) in the world’s eastern boundary upwelling ecosystems and the Kuroshio Current ecosystem offer prime examples of such attributes. At high latitudes in the Northeast Atlantic, herring stocks (family Clupeidae) also exhibit similar characteristics. Population sizes in these regions have fluctuated at multidecadal scales from near extinction to massive abundances supporting lucrative commercial harvests. In these systems, climate and oceanographic processes have long been hypothesized to influence the productivity of the fish populations, but the mechanisms that mediate variability in the fish catches remain unresolved.

Interest in the hypotheses explaining such variability in fish populations motivated a lively discussion in a full-day workshop (W1) on “*Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in an ecosystem context*” which took place on March 11, 2017 in association with the PICES/ICES Symposium on “*Drivers of dynamics of small pelagic fish resources*” in Victoria, Canada. The main objective of the workshop was to provide a forum for discussing some of the key issues raised during Session 1 of the symposium, a session which carried the same title as the workshop and included 52 oral and 26 poster presentations. Contributions to Session 1 were diverse, with investigations on addressing fish populations of all major ocean basins and the Mediterranean Sea. Rather than dealing with the diverse topics raised in the symposium session, the discussion in the workshop was more focused on a few critical, large-scale

questions that have stimulated interest in small pelagic fish for the last several decades:

1. Is there evidence for alternation of small pelagic fish species? If so, what are the mechanisms that control such alternations?
2. Is there continued evidence of synchrony in populations of small pelagic fish across different ecosystems? If so, what are the processes that might be responsible for such synchrony?

Before discussion of population synchrony and alternation, Dr. Roy Mendelssohn gave a brief tutorial on accessing environmental data from NOAA’s Environmental Research Division’s Data Access Program (ERDDAP). Workshop participants agreed that the data provided by this program could prove useful in analyzing environmental drivers of pelagic fish populations.

A limited number of participants were asked to share slides to stimulate thoughts on the questions noted above. In the emergent discussion, it was clear that the community has made progress during the last several decades in describing the oceanographic conditions that may be associated with periods of growth and decline in fish populations, but these efforts have largely focused on individual ecosystems (or at most, pairs of ecosystems). For example, the size structure of the zooplankton assemblages, the concentrations of dissolved oxygen, and oceanic transport are hypothesized to differentially influence the trophodynamics and recruitment of anchovy and sardine in eastern boundary current regions. However, such factors appear less important in the Kuroshio Current Ecosystem, where variability in surface ocean temperature remains a prominent hypothesis associated with sardine and anchovy alternations. In the Nordic Seas, there

are indications that feeding competition among planktivorous fish species may amplify the oscillations observed in abundance of pelagic fishes.

This lack of clear evidence for common environmental factors controlling variability across regions precluded thorough discussion of worldwide synchrony in small pelagic fish populations. The use of fishery-dependent population estimates in previous analyses highlighting global synchrony was also noted; the influence of global socioeconomic conditions and shared histories of industrialization may induce biases that are difficult to exclude in statistical analyses of population data, particularly when the low-frequency patterns of variability are of utmost importance. While the workshop participants were not prepared to dismiss the possibility of population synchrony across basins, evidence that common climate or oceanographic processes drives such synchrony remains elusive. Continued research on the topic may prove insightful.

Questions regarding alternations between periods of high anchovy and sardine abundance within individual ecosystems also stimulated lively discussion. Direct observations from the historical record continue to support the idea that one species or the other can be present in abundance, but decadal periods of high abundance of both species are not evident. Additionally, populations of other pelagic species are also highly variable at decadal scales (*e.g.*, mackerel and squid), and consideration of these additional species in hypotheses of alternations may be important.

Recent efforts in the Benguela, Humboldt, California, and Kuroshio Current Ecosystems have offered support for the hypothesis of niche partitioning among species (*e.g.*, trophodynamically, in their migration and spawning characteristics, and/or through differential responses to temperature variability). However, a vocal cohort of workshop participants with expertise in the marine sediment record offered a contrasting perspective. Varved sediments from anoxic basins contain fossilized fish scales that are identifiable to the species level. The abundance of scales in these layers has been implied to indicate fish abundance. While these centennial-scale sedimentary records suggest that alternating periods of sardine and anchovy dominance occur, the species alternations are neither present throughout the duration of the records nor consistent in their relationships with common climate indices. The degree to which these varved sediment records can accurately represent the abundance or productivity of pelagic fish species remains debated, as the distributions of species are known to vary with population size. Workshop participants were not in agreement regarding whether paleo evidence was sufficient to refute the hypothesis of alternation between species, and Salvador Lluich-Cota drafted the following statement in attempt to summarize the sentiment of the group:

“Paleorecords reveal that there are millennial-scale periods of presence/absence of small pelagics independent of the species. This may be related to changes in primary and secondary production in these regions. At centennial to multidecadal timescales, the paleorecords indicate different assemblages, proportions, and rates of scale deposition, indicating that these species fluctuate in time and suggesting changes in ecosystem rules between periods. Controversy remains as to whether or not there is conclusive evidence of alternation between species through time, particularly at the multidecadal scale, with supporting and contradicting evidence coming from both paleo and modern records.”

Several ideas for future efforts were proposed to better resolve the uncertainties regarding species alternations and synchrony:

1. Renewed efforts to apply modern techniques during coordinated, regional-scale process studies, utilizing high-resolution 4-D circulation models coupled with shipboard and autonomous sensors (*e.g.*, acoustics, optics, genetic) to explore the underlying mechanisms influencing recruitment and growth of larvae and juveniles at the regional scale rather than simply correlating catches with climate indices (suggested by Claude Roy, Svein Sundby, and Andrew Bakun).
2. Application of simple numerical modeling experiments to test hypotheses regarding mechanisms through which climate processes are related to population variability (suggested by Emanuele Di Lorenzo).
3. Continued development of scale records from multiple regions in each ecosystem, where possible, to offer insight to their accuracy in representation of population size (suggested by Salvador Lluich-Cota, Dimitri Gutiérrez, and David Field).
4. Comparison of temporal variability in spatially resolved ichthyoplankton records with estimates of population size as an analogue for varved sediment records to offer an improved understanding of their accuracy (suggested by Ryan Rykaczewski).
5. Increased use of fisheries-independent data in consideration of population variability (suggested by Rubén Rodríguez-Sánchez and Alexandra Silva).

A common sentiment at the conclusion of the workshop was that improved understanding of questions concerning species alternations and synchrony across regions will require increased consideration of ecosystem processes (that is, the coordinated biological and physical investigations of the mechanisms that influence stocks of small pelagic fish); statistical analyses of catch, biomass, and climate indices do not provide satisfactory answers. Additionally, the decadal scale intervals between gatherings of colleagues focused on variability in small pelagic fish is inadequate for improving scientific understanding of these issues. More frequent discussions and closer collaborations among researchers from various regions of the world ocean are required.



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(continued from page 6)

### **FUTURE roadmap and tasks**

The current [FUTURE roadmap](#) was developed in 2012. It includes products (new knowledge, status reports, forecasts and outlooks, outreach and engagement), Expert Group contributions and future needs, and events such as symposia and workshops. A new, more efficient and useful Roadmap–Product Matrix format will be developed and will include forecast/outlook and outreach variables. The SSC aims to finalize this product in time for PICES-2017.

The third day of the meeting was devoted to discussion on the next PICES integrative science program and the future of FUTURE. Many knowledge gaps still outstanding, such as coastal area stressors, marine ecosystem services, geoengineering (iron fertilization, carbon uptake) studies, ecosystem impacts of fishing, biodiversity questions, and marine pollution, were identified by the SSC. The plan is to eliminate or reduce these gaps through the current program so that the output from FUTURE can become the foundation of the next PICES integrative science program.



*Dr. Sukyung Kang (sukyungkang@korea.kr) is a Senior Scientist of the Fisheries Resources Management Division at the National Institute of Fisheries Science (NIFS) in Busan, Korea. After receiving her Ph.D. in fisheries oceanography from Pukyong National University in 2004, Sukyung began working in salmon research at NIFS. She currently works on the prediction of marine fisheries resources under climatic changes in Korean waters using ichthyoplankton and fishing data sets. Sukyung has been involved in several international organizations/projects besides PICES, such as NPAFC, Yellow Sea LME, and APEC. In PICES, she is a member of Science Board and the Section Climate Change Effects on Marine Ecosystems. She co-chairs the FUTURE Scientific Steering Committee with Steven Bograd.*



*Dr. Steven Bograd (steven.bograd@noaa.gov) is a Physical Oceanographer at NOAA's Southwest Fisheries Science Center, Environmental Research Division, in Monterey, California. Steven is currently involved in a number of research projects studying climate variability and its impacts on the marine ecosystems of the North Pacific Ocean, and is Editor-in-Chief of Fisheries Oceanography. Steven has been active in PICES for many years, and is a member of Science Board, the Physical Oceanography Committee, and WG 35 on the Third North Pacific Ecosystem Status Report. He co-chairs the FUTURE Scientific Steering Committee with Sukyung Kang.*

## SPF Workshop on “*Methods and techniques for sampling and assessing small pelagic fish populations*”

by Jennifer Boldt, Matthew Baker, Miguel Bernal and Stylianos Somarakis



Participants of Workshop 2 at the PICES/ICES symposium on small pelagic fish in March 2017 in Victoria, Canada.

Small pelagic fish (SPF) are essential prey species for a variety of predators and can also be culturally, commercially, and recreationally important. The abundance of SPF populations is highly variable both in space and time, attributes which complicate sampling, forecasts and retrospective analyses related to recruitment. Population abundance is affected by environmental conditions, system productivity, and the carrying capacity of the ecosystem, as well as by a variety of factors influencing survival and recruitment to the adult population. Understanding what factors affect the abundance, recruitment, age structure, size, condition, and distribution of SPF presents a challenge to the assessment of these species. Increased attention has been paid to the importance of pelagic fishes and the need understand their dynamics and responses to environmental conditions and their role within trophic food webs and ecosystems. Surveys and assessments for some stocks and species are often undeveloped, and important life history attributes remain unknown. Improved information on SPF is required to characterize their role in the ecosystem and advance both species-specific assessments as well as ecosystem models.

The goals of this ½-day workshop (W2) on “*Methods and techniques for sampling and assessing small pelagic fish populations*”, held March 11, 2017 during the PICES/ICES Symposium on “*Drivers of dynamics of small pelagic fish resources*”, in Victoria, Canada, were to: 1) identify and compare the efficacy of various survey assessment methods, and how to incorporate survey information into modeled assessments, and 2) pinpoint ongoing surveys and information for pelagic fishes and discuss opportunities for

sharing data, technologies, and advancing survey and assessment efforts directed towards these fish.

The workshop format included both presentations and discussions. Prior to the workshop, speakers and potential participants were asked to consider the following questions:

- What species/population do they study (brief overview of biology (*e.g.*, age of recruitment, basic life history)?
- What are the field sampling programs (*e.g.*, acoustic, spawn survey, juveniles) that provide information (*e.g.*, abundance recruitment) that might be used in an assessment?
- What types of assessments are used for the population?
- How is information from field sampling programs incorporated into the assessment?
- If there is no or limited data available, how is that addressed in the assessment of the population?
- Are there better ways to collect the data?
- What are the challenges to assessing the population?
- What are potential solutions to these challenges?

After the workshop, participants were encouraged to attend the W7 workshop (see page 24), as this was a continuation of the theme in W2.

Invited speaker, Dr. Tim Essington, gave a talk titled “*Delayed detection of productivity declines amplifies forage fish population collapses*” in which he evaluated whether forage fish collapses occur more frequently than expected. His main points were that forage fish productivity declines can be rapid and stock assessments can be slow to detect this change, delaying management



response. He pointed out that opportunities for more adaptive harvest control rule might address this issue. Dr. Essington concluded that future opportunities for stock assessments are to provide robust early warning indicators and improve forecasting for increased benefits to fisheries and conservation.

Sherri Dressel and Jaclyn Cleary presented a paper on “*Assessment of Pacific herring (*Clupea pallasii*) populations in the northeast Pacific Ocean*”. They compared assessment and survey methods between Alaska and British Columbia and identified challenges and opportunities to improve assessment procedures.



Sherri Dressel and Jaclyn Cleary (at the podium) making their presentation on Pacific herring in the northeast Pacific Ocean.

Sonia Sanchez (co-author) gave a talk titled “*Anchovy DEPM surveys 1987–2016 in the Bay of Biscay: BIOMAN survey*”. She discussed the methodological changes adopted in the estimation of total egg production and spawning frequency to improve the knowledge about the spawning and reproductive biology of anchovy in the Bay of Biscay.

Matt Wilson presented on “*Recruitment Processes Alliance: age-0 walleye pollock (*Gadus chalcogrammus*) in the Gulf of Alaska and eastern Bering Sea*” where he summarized Alaska’s juvenile walleye pollock field research programs, some of the challenges in collecting representative samples of age-0 juveniles, and some adaptations to gear configurations and sampling methodologies used in an effort to mitigate these challenges.

Leandra Sousa’s paper on “*Fish surveys in the Chukchi and Beaufort Seas*” summarized efforts and challenges in surveying Arctic cod in offshore, nearshore, and lagoon habitats with a variety of gear types, including acoustics and a variety of nets.

Fran Mowbray provided an overview of Atlantic (Newfoundland) herring assessments, surveys, and associated challenges, as well as solutions to improve the population assessment in her presentation on “*Assessment of division 3KL and subdivision 3Ps herring*”.

The workshop was well-attended, with over 35 participants from at least 10 countries. After presentations, participants discussed the general format for comparing assessments and sampling methods among regions. Discussion points included:

1. Some indicators of forage fish are not used directly in a stock assessment but are (or could be) incorporated into ecosystem assessments, otherwise, only commercially important forage species are considered. Some indicators, such as energy density as an indicator of recruitment, are not abundance indicators but may inform fish survival and recruitment estimates.
2. The definition of “stocks” varies by species and area, highlighting the need to be consistent or to define terms, such as “stocks”, “populations”, *etc.*, when using them.
3. Acoustics is an important tool for assessing pelagic fish biomass and can provide additional information on the upper and lower limits of the oxygen zone, internal waves, *etc.* ICES working groups have created free and open access software to analyse acoustic data (*e.g.*, Echoping). There is still a challenge of acquiring the training needed to process and analyze data, and maintain acoustic equipment.
4. Other potential tools discussed were utilizing commercial fishing vessels to provide daily catch data, LIDAR, and environmental DNA.

Participants then discussed developing a manuscript as a review to highlight the benefits and shortfalls of various approaches to effective sampling regimes for small pelagic fishes and how those approaches might best accommodate specific life history traits, physical or behavior attributes of the species, physical oceanographic conditions, availability of gear, and data of interest. Participants agreed that such a publication would be useful to both the research community and management agencies. Discussion points included:

1. Participants could fill in a table with answers to the main questions posed prior to the workshop. When identifying data availability, participants could also determine the confidence level in those data.
2. Comparisons could include data-rich *vs.* data-poor situations.
3. It is important to understand the biology of the species to sample it effectively. Biases in sampling may arise due to species life history, vertical migration patterns, day, location, weather, and gear selectivity.
4. There have been ICES working groups that have worked towards standardizing surveys and are a good source of information.

The workshop ended after a very productive discussion that accomplished its goal of reviewing methods and techniques for sampling and assessing small pelagic fish populations. In addition, participants accomplished the overall symposium goal of revitalizing global international cooperation on investigations of small pelagic fish.

(continued on page 19)

## SPF Workshop on “*Modeling migratory fish behavior and distribution*”

by Enrique Curchitser and Shin-ichi Ito



Some of the participants of Workshop 4 at the PICES/ICES symposium on small pelagic fish in March 2017 in Victoria, Canada.

Recent improvements in ocean model spatial-resolution and data assimilation techniques have enabled more realistic simulations of larval fish transport and distributions (e.g., Ospina-Alvarez *et al.*, 2015). Full life-cycle migratory fish models have also been developed using high-resolution circulation models (e.g., Rose *et al.*, 2015; Fiechter *et al.*, 2015). However, knowledge gaps in the behavior of migratory fish limit our ability to improve their simulation. Fish behavior is a consequence of genetics, environmental responses, prey availability, competition and interaction with other species, predator avoidance, maturity and learned behavior. All these factors can lead to complex behavior patterns. Enhancements in remote sensing, modeling techniques, tagging technologies for fish, otolith and genetic analyses are contributing to our understanding of fish migration patterns. The purpose of this ½-day workshop was to synthesize the current state-of-the-science in modeling of migratory fish behavior and their spatial distribution and to identify remaining challenges.

The workshop (W4) on “*Modeling migratory fish behavior and distribution*” was convened on Saturday, March 11, 2017 as part of the PICES/ICES Symposium on “*Drivers of dynamics of small pelagic fish resources*” held in Victoria, Canada. About 50 scientists from 13 countries attended the workshop. The workshop started with an introduction from the conveners. Four workshop questions were proposed: 1) How to model behavior and migration of small pelagic fish? 2) How to validate the model output? 3) What are biggest information gaps for modeling behavior and migration of small pelagic fish? and 4) What are necessary breakthroughs for modeling behavior and migration of small pelagic fish?

The first invited speaker, Dr. Akinori Takasuka (Fisheries Research and Education Agency, Japan), summarized the output of the international symposium and workshop on

“*Growth–survival paradigm in early life stages of fish*”, which was held in December 2015 in Yokohama. Dr. Takasuka presented an excellent review of the theory, advances, controversy, synthesis and multi-disciplinary approaches of the growth–survival paradigm. Dr. Takasuka also introduced observational approaches for testing the growth-survival paradigm.

The second invited speaker, Dr. Geir Huse (Institute of Marine Research, Norway), presented a review of individual based modeling (IBM) of small pelagic fish for their migration and distribution. Dr. Huse showed four examples of IBM application: 1) migrations of the pelagic complex in the Norwegian Sea, 2) cod-capelin interactions in the Barents Sea, 3) an analysis of capelin responses to climate change, and 4) use of migration models to test monitoring surveys. At the end of the presentation, Dr. Huse discussed possible future directions which include code sharing and community effort, standardized test cases for comparing efficiency of movement algorithms, efficient approaches for using available data in achieving realistic models of fish, local processing and machine learning.

Ms. Hitomi Oyaizu presented the super-IBM approach for Pacific saury and showed the importance of mixed queues of temperature and growth for migration behavior of Pacific saury. Dr. Shin-ichi Ito (U. Tokyo) discussed difficulties in determining mechanisms leading to small pelagic migration and other challenges for modeling migratory fish behavior and distribution using Pacific sardine in the western North Pacific as an example.

After the invited and contributed presentations, the participants discussed the workshop questions presented at the beginning of the day. Some of the topics that dominated the discussion were: the importance of carrying out sensitivity analyses and the development of a common

protocol for model comparisons, which should be as simple as possible. Lack of validation data was identified as the biggest existing gap. In addition, spatial resolution issues not only to represent the environments for small pelagic fish but also for searching distance for the model fish necessary to determine their migration direction was proposed. At the end, the participants discussed the need to form a working group to study IBMs. They agreed to submit a workshop/session proposal to the 4<sup>th</sup> International Symposium on “The effects of climate change on the world’s oceans” (Washington, DC, May 2016) in order to continue the discussion and development of common themes and ideas.

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(continued from page 17)



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## SPF Workshop on “Recent advances in the life stage ecophysiology of small pelagic fish: Linking laboratory, field and modeling studies”

by Myron A. Peck, Kirstin K. Holsman, Shin-ichi Ito and Laure Pecquerie



Some of the participants of Workshop 5 at the PICES/ICES symposium on small pelagic fish in March 2017 in Victoria, Canada. Late for the group photo were Laure Pecquerie and Susana Garrido but...

A ½-day workshop was held to provide a forum for field biologists, laboratory experimentalists and modelers to discuss recent physiological measurements and modelling that has advanced our understanding of the drivers of population dynamics of small pelagic fish. The workshop (W5) on “Recent advances in the life stage ecophysiology of small pelagic fish: Linking laboratory, field and modeling studies” was convened on Saturday, March 11, 2017 as part of the PICES/ICES Symposium on “Drivers of dynamics of small pelagic fish resources” held in Victoria, Canada, and was attended by 32 scientists from 13 countries.

This workshop featured a keynote presentation by Pierre Petitgas, on behalf of Martin Huret, which described the main properties of a Dynamic Energy Budget (DEB) model simulating the seasonality in growth and reproduction of anchovy and sardine in the Bay of Biscay and in other European waters. This DEB model provided the bioenergetics module of an Individual-based Model (IBM) of the anchovy population. This IBM includes a separate movement module within which the direction and speed of swimming depend on both the physical environment and nutritional condition (bioenergetics) of the fish. In the Bay of Biscay, migration was necessary for fish to meet their energy requirements for growth and reproduction. Based on the annual climatology of temperature and zooplankton, habitat suitability for anchovy was compared across European waters (from the Norwegian to Mediterranean Seas). The IBM predicted that survival was higher for adult anchovy with smaller body sizes in warmer and oligotrophic waters (predicted to be preferred habitats) and that survival (life cycle closure) was limited to latitudes



With Laure (centre), Susana and Shin-ichi Ito.

lower than the Norwegian Sea, both of which agree with observations.

Two subsequent talks, one by Paul Gatti and another by Laure Pecquerie, discussed data requirements of DEBs and provided additional examples of model applications. A powerful aspect of DEBs is the ability to make phylogenetic (cross-taxa) comparisons due to the generic structure of the model. For small pelagic fish, seasonally-resolved measurements of energy density are extremely helpful to calibrating the model and understanding how the environment regulates growth and reproduction. In particular, energy density can exhibit seasonal changes in condition (*e.g.*, due to spawning) at a higher resolution than growth or weight at age (which may remain constant across

seasons). Water, ash, protein and lipid content measurements provide alternative data to energy density data. Furthermore, depicting energy allocation to reproduction using DEB- or bioenergetics-based models is easiest if data are available on the fecundity, spawning frequency and composition of eggs, but remains challenging for indeterminate spawners such as small pelagic fish.

Laure Pecquerie also discussed a coupled DEB-Otolith model which can reveal a wealth of information from otolith image analysis (annual and daily variation in opacity, *i.e.*, changes in grey nuances). For example, that model can not only estimate growth but also the amount of food assimilated by a fish.

A talk by Eneko Bachiller discussed bioenergetics-based estimates of the annual consumption of zooplankton by three pelagic fishes (spring-spawning herring, blue whiting and Northeast Atlantic mackerel) in the Norwegian Sea. There were distinct differences in diet composition across seasons and species, with blue whiting consuming more euphausiids while the other two species consume large quantities of copepods. The consumption to biomass (C/B) ratio was between 8 and 11 for mackerel and herring, but was much lower (2.5) for blue whiting. To fuel observed rates of annual somatic growth, the three species were estimated to need to consume about 100 to 120 M tons of zooplankton.

A wide array of topics was discussed, including how prey fields are depicted within models and whether models have deterministic (*i.e.*, one-way) or dynamic (*i.e.*, two-way)

coupling between fish and lower trophic levels and between physical and trophic structuring processes. In particular, changes in prey quantity as well as prey quality may be important to include if we hope to adequately simulate bottom-up processes potentially influencing small pelagic fish populations. Unfortunately, most models are poorly equipped to incorporate prey quality, a factor largely governed by changes in fatty acid composition of food items. Prey inputs to DEBs and other models contain daily available energy and, in other models, prey items are depicted in discrete size classes and/or into components such as protein and lipid. The choice of how to depict prey within a model will depend on the research goals. It was agreed, however, that standard formats would be welcomed.

Workshop participants thought that a follow-up workshop discussing the coupling of field, laboratory and modelling research would be worthwhile. The workshop would likely happen in June 2018 as part of the 4<sup>th</sup> International Symposium on the “*The effects of climate change on the world’s oceans*” in Washington, DC, USA. Future topics mentioned at this workshop included the ability of models to i) simulate the impacts of low oxygen on the distribution and productivity of small pelagic and other fishes, ii) make projections of climate-driven changes in distribution based on mechanistic, cause-and-effect, understanding of fish physiology, and iii) explore the ‘growth-survival paradigm’ (*e.g.*, faster growth = higher survival) of fish early life stages. Ideally, the follow-up workshop would similarly include discussion around emergent empirical approaches and findings as well as comparative bioenergetics modelling methodologies.



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## SPF Workshop on “Remote sensing and ecology of small pelagics”

by Shubha Sathyendranath, Trevor Platt, Grinson George and Nandini Menon



Participants of Workshop 6 at the PICES/ICES symposium on small pelagic fish in March 2017 in Victoria, Canada.

Various remote-sensing methods have been proposed to understand variability in harvest fisheries, to improve catch per unit effort, and to explore potential impacts of climate change on future fisheries (Fernandes *et al.*, 2015). Remote sensing applications include potential fishing zone advisories, studies to understand the link between phytoplankton phenology and fisheries recruitment (testing the match-mismatch hypothesis of Hjort-Cushing) (Platt *et al.*, 2003; Koeller *et al.*, 2009), and links between phytoplankton community structure and fisheries. One may anticipate that such applications would work best for small pelagics, because of the shorter interval between the trophic level of remote-sensing observations (phytoplankton) and the fisheries, and because of the shorter time scales involved. In this context, the 1-day workshop (W6) on “Remote sensing and ecology of small pelagics”, held March 11, 2017, in association with the PICES/ICES Symposium on “Drivers of dynamics of small pelagic fish resources” in Victoria, Canada, was designed to:

- Discuss recent progress in the use of satellite data to improve our knowledge of fisheries variability;
- Explore the use of satellite data to improve fisheries models;
- Investigate the use of satellite data to improve fisheries management;
- Investigate the use of satellite data for high seas governance of fisheries;
- Assess the use of remote sensing in socio-economic studies related to fisheries fluctuations; and
- Plan a symposium on the topic of remote sensing and fisheries.

In 2010, India hosted the first symposium on Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery (SAFARI). Selected papers from the symposium were published subsequently as a special issue

of the ICES Journal of Marine Science (Stuart *et al.*, 2011). India is now in the initial stages of planning a second SAFARI symposium.

This workshop also served as a precursor to the second SAFARI symposium, and helped plan it. The workshop was built around three invited speakers:

- Daniel Pauly (Canada), who talked about “Mapping small pelagics, fisheries and the primary production they require”;
- Renato Quinos (Chile): who presented a talk on “Inter-annual variability of upwelling, nutrients and planktonic community net metabolism in the southern Humboldt Current System: Management implications for pelagic fisheries”; and
- José Fernandes (UK): whose talk was entitled “Prediction of species distribution and abundance using high quality satellite products in combination with Bayesian networks”.

There were also two contributed presentations:

- Grinson George: *Inter-annual variability in Sardinella longiceps in response to ENSO events in the coastal waters of India*;
- Nandini Menon: *Application of phytoplankton biomass as an aid in management of marine resources of the southeastern Arabian Sea*.

The workshop was open to all interested participants. Some 35 participants attended the workshop, and participated actively.

The format allowed time for discussion, which was mostly around the following themes:

- *Developing a remote sensing and fisheries community:*  
The participants agreed that there was a need for a

forum that would bring the remote sensing and fisheries communities together, as typically, the two groups tend to attend different meetings. The communications between the two groups need to be encouraged. The idea of a second SAFARI symposium was well received. Since the gap between symposia has been long, it was suggested that some electronic modes of communication between symposia should also be promoted.

- *Plan for a symposium on remote sensing and fisheries:* The participants then discussed plans for the proposed SAFARI symposium, which is to be held in India in January 2018. The participants requested to be included in a mailing list to be informed of the plans for the symposium, and expressed their interest in attending it. In addition to the use of remote sensing, in particular ocean colour and sea surface temperature, to understand variability in fisheries, to support harvest fisheries, and as a tool for fisheries and aquaculture management, it was suggested that GPS methods to track fishing vessels would also be particularly useful.
- *Explore ways in which we can work together:* The participants felt that personal contacts that emerged from the workshop should be maintained and built

upon to explore any future opportunities for working together as a team.

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## SPF Workshop on “Simulation approaches of forage fish populations for management strategy evaluations”

by Margaret Siple and Laura Koehn



Participants of Workshop 7 at the PICES/ICES on small pelagic fish in March 2017 in Victoria, Canada.

A ½-day workshop (W7) on “Simulation approaches of forage fish populations for management strategy evaluations” was convened on March 11, 2017, as part of the PICES/ICES Symposium on “Drivers of dynamics of small pelagic fish resources” held in Victoria, Canada. Chaired by Margaret Siple and Laura Koehn (USA, University of Washington), the workshop was designed to facilitate discussion between experts in forage fish assessment and ecology on the important uncertainties to consider in management strategy evaluation (MSE) for forage species. MSE is a powerful methodology that allows users to contrast the performance of proposed alternative management strategies or evaluate the performance of an existing management practice. It has been adopted for fisheries management in the U.S. (Pacific sardine; Hurtado-Ferro and Punt, 2014), South Africa (Butterworth and Punt, 1999), and Australia (Dichmont and Brown, 2010) among others, and is widely accepted as an appropriate methodology for evaluating trade-offs among management objectives. This workshop was intended to set some guidelines for scientists and managers who are interested in using MSE in the management of forage species, and to introduce new model developments. The workshop began with talks about considerations for using MSE on forage fish, detecting changes in mortality in forage fish populations, and making short-term predictions about forage fish abundance using nonlinear forecasting. The workshop discussion was organized into groups by ecosystem: i) Europe and the Mediterranean, ii) the Humboldt Current, iii) the Gulf of Alaska, and iv) the California Current. This workshop was intended as a partner workshop to W2 (“Methods and techniques for sampling and assessing small pelagic fish populations”; see page 16), and participants in each workshop were

invited to join the other. W7 had 31 participants in all.

Dr. André Punt (Invited, USA) reviewed MSE methodology, its utility for fisheries, and discussed forage fish MSEs currently used for management. He provided examples from the California Current (Punt *et al.*, 2016b) and South Africa (Robinson *et al.*, 2015) to review considerations for MSE of forage fish specifically. He emphasized the importance of identifying key uncertainties related to the functioning of the ecosystem and the assessment of fishery resources, and provided a summary of key uncertainties that many forage fisheries have in common: i) predator-prey relationships (*e.g.*, the influence of prey abundance on predator abundance or productivity), ii) regime shifts and unexpected, long-term shifts in productivity, and iii) spatial structure. Dr. Punt summarized some general recommendations for best practices for general fisheries MSE (Punt *et al.*, 2016a): i) ensure that the system is stable in the presence of recruitment variation, ii) use data to estimate parameters and confirm the realism of projections, and iii) use multiple model configurations, as opposed to many simulations with the same model, to account for model uncertainty. He emphasized the importance of choosing management strategies that were robust to model misspecification.

Nis Sand Jacobsen (Invited, USA) discussed the issues with assumptions about forage fish biology, specifically natural mortality. Natural mortality (*M*) is expected to be a main driver for forage fish dynamics because of their important role as prey. Consequently, misspecifying *M* can lead to erroneous predictions of reference points and biomass estimates. Incorrect assumptions about the magnitude, variability, or absolute change in *M* can also be



confused with changes in selectivity and steepness. Dr. Jacobsen introduced the possibility of size-based operating models instead of (or in addition to) MICE models or ecosystem models for performing MSE. He also discussed trade-offs between performance objectives, and how one might identify “efficiency frontiers” which could show optimal trade-offs between management objectives.

Jin Gao (Invited, USA) introduced nonlinear forecasting as a potential tool for making short-term predictions about forage fish abundance or productivity. Nonlinear forecasting is a nonparametric tool that describes a time series in terms of lags, using time-delay embedding. She provided an example using larval abundance data from CalCOFI in which she demonstrated the limits of how many data points were needed to make a reasonable prediction. Nonlinear forecasting *via* a Gaussian process model could make reasonable predictions using shorter time series that are replicated in space. In general, predictions one year into the future can be gained when time series appear to be in the chaotic domain where parametric methods fail, but predictability drops as the process (in this case, recruitment) is projected further into the future. Although nonlinear forecasting is not effective for long-term predictions or projections, it may have utility as auxiliary information in an assessment method within the MSE framework.

#### ***Discussion of MSE priorities for forage species in different regions***

Workshop attendees divided into four groups based on their regional expertise (California Current, Humboldt Current, Europe including the North Sea and the Mediterranean, and British Columbia/Alaska). They were given the following questions to inspire/stimulate discussion:

- 1) What processes have been/can be/should be considered when simulating forage fish dynamics for MSE?
- 2) How does the importance of these processes and our ability to incorporate them in simulation models vary among the ecosystems where small pelagic fishes occur, and among species?
  - Considerations may be data types and data limitations, scientific capacity (*e.g.*, is there a full stock assessment?), ecological role, ecosystem type, and environment influences. Is the ecosystem wasp-waisted? Is forage fish a “key” forage species in terms of ecosystem function (Plagányi and Essington, 2014)? How dependent are predators? What is the main driver of species fluctuations?

Here we summarize the points generated by group discussion, organized by region.

#### ***California Current***

In the California Current, ecosystem processes and environmental influences on recruitment interact to influence forage fish dynamics. The group assigned to the

California Current identified the following considerations: i) compensatory dynamics due to range contractions when abundances are low, ii) time-varying natural mortality due to changes in predator abundance, iii) how low-frequency variability influences ecosystem processes, iv) spatial considerations, such as impacts of changes in the range of forage fish population on central place foragers, and v) uncertainties about the influence of prey dynamics on predator abundance and/or productivity.

#### ***Europe (Baltic Sea, Bay of Biscay, Mediterranean Sea, Barents Sea and Norwegian Sea)***

Important considerations for MSE of forage fish in European waters included i) changes in growth, ii) stock mixing (the degree to which the fishery captures a mixture of individuals from different spawning populations), iii) changes in natural mortality (including abrupt changes in mortality as would occur from a parasite or disease outbreak), and iv) the cost of collecting additional data to inform EBFM, *vs.* the cost of constructing an MSE that can operate even if data are not widely or immediately available.

#### ***Humboldt Current***

The Humboldt Current group came up with the following set of uncertainties that should be addressed in an MSE framework: i) variation in functional responses of forage species to environmental conditions (*e.g.*, bottom-up effects), ii) variation in functional responses of predators to prey, iii) changes in biological parameters like somatic growth and mortality, which likely influence biomass, and iv) spatial variation in prey distribution (including spatial changes that may affect survey catchability) and predator needs. There is a wealth of oceanographic and fishery data for some parts of the Humboldt Current (*e.g.*, Peru). These data show substantial variability in oceanographic conditions, highly variable responses of the biological community to these conditions, and frequent regime shifts. Thus, the Humboldt Current presents an opportunity to challenge a simpler MSE framework with a well-studied and highly variable ecosystem, where fishing may exacerbate the effects of climate on prey and predators.

#### ***Gulf of Alaska***

The Gulf of Alaska (GoA) group discussed some broader issues that they would face with MSEs in their region in general, and brought up several key uncertainties relating specifically to the main forage species in the GoA: Pacific herring. The operating model for an MSE in the GoA would need to replicate the amplitude and frequency of population fluctuations that are seen in stock assessments. There are several ecological unknowns which should be considered in an MSE: fluctuations in natural mortality, high-amplitude fluctuations in population size, types of recruitment variation, and changes in growth and fecundity over time. Specific to Pacific herring, the maturity schedule

for adults is a source of uncertainty, as are migration and appropriate stock definitions. Sources of error in conducting assessments might be egg loss rates from spawning beaches or differences in survey methods between spawning locations (for example, aerial surveys are not included in the assessment for all locations). These were discussed in the context of Pacific herring in Alaska, but may apply to other regions and species.

### Discussion

Participants engaged in a broader discussion about best practices and considerations for MSE of forage fish. This discussion revealed many similarities between ecosystems, based on uncertainties related to the ecology and dynamics of forage species. Important themes included:

- 1) Changes in vital rates, such as growth, mortality, or age at maturity, especially as a function of predator abundance or density dependence;
- 2) Nonlethal impacts in population size and vital rates, such as disease outbreaks, parasites, and environmental conditions like hypoxia;
- 3) Low-frequency variability, a pattern often observed in forage species;
- 4) Spatial processes:
  - a. Migration,
  - b. Multiple stocks and stock mixing,
  - c. Spatial differences in predator needs (e.g., for central place foragers),
  - d. Spatial differences in the implementation of HCRs, as in different countries sharing the same resource;
- 5) Climate impacts such as PDO, ENSO, climate change;
- 6) Model uncertainty: the types of models (ecosystem or stock assessment) that are appropriate to use for simulations.

Participants also questioned whether the utility of the MSE approach is universal or whether there are scenarios where it would be less useful. Methodology questions centered around how to model space explicitly for central place foragers (e.g., Boyd *et al.*, 2016), how to use MSE-like methods in data-limited situations or situations where a full stock assessment was not available, and how to cope with cases where species range across two or more countries with different harvest strategies. Participants also agreed that for prey species, information about predator functional responses was critical for evaluating performance relative to ecosystem objectives for MSEs. This information may require experimental work, but may also be included as a source of uncertainty.

### Summary

MSE requires special considerations for small pelagic fishes. These considerations include *process uncertainty* about the biology of forage fish and their role in the ecosystem, *model uncertainty* about functional relationships between forage fish and the environment, and predators of forage fish, *parameter uncertainty* about selectivity and stock-recruitment relationships historically, and *assessment uncertainty* about the impact of certain survey methods on parameter or population estimates.

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## An ICES/PICES Workshop on “*Understanding the impacts and consequences of ocean acidification for commercial species and end-users*” How do we climb over the uncertainties? – A personal view

by Tsuneo Ono



Participants of the ICES/PICES Workshop on “*Understanding the impacts and consequences of ocean acidification for commercial species and end-users*” in Copenhagen.

Ocean acidification (OA) in the 21<sup>st</sup> century is a topic of considerable importance in both oceanography and fisheries. In PICES, major efforts have mainly focused on – in my opinion – the oceanographic aspects of OA, including the lower trophic ecosystem, while the ICES community has long extended their efforts to fisheries and socio-economic impacts. A trial to integrate the expertise from both communities was carried out last winter when an ICES/PICES Workshop on “*Understanding the impacts and consequences of ocean acidification for commercial species and end-users*” (WKACIDUSE) was held December 5–8, 2016, at ICES headquarters in Copenhagen, Denmark. The workshop was chaired by Silvana Birchenough (UK, ICES), Sam Dupont (Sweden, AMAP) and Tsuneo Ono (Japan, PICES). Thirty-six participants (26 in the room and 10 through WebEx) from ICES and PICES member countries met to:

- a) Provide evidence to support demonstration advice (meaning, who is going to use this information, and what is the level of evidence/detail needed) to inform end-users. Overall, there is a pressing need to translate existing information into dedicated, understandable and useful advice to make long-term investment decisions;
- b) Examine existing evidence from an “objective” basis on what is the reality of OA effects and potential consequences (considering the effects of single or multiple stressors);
- c) Provide examples to illustrate what are the current “prevailing conditions” (local variability of exposure at specific spatio-temporal scales). This information will help in placing into context species’ responses.
- d) Deliver an assessment on the potential for adaptation of commercial species (considering phenology, physiology, behavior and genetics);
- e) Understand what will be the consequences for end-users and who would be likely to be affected (answering the “so what?” question);
- f) Suggest practical solutions for end-users to prepare and adapt to potential OA effects in conjunction with combined multiple stressor effects;
- g) Discuss the best way to continue to support ICES/PICES and OSPAR/HELCOM in this area (*e.g.*, setting up an OA Working Group to summarize the “state of the art” science to support advisory requests).

From the beginning, it was apparent to this author that there was a need to conduct such a workshop. Despite the increase in scientific publications on OA, social attention to the OA problem has not been as focused as we might have expected, based on its potentially high impact on ocean ecosystems. In the Pacific region, the situation is gradually changing, as observed in a mass mortality of bivalves on the U.S. West Coast. In the ICES region, however, evidence of biological impacts due to OA has not been clearly seen yet. This is very fortunate for biota, but as a result, there is a complacent attitude in European society to not look at OA as an urgent problem. Obstacles that deter the propagation of scientific awareness about OA impacts were discussed on the first day of the workshop.

One big issue is the uncertainty in our present ability to predict the impact of OA on the ecosystem in the real ocean. There are many reports from laboratory and field-based experiments showing apparently contradictory biological responses and probable impacts. On the second day, several plenary talks were given by ICES and PICES scientists on the current understanding of oceanic OA status and biological OA responses. Then, a session was

dedicated to meta-analysis of existing OA experiment results for shellfish and crustaceans on the third day. The results showed that the biological response to OA may be variable, depending on other environmental/biological conditions, such as the existence of other stressors and interspecific competition. Workshop participants agreed there was a need to continue such a synthesis approach. The importance of field observations that provide information to interpret experimental results as applied to the real ocean was also highlighted, as was the need to develop a “common index” to monitor the state of progression of OA. Naomi Harada introduced a micro X-ray computer tomography (MXCT) technique to assess shell density of planktonic carbonate-shelled species such as foraminiferans and pteropods, and suggested that this parameter, shell density, could be a candidate for a “common biological OA index.”

Uncertainty also arises when we assess the overall socio-economic impacts of OA based on the limited experimental/monitoring results for each particular species. John Pinnegar introduced a series of examples of “heroic” (*i.e.*, daring) assumptions, without which the scientific community cannot scale up specific observed results into ecosystem models. Assessment of socio-economic OA impacts based on model results requires additional assumptions. Considering these uncertainties, scientists are forced to use many qualifiers to inform the public about OA impacts, which may result in the information being received with skepticism by the public.

Workshop participants were composed not only of natural scientists but also socio-economic scientists, and an open question from the natural to the social scientists was: “Do you think this “uncertain” information on OA impacts is still valuable? or “Is it even noise that sometimes causes incorrect social reactions?” to which all the social scientists had the same answer: “*It is valuable information. It is true that prediction of OA impacts based on the many uncertain assumptions sometimes leads to social measures that end in vain, but that is far better than to have no information and hence do nothing.*”

In all honesty, I was surprised by their answer. I have spent a long career as a scientist in the Japanese fisheries sector, and there, uncertain information tends to be excluded. The Japanese fisheries sector is made up mainly of a guild of private owners, and an individual player does not have sufficient capital to compete. An incorrect social measure against a predicted environmental problem often causes an impact worse than the actual environmental problem itself. But a socio-economic point of view suggests that for the nation-level community as a whole, the risk of uncertain environmental prediction is less than that of taking no measures at all.

Everyone agreed there was a need to communicate information on OA impacts to the public even under

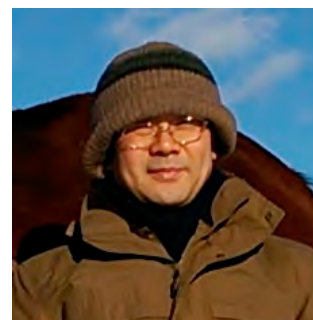
present-level uncertainties, with clear mention of assumptions and uncertainties. There was also agreement on the need for continuing efforts to fill the gap between scientific understanding and its socio-economic consequences.

Finally, on the last day workshop participants summarized requisite activities to promote future OA studies and propagate the knowledge to end-users:

- We need to develop biological indicators for subtropical surface waters and for benthic biota. We already use aragonitic shelled pteropods as pelagic biological indicators, but this is useful only for high latitude surface waters;
- We need to summarize information on threshold  $\Omega_{\text{aragonite}}$  among species and stages;
- We need to continue an interdisciplinary approach to understand multiple stressor studies;
- We need to develop methodology to close the existing gap between scientific understanding and socio-economic consequences/management advice, given the limited knowledge;
- We need to scale up and include experimental results into models and socio-economic evaluations with regard to OA. The group also recognized the need to adopt a series of heroic assumptions;
- PICES needs to check with ICES on opportunities to support the Global Ocean Acidification Observing Network hub in Europe;
- We need to foster active collaboration between ICES, PICES and AMAP (Arctic Monitoring and Assessment Program); for example, a proposal for an ICES/PICES/AMAP joint theme session at the 4<sup>th</sup> International Symposium on “*The effects of climate change on the world’s oceans*” (June 4–8, 2018, Washington, DC);
- We need to recommend an ICES-SGOA (Joint OSPAR/ICES Ocean Acidification Study Group) to support time-series observations (both on funding and continuity of the work).

These activities will be included in the formal WS report that will be published by ICES soon.

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## The 26<sup>th</sup> International Hydrological Program (IHP) training course on “Coastal vulnerability and freshwater discharge”

by Joji Ishizaka



Training course participants at the Welcome Reception.

A training course of the UNESCO International Hydrological Program (IHP) on “Coastal vulnerability and freshwater discharge” was conducted from November 30 to December 10, 2016 at the Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan, with support of PICES. This was one of a series of IHP training courses for early career administrative officials, scientists, and students, mainly from the Asia-Pacific region, which has been operating since 1990 at ISEE (the former Institute for Hydrospheric–Atmospheric Sciences, IHAS, and Hydrospheric–Atmospheric Research Center, HyARC), Nagoya University, with collaboration of the Disaster Prevention Research Institute (DPRI), Kyoto University, recently. In addition to IHP, PICES, ISEE, and DPRI sponsoring this 26<sup>th</sup> IHP training course, the Oceanographic Society of Japan (JOS) and UNEP/Northwest Pacific Action Program (NOWPAP)/Special Monitoring and Coastal Environmental Assessment Regional Activity Center (CEARAC) also provided support.

The coastal zone of Asian countries is one of the most densely populated in the world. The area is important for various human activities including fisheries, shipping, farming, and many other industries. Rapid population growth in the coastal area adds to the pollution of waters, both fresh and salt, inducing environmental problems in the area. Freshwater input to the coastal area modifies the circulation of estuarine waters. Large amounts of material discharged with freshwater to the coastal waters is considered natural, and play an important role in the coastal ecosystem; however, the pollution of the freshwater is altering the coastal ecosystem. Rivers are a major source of freshwater, and more recently, the importance of underground discharge has been also recognized.

However, freshwater discharges are changing significantly due to climate change, construction of dams on rivers, and freshwater usage. The coastal area is often destroyed to make land for farming, industry or living space. The coastal area is also vulnerable to such natural hazards as tsunamis caused by earthquakes and to storm surges caused by typhoons, so it is necessary to manage the area to make it safe, comfortable, and productive for society.

In this training course, basic knowledge of the physical, biological and chemical characteristics of coastal waters and forcings, including freshwater from rivers and underground discharge, was covered. Furthermore, the interaction between the natural coastal environment and human society was discussed. Technical training on-board the Mie University Training Vessel, T/S *Seisui-Maru*, covered the basic techniques to sample waters, analyze the quality and interpret the data in the large estuarine basins of Ise Bay and Mikawa Bay at the south of Nagoya city. Hands-on analysis of satellite data and numerical models results was also covered.

Ten participants were specifically invited to the 2-week training course; students from Indonesia, Vietnam, Singapore, Thailand, and Russia were supported by ISEE, and students from Russia, China, Korea, Japan and Canada were supported by ISEE and partially supported by PICES. Additionally, four international students (1 Indonesian, 1 Chinese, 1 American, 1 Bulgarian) and one visiting scientist (Indonesian) from DPRI participated. Seven students (3 Chinese, 2 Japanese, 1 Mozambican, 1 Thai) from the Graduate School of Environmental Studies, Nagoya University also participated. Invited keynote speakers were Drs. C.-T. Arthur Chen (Taiwan) and Tetsuo Yanagi (Japan). Lecturers were Drs. Kenji Tanaka (DPRI),



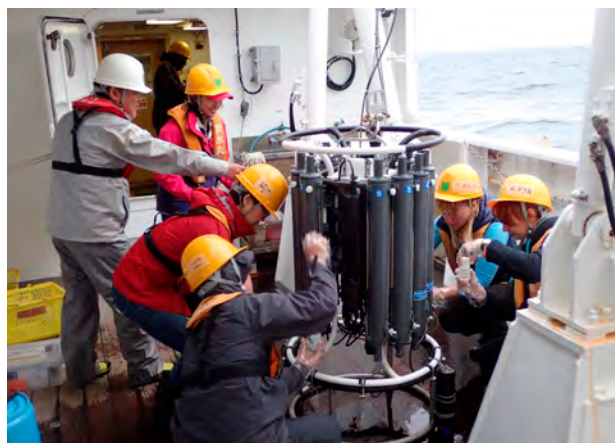
Group photo in front of the T/V Seisui-Maru.

Akhide Kasai (Hokkaido Univ.), Makoto Taniguchi, Satoshi Ishikawa (Research Institute for Humanity and Nature), Yu Umezawa (Nagasaki Univ.), Hiromi Yamashita (Ritsumeikan Asia-Pacific Univ.), Genki Terauchi (Northwest Pacific Environmental Cooperation Center), Takashi Tomita (Nagoya Univ.), Hidenori Aiki, Yoshihisa Mino, and Joji Ishizaka (ISEE).

The keynote speeches dealt with the “Satoumi Concept” (Yanagi) and “Melting Tibetan Ice Shield” (Chen), and lectures covered a wide range of basics to applied sciences related to “coastal vulnerability and freshwater discharge”, including river discharge, underground water discharge, circulation of coastal water, nutrient dynamics, plankton ecosystem, influence on fisheries, tsunami and disaster prevention, and tidal flat conservation. The participants were very enthusiastic to learn from the training course.

Participants not only listened to the lectures, but asked many questions during and after the sessions so that there was much interaction between them and the lecturers. These discussions generated such interest that further communication between some students and lecturers was continued after the training course. The participants were also able to experience real oceanographic observations, both the fun parts and serious parts, during a field cruise on the T/V Seisui-Maru in Ise and Mikawa Bays.

Besides class and field work, participants had a chance to experience local culture on the weekend when they were taken by the local organizers to visit the Ise Shrine, which is one of the oldest and largest shrines for the Japanese ethnic religion, Shinto, and learned about Japanese traditions.



Taking water samples from a Niskin sampler.



Study of Japanese culture at the Ise Shrine.

(continued on page 34)

## PICES/MAFF MarWeb project collaborates with the United Nations program on the development of Marine Protected Areas in Guatemala

by Vera L. Trainer, William P. Cochlan, Julian Herndon and Charles G. Trick

### Background

The PICES/MAFF Marine Ecosystem Health and Well-Being ([MarWeb](#)) project and the [United Nations project](#) on the “*Conservation and sustainable use of biodiversity in coastal and marine protected areas*” supported a multi-day workshop for an “Exchange of experiences for conservation and sustainable use of biodiversity in protected areas on the marine coast” in which 21 senior undergraduate and graduate (licentiate – a step beyond a bachelor’s degree, but not quite a master’s degree) students participated from the Biology and Aquaculture departments from Universidad del Valle (University of the Valley) and Universidad de San Carlos de Guatemala (University of San Carlos), respectively. These students had diverse interests—from phytoplankton to marine mammals, anthropology to pollution, fisheries management and coastal conservation. In collaboration with experts from the North Pacific Marine Science Organization (PICES), the National Oceanic and Atmospheric Administration (NOAA), the Romberg Tiburon Center for Environmental Studies (RTC) of San Francisco State University and Western University in Ontario, Canada, under the leadership of the Director of Regulations of Fisheries and Aquaculture, Ministry of Agriculture, Ranching, and Food (DIPESCA-MAGA), the participants conducted fieldwork

with local fishers to learn about inshore and estuarine fishing operations, the management and challenges associated with fin-fish and marine products and distribution, analysis of case studies on problems with fishing gear in the multipurpose Natural Reserve of Monterrico, on the Pacific coast of Guatemala, and participated in a series of interactive seminar sessions on coastal marine issues associated with climate change.

### Overview

On February 6–10, 2017, Drs. Vera Trainer, Charles Trick, and William Cochlan and Mr. Julian Herndon traveled to Monterrico, Guatemala, to visit with personnel from DIPESCA (Fisheries and Aquaculture Agency), the National Forest Institute (INAB), Ministry of Environment and Natural Resources (MARN), the Protected Areas National Council (CONAP), the Center for Conservation Studies (CECON) and the Association for Rescue and Conservation of Wildlife (ARCAS). The primary goal of this visit was to share our goals and transfer our knowledge obtained from the PICES-supported MarWeb project with the investigators leading a new United Nations funded project on the establishment of five Marine Protected Areas (MPAs) in Pacific coastal Guatemala. The plan for these five MPAs is being designed by the lead organizations



*The students and instructors of the joint PICES and Director of Regulations of Fisheries and Aquaculture, Ministry of Agriculture, Ranching, and Food (DIPESCA-MAGA) training class in Monterrico, Guatemala.*

listed above. We followed an agenda that included representatives from each of the collaborating agencies, followed by student fieldwork and discussion of strategies for project success. We discussed in detail the design of these MPAs, including how to promote sustainable fishing while respecting the needs of families, how best to communicate the science to a population with broadly variable education levels, and how to sustain MPAs into the future. This training session supported an exchange of experiences for conservation and sustainable use of biodiversity in protected areas on the coast.

### *Elements critical to the establishment of successful Marine Protected Areas*

Overall project findings and recommendations by MarWeb investigators were:

1. **Student input.** The collaboration of students from the University of San Carlos and University of the Valley with UN project investigators benefits both the UN project and the students. By keeping the students informed of the current issues and challenges (both legal and scientific) of the project, they can help brainstorm and implement pro-active solutions to known and potential problems. In particular, the students were interested in establishing the proper balance between enforcement of fishing rules for fishers and education of the citizens – both fishers and non-fishers alike. This is particularly important because of the high rate of illiteracy in coastal Guatemala – enforcement without education is unfair, unproductive and contributes to social injustice for the impacted citizens in a very challenging economic region of Guatemala.



*A fisherman casting his net in the estuary near Monterrico, Guatemala.*

2. **Empowerment of locals.** The students developed strategic solutions to a series of fisheries problems in coastal Guatemala (e.g., preventing the use of illegal fishing nets in estuaries). The solutions included providing outreach to entire family groups, not just male fishers. The inclusion of men, women, and children in the decision-making process, allowing them

to have enthusiasm in the outcome, is important to ensure successful recruitment of a wide spectrum of community members as coastal stewards. The “stickers and clickers” approach (using anonymous surveys combined with interesting activities for the children) introduced by the MarWeb project will be continued in the future by the university faculty and students participating in the UN project.

3. **Incentives.** The sea turtle project is an example of successful conservation in coastal Guatemala. By offering an incentive for harvesters to provide 20% of the harvested eggs for conservation, there has been a substantial rebound in turtle populations. This incentive is also supported by enforcement as there is a fine for those who violate the 20% return policy. This strategy could be used as a model for other conservation programs yet to be established, such as exchanging illegal ‘window screen’ type nets for legal ones of a defined and ecologically sustainable mesh size. Those adopting legal nets would be presented with a fishing license to the fisher of the family upon demonstrating an understanding of the fishing regulations while emphasizing to the entire family that they have now joined the realm of coastal stewards (this was suggested by a student group during their discussions).



*Olive Ridley sea turtles were released after being collected and hatched under the protection of ARCAS, the Wildlife Rescue and Conservation Agency, a collaborator in the establishment of MPAs in Pacific Guatemala.*





*The students studying the species of fish caught in the estuary.*

4. **Sustainability.** There has been little discussion in country about how the MPAs established in Guatemala will be maintained after the UN project funding ends. We have suggested that Guatemala should consider developing partnerships with international experts of the Natural Capital Project and NOAA's International Marine Protected Area Capacity Building Team to develop a plan for sustaining the MPAs into the future.

5. **Partnerships.** It is critical to establish strong partnerships with all the environmental agencies playing important roles in sustaining coastal resources and protecting the Guatemalan coastal, estuarine and nearshore waters. It is essential that all parties responsible for the creation and management of the MPAs have an active role in the development of these areas, and that they continue to be invited and participate in future meetings.

6. **Training of the next generation.** The students are starved for advanced training in subjects such as stock assessment, integrated ecosystem assessment, and general oceanography (in particular, chemical and biological) and marine biology. Much of their current training is focused on the very practical aspects of establishing and maintaining aquaculture operations. Future opportunities should be sought to bring in international experts to provide training in fisheries, ecosystem science, and the challenges facing people and coastal organisms due to climate change. It will be important to provide a translator for locals who want to listen and learn from the lecturers, but don't understand English fluently. A rewarding observation was that two of the leaders of this workshop had participated in previous trainings and workshops sponsored by PICES under the Seafood Safety Program as students at the University of San Carlos. Currently, one of them oversees Fisheries Resources Regulation, Control and Enforcement on both coasts of Guatemala and another was the professor for the oceanography class from the University of San Carlos. Both of these individuals

have put their prior PICES experience to good use in Guatemala.

7. **Perceptions of fish and establishment of a supply chain.**

The supply chain for fish transport to Guatemala City is not well developed in that it is difficult to get fresh fish to it and other cities in Guatemala. In part, this is due to the lack of education about the nutritional value of fish as a valuable source of protein and essential fatty acids (e.g., omega-3 fatty acids). The Guatemalan public has the general perception that "fish are smelly, toxic and taboo", which leads to relatively little domestic consumption, and export of much of their fish and shrimp products to other countries, with the result that "Guatemala is exporting health." The importance of "eat at home aquaculture" was stressed as a key to a future healthy Guatemalan population.

8. **Tourism.** The importance of tourism education and responsible commercialization of fisheries cannot be understated. There are many examples in Guatemala of successful implementation of sustainable tourism efforts as an alternative to non-sustainable fishing in Guatemala. For example, the sailfish tourist fishery nets \$6,000 US per tourist per day, whereas the economic value of harvesting and local selling of sailfish is two orders of magnitude less profitable as a single sailfish sells for only about \$75 per fish. The fisheries enforcement groups are attempting to educate coastal communities about the importance of sailfish as a catch-and-release fishery to sustain this profitable and sustainable tourist fishery. Heavy fines and jail time are the consequence of illegal sailfish capture, processing (e.g., smoking) and domestic sales, and relatively sophisticated and modern methods (e.g., aerial drones) are used to find illegal sailfish smoking operations and help enforce existing regulations.

In summary, we concluded that it is essential that we listen to community members and not tell them what to do, but certainly provide guidance where needed. This helps promote the important message that community members are the coastal stewards, not experts from outside of the country, who must protect the ocean resources for future generations. We witnessed through discussions with fishers, community members, project leads and students that the fishers and other coastal dwellers are very interested in gaining knowledge on ocean changes in order to learn and lead as coastal stewards. It will be important to capitalize on their interest and motivation to become more responsible guardians of their marine resources, and to provide our expert assistance when possible and requested. A series of community lectures could help bridge the gap between researchers and coastal stewards/coastal community members. Moving forward, the agencies involved in the UN project should work closely together, including working closely with the next generation (students) to maximize the impact of their work.

In particular, those agencies that are responsible for each of the five MPAs must work collaboratively, learning from

the successes and failures in each of the areas.



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*Dr. William Cochlan (cochlan@sfsu.edu) is a Senior Research Scientist at Romberg Tiburon Center for Environmental Studies, San Francisco State University, USA. His key research questions revolve around factors that control phytoplankton growth, and their nutrition and distribution in the ocean. His research on harmful algal blooms and other phytoplankton covers multiple interactions of light and macro- and micro-nutrients affecting the physiology of marine phytoplankton. In PICES, he is a member of the Section on Ecology of Harmful Algal Blooms in the North Pacific.*

*Julian Herndon (julian.herndon@noaa.gov) is a Research Scientist at the Joint Institute for the Study of the Atmosphere and Ocean (JISAO), a collaboration between the University of Washington and NOAA's Pacific Marine Environmental Lab (PMEL). Since completing his Master's Degree in Dr. Cochlan's lab at San Francisco State University's Romberg Tiburon Center, his professional research experience has been primarily in Biological Oceanography, focusing mostly on the physiology and ecology of marine algae. At JISAO he is part of the Carbon Group which measures and studies the effects of anthropogenic carbon on marine chemistry resulting in ocean acidification.*

*Dr. Charles Trick (trick@uwo.ca) is a Distinguished Research Professor for Ecosystem Health at Western University, London, Canada, a position that emphasizes the merging of science, health/medicine, social and psychological aspects of environmental programs. Since receiving his Ph.D. in Oceanography, Charlie has worked in a variety of different coastal and open ocean projects. He has recently completed a sustainability assessment of the Persian Gulf and continues his research in marine and freshwater harmful algal blooms. In PICES, he is a member of the Section on Ecology of Harmful Algal Blooms in the North Pacific.*

*(continued from page 30)*

During the second half of the training course, participants experienced hands-on exercises in data analysis of the *Seisui-Maru* cruise, ocean color satellite, and numerical model output so that participants could learn how to process ocean environment data from various sources. In the afternoon, one day before the last lecture, they were divided into four groups, with three groups using the data sources for hands-on exercises and one group using a brain-storming approach to deal with the social science aspect of coastal vulnerability. It was very challenging for everyone to work together intensively to problem solve and to prepare a final report but it was a good opportunity for participants to gain experience in international collaboration. On the last day, final presentations were made by each group followed by discussions. A completion ceremony wrapped up a very successful training course after which a farewell party was held at Nagoya University.

This 2-week training course provided a valuable experience for all of the participants to not only understand the dynamics of freshwater discharge in relation to highly

sensitive and vulnerable ecosystems and added human dimension, but also to meet and work with people from different backgrounds who have similar interests.

I would like to thank PICES, IHP, ISEE, DPRI, JOS and CEARAC for their financial support. I also would like to thank the keynote speakers, all the lecturers, crew members of T/V *Seisui-Maru*, and staff who helped to make the training course a success.

*Dr. Joji Ishizaka (jishizaka@nagoya-u.jp) is Vice-Director of the Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan. He is working on phytoplankton dynamics using mostly ocean color remote sensing. He has served as Co-Chair of the Advisory Panel for a CREAMS/ PICES Program in East Asian Marginal Seas since October 2009.*



## Program of topic sessions and workshops at PICES-2017

### ▪ S1: Science Board Symposium

Environmental changes in the North Pacific and impacts on biological resources and ecosystem services

### ▪ S2: MEQ Topic Session

Microplastics in marine environments: Fate and effects

*Co-sponsored by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection ([GESAMP](#)) and the Northwest Pacific Action Plan ([NOWPAP](#))*

### ▪ S3: FUTURE Topic Session

Below and beyond maximum sustainable yield: Ecosystem reference points

### ▪ S4: MONITOR Topic Session

Adverse impacts on coastal ocean ecosystems: How do we best measure, monitor, understand and predict?

### ▪ S5: FIS Topic Session

Coastal ecosystem conservation and challenge

### ▪ S6: FIS/POC Topic Session

Interannual variability in marine ecosystems and its coupling with climate projections

### ▪ S7: Topic Session (CANCELLED)

Indicators for assessing and monitoring biodiversity of biogenic habitats

### ▪ S8: HD Topic Session

Marine ecosystem health and human well-being: A social-ecological systems approach

### ▪ S9: POC Topic Session

Meso-/submeso-scale processes and their role in marine ecosystems

### ▪ S10: FUTURE Topic Session

Emerging issues in understanding, forecasting and communicating climate impacts on North Pacific marine ecosystems

### ▪ S11: FIS/POC Topic Session

Environmental variability in Arctic and Subarctic ecosystems and impacts on fishery management strategies

### ▪ S12: BIO Topic Session

Seasonal and climatic influences on prey consumption by marine birds, mammals and predatory fishes

### ▪ S13: BIO Topic Session

Joint PICES-ICES Session on Anthropogenic effects on biogeochemical processes, carbon export and sequestration: Impact on ocean ecosystem services

*Co-sponsored by the International Council for the Exploration of the Sea ([ICES](#))*

### ▪ BIO, FIS, HD, MEQ, POC Contributed Paper Sessions

### ▪ General Poster Session

### ▪ W1: MONITOR/TCODE Workshop

The role of the northern Bering Sea in modulating the arctic II: International interdisciplinary collaboration

### ▪ W2: HD Workshop

Coastal ecosystem services in the North Pacific and analytical tools/methodologies for their assessment

### ▪ W3: FIS Workshop

Linking oceanographic conditions to the distribution and productivity of highly migratory species and incorporation into fishery stock assessment models

*Co-sponsored by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean ([ISC](#))*

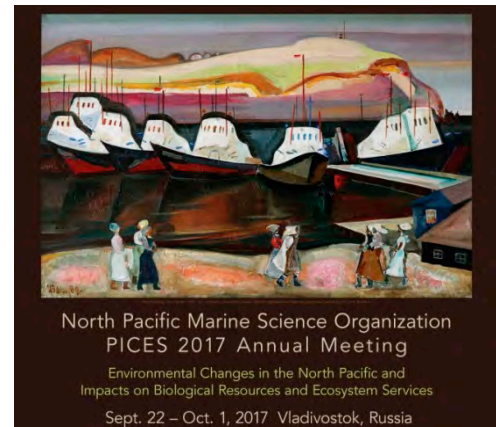
### ▪ W4: MEQ Workshop

Long-term changes in HAB occurrences in PICES nations; the Eastern vs. Western Pacific

*Co-sponsored by the Northwest Pacific Action Plan ([NOWPAP](#))*

### ▪ W6: BIO Workshop

Advantages and limitations of traditional and biochemical methods of measuring zooplankton production



## The 3<sup>rd</sup> PICES/ICES Early Career Scientist Conference takes place in Busan, Korea

by Antje Gimpel and Maija Viška



*“She sells sea shellfish by the sea shore, no more (Pers. comm., 2050)”*

Twitter-message by Travis Tai

Check my talk @ [#ECSC17](#)

*“Climate, oceans and society: Challenges and opportunities”* – the topic of the 3<sup>rd</sup> PICES/ICES Early Career Scientist Conference (ECSC 2017), which was held from May 30 to June 2 in Busan, Korea, reflects the current and future issues that are being dealt with by research and management institutions around the globe. More than 100 early career marine scientists (including graduate students, post docs and others who received their Ph.D. within the last 5 years) from 30 countries attended the conference. The conference was aimed to encourage participation of young scientists in international scientific investigations and to promote their involvement in the management and stewardship of the marine environment, as well as involvement in international organizations like the North Pacific Marine Science Organization (PICES) and the International Council for the Exploration of the Sea (ICES). This was stressed at the Opening Ceremony by PICES Chair, Dr. Chul Park, who noted that building future capacity in PICES and ICES is through young scientists and that all ocean sciences intercorrelate with each other and it is very important to know what others are doing and through that, to understand one’s own work better. ICES convener, Dr. Wojciech Wawrzynski, emphasized the networking aspect of the conference: *“This conference is bringing together people with different backgrounds. Let us learn from each other and create friendships and cooperation.... Let the science inspire you!”* Putting these words into action, 87 oral presentations and 26 posters were presented over four days.

This year’s theme sessions were on: 1) climate effects on physical, chemical and biological processes, 2) anthropogenic

effects on the marine environment, and 3) patterns and processes in marine ecosystems, which were further divided into [several sub-sessions](#).

Studies described tools and models for understanding patterns such as biodiversity hotspots, the dynamics of populations and communities, and fundamental processes in marine ecology and oceanography, while being of direct relevance for managing marine populations and determining human impacts. The introduction of anthropogenic substances to the ocean and their impacts was approached as well as the key question of how to adapt to ecosystem-based management while accounting for direct and indirect effects of human uses. Methods to facilitate communication and decision-making while improving the law-science interface were also of particular interest. Additionally, topics considered the ecosystem effects of melting sea ice, sea surface temperature rise, or ocean acidification and how it affects coral reefs. Emphasis was also placed on wave modelling and estimations of coastline changes due to erosion and sea level rise. Oral presentations and posters covered a broad spectrum of research areas related to marine ecosystems. Presentations were followed by lively discussions, and constructive feedback was offered to all presenters.

Plenary keynote lectures given by Dr. Suam Kim (PICES/Korea) on *“Fish and fisheries in a changing environment”*, Dr. Shin-ichi Ito (PICES/Japan) on *“Challenges and advances in understanding marine ecosystems and projecting oceans futures”* and Drs. Alejandra Bize and Simon Cooper (ICES/Denmark) on

“*Marine science and social media*”, gave further food for thought. The latter nailed the daily challenges young researchers are confronted with in international scientific communities: How do you present yourself and your work to an international audience? How do you reach public interest? How do you get heard?

The conference also provided networking opportunities for participants to have informal discussions while enjoying communal meals, poster sessions, and an afternoon offsite excursion to Yeong-do (Yeong Island), the National Maritime Museum and the Taejongdae natural park. The excursion helped the ECSC participants (*i.e.*, those not from the region) to become acquainted with Korean culture. Our local hosts provided us with buses and knowledgeable guides who told us many interesting facts about Korea and helped to keep our large, slow moving group on schedule. We visited the National Maritime Museum where we viewed many different displays on marine life, and where we learned about the development of the marine industry and ocean science in Korea. The museum also housed an aquarium with many colorful fishes and turtles, which attracted great interest from the group. Afterwards, we had the opportunity to visit Taejongdae, which is a natural park facing the open sea, and have a quick stroll along a rocky coastal walkway. Although there was a thick fog, the view from the pathway near the lighthouse was impressive and mystical.

The conference was a great experience for all attendees, not only for its scientific content but also for the opportunity to forge new collaborations. In closing, Dr. Cornelius Hammer, president of ICES, provided us with advice on creating our own personal networks after ECSC 2017 and keeping up the relationships. Moreover, he invited all early career scientists to get involved in ICES working groups and become part of the international network – and therefore part of ICES family. The fascinating venue of ECSC 2017 and the opportunity for many of the participants to become acquainted with the Korean culture and the amazing Korean food, accompanied by unrivalled (*i.e.*, karaoke) experiences apart from the official program, has led to connections which extend beyond purely scientific motivation.

We, the SSC, hope the participants will use the feedback they obtained during the conference, actively take part in the large network of the P/ICES community and reinforce their voice through the P/ICES channel – working together on the challenges and opportunities of the future.



The Scientific Steering Committee (SSC) of the PICES/ICES Early Career Scientist Conference, from left: Tae-Wook Kim (PICES/Korea), Maija Viška (ICES/Latvia), Antje Gimpel (ICES/Germany), Haruka Takagi (PICES/Japan), and Daniel van Denderen (ICES/Denmark). Unfortunately, SSC member, Allan Hicks (PICES/USA), was not able to attend the conference.

**Acknowledgements:** The ECSC was sponsored by PICES and ICES, Ministry of Oceans and Fisheries (MOF) of Korea, Korea Institute of Ocean Science and Technology (KIOST), Scientific Committee on Oceanic Research (SCOR) and the North Pacific Research Board (NPRB). We also thank Dr. Hal Batchelder (PICES convener) and Dr. Kyungjin Kim (head of the Korean local organizing committee) and the many Korean students and KIOST locals who aided with the conference logistics.



Suyeong Bay, Busan



Dr. Maija Viška (left) ([maija.viska@lhei.lv](mailto:maija.viska@lhei.lv)) received her Ph.D. in environmental engineering from Tallinn University of Technology and now is a researcher at the Latvian Institute of Aquatic Ecology. Her main research topic is coastal sediment dynamics and complex interactions of physical processes in the coastal zone. Her other interests lie in interdisciplinary communication and philosophy of science.

Dr. Antje Gimpel (right) ([antje.gimpel@thuenen.de](mailto:antje.gimpel@thuenen.de)) is working as a post doc at the Thünen-Institute (TI), Institute of Sea Fisheries in Hamburg, Germany. Her focus is on GIS-based decision support tools allowing for a spatial assessment of inter-sectorial, environmental, economic and socio-cultural effects of (newly proposed) human activities in a multi-use environment. She is also part of the ICES Working Group on Marine Planning and Coastal Zone Management (WGMPCZM).



**Feedback received from some of the attendees of the ECSC following the event...**

*I would like to thank ICES and PICES for the opportunity to meet fellow young marine scientists all over the world. Thank you very much. — Erwin Don R. Racasa (Philippines)*

*The conference was great, I had a great time and met so many scientists working on similar topics and forged many collaborations. Thanks so much again for putting that all together! — Cecilia O’Leary (USA)*

*I was very glad to take in the conference and get financial support! Thanks organizers for that opportunity. I still remember time spent in Busan in Commodore Hotel and all our activities: excursion and outdoor dinner. The organization was very good!!! The conference gave me a chance to meet new colleagues from Latvia and now we have some plans of collaboration. Maybe, it will work! Also I was happy meeting some colleagues from other cities of Russia... Busan was nice place for sharing our science. — Polina Lobanova (Russia)*

*Firstly, I got much from this meeting. I not only got a chance to share my research, but also met new friends like Esther and Antje. They shared their researches and life experiences with me. Also, they gave me advices to find scientists who do the same research area. Therefore, I have learned much information of ecosystem based marine management & marine spatial planning in Europe and I have known as well who do good job in this area that I can learn from in future. Secondly, I get more familiar with PICES and ICES. It is a big family that scientist can learn from and communicate with each other. Attending this meeting was amazing experience that I can make friends with foreign scientists which I never have before. — Ou Ling (China)*

*Thank you for the wonderful meeting in Busan. I enjoyed the conference very much and got some feedback on my current project. Small size of the meeting and many occasions to encourage interactions, including coffee breaks and meals, were very helpful to get to know each other during the short period of time. I also appreciate the travel support. I would like to thank you and Scientific Steering Committee for organizing the wonderful conference. I will look into a path to involve in the PICES through working groups in the future. — Mei Sato (USA)*

*Thanks a lot for the wonderful opportunity. It was a great experience to interact with the fellow researchers and had a great time at Busan. We have to specially thank the local organizers, the conference days will be memorable forever. Thanks for your kind support and hope I will get much more opportunities in the future. — Muthukumar Chandrasekaran (India)*

*I would like to express my gratitude for the perfect conference organization, and also for my financial support to attend it. In addition to pretty comfort environment, the meeting went amazingly productive both in terms of scientific networking and knowledge exchange. — Kirill Kivva (Russia)*

*Indeed it was a great conference and I met a lot of scientist and we are already looking forward for collaborations. PICES-ICES really helped me in my career. — Nadeem Nazurully (Mauritius)*

*I like to say that I really enjoyed the conference and I also very much enjoyed to be part of the scientific committee. Thanks for all the support! And hopefully we meet again! — Daniel van Denderen (Denmark)*



## The Bering Sea: Current status and recent trends

by Lisa Eisner

### *Climate and oceanography*

It was considerably warmer than normal for the Bering Sea during the period of October 2016 through March 2017. This represented the fourth year in a row of warm conditions during this time of year. The distribution of mean surface air temperature anomalies for October 2016 through March 2017 (Fig. 1) shows that it was particularly warm over the Gulf of Anadyr in the northwest portion of the Bering Sea with average temperatures more than 6°C above normal for the 6-month period. Not surprisingly, there was considerably less sea ice than usual in that region. The air temperatures were much less anomalous over the southeast Bering Sea shelf. This portion of the Bering Sea had sea surface temperature (SST) anomalies of about +1°C, mostly due to pre-existing warmer than normal conditions (Fig. 2). There were some cold periods, notably during the middle of February, and to a lesser extent, early April 2017, that promoted the development of greater sea ice coverage on the southeast Bering Sea shelf than during the previous year.

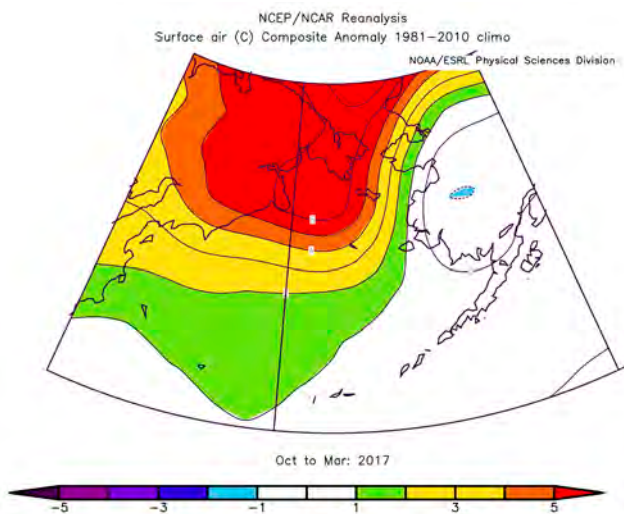


Fig. 1. Mean surface air temperature anomalies (°C) from the NCEP/NCAR Reanalysis for October 2016 through March 2017. Figure courtesy of Nick Bond, PMEL.

The relatively warm weather in the northern Bering Sea can be attributed to the sense of the low-level flow as indicated by the mean sea level pressure (SLP) pattern for October 2016 through March 2017 (Fig. 3). The higher than normal SLP centered over the Alaska Peninsula and lower than normal SLP over the Kamchatka Peninsula and eastern tip of Siberia implies strong wind anomalies from the south, and hence enhanced transport of mild maritime air masses through the central Bering Sea into the Chukchi

Sea. The positive SLP anomalies over the southeast Bering Sea shelf also indicate suppressed storminess from an overall perspective. The higher than normal pressure, *i.e.*, weak Aleutian Low may be attributable, at least in part, to the La Niña of the fall and winter of 2016–2017. While the SST anomalies in the tropical Pacific were only of moderate amplitude, this event appears to have had substantial impacts on the atmospheric circulation over the North Pacific Ocean. From a basin-scale perspective, the last vestiges of the record-setting North Pacific marine heat wave (MHW) that began developing late in 2013 were present over the Bering Sea shelf in spring 2017.

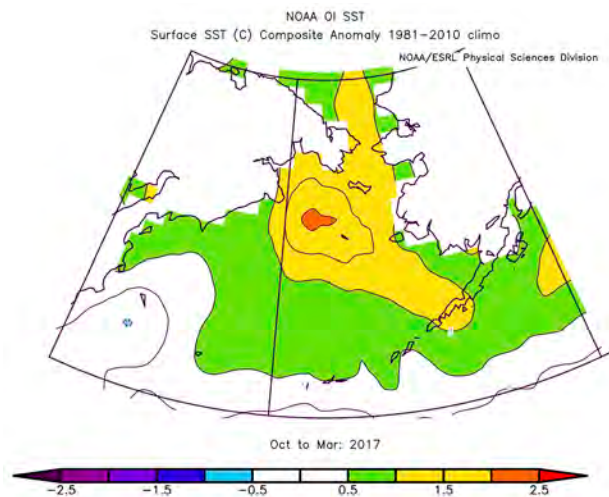


Fig. 2. Mean sea surface temperature (SST, °C) anomalies (deviations from 1981–2010 climatology) for October 2016 to March 2017. Figure courtesy of Nick Bond, PMEL.

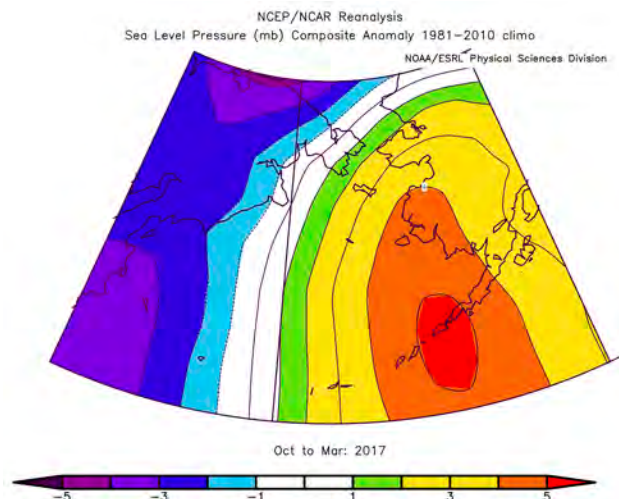


Fig. 3. Mean sea level pressure (SLP, mb) anomalies from the NCEP/NCAR Reanalysis for October 2016 to March 2017. Figure courtesy of Nick Bond, PMEL.



Sea ice over the outer shelf was also unusually low over the north outer shelf (~100–200 m bathymetry) (Fig. 4).



Fig. 4. Sea ice during early spring (March) 2017 in the eastern Bering Sea. Figure courtesy of Phyllis Stabeno at PMEL, NOAA.

Western Bering Sea water temperatures were measured in summer 2016 on a joint trap survey on the western Bering Sea shelf conducted by KamchatNIRO (Petropavlovsk-Kamchatsky) with assistance from TINRO-Center (Vladivostok), May 28–June 26, 2016, onboard the R/V *Potapovo*. Summer conditions in the western Bering Sea were distinguished by elevated temperature in the whole water column on the shelf (anomalies +0.2 to +0.5) with general patterns typical for strong (wind-driven) advection from the south (Fig. 5). The cold water belt along the Asian coast, known as the Kamchatka Current, was absent.

#### ***Capturing history and forging the future: Alaskan Native women in fisheries***

It is well-documented that Alaskan Natives heavily depend upon fishing for their livelihoods, culture and survival. However, there is no comprehensive research or documentation of Alaskan Native women's roles in and perspectives of fisheries. Moreover, the current and potential impacts of climate change are constraining these livelihoods which are already facing rapid socio-economic and cultural change due to globalization. Social scientists at the Alaska Fisheries Science Center (AFSC), NOAA are partnering with the Bristol Bay Native Association to produce oral histories of fisherwomen in Bristol Bay communities. This cultural preservation project will document Alaskan Native women's historical and current subsistence and commercial fishery practices, and how they and others have identified and responded to the impacts of environmental change. These products are a means of socio-ecological preservation and can be utilized by communities and researchers alike for education and outreach. The project also serves as pilot research of gendered aspects of fisheries in Alaska, and gendered responses to drivers of change, which is lacking despite extensive evidence of the significant roles of women in fisheries around the globe. For more information, see: [https://www.afsc.noaa.gov/Science\\_blog/BristolBay\\_main.htm](https://www.afsc.noaa.gov/Science_blog/BristolBay_main.htm)

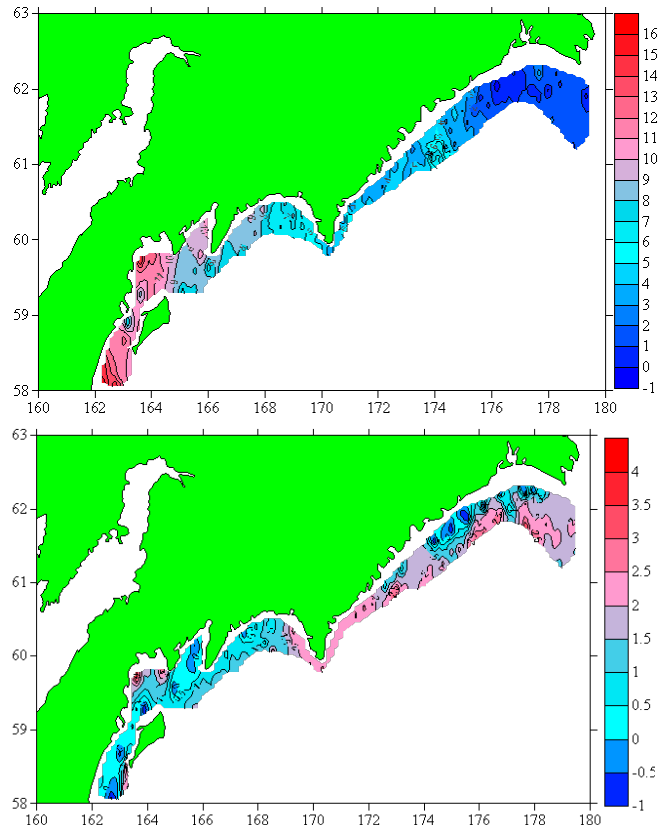


Fig. 5. SST ( $^{\circ}\text{C}$ , top panel) and bottom temperatures (bottom panel) in the western Bering Sea in summer 2016. Figure and text courtesy of Alexander Figurkin and Yury Zuenko, TINRO-Center.

#### ***Upcoming Sairdrone surveys in the Bering and Chukchi seas***

The Pacific Marine Environmental Lab (PMEL), NOAA and Sairdrone Inc. will embark on a third year of cooperative development. As part of this, the Innovative Technology for Arctic Exploration (ITAE) program will use three Sairdrone Unmanned Surface Vehicles (USVs) for scientific operations in the Bering and Chukchi seas. ITAE Principal Investigators will lead a three-month field mission to further test passive and active acoustics on one Sairdrone in the Bering Sea, as well as a newly integrated technology, a CO<sub>2</sub> system (ASVCO2) on a second and third vehicle in the Chukchi Sea. All USVs will depart Dutch Harbor, Alaska in July, 2017. The Bering mission will look to further knowledge gained in 2016 by extending the pollock distribution survey region farther north and will include enhanced tagging techniques for visualization of foraging behavior of Northern fur seals. The Chukchi mission will mark, if successful, the first time a Sairdrone USV is in the Arctic and increased sensor capacity with the ASVCO2 system. You can follow the mission and download mariner notices of research at: <https://www.pmel.noaa.gov/itae/>.

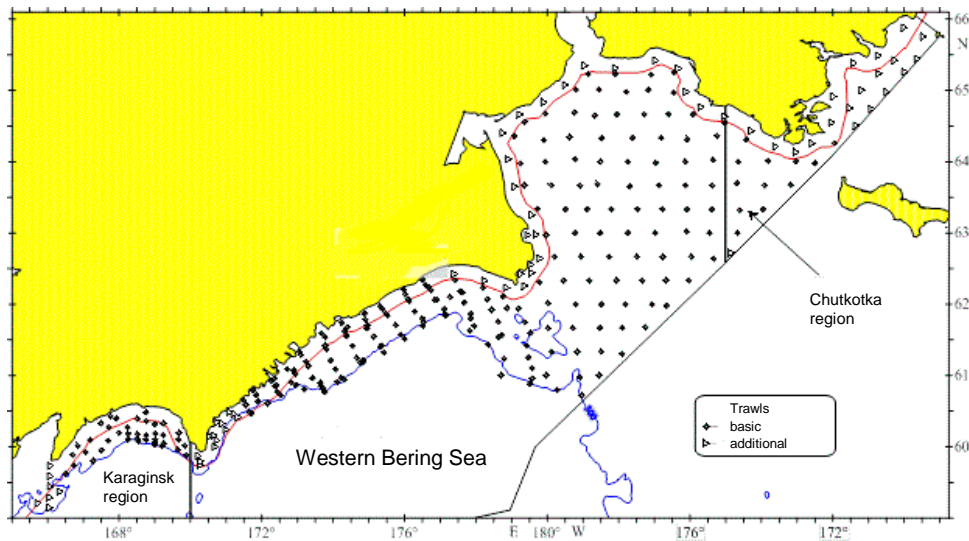


Fig 6. Bottom trawl survey planned for the western Bering Sea, summer 2017. Small points – basic trawl and oceanographic stations, Triangles – additional trawl and oceanographic stations (time permitting), Red line – border of the territorial sea, Black lines – borders of the fishery districts. Figure courtesy of Andrey Savin, head of the expedition, and Yury Zuenko (TINRO-Center, Vladivostok).

**Upcoming Bering Sea surveys**

- AFSC, NOAA will conduct bottom trawl surveys in the eastern Bering Sea, May 31–August 7, 2017, and in the northern Bering Sea, August 8–30, 2017. This is only the second time since 2010 that the survey has been expanded to include the entire northern Bering Sea shelf. Surveys will be conducted onboard the F/Vs *Vesteraalen* and *Alaska Knight*. Please see the [survey blog](#).
- TINRO-Center will conduct a bottom trawl survey in the western Bering Sea from June 4–August 8, 2017 onboard the R/V *Buhoro* (Fig. 6).
- Scientists with the University of Alaska, Fairbanks, and the University of Washington, with guest collaborators from Hokkaido University, the U.S. Fish and Wildlife Service, and NOAA will conduct an oceanography and fisheries survey on the R/V *Sikuliaq*, June 9–29, 2017 in the Northern Bering and Chukchi seas. Please see the [survey blog](#).
- The T/V *Oshoro-Maru*, Faculty of Fisheries Sciences, Hokkaido University, Japan, will conduct hydrographic, biogeochemical, biological, and meteorological surveys in the central and eastern Bering Sea, June–early August, 2017.
- AFSC, NOAA and the Alaska Department of Fish and Game, with guest collaborators from the U.S. Fish and Wildlife Service, University of Alaska, Fairbanks, and Alaska Pacific University will conduct a fisheries oceanography survey on the northeastern shelf onboard the F/V *Northwest Explorer*, late August to mid-September, 2017.
- PMEL and AFSC, NOAA will deploy moorings and conduct oceanography and plankton surveys on board the NOAA Ship *Oscar Dyson* on the southeastern shelf during late September/early October 2017. New to this survey is sampling for coccolithophores (small single celled phytoplankton that are surrounded by calcium

carbonate plates that turn the water a milky aqua color) by PhD student Tanika Ladd, University of California, Santa Barbara, with funding from the North Pacific Research Board.

**Upcoming Bering Sea meetings**

- [7<sup>th</sup> Symposium on the “Impacts of an ice-diminishing Arctic on naval and maritime operations”](#), July 18–20, 2017, Washington, DC;
- [OCEANS 17](#), September 18–21, 2017, Anchorage, Alaska;
- North Bering Sea workshop W1 on “*The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration*” at PICES-2017, September 23, 2017, Vladivostok, Russia;
- Alaska Marine Science Symposium, late January 2018, Anchorage Alaska.

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Dr. Lisa Eisner ([lisa.eisner@noaa.gov](mailto: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 state of the western North Pacific during the 2016/2017 cold season

by Toshiya Nakano

The western North Pacific was characterized by persistent below-average sea surface temperatures (SSTs) around 45°N (Fig. 1) during the first half of the 2016/2017 cold season. This characteristic dissipated toward the end of the season.

The winter maximum sea ice extent in the Sea of Okhotsk was 0.94 million km<sup>2</sup> in early February, which was around 80% of the 30-year average of 1.17 million km<sup>2</sup>. The seasonal maximum exhibits a long-term downward trend of 0.069 million km<sup>2</sup> per decade, which corresponds to 4.4% of the Sea of Okhotsk's total area (Fig. 2).

The Japan Meteorological Agency (JMA) has conducted oceanographic observations in the western North Pacific

for more than 50 years to monitor the long-term variability of ocean-related changes. This work includes monitoring to highlight long-term trends of oceanic/atmospheric CO<sub>2</sub> concentrations and to determine pH in surface seawater from 3 to 34°N along JMA's repeat hydrographic line at 137°E and from 5°S to 35°N along the line at 165°E, respectively (Fig. 3a). Data show that growth rates for oceanic and atmospheric CO<sub>2</sub> concentrations along 137 and 165°E are 1.2–3.4 and 1.7–2.1 μatm/year, respectively (Fig. 3a, b). Values of pH in surface seawater show a clear long-term trend of decrease at rates of approximately 0.01 to 0.03 per decade (Fig. 3c, d). For more details, see JMA's [CO<sub>2</sub>](#) and [ocean acidification](#) trends in the western North Pacific.

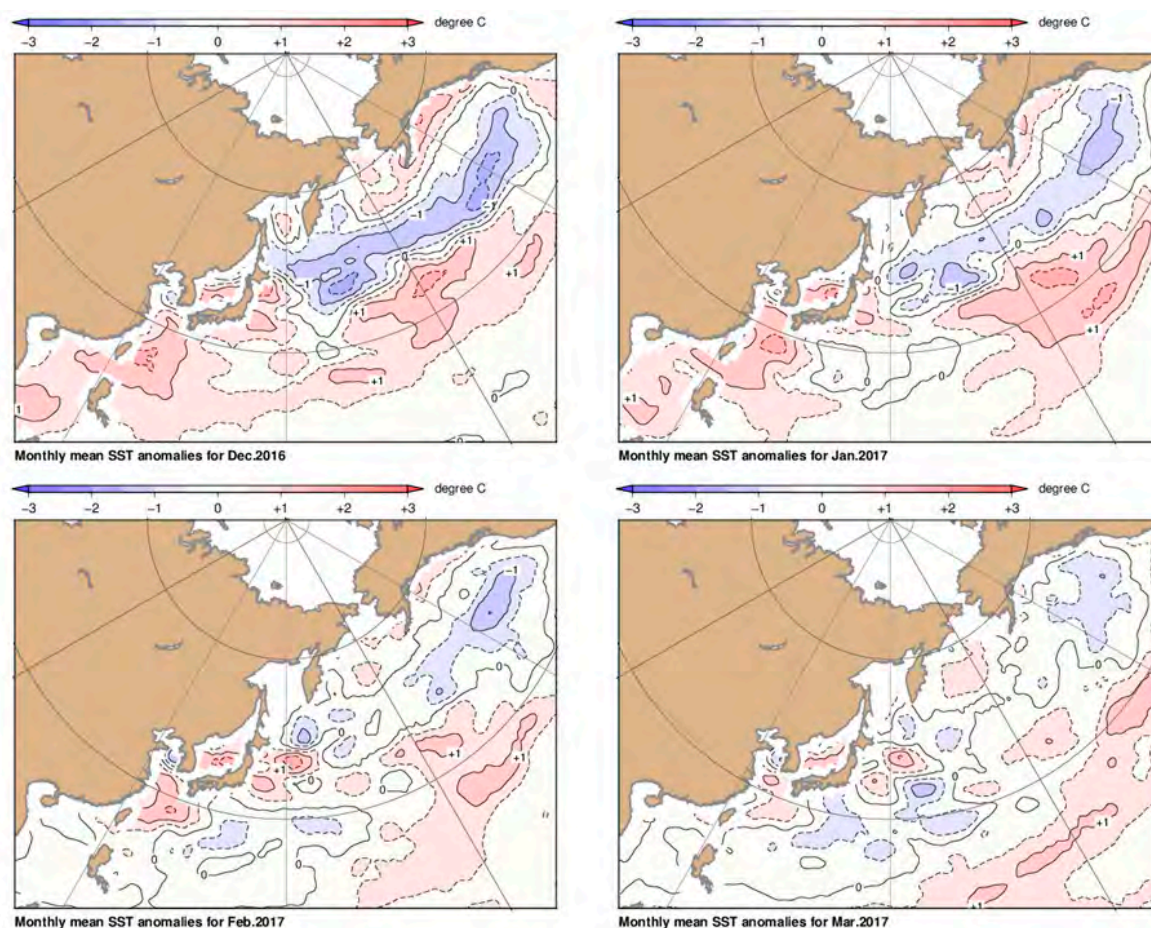


Fig. 1 Monthly mean sea surface temperature anomalies for December 2016 and January, February and March 2017. Monthly mean SSTs are based on JMA's COBE-SST (centennial in-situ observation-based estimates of variability for SST and marine meteorological variables). Anomalies are deviations from the 1981–2010 climatology.

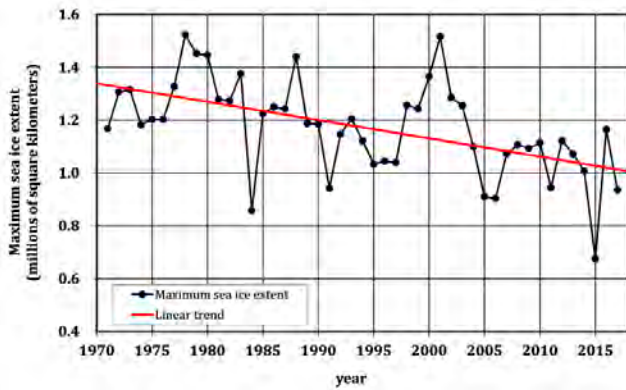


Fig. 2 Time-series representation of winter maximum sea ice extents in the Sea of Okhotsk from 1971 to 2017. The red line represents the long-term linear trend.

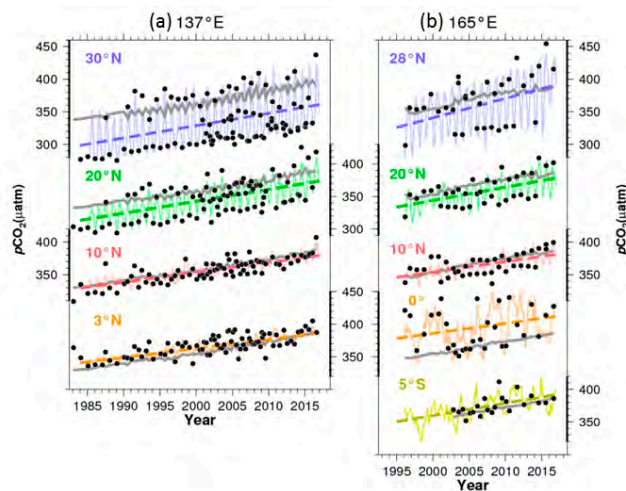


Figure (e) shows JMA's repeat hydrographic line at 137 and 165°E. Long-term trends of pCO<sub>2</sub> (a, b) and pH (c, d) at each latitude in JMA's repeat hydrographic lines (d) at 137 and 165°E. Black plots show oceanic pCO<sub>2</sub> and pH observation values. Solid lines represent monthly oceanic pCO<sub>2</sub> and pH values reconstructed using the method of Ishii et al. (2011), while dashed lines show the long-term trend of oceanic pCO<sub>2</sub> and pH. The grey lines in (a) and (b) indicate atmospheric pCO<sub>2</sub> observation values, and the numbers in (c) and (d) indicate rates of pH change at each latitude.

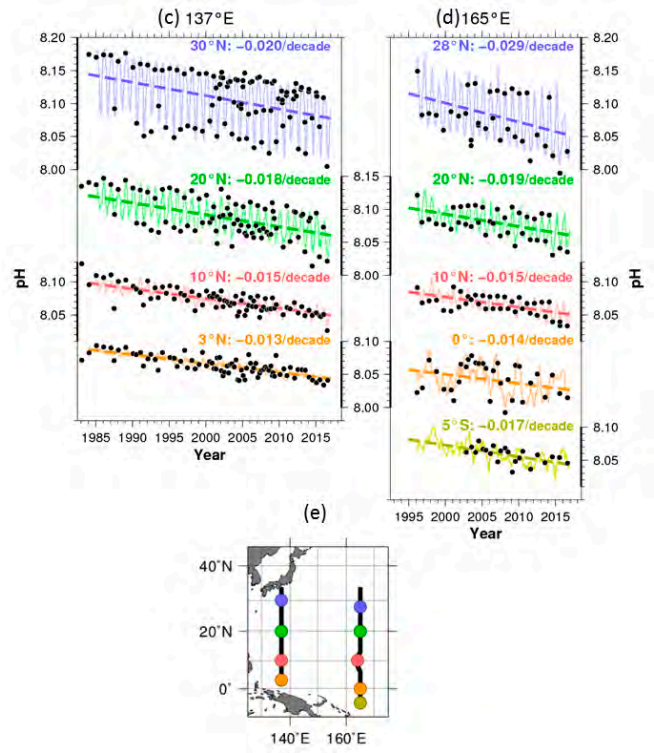


Fig. 3 Continued.

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