

Report of Science Board

Science Board met in San Diego, USA, from 12:30 to 17:00 on November 6, 2016. Science Board Chairman, Dr. Thomas Therriault, welcomed guests and members to the meeting and self-introductions were made (*SB Endnote 1*). The agenda was adopted without revisions, but some items were re-ordered to accommodate invited observers (*SB Endnote 2*). A second meeting was held after the Closing Session, from 13:30 to 18:00 on November 11 and a one-day meeting was held from 9:00 to 18:00 on November 12.



Committee/Program Chairs comprising Science Board (left to right): Steven Bograd (FUTURE SSC), Angelica Peña (BIO), Elizabeth (Libby) Logerwell (FIS), Jennifer Boldt (MONITOR), Thomas Therriault (Science Board Chair), Harold (Hal) Batchelder (Deputy Executive Secretary), Hiroaki Saito (Science Board Chair-elect; FUTURE SSC), Igor Shevchenko (representing Russia), Toru Suzuki (TCODE), Chuanlin Huo (MEQ), Se-Jong Ju (BIO Vice-Chair). Missing from photo: Michael Foreman (POC Vice-Chair).

Sunday, November 6, 2016

AGENDA ITEM 2

Procedures for Science Board Symposium and Session awards

Science Board revisited procedures for judging sessions and conferring awards. Science Board will be responsible for judging the Science Board Symposium, and FUTURE-sponsored and S-HD-sponsored topic sessions and one “PICES” award will be granted between these. Awards will be handed out for oral presentations and posters if there are at least 5 early career scientists to judge in each category. Best Poster award will be considered this time only even though it does not meet the minimum criteria. Dr. Therriault delegated Drs. Boldt and Bograd to prepare an S1 session summary of the talks. Science Board debated how to alleviate the burden of some Committees having to judge a disproportionate number of presentations every year but there was no consensus on the best method

Action:

- discuss whether to maintain individual Committee awards, or base on a larger pool at ISB-2017;
- Drs. Boldt and Bograd to write session summary for S1.

AGENDA ITEM 3

Template for Committee reports to Science Board

Dr. Therriault confirmed that all proposals submitted at PICES-2016 should be reviewed by all Committees.

Action: Secretariat to recirculate PICES-2016 proposals for review by all Committees by mid-day Wednesday.

AGENDA ITEM 4A

Strategic collaborations

A) *ICES (International Council for the Exploration of the Sea)*

Dr. Cornelius Hammer (President, ICES) reviewed past and present collaborations with PICES and discussed opportunities for future work together, which included identifying themes of common interest that are linked to strategic priorities within each organization. Continuing to support and organize scientific events was a priority, but he asked Science Board to consider a mechanism to plan these strategically, such as elevating the planning process to a more political/strategic level, and consulting each other when setting directions in the ICES and PICES Strategic Plans. As ICES focuses on human dimension and Arctic activities, Dr. Hammer urged PICES to consider forming a joint expert group, such as a P/ICES Study Group on Strategic Planning, to address these issues.

B) *NPAFC (North Pacific Anadromous Fish Commission)*

Dr. Vladimir Radchenko (Executive Director, NPAFC) focused on the International Year of the Salmon (IYS) as one of the joint initiatives to strengthen collaboration between PICES and NPAFC. A second IYS scoping meeting was held March 15-16, 2016, in Vancouver, Canada, to set the timeline for launching an international symposium in late 2018, and Dr. Radchenko invited PICES to suggest a name to be added to the symposium SSC (see Agenda Item 10 for FIS recommendations).

C) *ISC (International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean)*

Dr. Gerard DiNardo (Plenary Chairman, ISC) talked about the mutual interests of PICES and ISC and the goals, and research themes designed to achieve them, of the joint PICES/ISC Working Group (WG 34) on *Ocean Conditions and the Distribution and Productivity of Highly Migratory Fish*. Dr. DiNardo noted two challenges in the Working Group: no PICES US representation and limited highly migratory species expertise from PICES. To alleviate the former, Dr. DiNardo suggested that he would be prepared to step down as Co-Chair and take the position of US PICES member. Dr. Hide Kiyofuji (Japan) was a potential name to replace Dr. DiNardo as Co-Chair. Dr. Dai (Shanghai University) was suggested as an expert on highly migratory species.

D) *NOWPAP (Northwest Pacific Action Plan)*

Dr. Genki Terauchi, representing NOWPAP, reported on past and current collaborations with PICES, and suggested future activities PICES could be involved in with three of the Regional Activity Centres of NOWPAP. In CEARAC, joint activities would include harmful algal bloom-related efforts with S-HAB; marine environmental issues with DINRAC; and activities related to oil and chemical spills with MERRAC.

NOWPAP is keen on working with PICES and requests PICES to draw up an MOU for more formal collaboration which could be presented at the 21st NOWPAP Intergovernmental Meeting that will take place November 23-25, 2016, in Seoul, Korea. Dr. Saito will represent PICES at the meeting and agreed to work on a framework for joint activities with NOWPAP.

Action: Secretariat to write an MOU for presentation at NOWPAP IGM.

AGENDA ITEM 4B

Other collaborations*A) Scientific Committee on Oceanic Research (SCOR) [presented Friday, Nov 11]*

Dr. Ed Urban (Executive Director, SCOR) recounted the common interests between PICES and SCOR and noted that both organizations were strong proponents of capacity building. One suggestion was to be involved in POGO-related projects such as ocean observing training cruises. PICES might also consider instigating a SCOR working group proposal. Dr. Urban also noted that SCOR and PICES co-funded an [Open Access article](#) by SCOR Working Group 146 (*Scientific Committee on Oceanic Research*) and PICES Working Group 30 (*Assessment of Marine Environmental Quality of Radiation around the North Pacific*) in the annual Review of Marine Science. SCOR's policy is to normally fund one Open Access (usually a synthesis) article per working group. SCOR used to buy special issues and distribute them to developing countries, but the procedure became too expensive to continue.

Dr. Therriault clarified MONITOR's query on inviting observers to its Committee meeting to state that Committees were not limited to those that were suggested by the Secretariat.

B) Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Dr. Gro van der Meeren (Executive Officer, IMBER) reported on IMBER's structure and transition to the umbrella of Future Earth. IMBER is in the process of shifting its direction more to include linking the ocean to the human dimension and noted there is strong overlap between IMBER's Human Dimensions Working Group and FUTURE. IMBER is a strong proponent of capacity building, reaching out to early career scientists through its ClimEco Summer Schools and IMBIZOs. Dr. van der Meeren invited PICES to co-sponsor IMBIZO V which will take place from October 2-6, 2017 at Woods Hole, USA. She also suggested that its regional program, CLIOTOP, could be a possible collaborator with WG 34.

D) IOCCP (International Ocean Carbon Coordinated Project)

Dr. Maciej Telszewski (Project Director, IOCCP) discussed IOCCP and GOOS biogeochemistry strategic issues in common with PICES. Countries cannot afford to set up observing systems for every single variable so the Framework for ocean observing acts to measure, organize, and coordinate autonomous observing networks and deliver data. For instance, data from GOOS was used to produce GLODAP, version 2, in January 2016 and the Surface Ocean CO₂ Atlas, version 4, in September 2016. An observing system for biogeochemistry was set up to measure nine essential ocean variables. Also in 2016, GOA-ON (Global Ocean Acidification Observing Network) developed an ocean acidification data portal for data, and a regional ocean acidification data synthesis of the western Pacific (mainly China, Japan, Korea, and Chinese Taipei) and NE Atlantic and European seas is underway. There is high demand for instruments and sensors training and IOCCP conducted its first International Summer Course on "*Best practices for selected biogeochemical sensors*" in 2015 in Kristineberg, Sweden. IOCCP is also conducting several small training workshops for post docs and technicians, especially in Latin America. PICES is invited to explore these capacity building issues with IOCCP.

E) WESTPAC (IOC Sub-Commission for the Western Pacific)

Dr. Fangli Qiao, representing WESTPAC, reported that WESTPAC mainly focuses on the Indonesian area which is a hotspot for ocean circulation and marine biodiversity. WESTPAC and PICES hold similar interests in ocean ecosystem monitoring (GOOS), harmful algal blooms (IPHAB, GEOHAB), CO₂ data integration and synthesis (IOCCP), and capacity building (through joint training programs and summer schools). Science Board noted that PICES has interests in the area through its MarWeB project and would be willing to collaborate with WESTPAC on any capacity building efforts.

F) NPFC (North Pacific Fisheries Commission)

Dr. Aleksandr Zovolokin (Science Manager, NPFC), provided a brief overview of NPFC whose Convention entered into force in July 2015. NPFC looks forward to collaborating with PICES, as they share the same countries and overlap in Convention area. NPFC will be holding three meetings shortly: a Pacific Saury Stock Assessment Workshop (December 13-15, 2016, Busan, Korea), Meeting of the Technical Working group on Pacific Saury Stock Assessment (February 20-22, 2017, Tokyo, Japan), and a Chub Mackerel Workshop (February 23-24, 2017, Tokyo, Japan) and PICES is invited to send a representative to observe as a prelude to potential collaboration.

Friday, November 11, 2016

AGENDA ITEM 4C

Status, trends and outlooks

Dr. Hiroaki Saito represented PICES at a Sustainable Ocean Initiative workshop, under the auspices of the Convention on Biological Diversity (September 26-29, 2016, Seoul, Korea). The purpose of the workshop was to instigate global dialogue between regional seas organization and regional fisheries bodies on meeting Aichi biodiversity targets. Dr. Saito provided examples of NOWPAP and PICES collaborations at the meeting.

AGENDA ITEM 5

Status of venue for PICES-2017

Science Board expressed some concern about the dates of PICES-2017 due to conflicting overlap with other meetings, especially with ICES ASC, or with national holidays. The matter will be discussed at the Governing Council meeting. Science Board was assured that the venue, on the campus of the Far Eastern Federal University, Vladivostok, will be able to accommodate up to seven concurrent paper sessions, if required.

AGENDA ITEM 6

Mid-year reports from expert groups reporting to Science Board

A) Section on *Human Dimensions of Marine Systems* (S-HD)

Dr. Keith Criddle, Co-Chair of the Section on *Human Dimensions of Marine Systems*, reported that S-HD was very active in 2016. The MarWeB project team held an inter-sessional meeting in Victoria, Canada, in June 2016. The project is nearing completion and has achieved its research and capacity building objectives, and at least one MarWeB-related article has been published in every PICES Press issue since 2013. S-HD nominated ETSO datasets for review at the SG-NPESR3 inter-sessional workshop in Sidney, Canada in June 2016, where S-HD was represented. S-HD regarded the ICES MSEAS Symposium (May 30–June 3, 2016, Brest, France), as a watershed meeting. The PICES region was well represented by 20 scientists, several of who were S-HD speakers (see PICES Press 24(2): 24–25).

The S-HD Work Plan for 2017 includes contributing to a topic session D21 on “Coastal Ecosystem Services and Marine Social-economic Analysis with the Future Earth / SIMSEA” at the IOC/WESTPAC 10th International Scientific Conference April 17-20, 2017 (including co-convenors, Drs. Shang Chen and Mitsutaku Makino), proposals for a workshop and topic session at PICES-2017. S-HD will submit two articles to PICES Press on these meetings.

Other S-HD proposals include the establishment of a Human Dimensions Committee, a new MAFF project on “*Building capacity for ecosystem based management in small-scale nearshore fisheries impacted by coastal zone development*”, and travel support for speakers and/or convenors to attend MSEAS II (2019/2020 in Yokohama, Japan) and in kind Secretariat support for the symposium.

Recommendation:

Science Board recommends reclassifying S-HD to a Committee and disbanding S-HD;
 Science Board approves, in principle, travel support and in kind support for MSEAS II;
 Science Board supports new MAFF project.

Action: Secretariat to secure nominations from all PICES member countries for new MAFF project group.

Action: as for approval in principle for in kind PICES support and support for travel

B) Study Group on *North Pacific Ecosystem Status Report* (SG-NPESR3)

Dr. Se-Jong Ju reported for SG-NPESR3 Chair, Dr. Philip Mundy, who was unable to attend the Science Board Meeting. SG-NPESR3 held a 3-day inter-session workshop June 28-30, 2016, in Sidney, Canada, to review and evaluate a total of 435 North Pacific time series observations (TSOs) of 38 different types nominated from the Standing Committees, Section on *Human Dimensions of Marine Systems*, and Working Group (WG 31) on Emerging Topics in Marine Pollution. The SG recommended using Large Marine Ecosystem numbering convention as the preferred approach for biogeographical classification. The SG will send invitations and confirmations to TSO authors, and will review nominations in December

Science Board recognized that no single existing classification system met the PICES needs, so a modified biogeographical classification system (not a geographical one) was proposed. This includes 15 biogeographical regions around the North Pacific that can be used for ETSO submission. As the biogeographical system proposed by SG-NPESR3 represents an amalgamation of several other conventions, Science Board recommended these units be identified as PICES Region 1, PICES Region 2, *etc.*

Working Group (WG 35) on *Third North Pacific Ecosystem Status Report* proposes to convene a progress meeting in Spring 2017 in Honolulu, USA.

Recommendation: Science Board recommends a classification system that can be submitted to without any names, *i.e.*, PICES biogeographic Region x.

Action: Secretariat to contact Dr. Mundy to revise biogeographical map and submit SG-NPESR final report to Science Board.

C) Study Group on *Socio-Ecological-Environmental Systems* (SG-SEES)

SG-SEES Chair, Dr. Emanuele Di Lorenzo, was not available to make a presentation, but the SG final report was submitted to Science Board shortly before its meeting. Dr. Therriault suggested the report be returned to the author for more details as to why the SG was extended for one year to develop a pilot study and why the pilot did not proceed.

Recommendation: Science Board recommends the report be returned to Dr. Di Lorenzo for more details.

D) Study Group on *Common Ecosystem Reference Points across PICES Member Countries* (SG-CERP)

Dr. Mary Huniscker reported for SG-CERP Chair, Dr. Elliott Hazen, who was unable to attend the Science Board Meeting. SG-CERP identified a suite of indicators in relation to climatic variables/key ecological species, reference point methodologies. The SG proposes the establishment of a Working Group on *Ecosystem Reference Points as a Common Currency across PICES Member Countries* under the guidance of FUTURE (**SB-2016 Endnote 3**). Pending the endorsement of the Working Group proposal by Science Board and Governing Council, SG-CERP proposed a 2-day inter-session workshop on “Identifying ecosystem indicators for reference point selection methods” in conjunction with ISB-2017. SG-CERP also proposed a

SB-2016

Topic Session on “*Below and beyond maximum sustainable yield: Ecosystem reference points*” at PICES-2017 (**SB-2016 Endnote 4**). Because the SG-CERP final report was submitted only prior to the Science Board meeting, Science Board did not have time to review it.

Action: Science Board to review the SG-CERP report and correspond inter-sessionally.

E) Study Group on *Climate and Ecosystem Predictability* (SG-CEP)

SG-CEP Chair, Dr. Nicholas Bond, was not available to make a presentation, and no report was issued.

Action:

- Secretariat to contact Dr. Bond for final SG-CEP report;
- Science Board to review inter-sessionally

Science Board agreed that periodic notices needed to be sent to Study Group Chairs to have final reports ready for review at a reasonable time for to Science Board to review before (Annual and ISB) meetings.

Study Group report actions:

- Secretariat to send periodic notices to Study Group Chairs to ensure timely review of reports before Science Board meetings
- Science Board to review SG-SEES and SG-CERP reports and provide comments by early December Dr. Therriault to collate comments, ccing Dr. Saito, and sending back to the Study Group authors

AGENDA ITEM 7

Report from FUTURE SSC

Dr. Steven Bograd, FUTURE SSC Co-Chair, reported that attendance was high at the FUTURE Mini-Symposium and all expert groups, except for WG 33, were represented. FUTURE SSC contacted all expert groups for input on the Social-Ecological-Environmental Systems schematic, but received little feedback.

FUTURE SSC strongly supported the establishments of a Working Group on *Ecosystem Reference Points as a Common Currency across PICES Member Countries* (WG-CERP), Working Group on *Climate and Ecosystem Predictability* (WG-CEP), and Study Group on *Marine Ecosystem Services* (SG-MES), with moderate support for a Working Group on *Ecosystem Impacts of Mesoscale and Sub-Mesoscale Processes in the North Pacific* and Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions*. FUTURE SSC recommended

Dr. Sukyung Kang (Korea) was elected FUTURE SSC Co-Chair, replacing Dr. Hiroaki Saito (Japan) who will assume the position of Science Board Chair at the end of PICES-2016.

Recommendation:

- Dr. Chan Joo Jang (Korea) be added to the proposed WG-CEP;
- a Chinese human dimensions expert be added to WG-CERP;
- Dr. Vladimir Kulik be added for Russian membership to WG-CEP and WG-CERP;
- Drs. Thomas Therriault (Canada) and Ryan Rykaczewski (USA) to be added to FUTURE SSC membership.

For PICES-2016, FUTUER SSC gave highest rank for potential sponsorship to Topic Sessions on:

- *Can short-term forecasts inform long-term climate projections and visa-versa?*
- *Marine ecosystem health and human well-being: a social-ecological systems approach;*
- *Emerging issues in understanding, forecasting and communicating climate impacts on north pacific marine ecosystems.*

and Workshop on *Coastal ecosystem services in the North Pacific and analytical tools/methodologies for the assessment*.

FUTURE SSC requested Science Board to support an inter-sessional FUTURE SSC meeting (spring 2017, location TBD, possibly in conjunction with ISB-2017).

AGENDA ITEM 8

Venue and date for ISB-2017

It was agreed that inter-sessional Science Board meetings were integral for keeping on top of science business and that they should be a yearly event, unless specified otherwise. ISB-2017 will take place in the United States, with venue to be decided.

AGENDA ITEM 9

Discussion of an integrated science program

Science Board discussed options for the next PICES integrated science program. The FUTURE SSC and Science Board will discuss the topic at their respective inter-sessional meetings. Science Board noted that as FUTURE has incorporated the last of its expert groups, it is time to look at any gaps remaining in the Program, with the aim of extending FUTURE if necessary.

Actions:

- FUTURE SSC to initiate discussion on next integrative science program at its inter-sessional meeting;
- Science Board to discuss any gaps left in FUTURE at ISB-2017.

Saturday, November 12, 2016

AGENDA ITEM 10

Reports from Scientific and Technical Committees plus high priority requests

Progress reports since PICES-2014 highlighting high priority items or those with financial implications of Committees and ExGs are provided below.

Biological Oceanography Committee (BIO)

BIO Chair, Dr. Angelica Peña, remarked that there was good attendance by members at the Sunday overture and Wednesday meetings, but that there was no representation by members from China. Dr. Chuanlin Huo will relate this information to the Chinese delegation.

Action: Dr. Chuanlin Huo to inform Chinese delegation on lack of BIO meeting participation.

Dr. Patrick O'Hara (Canada) replaced Dr. Rolf Ream (USA) as Co-Chair in the Section on *Marine Birds and Mammals*. BIO reviewed and approved a minor modification to S-MBM's terms of reference. No members from China and Russia attended the S-MBM meeting and the Section requested national delegates to review membership and appoint members who were willing to contribute to the Section, but did not provide suggested names. S-MBM will undertake a project on "*Climate and trophic ecology of marine birds and mammals*". S-MBM proposed a 1-day Workshop on "*Consumption of North Pacific forage species by marine birds and mammals*" at PICES-2017.

Recommendations:

- Science Board supports the change in S-MBM's term of reference #3.

- Science Board recommends Governing Council to review S-MBM participation and membership.

Dr. Anya Dunham (Canada) is acting as Co-Chair of Working Group on *Biodiversity of Biogenic Habitats* (WG 32) for Dr. Janelle Curtis. The Working Group proposed a 1½-day Topic Session on “*Indicators for assessing and monitoring biodiversity of biogenic habitats*” at PICES-2017.

The PICES/ICES Working Group on *Climate Change and Biologically-driven Ocean Carbon Sequestration* (WG 33) held an inter-sessional meeting in May 2016 (China) and submitted its report to BIO and the Secretariat. The Working Group also met at the 2016 ICES ASC where it submitted a topic session for the 2017 ASC, which was approved by ICES, but cancelled its meeting at PICES-2016. Dr. Peña expressed concern that the Working Group was more active in ICES than PICES, and it was possible that WG 33 may not attend PICES-2017. Science Board agreed WG 33 was not very familiar with PICES and was not aware of its commitments to PICES. No concrete answers on how to address the issue were offered.

Dr. Peña reported that the final report of Working Group on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (WG 28) and of Working Group on *Regional Climate Modeling* (WG 29) were still pending. Dr. Therriault recommended progress on the two reports be monitored.

BIO strongly supported the establishment of the Working Group on *Zooplankton Production Methodologies, Application and Measurements in the PICES Regions*.

For PICES-2017, BIO gave highest rank for potential sponsorship to Topic Sessions on:

- *Indicators for assessing and monitoring biodiversity of biogenic habitats,*
- *Meso-/submeso-scale processes and their role in marine ecosystems,*
- *Seasonal and climatic influences on prey consumption by marine birds, mammals, and predatory fishes.*

For the 2017 ICES ASC, BIO recommended PICES sponsorship of Proposal 7, *Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries, and fishery dependent communities*.

Action: Secretariat and Committee Chairs of the parent Committees to follow up on progress of WG 28 and WG 29 final reports.

Fishery Science Committee (FIS)

FIS Chair, Dr. Elizabeth Logerwell, announced that Dr. Laura Brown (Canada) stepped down as member of FIS. Dr. Angelica Peña replaced Dr. Michael Foreman as member from Canada in S-CCME and Dr. Phoebe Woodworth-Jefcoats replaced Dr. Jeffrey Polovina as member from the United States. Dr. Kirstin Holsman (USA) and Dr. Alan Haynie (USA) were nominated to serve as members in S-CCME.

PICES/ISC Working Group on *Ocean Conditions and the Distribution and Productivity of Highly Migratory Fish* (WG 34) requested a U.S. member from PICES be added to its WG and that Dr. Gerard DiNardo (presently Co-Chair, representing ISC) be added as a PICES member, representing the USA. Dr. DiNardo also recommended that Dr. Hidetada Kiyofuji (Japan) replace Dr. DiNardo as ISC Co-Chair.

Recommendation: Dr. DiNardo to be added as PICES member of WG 34.

FIS recommended a salmon expert (Dr. Kudoh or Dr. Shimuzu) from Hokkaido University for membership on the International Year of the Salmon (IYS) North Pacific Steering Committee and Dr. Nathan Mantua (USA) or Brian Wells (USA) for the IYS Symposium Scientific Steering Committee, and that Dr. Harold (Hal) Batchelder represent the Secretariat on the IYS Symposium SSC.

Recommendations:

- Dr. Kudoh or Dr. Shimuzu (Japan) to represent PICES on the IYS SSC;
- Dr. Mantua or Dr. Wells (USA) to represent PICES on the IYS Symposium SSC;
- Dr. Batchelder to represent the Secretariat on the IYS Symposium SSC.

The North Pacific Fishery Commission will hold a Pacific Saury Stock Assessment Workshop on December 13-15, 2016 in Busan, Korea.

Recommendation: Dr. Sukgeon Jung (Korea) to represent PICES at the workshop.

Dr. Laura Richards (Canada) gave a presentation at the Fourth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean (September 26-28, 2016, Tromsø, Norway). Ten governments, including those of all PICES member countries, were represented. An ICES/PAME Working Group on Integrated Ecosystem Assessment for the Central Arctic Ocean (WGICA) will meet in spring 2017 in Seattle, USA, and WG Chair, Dr. John Bengston (USA) requested PICES participation.

Recommendation: Dr. Logerwell to represent PICES as observer at the ICES/PAME WGICA meeting.

For PICES-2016, FIS gave highest rank for potential sponsorship to Topic Sessions on:

- *Coastal ecosystem conservation and challenge,*
- *Interannual variability in marine ecosystems,*
- *Can short-term forecasts inform long-term climate projections and visa-versa?*
- *Marine ecosystem health and human well-being: a social-ecological systems approach,*
- *Environmental variability in Arctic and Subarctic and evaluating fishery management strategy.*

and Workshops on:

- *The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration,*
- *Linking oceanographic conditions to the distribution and productivity of highly migratory species and incorporation into fishery stock assessment models,*
- *S-CCME Phase 2 planning workshop.*

For the 2017 ICES ASC, FIS gave equal high priority ranking to the following sessions for recommended PICES sponsorship:

- Proposal 7, *Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries, and fishery dependent communities,*
- Proposal 17, *Challenges to marine aquaculture in a rapidly changing environment,*
- Proposal 13, *Considering culture in aquaculture for the social license to operate,*
- Proposal 5, *Advancement of stock assessment methods for sustainable fisheries,*
- Proposal 12, *Quantifying and communicating uncertainties in stock assessment,*
- Proposal 25, *Designing fishery stock assessments: should they be simple, complex, or include an ensemble of structural assumptions?*
- Proposal 8, *The practical use of ecosystem indicators for decision-making.*

Marine Environmental Quality Committee (MEQ)

MEQ Chair, Dr. Chuanlin Huo, reported that about half of the MEQ members attended the business meeting and all member countries were represented except Russia. MEQ discussed the future direction the Committee should take, based on the experience and guidance of the past MEQ Chairs/Vice Chairs and expert group chairs in attendance. MEQ also discussed how it could work closely with the Section on *Human Dimensions of Marine Systems* (tentatively to transition to a Committee) and to reinforce its working relationship with NOWPAP.

The Section on *Ecology of Harmful Algal Blooms in the North Pacific* (S-HAB) requested travel support (\$5,000) for Dr. Vera Trainer to attend a Global HAB SSC meeting on developing a Global Harmful Algal

Bloom Status Report (March 27-29, 2017 in Naples, Italy). Science Board recommended that IOC/IPHAB be encouraged to appoint Dr. Trainer as PICES *ex officio* member of the SSC before committing to supporting her to attend the meeting. S-HAB requested travel support (\$6,000) for Dr. Mark Wells and Dr. Charles Trick to attend a mini-workshop on developing a HAB best practices manual (May 2017 in Paris, France). S-HAB requested Dr. Polina Kameneva (Zhirmunsky Institute of Marine Biology, Russia) be added to its membership. S-HAB is proposing a PICES Scientific Report on East-West comparison of *Pseudo-nitzschia*, to be submitted tentatively in summer 2017.

Action: Secretariat to work with IOC/IPHAB to clarify Dr. Trainer's status on Global HAB SSC.

Recommendation: Travel support (\$5,000) for Dr. Wells to attend best practices workshop.

Working Group on *Assessment of Marine Environmental Quality of Radiation around the North Pacific* (WG 30) requested an extension for 1 year to complete its terms of reference and prepare its final report. WG 30 requested travel support for Co-Chair, Dr. Kathryn Higley, to attend a SCOR Working Group 146 Radioactivity in the Ocean, 5 Decades Later (Rio5) Workshop on "*Radionuclide applications and methods*" (August 2017, Paris, France). WG 30 is preparing a brochure of its findings for policy makers and stakeholders. No funding is required at this time.

Working Group on *Emerging Topics in Marine Pollution* (WG 31) has been active in contributing ETSO data for NPESR3. The WG requested an extension for 1 year to complete its terms of reference and prepare its final report. Three special issues on selected papers from Topic Session S4 and Workshop W4 (from PICES-2015) and Topic Session S3 (PICES-2016) in the *Archives of Environmental Contamination and Toxicology* will be published late 2017 and in 2018.

Recommendations:

- Travel support (\$3,000) for Dr. Higley to attend SCOR WG 146 workshop;
- WG 30 and WG 31 to be extended for 1 year.

For PICES-2017, MEQ gave highest rank for potential sponsorship to Topic Sessions on:

- *Microplastics in marine environments: Fate and effects,*
- *Adverse impacts on coastal ocean ecosystems: How do we best measure, monitor, understand and predict?*
- *Marine ecosystem health and human well-being: a social-ecological systems approach,*
- *Emerging issues in understanding, forecasting and communicating climate impacts on north pacific marine ecosystems.*

For the 2017 ICES ASC, MEQ recommended PICES sponsorship of:

- Proposal 04, *ICES-PICES-CIESM session: Bioinvasion trajectories and impacts in contrasting marine environments,*
- Proposal 18, *Integrating economic and social sciences in marine ecosystem services research,*
- Proposal 17, *Challenges to marine aquaculture in a rapidly changing environment.*

Physical Oceanography and Climate Committee (POC)

POC member, Dr. Steven Bograd, reported for Dr. Michael Foreman, who was unable to attend the Science Board meeting. Dr. Emanuele Di Lorenzo is a new member, representing USA, and replacing Dr. Enrique Curchitser. Dr. Di Lorenzo was elected POC Chair, replacing Dr. Kyung-Il Chang (Korea) who completed two terms. Dr. Yury Zuenko (Russia) replaced Dr. Michael Foreman (Canada) as Vice-Chair. POC strongly supported the establishment of the Working Group on *Mesoscale and Submesoscale Processes* and Working Group on *Climate and Ecosystem Predictability*.

For PICES-2017, POC gave highest rank for potential sponsorship to Topic Sessions on:

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

- *Interannual variability in marine ecosystems.*

For the 2017 ICES ASC, POC recommended PICES sponsorship of Proposal 7, *Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries, and fishery dependent communities.*

The final report of Working Group on *North Pacific Climate Variability and Change* (WG 27) was submitted to Science Board and the Secretariat just prior to PICES-2016 (see Action in Agenda Item 14A). The final report of Working Group on *Regional Climate Modeling* (WG 29) will be submitted early in 2017. AP-CREAMS requested a publication extension of 1 year to complete its report on “*Oceanography of the Yellow and East China seas*” in the PICES Scientific Report series. S-CC requested \$10,000 for a graphic designer to be involved in its completion of its PICES Scientific Report on “*Basin-wide assessment of ocean acidification*”.

Recommendations:

- \$10,000 be allotted for publication costs for S-CC PICES Scientific Report;
- Extension of publication date to 2017 for completion of AP-CREAMS PICES Scientific Report.

Technical Committee on Monitoring (MONITOR)

MONITOR Chair, Dr. Jennifer Boldt, reported that a total of 13 members from all member countries plus one *ex officio* attended the business meetings, along with 10 observers. Dr. Boldt and Vice-Chair, Dr. Sanae Chiba, were re-elected for a second term. Dr. Tetjana Ross is a new member, representing Canada, and replacing Dr. Charles Hannah. Dr. Jeffrey Napp (USA) stepped down and a replacement is being sought.

MONITOR supported the establishment of the Study Group on *Marine Ecosystem Services*, Working Group on *Ecosystem Reference Points as Common Currency across PICES Member Countries*, Working Group on *Zooplankton Production Methodologies, Application and Measurements in the PICES Regions*, Working Group on *Mesoscale and Submesoscale Processes*. MONITOR member, Dr. Sung Yong Kim (Korea) expressed interest in being a member of the latter group.

The Advisory Panel on North Pacific Coastal Ocean Observing Systems (AP-NPCOOS) proposed a 5-day PICES Summer School on “*Coastal ocean observing systems and ecosystem monitoring*” to be held in 2018 on Vancouver Island. AP-NPCOOS suggested that this could be a yearly event, to alternate between the Western and Eastern Pacific. AP-NPCOOS requested the addition of Dr. Naoki Yoshi (Japan) to its membership of AP-NPCOOS.

Recommendations:

- Dr. Sung Yong Kim (Korea) to be added to Working Group on *Mesoscale and Submesoscale Processes*;
- Dr. Naoki Yoshi (Japan) to be added to AP-NPCOOS.

Dr. Chiba, PICES member of the GOOS Biology and Ecosystem Panel, requested that PICES play a stronger role in international observation networks and data sharing, and to participate in Ocean Obs19.

For PICES-2017, MONITOR gave highest equal rank for potential sponsorship to Topic Sessions on:

- *Adverse impacts on coastal ocean ecosystems: How do we best measure, monitor, understand and predict?*
- *Interannual variability in marine ecosystems,*
- *Meso-/submeso-scale processes and their role in marine ecosystems*

and workshops on:

- *The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration,*
- *Comparative analysis of Ecosystem Time Series Observations (ETSO) trends of marine pollution in North Pacific.*

For the 2017 ICES ASC, MONITOR recommended PICES sponsorship of:

- Proposal 4, *ICES-PICES-CIESM session: Bioinvasion trajectories and impacts in contrasting marine environments*,
- Proposal 15, *Poleward shifts and ecological changes of arctic and subarctic zooplankton and fish in response to climate variability and global climate change*,
- Proposal 8, *The practical use of ecosystem indicators for decision-making*,
- Proposal 6, *Ecosystem monitoring in practice* (pending more details from ICES).

Technical Committee on Data Exchange (TCODE)

TCODE Chair, Dr. Toru Suzuki, announced that there was good attendance at TCODE's meetings, with all member countries represented and 11 members attending (Dr. Wan Fangfang sitting, on behalf of Dr. Jinkun Yang). Dr. Joon-Soo Lee (Korea) was elected TCODE Chair, replacing Dr. Toru Suzuki who stepped down after serving two terms. Mr. Peter Chandler (Canada) was elected Vice-Chair, replacing Dr. Hernan Garcia (USA).

Dr. Igor Shevchenko reported that TCODE has implemented a standard data policy but has no details yet on how to manage datasets. Dr. Saito sees confusion between TCODE's data policy and data management strategy and recommended a diagram or chart to explain the concept. Mr. Robin Brown strongly encouraged TCODE to provide a clear statement on how the policy will affect the Secretariat. Dr. Shevchenko will have the next draft by ISB-2017 after getting input from the Committees and expert groups so they can publish their datasets for NPESR ETOS. TCODE will also work with the FUTURE SSC and Secretariat to get FUTURE data products on the PICES website.

Action:

- Dr. Shevchenko to work with the Secretariat and FUTURE SSC to get FUTURE data up on web;
- Dr. Shevchenko to have next draft of data policy ready for ISB-2017.

For PICES-2017, TCODE gave highest rank for potential sponsorship to Topic Sessions on *Adverse impacts on coastal ocean ecosystems: How do we best measure, monitor, understand and predict?* And Workshops on *A guide to communicating PICES science to scientists, governments, stakeholders and the public* and *Coastal ecosystem services in the North Pacific and analytical tools/methodologies for the assessment*.

Science Board recommendations for 2017

The theme for PICES-2017 is "*Environmental changes in the North Pacific and impacts on biological resources and ecosystem services*". The Annual Meeting will be held from September 20 to October 1, 2017, in Vladivostok, Russia. The following topic sessions and workshops were recommended by Science Board (final descriptions can be found in **SB-2016 Endnote 5**):

¾-day Science Board Symposium

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

1-day MEQ Topic Session

Microplastics in marine environments: Fate and effects (co-sponsored by GESAMP and NOWPAP)

1-day FUTURE Topic Session

Below and beyond maximum sustainable yield: Ecosystem reference points

1½-day MONITOR Topic Session

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

½-day FIS Topic Session

Coastal ecosystem conservation and challenge

1-day FIS/POC Topic Session

Interannual variability in marine ecosystems [merged with Topic Session on “*Can short-term forecasts inform long-term climate projections and visa-versa?*” and renamed as “*Interannual variability in marine ecosystems and its coupling with climate projections*”]

1-day Topic Session

Can short-term forecasts inform long-term climate projections and visa-versa? [merged with Topic Session on “*Interannual variability in marine ecosystems*”]

1-day BIO Topic Session

Indicators for assessing and monitoring biodiversity of biogenic habitats

1-day HD Topic Session [combined with HD Paper Session]

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

1-day POC Topic Session

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

1-day FUTURE Topic Session

Emerging issues in understanding, forecasting and communicating climate impacts on north pacific marine ecosystems

1-day FIS/POC Topic Session

Environmental variability in Arctic and Subarctic and evaluating fishery management strategy

1-day BIO Topic Session

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

½-day BIO Paper Session

½-day FIS Paper Session

½-day MEQ Paper Session

½-day POC Paper Session

½-day HD Paper Session [combined with HD Topic Session on “*Marine ecosystem health and human well-being: a social-ecological systems approach*”]

1-day MONITOR/TCODE Workshop (co-sponsored by NPRB)

The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration

1-day HD Workshop

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

1-day FIS Workshop

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

SB-2016

1½-day MEQ Workshop

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

1-day Workshop

A guide to communicating PICES science to scientists, governments, stakeholders and the public [postponed until next Annual Meeting]

1-day Workshop (co-sponsored by ICES)

S-CCME Phase 2 planning workshop [rescheduled to meet inter-sessionally prior to the Symposium on “Drivers of dynamics of small pelagic fish resources”, March 2017, Victoria, Canada]

1-day BIO Workshop

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

The following are business meeting requests for PICES-2016:

- 2-hour overture meeting, ½-day meeting preceding a joint meeting with FUTURE SSC, and a 1-day meeting of Science Board;
- 1-day FUTURE SSC meeting and ½-day Mini-Symposium;
- 2-hour overture meetings and ½-day meetings of Standing Committees;
- 1-day meeting of the Section on *Carbon and Climate* (S-CC);
- 1-day meeting of the Section on *Ecology of Harmful Algal Blooms in the North Pacific* (S-HAB);
- 1-day meeting of the Section on *Marine Birds and Mammals* (S-MBM);
- 1-day meeting of the joint PICES/ICES Section on *Climate Change Effects on Marine Ecosystems* (S-CCME)*
-
- 1-day meeting of the Study Group on Marine Ecosystem Services (SG-MES);
- 2-day meeting of the Working Group on *Assessment of Marine Environmental Quality of Radiation around the North Pacific* (WG 30);
- 1-day meeting of the Working Group on Working Group on *Biodiversity of Biogenic Habitats* (WG 32);
- joint PICES/ICES Working Group on *Climate Change and Biologically-driven Ocean Carbon Sequestration* (WG 33)**;
- 1½-day meeting of the joint PICES/ISC Working Group on *Oceanographic Conditions and the Distribution and Productivity of Highly Migratory Fish* (WG 34)***;
- 1-day meeting of the Working Group on *North Pacific Ecosystem Status Report* (WG 35);
- 1-day meeting of the Working Group on *Ecosystem Reference Points as Common Currency across PICES Member Countries* (WG 36);
- ½-day meeting of the Working Group on *Zooplankton Production Methodologies, Application and Measurements in the PICES Regions* (WG 37);
- ½-day meeting of the Working Group on *Mesoscale and Submesoscale Processes* (WG 38);
- ½-day meeting of the Working Group on *Climate and Ecosystem Predictability* (WG 39);
- ½-day meeting of the Advisory Panel for a *CREAMS/PICES Program in East Asian Marginal Seas* (AP-CREAMS);
- 1-day meeting of the Advisory Panel on *North Pacific Coastal Ocean Observing System* (AP-NPCOOS);
- ½-day meeting of the Advisory Panel on *Marine Non-indigenous Species* (AP-NIS).

*S-CCME requests its meeting to be on a Sunday in order to accommodate travel from ICES ASC to PICES-2017;

** WG 33 will meet at ICES 2017 ASC;

***WG 34 will meet at ISC 2017.

*Other Science Board recommendations***Proposed new expert groups**

- Human Dimension Committee;
- Study Group on *Marine Ecosystem Services* (SG-MES);
- Working Group on *Ecosystem Reference Points as Common Currency across PICES Member Countries* (WG 36);
- Working Group on *Zooplankton Production Methodologies, Application and Measurements in the PICES Regions* (WG 37);
- Working Group on *Mesoscale and Submesoscale Processes* (WG 38);
- Working Group on *Climate and Ecosystem Predictability* (WG 39).

Expert groups to be disbanded upon completion of their final reports

- Section on *Human Dimensions of Marine Systems* (S-HD) [completion of final report does not apply];

Amendments to existing expert groups

- Deletion of “demographic” from S-MBM’s term of reference #3 “Assemble information on the status and key demographic parameters of MBMs, and contribute to the Status Reports and Outlooks—and improve collaborative, interdisciplinary research with MBM experts and the PICES scientific community.”
to read “Assemble information on the status and key parameters of MBMs, and contribute to the Status Reports and Outlooks—and improve collaborative, interdisciplinary research with MBM experts and the PICES scientific community.”
- Extension of WG 30 for 1 year to complete its terms of reference;
- Extension of WG 31 for 1 year to complete its terms of reference;
- Endorsement of Biogeographical convention for NPESR-3 ETSO submission.

Changes in Committee Chairmanship/Vice-Chairmanship (as result of elections)

- Dr. Sukyung Kang (Korea) was elected Co-Chair of FUTURE SSC, replacing Dr. Hiroaki Saito (Japan);
- Dr. Se-Jong Ju (Korea) was elected Chair of the Biological Oceanography Committee, replacing Dr. Angelica Peña (Canada);
- Dr. Debora Iglesias-Rodriguez (USA) was elected Vice-Chair of the Biological Oceanography Committee, replacing Dr. Se-Jong Ju (Korea);
- Dr. Patrick O’Hara (Canada) was elected Co-Chair of Section on Marine Birds and Mammals, replacing Dr. Rolf Ream (USA);
- Dr. Emanuele Di Lorenzo (USA) was elected Chair of POC, replacing Dr. Kyung-II Chang (Korea);
- Dr. Yury Zuenko (Russia) was elected Vice-Chair of POC, replacing Dr. Michael Foreman (Canada);
- Dr. Jennifer Boldt (Canada) was re-elected Chair of MONITOR for a second term;
- Dr. Sanae Chiba (Japan) was re-elected Vice-Chair of MONITOR for a second term;
- Dr. Joon-Soo Lee (Korea) was elected Chair of the Technical Committee on Data Exchange, replacing Dr. Toru Suzuki (Japan);
- Mr. Peter Chandler (Canada) was elected Vice-Chair of the Technical Committee on Data Exchange, replacing Dr. Hernan Garcia (USA).

Changes/additions in expert groups

- Additional Chinese and Russian members to be added to S-MBM;
- Additional member from USA to be added to Oceanographic Conditions and the Distribution and Productivity of Highly Migratory Fish (WG 34);
- Dr. Gerard DiNardo (USA) to be added as PICES member and PICES Co-Chair of the joint PICES/ISC Working Group on Oceanographic Conditions and the Distribution and Productivity of Highly Migratory Fish (WG 34);
- Dr. Tetjana Ross (Canada) to replace Dr. Charles Hannah (Canada) as MONITOR member;
- Dr. Polina Kameneva (Russia) be added to S-HAB membership;
- Replacement for Dr. Jeffrey Napp (USA) who stepped down;

- Dr. Naoki Yoshie (Japan) be added as a member of AP-NPCOOS;
- Dr. Thomas Therriault (Canada) and Dr. Ryan Rykaczewski (USA) to be added as members to FUTURE SSC;
- Dr. Angelica Peña (Canada) to replace Dr. Michael Foreman (Canada) as S-CCME member.

Joint ICES/PICES theme sessions at the ICES 2017 Annual Science Conference, September 18–21, 2017, Fort Lauderdale, USA

- *Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries, and fishery* (Theme Session A; PICES Co-Convenor: Shin-ichi Ito);
- *ICES-PICES-CIESM session: Bioinvasion trajectories and impacts in contrasting marine environments* (Theme Session B; PICES Co-Convenor: Thomas Therriault);
- *Combination of Integrating economic and social sciences in marine ecosystem services research and Assessment and management of marine Ecosystem Services* (Theme Session Q; PICES Co-Convenor: TBD)

Inter-sessional symposia/sessions/workshops/meetings

- AP-CREAMS Workshop on “*Oceanography of the Yellow and East China seas*” (January 2017, Xiamen, China);
- 1-day PICES/ICES S-CCME Phase 2 workshop (in conjunction with the Symposium on “*Drivers of dynamics of small pelagic fish resources*”, March 6-11, 2017, Victoria, Canada);
- Study Group on *Marine Ecosystem Services* Workshop on “*Taking stock of marine ecosystem services in the North Pacific—exploring examples and examining methods*” in conjunction with IOC/WESTPAC 10th International Scientific Conference (April 17-20, 2017, Qingdao, China);
- 2½-day Working Group on *North Pacific Ecosystem Status Report* (WG 35) inter-sessional workshop (April 2017 prior to ISB-2017, Honolulu, USA);
- 2½-day inter-sessional Science Board meeting (April, 2017, Honolulu, USA);
- 2-day inter-sessional meeting of the FUTURE Scientific Steering Committee (spring 2017, TBD USA);
- Working Group on *Common Ecosystem Reference Points across PICES Member Countries* Workshop on “*Identifying ecosystem indicators for reference point selection methods*” (2017, location TBD);
- ICES/PICES MSEAS II symposium (2019 or 2020, Yokohama, Japan; approved in principle).

Capacity building

- 1 early career scientist from a PICES member country to attend the Lowell Wakefield Symposium on “*Impacts of a changing environment on the dynamics of high-latitude fish and fisheries*” (May 9-12, 2017, Anchorage, USA);
- early career scientists (up to 12.5k) from PICES member countries to attend ESSAS Open Science Meeting (June 11-15, 2017, Tromsø, Norway);
- 5-day PICES Summer School on “*Coastal ocean observing systems and ecosystem monitoring*” (July or August 2018, Vancouver Island, Canada).

Priority items with funding implications

Inter-sessional events

- 1 FIS member to attend a 3-day NPFC Pacific Saury Stock Assessment Workshop (December 13-15, 2016, Busan, Korea);
- 1-2 PICES members to attend International Year of the Salmon North Pacific Scientific Steering Committee Meeting (February 28-March 2, 2017, Richmond, Canada);
- 1 FIS member to attend an ICES/PAME WG on Integrated Ecosystem Assessment for the Central Arctic Ocean workshop (April/May 2017, Seattle, USA);
- 1 S-HAB member to attend a HAB Best Practices Manual workshop (May 2017, Paris, France);
- 1 WG 30 member to attend SCOR Rio5 Workshop on “*Radionuclide applications and methods*” (August 2017, Paris, France);

Publications

Special issues in primary journals (2017–2018)

- Special issue of *Archives of Environmental Contamination and Toxicology* based on selected papers from the PICES-2015 Topic Session S4 on “*Indicators of emerging pollution issues in the North Pacific Ocean*” (Guest Editors: Tanya Brown and Hideshige Takada; approved at PICES-2016);
- Special issue of *Archives of Environmental Contamination and Toxicology* based on selected papers from the PICES-2015 Workshop W4 on “*Marine environment emergencies: Detection, monitoring, response, and impacts*” (Guest Editors: Jeff Short and Un Hyuk Yim; approved at PICES-2016);
- Special issue of *Archives of Environmental Contamination and Toxicology* based on selected papers from the PICES-2016 Topic Session S3 on “*Source, transport and fate of hydrocarbons in the marine environment*” (Guest Editors: TBD; approved at PICES-2016);

PICES Scientific Report series (2017–2018)

- Report on “Oceanography of the Yellow and East China Seas (EAST-II region)” by the Advisory Panel for a *CREAMS/PICES Program in East Asian Marginal Seas* (Editors: J. Ishizaka, T. Matsuno, J. Zhang, J-H. Lee, S. Kim, D. Xu, Y. Fei, S.-M. Liu and V. Lobanov; approved at PICES-2013);
- Report on “East-West comparison of *Pseudo-nitzschia*” by Section on *Ecology of Harmful Algal Blooms in the North Pacific* (Editors: Douding Lu and Vera L. Trainer; approved at PICES-2016);
- Report on “*Basin-wide assessment of ocean acidification*” by Section on Carbon and Climate (Editors: James Christian and Tsuneo Ono; approved at PICES-2016).

AGENDA ITEM 11

PICES Annual Meeting structure

Science Board discussed how this year’s Annual Meeting was structured and if any changes could improve the efficiency of the meeting. The major complaint from Committee members was that the length of the meeting was becoming too long in general, and FUTURE needed to be better situated within the Meeting to garner maximum exposure.

It was agreed to keep the Mini-Symposium on a Sunday but to place FUTURE in the middle of the week (Wednesday). Workshops and business meetings would move back from Wednesday through Friday to Thursday through Saturday; the FUTURE SSC would meet Wednesday or Thursday. Workshops might be constrained to half days. The Science Board luncheon could revert back from half a day to two hours, with a limited number of invited observers.

To lessen the confusion of late topic session/workshop proposal submissions, it was suggested that cut off times be 24 hours before the Committee meetings on Wednesday, to allow Committee members enough time to review the proposals. Proponents of sessions should consider including early career scientists as convenors. Any proposals coming after the web closing of submissions should be sent to the Secretariat for dissemination to the appropriate Committee(s), and late submissions should be considered exceptions, not the rule. Science Board agreed that the pooled funding model for invited speakers worked well.

AGENDA ITEM 12

Schedule for PICES-2017 and inter-session workshops (All) (90 min)

Science Board reviewed the topic session proposals to determine scheduling of PICES-2017. Four parallel topic sessions will be held on Tuesday and Thursday. Wednesday will consist of a FUTURE Plenary Friday morning will consist of paper sessions for BIO, FIS, MEQ, POC and HD, with MONITOR preferring a MONITOR-sponsored topic session.

FIS requested Topic Session 5 (*Coastal ecosystem conservation and challenge*) to be sponsored by FUTURE and description clarification of Topic Session 12 (*Environmental variability in Arctic and Subarctic and evaluating fishery management strategy*) and suggested Drs. Andrew Edwards and Curry Cunningham as potential co-convenors from the Eastern Pacific. Science Board recommended Topic Session 13 (*Advanced optical survey approaches for broad-scale fishery independent surveys of fish and their habitats*) to fold into the FIS Paper Session and that Topic Session 6 (*Interannual variability in marine ecosystems*) and Topic Session 7 (*Can short-term forecasts inform long-term climate projections and visa-versa?*) be merged.

Action: Secretariat to contact Andrew Edwards and Curry Cunningham, and contact proponents of Topic Sessions 6 and 7.

Science Board reviewed six proposals for inter-sessional workshops. Science Board approved the ICES-led initiative for a workshop on “*Regional climate change vulnerability assessment for the large marine ecosystems of the northern hemisphere*”, but at a lower priority. MONITOR suggested the term “and fisheries” be added after “large marine ecosystems”. Science Board agreed that ISB-2017 should be tied in with the North Pacific Ecosystem Status Report progress meeting. Dr. Bograd will explore options for the timing of the FUTURE SSC meeting, preferably with that of SG-CERP of ISB.

Action: Secretariat to contact Peter Chandler for NPESR scheduling details.

Recommendations:

- SG-CERP Workshop on “Identifying ecosystem indicators for reference point selection methods”;
- AP-CREAMS Workshop on “Oceanography of the Yellow and East China Seas”;
- North Pacific Ecosystem Status Report progress meeting;
- S-CCME Workshop to discuss Phase III to be held in conjunction with the International Symposium on “*Drivers of dynamics of small pelagic fish resources*”;
- SG-MES Workshop on “*Taking stock of marine ecosystem services in the North Pacific—exploring examples and examining methods*”;
- ISB-2017;
- FUTURE SSC meeting.

MONITOR suggested co-convenors be allowed to choose an alternate when an original convenor cannot attend the session. Science Board agreed that convenors who perpetually do not show up at PICES Annual Meetings should be excluded from chairing sessions, and a note to this effect should be posted on the submissions page for next Annual Meeting. It was also suggested that convenors should be limited to chairing one session.

Action: Secretariat to post a rule on submissions page limiting convenors to one session at an Annual Meeting and banning convenors who cancel chairing a session more than once.

AGENDA ITEM 13

Review/decision of proposed new expert groups (Therriault) (30 min)

Science Board reviewed proposals for expert groups received during PICES-2016 and recommended the establishment of the following:

- Human Dimension Committee;
- Study Group on *Marine Ecosystem Services* (SG-MES);
- Working Group on *Ecosystem Reference Points as Common Currency across PICES Member Countries* (WG 36);
- Working Group on *Zooplankton Production Methodologies, Application and Measurements in the PICES Regions* (WG 37);

- Working Group on *Mesoscale and Submesoscale Processes* (WG 38)*;
- Working Group on *Climate and Ecosystem Predictability* (WG 39).

* Sung Young Kim (Korea) expressed interest in being added to Working Group on *Mesoscale and Submesoscale Processes* if it is endorsed by Governing Council.

AGENDA ITEM 14

Status of PICES publications (45 min)

Dr. Batchelder briefly reviewed the status of publications and reports. The S-HD review paper on “*The legal and regulatory foundations of fisheries management in PICES member countries*” is in preparation. Lead author, Dr. Keith Criddle, will work on the paper during his sabbatical in 2017. The final report of the Working Group 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* is in preparation and is unlikely to be finalized for review at ISB-2017. See Agenda Items 6C and 6D for details on the SG-SEES and SG-CERP final reports.

Action: Science Board to review SG-SEES by December 2016.

AGENDA ITEM 14A

PICES publications requiring Science Board approval (Therriault)

See Agenda Items 6C and 14 for final report of SG-SEES action. See Action item under POC in Agenda Item 10 for WG 27 final report.

Action: Member(s), excluding Dr. Di Lorenzo, to review WG 27 report before making recommendations to Science Board.

AGENDA ITEM 14B

Update on other PICES publications (Batchelder)

See Agenda Item 10 under FIS for a WG 30 brochure.

An action item from ISB-2016 showed that the majority of Committees preferred PICES Scientific Reports in electronic form, but that a limited number of hard copies could be produced for libraries, students, or any Committee member requesting a copy.

AGENDA ITEM 14C

Developing guidelines around open access for PICES (Therriault)

Science Board had no suggestions or recommendation for developing open access for PICES publications, deferring the issue to F&A.

Action: Science Board to continue discussions on Open Access at ISB-2017.

AGENDA ITEM 15

Review of PICES Standing Committees

Discussion on strategic priorities, strengths or gaps, alignment with the Rules of Procedure, and standardization of terms of reference for Committees was deferred to ISB-2017.

SB-2016

Action: Science Board to review Standing Committees at ISB-2017.

AGENDA ITEM 16

Implementation of Science Board recommendations and Governing Council decisions from PICES-2015 and ISB/GC-2016

Science Board had no comments.

AGENDA ITEM 17

PICES-sponsored conferences/symposia

Science Board recommended support for the following:

- ESSAS Open Science Meeting on “*Moving in, out and across the Subarctic and Arctic*” (June 11-15, 2017, Tromsø, Norway) – up to \$12,500 travel support for early career scientists from PICES member countries;
- IMBIZO V (October 2–6, 2017, Woods Hole, USA) – \$5,000–7,000 travel support for early career scientists from PICES member countries.
- ICES MSEAS II (2019 or 2020, Yokohama, Japan) – approved in principle;
- Lowell Wakefield Fisheries Symposium (May 9–12, 2017) – travel support for 1 early career scientist from a PICES member country.

AGENDA ITEM 18

Capacity building/plan for PICES summer schools

Early Career Scientist conferences

Dr. Batchelder provided a brief update on the P/ICES ECS Conference on “*Climate, oceans and society: Challenges and opportunities*”, May 30-June 2, 2017 in Busan, Korea.

Science Board recommended support for the Pacific Ecology and Evolution Conference (PEEC 2016; February 24-26, 2017) on the order of previous years. It was also suggested that a Science Board member attend the Conference as a matter of good will.

Recommendation: Science Board supports PEEC2017 at \$1,500.

PICES Summer Schools

Science Board did not support a PICES 2017 Summer School on “*Advanced survey approaches for broad-scale fishery independent surveys of fish and their habitats*” as NOAA funding was not approved and proposal details were incomplete.

Science Board supported AP-NPCOOS’ request for a PICES Summer School on “*Coastal ocean observing systems and ecosystem monitoring*” for \$10,000 in support of student travel and an additional \$5,000 support for on-site summer school costs. The summer school will be supported by a variety of other sources including the University of Victoria via Oceans Networks Canada. AP-NPCOOS requested that the PICES Summer School be an annual event, to alternate between the eastern and western Pacific. Science Board was receptive to the idea, in principle, but recommended AP-NPCOOS identify other co-sponsors to share the costs. Science Board emphasized that other summer school proposals should also be entertained.

Recommendation: Science Board approves, in principle, \$15,000 for a PICES Summer School in 2018.

AGENDA ITEM 19

Other business

MONITOR suggested the Secretariat keep IOC GOOS as the primary contact in correspondence with organizations.

Action: FUTURE/Committees to identify any new organizations PICES to engage with.

Day 3 meeting adjourned at 5:00 pm.

SB-2016 Endnote 1**Science Board participation list**Members

Steven Bograd (Co-Chair, FUTURE SSC)
 Jennifer Boldt (Chair, MONITOR)
 Michael Foreman (Vice-Chair, POC, absent)
 Chuanlin Huo (Chair, MEQ)
 Elizabeth Logerwell (Chair, FIS)
 Angelica Peña (Chair, BIO)
 Hiroaki Saito (Chair-elect, Science Board;
 Co-Chair, FUTURE SSC)
 Igor Shevchenko (representing Russia)
 Toru Suzuki (Chair, TCODE)
 Thomas Therriault (Science Board Chair)

Secretariat

Robin Brown (Executive Secretary, Nov. 6, 11)
 Harold (Hal) Batchelder (Deputy Executive
 Secretary)
 Rosalie Rutka (Administrative Assistant)
 Laura Richards (PICES Chair)

Observers/Expert Group Chairs

Shang Sunny Chen (S-HD, Nov. 11)
 Cornelius Hammer (ICES; Nov. 6)
 Gerard DiNardo (ISC; Nov. 6)
 Fangli Qiao (WESTPAC; Nov. 6)
 Vladimir Radchenko (NPAFC; Nov. 6)
 Chi-Lu Sun (ISC; Nov. 6)
 Maciej Telszewski (IOCCP; Nov. 6)
 Gro van der Meeren (IMBER; Nov. 6)
 Cisco Werner (IMBER; Nov. 6)
 Alexander Zavolokin (NPFC; Nov. 6)
 Wojciech Warezki (ICES; Nov. 6)
 Keith Criddle (S-HD; Nov. 11)
 Emanuele Di Lorenzo (SG-SEES; Nov. 11)
 Elliot Hazen/Mary Hunsicker (SG-CERP; Nov. 11)
 Edward Urban (SCOR; Nov. 11)

SB-2016 Endnote 2**Science Board meeting agenda**

Sunday, November 6, 2016

1. Welcome and adoption of agenda (Therriault)
2. Review of procedures for Science Board Symposium and Session awards, and Closing Session (Therriault, Batchelder)
3. Review template for Committee reports to Science Board (Therriault, Batchelder)
4. Current and potential collaborations with international organizations/programs (Therriault/Invited Guests)
 - 4A Strategic collaborations
 - 4B Other collaborations
 - 4C Status, trends and outlooks
5. Status of venue for PICES-2017, Vladivostok (Therriault, Secretariat)

Saturday, November 11, 2016

6. Venue, and dates for ISB-2017 (Therriault/Secretariat)
7. Mid-year reports from expert groups reporting to Science Board (Therriault)
8. Report from FUTURE SSC (Saito/Bograd)
9. Discussion of an integrated science program: Beyond FUTURE (Therriault)

Saturday, November 12, 2016

10. Reports from Scientific and Technical Committees (Chairs)
11. Discussion of PICES Annual Meeting structure (Therriault)
12. Schedule for PICES-2017 and inter-sessional workshops (All)
13. Review/decision of proposed new expert groups
14. Status of PICES publications
 - 14A PICES publications requiring Science Board approval
 - 14B Update on other PICES publications (Batchelder)
 - 14C Developing guidelines around open access for PICES (Therriault)
15. Review of PICES Standing Committees (Therriault)
16. Implementation of Science Board recommendations and Governing Council decisions from PICES-2015, Yeosu and ISB/GC-2016, Hangzhou (Batchelder)
17. Update on PICES-sponsored conferences/symposia (Secretariat)
18. Update on capacity building/plan for PICES summer schools (Batchelder)
19. Other PICES business

SB-2016 Endnote 3

**Proposal for the establishment of a Working Group on
*Ecosystem Reference Points as a Common Currency across PICES Member Countries***

Parent Committee/Program: FUTURE

Proposed Co-Chairs: Mary Hunsicker (USA), Robert Blasiak (Japan)

Proposed Members: Elliott Hazen (USA), Jennifer Boldt (Canada), Qing Yang (China), Kazumi Wakita (Japan), Jung Hee Cho (Korea), Jung Hwa Choi (Korea), Chung Il Lee (Korea), Mitsutaku Makino (Japan - proposed), Vladimir Kulik (Russia - proposed), Ian Perry (Canada - proposed), Scott Large (USA - proposed)

Background

Reference points for fisheries management are generally determined under a single set of environmental conditions with a single species focus. All forms of fisheries management rely on reference points in order to manage a species (e.g. BMSY, Potential Biological Removal, Yield per Recruit) or ecosystem (e.g. Maximum Ecosystem Yield in Gulf of Alaska and Bering Sea, 1/3rd forage fish for the birds). However, more attention is needed on setting reference points in relation to ecosystem functioning such as climatic forcing and predator-prey relationships. Maximum ecosystem yield (MEY) is one example of an ecosystem reference point, and provides an umbrella on total catch but still does not account for intraspecific dynamics or climate forcing.

North Pacific marine ecosystems are influenced by dynamic atmospheric and oceanographic drivers, and most marine species have shown both cyclical and unidirectional trends over time. Broad scale environmental forcing and fine-scale ecological interactions together drive ecosystem responses. An open question is whether biological responses within the ecosystems are linear or nonlinear in relation to the magnitude and direction of climatic forcing variables or the abundance of other species (especially in the context of predator-prey relationships). Recent research indicates that the relationships between ecosystem states and biophysical drivers are often strongly nonlinear (Large et al. 2013, Fay et al. 2013, Large et al. 2015, Hunsicker et al.

2016). Strong nonlinearities suggest the existence of thresholds beyond which small changes in a climatic variable or species abundance cause large responses in another ecosystem component (Samhoury et al. 2011). Crossing ecological thresholds can alter or redistribute ecosystem benefits to humans, with potentially negative outcomes for livelihoods, economic well-being and public health (Golden et al. 2016). In many decision-making contexts, such as fisheries and water quality, thresholds are used as target or limit reference points to prevent ecosystem components from tipping into undesirable states. Identifying such ecosystem reference points in relation to climatic variables or key ecological species is a primary goal, but a critical gap, at this time in many PICES member countries. To move forward on this front, we need 1) methodologies for determining how ecological (e.g. trophic) interactions and societal needs can be directly included in establishing reference points, 2) an examination of how climate variability and change can be incorporated into the determination of biological reference points, and 3) a methodological framework for identifying non-linearities in common ecosystem indicators (Table 1).

Table 1. Methodologies for assessing non-linear driver-pressure relationships that will be evaluated as part of this WG.

Methodology	Purpose	Citation
Specified functional forms	Identify nonlinearities in stressor-response relationships, sign and form of those relationships, and threshold values	Samhoury et al. 2011
Random gradient analysis	Detect threshold responses in stressor-response relationships	Large et al. 2015, Samhoury et al. <i>in prep</i>
Generalized Additive Models (incl. mixed effects GAMs and threshold GAMs)	Identify nonlinearities in stressor-response relationships, determine sign and form of those relationships	Large et al. 2013, Karr et al. 2015, Hunsicker et al. 2016, Samhoury et al. <i>in prep</i>
Nonlinear time series analysis	Test for nonlinear time series behavior	Deyle et al. 2013, Glaser et al. 2014, Liu et al. 2014, Hao et al. 2015
Second derivative analysis	Inflection point / threshold detection in stressor-response relationships	Large et al. 2013, Burthe et al. 2016, Samhoury et al. <i>in prep</i>
Changepoint analysis	Threshold detection in stressor-response relationships	Cury et al. 2011
Breakpoint analysis	Threshold detection in stressor-response relationships	Bestelmeyer et al. 2011
Sequential t-test analysis of regime shifts	Threshold detection in time series data	Rodinov et al. 2004 Vert-pre 2013
Structural equation modeling	Evaluation of heuristic model	Byrnes et al. 2011

The proposed WG would contribute to Objective 1.1 of the FUTURE Science Plan to understand what determines “an ecosystem’s intrinsic resilience and vulnerability to natural and anthropogenic forcing.” Managing ecosystems under a changing climate requires flexibility in order to facilitate resilient ecosystems for ecological and societal goals. For example, high fishing rates under poor climatic conditions and high predation pressures are less likely to produce favorable management outcomes than the same fishing rates under good climatic conditions. This kind of observation motivates the need for dynamic reference points that reflect a dynamic marine environment and a coupled social-ecological system. This WG would build on the findings of PICES Working Group 28 on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors and WG-NPESR3 on identifying indicators, and will seek to work closely on reference points under future climate scenarios developed by WG-CEP (proposed, see below) and S-CCME (Figure 1). A timeline of planned activities are outlined below (Figure 2).

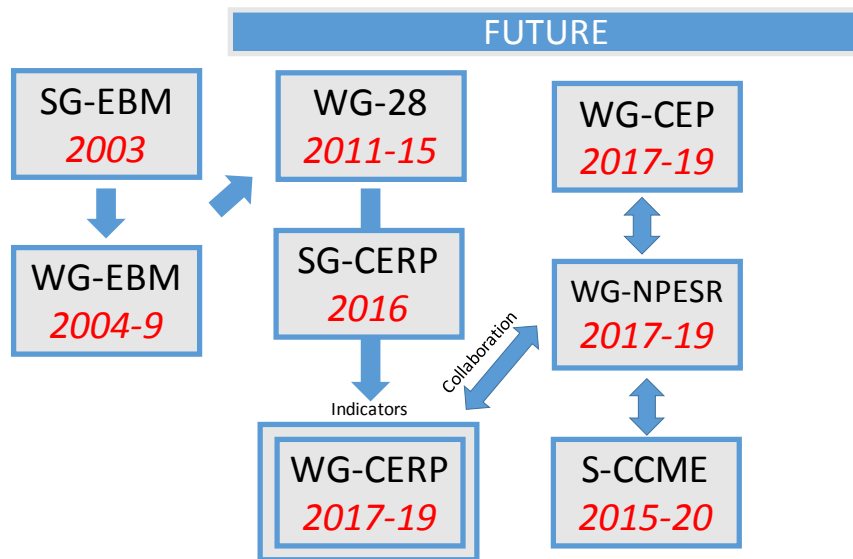


Figure 1. Alignment of WG-CERP within past, current and proposed PICES Expert Groups.

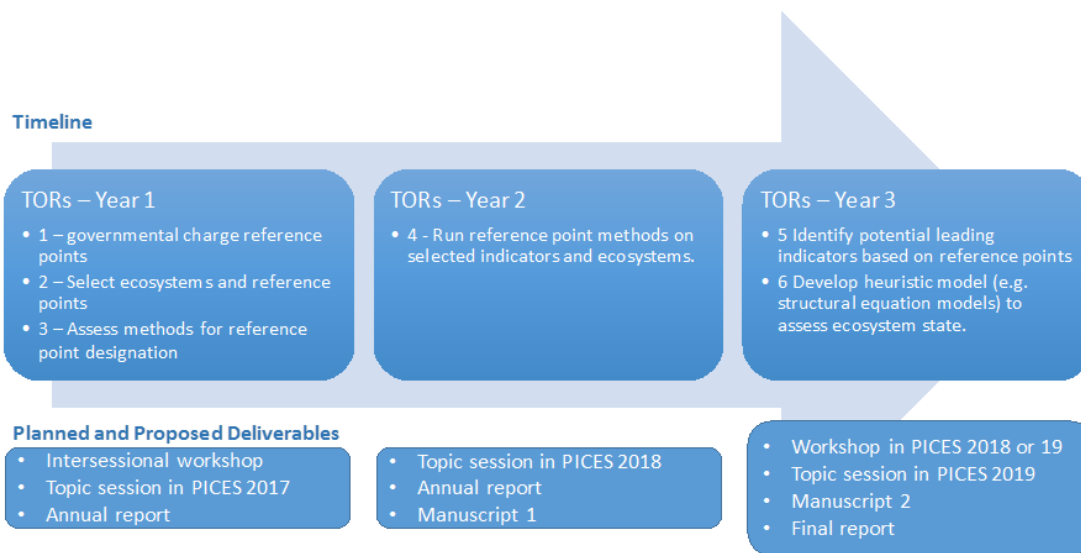


Figure 2. Proposed timeline for terms of reference and deliverables for WG-CERP.

Proposed Terms of Reference

- 1) Continuing from the SG-CERP meeting, outline each country’s mission, goals, and governmental science plans that point to the establishment of reference points across PICES member nations, and identify those that are comparable. (Intersessional / Yr1)
- 2) Summarize previous efforts identifying data availability for geographic areas and time periods of particularly strong climate influence & dependence on marine systems within specific N. Pacific ecosystems, fish stocks, and fishing communities. This will build upon indicators identified via WG-19, WG28, S-HD, and NPESR3. Determine a subset (or not) of ecosystems and indicators that will be the focus of WG activities (Appendix 1). (Intersessional / Yr 1)

- 3) Summarize and select previous methods for determining thresholds (both non-linear and societal limits) in ecosystem indicators. This would include statistical and objective-based approaches (Table 1). (Intersessional / Yr 1)
- 4) Determine shapes or functional forms of driver - response relationships from available datasets, and quantify thresholds to identify potential ecosystem reference points (Figure 1). (Yr 2)
- 5) Identify ecosystem components that respond earliest to changes in biophysical drivers and could potentially serve as leading indicators of loss of resilience and ecosystem change. (Yr 3)
- 6) Develop a “heuristic model” to examine drivers (climate forcing, fishing) and ecosystem response using selected ecosystem reference points for member nations (Figure 4). (Yr 3)

Expected Deliverables

- 1) Intersessional workshop in 2017 on “Identifying Ecosystem Indicators for Reference Point Selection methods” (Hunsicker, Blasiak, Boldt, Hazen)
- 2) Topic Sessions in 2017-19 on Ecosystem Reference Point relevant topics.
“Above and beyond Maximum Sustainable Yield: Ecosystem reference points” (Hunsicker, Blasiak, Boldt, Hazen)
- 3) Workshop in 2018 on methodological testing of reference point identification.
- 4) Annual reports on WG progress.
- 5) Two manuscripts on ecosystem reference points.
- 6) Submit a final report summarizing WG results and next steps with special attention to FUTURE needs and goals.

SB-2016 Endnote 4

Proposal for a 1-day Topic Session on
“*Below and beyond maximum sustainable yield: Ecosystem reference points*” at PICES-2017

Convenors: EL Hazen (USA), elliott.hazen@noaa.gov*, J Boldt (Can), Jennifer.Boldt@dfo-mpo.gc.ca, R. Blasiak (Japan), a-rb@mail.ecc.u-tokyo.ac.jp, M Hunsicker (USA), mary.hunsicker@noaa.gov

Co-sponsors: ICES / INDISEAS?

Invited speakers: Mitsutaku Makino (Japan – Satoumi), William Sydeman (USA – 1/3 for the birds), Kirstin Holsman (ACLIM)

PICES SG/WG-CERP has been chartered with identifying ecosystem reference points that would integrate across committees to achieve FUTURE goals and missions. Specifically, we suggest a topic review session that would examine both a) examples of ecosystem reference points that have been established, and b) methodologies for calculating ecosystem reference points from driver-pressure relationships across PICES ecosystems. The goal would be for this topic session to bring together experts from physical, biological, and human dimensions to explore past and future approaches to understand how ecosystem management have and can best set reference points that deal with ecological and societal goals. Convenors EL Hazen (USA), J Boldt (Can), R. Blasiak (Japan), M Hunsicker (USA) Potential co-sponsors ICES / INDISEAS Overview Reference points for fisheries management are generally determined under a single set of environmental conditions with a single species focus. Almost all forms of resource management rely on reference points in order to manage a species (e.g. BMSY, Potential Biological Removal, Yield per Recruit). However, ecosystem reference points that have been developed have largely focused on additive relationships but more attention is needed on setting

reference points in relation to ecosystem functioning such as climatic forcing and predator-prey relationships. One such example, maximum ecosystem yield (MEY) in the Gulf of Alaska and Bering Sea provides an umbrella on total catch, but still does not account for intraspecific dynamics or climate forcing. We propose a topic session that will involve participation from multiple PICES committees and will focus on reviewing examples of ecosystem reference points and methods for defining reference points that have been used internationally. Anticipated Outcomes: Topic session report to be distributed to PICES on the summary of the presentations and discussion; Special issue on “Ecosystem reference points” including a manuscript from WG participants in collaboration with a journal TBD Topic Session Format & Participants We anticipate a 1-day topic session with talks focusing on (a) examples of ecosystem reference points, (b) modeling studies examining mechanistic linkages between pressure – driver relationships, (c) methodological approaches towards identifying reference points. We anticipate 3 invited talks (Mitsutaku Makino – Japan – Satoumi, William Sydeman - USA – 1/3 for the birds, Kirstin Holsman - ACLIM), and up to 20-30 participants from around the North Pacific who have research interests on ecosystem ecology and human dimensions ultimately to inform ecosystem based management. Topic Session Requirements We would like funds (\$5000) to support partial travel to Vladivostok request a projector, laser pointer, VGA or DVI cable, and audio-conference equipment (speaker and microphone) for remote attendees.

SB-2016 Endnote 5

Approved Topic Sessions and Workshops for PICES-2017

S1 Science Board Symposium: *Environmental changes in the North Pacific and impacts on biological resources and ecosystem services*

Duration: ¾-day

Convenors: Hiroaki Saito (SB), Se-Jong Ju (BIO), Elizabeth Logerwell (FIS), Chuanlin Huo (MEQ), Jennifer Boldt (MONITOR), Emanuele Di Lorenzo (POC), Joon-Soo Lee (TCODE), Steven Bograd (FUTURE), Sukyung Kang (SB, FUTURE), Motomitsu Takahashi (Japan), Igor Schevchenko (Russia)

Marine ecosystems around the North Pacific are changing. Over the past decade physical, chemical, and biological processes have been altered by climate change and anthropogenic impacts. In response, species' ranges have shifted, disrupting ecosystem goods and services, including fisheries resources upon which communities around the North Pacific depend. Understanding, characterizing and forecasting ecosystem changes will ensure managers and policy makers have the information needed to maintain ecosystem biodiversity, structure and function, and ultimately sustainable utilization of ocean resources. Assessments that use observation-based indicators of ecosystem conditions coupled with numerical models capable of predicting future marine ecosystem conditions at short (seasonal to interannual), medium (decadal) and long-term (multi-decadal) scales can inform management and policy decisions.

We invite submissions related to characterizing and understanding drivers of North Pacific ecosystem change and their impacts to, and resilience of, ecosystem resources and services. Drivers may include but are not limited to climate change, ocean acidification, coastal eutrophication, aquaculture, fishing, pollution, coastal development, non-indigenous species, and cumulative impacts of multiple stressors. Further, it is recognized that there are inherent trade-offs among multiple-use ocean activities, and mechanisms are needed to resolve these to ensure sustainable use of North Pacific resources and ecosystems. Thus, presentations are welcome that address leading indicators of change in exploited resources (i.e., fisheries stocks), non-linear and threshold responses of trophic linkages from phytoplankton to top predators, and approaches integrating monitoring and modeling to forecast ecosystem responses that can inform management and policy options.

S2 *Microplastics in marine environments: Fate and effects*

Sponsoring Committee: MEQ

Co-sponsored by GESAMP and NOWPAP

Duration: 1 day

Convenors: Wonjoon Shim (Korea), Hideshige Takada (Japan), Peter Ross (Canada), Peter Kershaw (GESAMP), TBA (NOWPAP)

Invited speakers:

Microplastics are now ubiquitous from the near shore to open ocean, from the sea surface to bottom, and from subtropical to polar seas. Relatively high abundance of microplastics has been reported in the North Pacific Gyre as well as coastal waters of North Pacific region among the world oceans. In addition, with decreasing size, they become more bioavailable to small aquatic organisms down to zooplankton. Ingested microplastics have been found in various taxa across trophic levels. Associated chemicals in microplastics may be transferred to an organism upon ingestion. Microplastics represent trans-boundary pollution which can also deliver associated chemicals and invasive organisms to regions far removed from source. Microplastics are increasingly recognized as a potential threat to biota in the ocean. However, because of their size detecting the presence of microplastics and adverse biological effects, if any, becomes considerably more challenging. The objective of this session is to present status and trend information for microplastic pollution and its environmental consequences in the PICES region. Papers are invited that assess microplastics 1) hotspots in the PICES region, 2) sources and input pathways, 3) fate and behaviour of microplastics, 4) role as sink or source of associated toxic chemicals, and 5) biological and ecological effects. Recommendations on how to address growing problems associated with microplastics will be also considered.

S3 *Below and beyond maximum sustainable yield: Ecosystem reference points*

Sponsoring Committee:

Co-sponsored

Duration: 1 day

Convenors: Elliott Hazen (USA), Jennifer Boldt (Canada), Robert Blasiak (Japan), Mary Hunsicker (USA)

Invited speakers: Mitsutaku Makino (Japan), William Sydeman (USA), Kirstin Holsman (ACLIM)

PICES SG/WG-CERP has been chartered with identifying ecosystem reference points that would integrate across committees to achieve FUTURE goals and missions. Specifically, we suggest a topic review session that would examine both a) examples of ecosystem reference points that have been established, and b) methodologies for calculating ecosystem reference points from driver-pressure relationships across PICES ecosystems. The goal would be for this topic session to bring together experts from physical, biological, and human dimensions to explore past and future approaches to understand how ecosystem management have and can best set reference points that deal with ecological and societal goals. Convenors EL Hazen (USA), J Boldt (Can), R. Blasiak (Japan), M Hunsicker (USA) Potential co-sponsors ICES / INDISEAS Overview Reference points for fisheries management are generally determined under a single set of environmental conditions with a single species focus. Almost all forms of resource management rely on reference points in order to manage a species (e.g. BMSY, Potential Biological Removal, Yield per Recruit). However, ecosystem reference points that have been developed have largely focused on additive relationships but more attention is needed on setting reference points in relation to ecosystem functioning such as climatic forcing and predator-prey relationships. One such example, maximum ecosystem yield (MEY) in the Gulf of Alaska and Bering Sea provides an umbrella on total catch, but still does not account for intraspecific dynamics or climate forcing. We propose a topic session that will involve participation from multiple PICES committees and will focus on reviewing examples of ecosystem reference points and methods for defining reference points that have been used internationally. Anticipated Outcomes o Topic session report to be distributed to PICES on the summary of the presentations and discussion; o Special issue on “Ecosystem reference points” including a manuscript from WG participants in collaboration with a journal TBD Topic Session Format & Participants We anticipate a 1-day topic session with talks focusing on (a) examples of ecosystem reference points, (b) modeling studies examining mechanistic linkages between pressure – driver relationships, (c) methodological approaches towards identifying reference points. We anticipate 3 invited talks (Mitsutaku Makino – Japan – Satoumi,

William Sydeman - USA – 1/3 for the birds, Kirstin Holsman - ACLIM), and up to 20-30 participants from around the North Pacific who have research interests on ecosystem ecology and human dimensions ultimately to inform ecosystem based management. Topic Session Requirements We would like funds (\$5000) to support partial travel to Vladivostok request a projector, laser pointer, VGA or DVI cable, and audio-conference equipment (speaker and microphone) for remote attendees.

S4 Adverse impacts on coastal ocean ecosystems: How do we best measure, monitor, understand and predict?

Sponsoring Committee:

Duration: 1½ days

Convenors: Akash Sastri (Canada), Naoki Yoshie (Japan), Jack Barth (USA)

Adverse impacts on coastal ocean ecosystems by, for example, by episodic harmful algal blooms and hypoxic events and by increasing ocean warming and acidification, are prevalent in North Pacific coastal waters. These can occur both in semi-enclosed basins and open coastal areas, and in regions with and without strong anthropogenic impact. These adverse impacts share a common characteristics in that they all involve linked physical, biological, and chemical processes as well as, in some cases, human-related actions. To achieve a complete understanding of these negative impacts on coastal ocean ecosystems requires multi-parameter observations from a variety of in-water platforms. Measurements include those from physical, chemical and biological sensors and from discrete water samples and net tows. Time series are necessary to define the time scale of the impact and the seasonal and interannual conditions present at the time of the impact. These critical in-water measurements are often combined with remotely sensed observations and with numerical models to gain further understanding of the origin and evolution of the negative impacts. We invite contributions that identify adverse impacts on coastal ocean ecosystems in North Pacific coastal waters and that use multi-sensor time series and models to understand and predict these phenomena. Contributions may include the description of multi-parameter coastal ocean observing systems designed to address the causes and evolution of negative impacts on coastal ocean ecosystems. We are particularly interested in studies that address these adverse coastal ocean ecosystem impacts from a transdisciplinary point-of-view.

S5 Coastal ecosystem conservation and challenge

Sponsoring Committee:

Duration: ½ day

Convenors: Xianshi Jin (China), TBD

Under the impacts from climate change and human activities, many stocks were depleted, and habitats were degraded, Stock releasement and artificial reefs construction have been widely used in coastal area for restoring the depleted stocks and conservation of the ecosystem, as well as increasing the abundance for recreational fisheries. This session will focus on the studies of methods, results of the conservation measures and effects on fisheries and ecosystem, aiming at sharing the information of advantages and challenges, evaluating the results and ecological effects and management implications.

S6 Interannual variability in marine ecosystems

Sponsoring Committee:

Duration: 1 day

Convenors: Yury Zuenko (Russia), Hee-Dong Jeong (Korea), TBD from the eastern Pacific

Invited speaker: Elena Ustinova (Russia)

In practice of environmental maintenance of fisheries and other human activities in the World Ocean, year-to-year variability is more important than the changes of longer scale. However, its mechanisms are poorly known yet, the cyclic processes in the scale from 2 to 20 years are usually considered and forecasted without real understanding of their nature. The ideas on the year-to-year variability mechanisms and results of their revealing and practical using are welcome. The session will be held concurrently with the ICES/PICES session

on predictability in interannual scale, some on-line and post-session communications between them are considered.

S7 Can short-term forecasts inform long-term climate projections and visa-versa?

Sponsoring Committee:

Duration: 1 day

Convenors: Jacquelynn King (Canada), Masami Nonaka (Japan)

Invited speaker: Desiree Tommasi (USA)

PICES has long recognized the importance of climate variability and climate change on marine ecosystems. The types of modeling approaches used to predict ecosystem responses to interannual to decadal climate variability often differ from those working used to project longer term responses to climate change. This session seeks to integrate the modeling communities working on at these two temporal scales to identify opportunities for collaboration. This session is designed to facilitate the exchange of information on topics such as: reviews of the empirical evidence underlying assumptions regarding the form and parameterization of functional linkages between climate variability and ecosystem response; and assessments of the retrospective skill of coupled bio-physical models. We are especially interested in papers that demonstrate how information regarding parameter uncertainty can be transferred to longer term projection models.

S9 Marine ecosystem health and human well-being: a social-ecological systems approach

Sponsoring Committee:

Co-sponsored by ICES and IMBER

Duration: 1 day

Convenors: Mitsutaku Makino (Japan), Ian Perry (Canada), Mark Wells (USA), Masahito Hirota (Japan)

Invited speakers: Suhendar Sachoamer (Indonesia) and 1 or more from ICES and IMBER

Ecosystem-based fisheries management seeks to restore, enhance, and protect living resources, their habitats, and ecological relationships to sustain all fisheries and provide for balanced ecosystems. Progress has been made internationally toward adopting ecosystem based fisheries management of marine systems (EBFM), with PICES countries contributing through regional applications in the North Pacific. Examples are the Study Group on Ecosystem-based management science and its application to the North Pacific (SG-EBM: 2003-2004) and the Working Group on Ecosystem-based management science and its application to the North Pacific (WG-19: 2004-2009). Recent initiatives have expanded the concept of ecosystem to include human influences, both positive and negative, which is emerging as coupled marine social-ecological studies (Marine SES). An integrated understanding of how ecosystem changes affect human social systems and their well-being, and vice versa, are necessary to improve environmental stewardship. The PICES Study Group on Human Dimensions (SG-HD: 2009-2011), Section on Human Dimensions of Marine Systems (S-HD: 2011-), and PICES-MAFF Project on Marine Ecosystem Health and Human Well-being (MarWeB: 2012-2017) have contributed to ecosystem-based management efforts in the North Pacific. Also, international corporation with other international scientific organizations/programs have been developing, such as MSEAS 2016 which was co-sponsored by PICES, ICES, Ifremer, etc. Key questions that structure these scientific activities are: (a) how do marine ecosystems support human well-being and (b) how do human communities support sustainable and productive marine ecosystems? This Topic Session welcomes papers that addresses all aspects of Marine SES, and particularly research that addresses the above two questions.

S10 Meso-/submeso-scale processes and their role in marine ecosystems

Sponsoring Committee:

Duration: 1 day

Convenors: Hiromichi Ueno (Japan), M. Debora Iglesias-Rodriguez (USA), Sachihiko Itoh (Japan), Elena Ustinova (Russia)

Invited speaker: Yevgeny Samko (Russia)

Mesoscale and submesoscale (~1 to 100 km) currents and fronts such as eddies, streamers, filaments and streaks are ubiquitous features of the ocean. These complex but coherent patterns in the sea surface are often captured by satellite imagery and partially reproduced by high-resolution numerical ocean-circulation/biogeochemical models. While the interior structure of these fine-scale features and its dynamics are still in exploration, it has been well-known that there are tight linkages between physics and distribution of marine organisms at these scales, which includes dispersion, patchiness and aggregations of plankton, nekton, birds and mammals. Understanding the structure and physics of these horizontal fine-scale features, their effects on distribution and production of marine organisms, and how they influence the functioning of the marine ecosystem and its services such as fisheries yield and efficiency is necessary in order to assess likely system changes and shifts under a changing climate. This topic session aims to discuss the interaction between physics, chemistry, biology and fisheries of the ocean at the meso- and sub-mesoscale based on observations and modeling. Presentations will include various levels of organization (physics, biogeochemistry, fish/fisheries and other marine predators) from different areas in the PICES region, and participants will be invited to compare differences and discuss the underlying mechanisms.

S11 Emerging issues in understanding, forecasting and communicating climate impacts on north pacific marine ecosystems

Sponsoring Committee:

Duration: 1 day

Convenors: Steven Bograd (USA), Sukyung Kang (Korea) Oleg Katugin (Russia) Guangshui Na (China)

‘Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems’ (FUTURE) is an integrative Scientific Program undertaken by the member nations and affiliates of PICES 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. While PICES has fostered advances in understanding how environmental and climate variability impacts marine ecosystems, our capacity to forecast these climate-driven impacts, at seasonal to decadal time scales, is less well developed. Similarly, there have been impediments in broadly disseminating results from the FUTURE Science Program in ways that optimize the utilization of the science. In this session, we will provide an assessment of our capacity to forecast climate-driven marine ecosystem changes on seasonal to decadal scales and review strategies for communicating FUTURE and PICES science. Advances in the understanding of climate impacts on marine ecosystems, and a broad dissemination of this information, are essential for preserving a healthy and sustainable North Pacific for FUTURE generations.

S12 Environmental variability in Arctic and Subarctic and evaluating fishery management strategy

Sponsoring Committee: FIS

Duration: 1 day

Convenors: Mikhail Stepanenko (Russia), TBA

Environmental variability in Arctic and Subarctic affects on recruitment, abundance, behavior and seasonal spatial distribution of fish and invertebrate populations which challenge on fishery management strategies. Understanding of environmental driven changes in fish populations can be used to improve predictions of assessed populations and will positively affect on recreational fishing, commercial harvest and fishery-dependent coastal communities. This session explores the impacts of environmental variability projections to

applied fishery problems in the Arctic and Subarctic and development of environmental - enhanced strategy of management.

S13 *Seasonal and climatic influences on prey consumption by marine birds, mammals, and predatory fishes*

Sponsoring Committee:

Duration: 1 day

Convenors: Andrew Trites (Canada), Rob Suryan (USA), Michael Seki (USA), Tsutomu Tamura (Japan)

Seasonal and Climatic Influences on Prey Consumption by Marine Birds, Mammals, and Predatory Fishes
 Rationale Marine birds, mammals, and fishes exert substantial top-down forcing on marine ecosystems through consumption of key mid-trophic level forage species. These predators are indicators of changes in food webs, and have been implicated in trophic cascades in marine ecosystems. The goal of this session is to gain deeper insight into the relative importance of seasonal and climatic influences on prey consumption — and to inform understanding of North Pacific food-web dynamics under changing ocean conditions. This session contributes to the goals of PICES-FUTURE by bringing forward new knowledge needed to forecast North Pacific ecosystem dynamics relative to climate change and anthropogenic influences (COVE and AICE). In addition, results of this session will contribute to the PICES MBM 3-5-year focus on climate and trophic ecology of marine birds and mammals.

Prey consumption by mid to upper trophic level marine birds, mammals, and predatory fishes is influenced by changes in prey abundance, prey availability, ocean climate and anthropogenic stressors. However, the extent to which predators can adapt to such changes and still meet their minimum energy requirements is uncertain. Understanding dietary changes of predators under varying environmental conditions is critical to informing prey consumption models and estimating relative contributions of bottom-up vs. top-down forcing in marine systems. Understanding how prey consumption of marine birds, mammals and predatory fishes will respond to climate change is also needed to predict changes in energy flow pathways in ecosystems, and has consequences for conservation initiatives and ensuring the sustainability of commercially important fishery resources. For this session, we will request presentations on topics that address (a) the significance of seasonal changes in prey consumption on energy budgets and ecosystem dynamics, (b) the effects of changes in water temperature and other climatic variables on food requirements, (c) relationships between dietary shifts and population trends, (d) the limits of plasticity in prey selection, and (e) how prey consumption of birds, mammals, and predatory fishes is affected by the recent extreme climatic events—the blob, El Nino, ice cover changes, etc. Potential Participants Yuri Artukhin, Russia Vladimir Burkonov, Russia/USA Mark Hipfner, Canada Laurie Wilson, Canada Russ Bradley, USA Heather Renner, USA Stephanie Zador, USA Kerim Aydin, NOAA REEM, USA Yutaka Watanuki, Japan.

½-day BIO Paper Session

½-day FIS Paper Session

½-day MEQ Paper Session

½-day POC Paper Session

W1 *The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration*

Sponsoring Committee:

Co-sponsored by NPRB

Duration: day

Convenors: Matthew Baker (USA), Lisa Eisner (USA), Kirill Kivva (Russia)

We request endorsement of a workshop for the 2017 PICES Annual Meeting in Vladivostok, Russia for the second of a two-part workshop designed to promote synthesis and understanding of physical and biological interactions in the northern Bering Sea and to promote international efforts towards data sharing, active research and increased collaboration at the international level. Please find below the abstract for the proposed 1-day workshop to be considered at the PICES Governing Council and Science Board at the 2016 PICES Annual Meeting in San Diego. Workshop Title: The role of the northern Bering Sea in modulating the Arctic II: international interdisciplinary collaboration Conveners Matthew Baker (USA) Kirill Kivva (Russia) Lisa Eisner (USA) Description The northern Bering Sea is at the confluence of the North Pacific and Arctic Ocean. Physical processes in the northern Bering Sea link currents, productivity regimes, and species distributions and interactions ranging from North Pacific ecosystems to the Arctic. The processes in this region influence the state and ecosystem structure in the southern Chukchi Sea ecosystem as well as the functioning of other Arctic regions. While the Pacific Arctic Region has received great attention during the past few years, scientific efforts in the Northern Bering – Southern Chukchi Sea region are mostly conducted at the national level. International collaboration and data integration remain limited. This workshop is proposed as the second of two consecutive workshops to bring together researchers representing different scientific programs to synthesize knowledge, share data, and discuss further opportunities for cooperation at the international level. The workshop will build on themes addressed in the first workshop at the PICES 2016 annual meeting. The format will include invited talks followed by discussion in the morning on the following themes: (1) the physical environment and chemical fluxes (2) plankton distribution and dynamics (3) fish population and dynamics; and (4) recent modeling efforts in the region. In the afternoon, participants will work through facilitated sessions to: (1) consolidate existing and identified data (2) strategize opportunities for further data integration and coordinated analysis (3) identify new data streams, new participants, and new research efforts to include (4) determine opportunities for long-term data sharing in the region Participants will be asked to submit applicable Ecological Time Series Observations (ETSOs) and identify available data and metadata on new data streams, including satellite observations, glider and mooring data, oceanographic cruise data, bottom, midwater, and surface trawl data, acoustic surveys, bathymetric and multibeam data. Workshop products This workshop aims to increase collaboration and build linkages and synergies among scientists and researchers on both sides of the northern Bering and Chukchi seas as well as among a diverse suite of national and international research efforts operating in this region. Data will be integrated with efforts relevant to the North Pacific Ecosystem Status Report. Results will be summarized in a report in PICES Press semi-annual newsletter and, where appropriate be made available to ongoing research efforts in the region. PICES co-sponsorship Support is requested by the North Pacific Marine Science Organization (PICES), the North Pacific Research Board (NPRB), and the Arctic Monitoring and Assessment Program (AMAP). The relevant PICES committees and working groups include MONITOR, POC, BIO, FIS, S-CCME and TCODE.

W2 Coastal ecosystem services in the North Pacific and analytical tools/methodologies for the assessment

Sponsoring Committee:

Duration: 1 day

Convenors: Shang Chen (China), Mitsutaku Makino (Japan), Daniel K. Lew (USA), Minling Pan (USA), Sebastian Villasante (Spain)

Coastal ecosystem services are the benefits people obtain from the coastal ecosystem. These services include seafood, regulation of climate, reduction of storm impacts, waste assimilation, recreation and leisure, and biodiversity maintenance etc.,. The identification, quantification, and valuation of ecosystem services and understanding the impacts of human activities and climate change on ecosystem services are key scientific questions. The ecosystem services-based approach to marine ecosystem management is a new approach meant, in part, to enhance human well-being. The goals of this workshop are: (1) to present research that enhance understanding of the interactions between human activities and ecosystem services; (2) to provide a venue for natural scientists and social scientists to exchange results from research on identification, assessment, management and investment of ecosystem services, and (3) to provide SG-MES members and scientists around the North Pacific a chance to discuss collaboration on scientific projects within the North Pacific Ocean. We believe this workshop will contribute to a greater understanding of the status of human dimensions of the North Pacific ecosystem and fill the gaps to achieve the FUTURE Objectives.

W3 Linking oceanographic conditions to the distribution and productivity of highly migratory species and incorporation into fishery stock assessment models

Sponsoring Committee:

Duration: 1 day

Convenors: Carrie Holt (Canada), Gerard DiNardo (USA)

This workshop will be convened by the proposed Joint PICES-ISC Working Group on Oceanographic Conditions and the Distribution and Productivity of Highly Migratory Fish, as identified in the Working Group's Terms of Reference. The distribution and productivity of many pelagic fish populations in the North Pacific are determined by large-scale oceanographic processes and climate variability. One hypothesis is that highly migratory species, such as albacore tuna (*Thunnus alalungus*) or Pacific sardine (*Sardinops sagax*), have environmental thresholds and preferences that drive their distribution and productivity. This workshop will provide an overview of contemporary research on the topic, including the identification of statistical modeling approaches that link spatially explicit environmental data (e.g., satellite derived SST) to distributional fish data (e.g., fishery-dependent and fishery-independent), methods to assess impacts of climate variability on fish productivity, and approach methodologies that explicitly incorporate environmentally driven dynamics into stock assessments, for highly migratory species. Group discussion will help facilitate identification by the Joint Working Group of a suitable methodology to use to develop habitat models of albacore tuna and other highly migratory species, and to provide possible scenarios for future fishery CPUE 'hot spots' and advancement of fish stock assessments. Papers that deal with common difficulties in relating spatially explicit data to fish distributional data (e.g., zero-inflated data, mismatch between spatial or temporal resolution of oceanographic to distributional datasets), are also encouraged.

W4 Long-term changes in HAB occurrences in PICES nations; the Eastern vs. Western Pacific

Sponsoring Committee:

Co-sponsored by NOWPAP and GlobalHAB

Duration: 1½ days

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

Invited speakers: Adrianna Zingone (GlobalHAB), Takafumi Yoshida (NOWPAP), Dr. Nishikawa (Japan – Time series data on *Chattonella* sp., *Karenia* sp. in the Seto Inland Sea), Nick Bond (USA)

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

W5 A guide to communicating PICES science to scientists, governments, stakeholders and the public

Sponsoring Committee:

Duration: 1 day

Convenors: Jacquelynne King (Canada) Matthew Baker (USA), Sukyung Kang (Korea) Mitsutako Makino (Japan)

As the integrative Science Program of PICES, FUTURE ('Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems') has been facilitating research on understanding how marine ecosystems in the North Pacific respond to climate change and human activities, and developing the capacity to forecast ecosystem status based on a contemporary understanding of how nature functions. Another key objective of FUTURE is to effectively communicate new insights of PICES science to its members, governments, stakeholders and the public, a skill that is not broadly shared amongst PICES scientists. In this Workshop, we will provide presentations and training from professional science communicators on the best practices for PICES scientists to synthesize, communicate, and disseminate their research activities to diverse audiences. Workshop participants are encouraged to come prepared to discuss and develop communication strategies for their research activities, and to prioritize communication and outreach products for FUTURE and PICES to develop.

W6 S-CCME Phase 2 planning workshop

Sponsoring Committee:

Co-sponsored by ICES

Duration: 1 day

Convenors: Anne Hollowed (USA), Myron Peck (ICES), Kirstin.Holsman (USA)

The S-CCME implementation plan recommended a phased period of implementation with periodic reviews of its goals and objectives. Phase 1 ends in 2017. This workshop seeks funds to support a 1 day meeting to be held in conjunction with the Drivers of Dynamics of Small Pelagic Fish Resources Symposium in Victoria, British Columbia. The goals of the workshop will be to review and modify the existing Phase 2 plans to ensure that S-CCME continues to conduct cutting edge science on climate change effects on marine ecosystems.

W7 Advantages and limitations of traditional and biochemical methods of measuring zooplankton production

Sponsoring Committee:

Co-sponsored by ICES

Duration: 1 day

Convenors: Toru Kobari (Japan), Akash Sastri (Canada)

Zooplankton communities occupy a central position in the flow of matter and energy passing from primary producers to animals at higher trophic levels in marine ecosystems. Over the past two decades, the increasing emphasis on quantitative assessments of marine ecosystem function has been focused on improving our understanding of how marine ecosystems respond to global climate change. Zooplankton (secondary) production represents a quantitative proxy for the functional response of marine ecosystems since it corresponds to the zooplankton biomass accrued through consumption of lower food-web levels.

Zooplankton production has traditionally been estimated using methods which either: 1) follow the development of zooplankton populations/communities over the course of several weeks or months (cohort approaches); or 2) employ ex situ fixed-period incubations. Incubation-based techniques with simultaneous sampling of natural communities are the most widely used traditional methods in the field. Recent advances in biochemical methods for measuring zooplankton growth and production, such as quantification of RNA/DNA ratios, chitobiase, or aminoacyl-tRNA synthetases, have been developed and applied to a diverse range of organisms and habitats. There is a need for examination and comparison of traditional and biochemical approaches to estimating zooplankton secondary production.

