Report of the Biological Oceanography Committee

The meeting of the Biological Oceanography Committee (BIO) took place from 18:00–20:00 h on Sunday, October 20, 2019 and 14:00–18:00 h on Wednesday, October 23, 2019, in Victoria, British Columbia, Canada. The Chair, Dr. Se-Jong Ju, called the meeting to order and welcomed members and observers (***BIO Endnote 1***). All members in attendance introduced themselves and absent members were noted. The Chair reviewed membership changes and noted that there was no official representation from China and Russia. Members from all other PICES member countries were present. There were no changes/additions offered and the agenda was adopted (***BIO Endnote 2***). Dr. Akash Sastri agreed to act as rapporteur.

BIO participants at PICES-2019, Victoria, Canada. Front row from left: Julie Keister, Se-Jong Ju. Middle row from left: Angelica Peña, Motomitsu Takahashi, David Kimmel. Back row from left: Kirill Kivva, Akash Sastri, Kaoru Hattori, Wongyu Park, and Taewon Kim.

AGENDA ITEM 3
Membership changes

- **BIO**: Dr. Akash Sastri (Canada) was elected Chair, replacing Dr. Se-Jong Ju (Korea); Dr. Wongyu Park (Korea) was elected Vice-Chair, replacing Dr. Sastri (USA). Dr. David Kimmel is a new member representing USA;
- **S-MBM**: Dr. Liyuan Zhao is a new member representing China;
- **WG 37**: Drs. Russell H. Hopcroft (USA) and Karyn D. Suchy (Canada) are new members of WG 37 representing USA and Canada, respectively.

AGENDA ITEM 4
Annual review of BIO activities

a) 2019 Inter-sessional symposia/sessions/workshops/meetings:
- The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop (April 14–17, 2019; Hangzhou, China). S-CC and BIO members participated in the workshop;
- SOLAS Open Science Conference (April 21–29, 2019; Sapporo, Japan). PICES provided financial support for 3 Early Career Scientists to attend;
- IMBeR Open Science Meeting (June 17–21, 2019; Brest, France). PICES provided financial support for 4 Early Career Scientists to attend;
- 2019 PICES training courses: WG 37 Practical Workshop on Biochemical Methods for Measuring Zooplankton Production, Phase 2 (October 12–13, 2019; Quadra Island, BC, Canada).

b) Publications
- PICES Special Publication 5 (edited by S-CC members, J.R. Christian and T. Ono) on "*Ocean Acidification and Deoxygenation in the North Pacific Ocean*";
- WG 32 on *Biodiversity of Biogenic Habitats* PICES Scientific Report of (edited by Janelle Curtis and Masashi Kiyota) in preparation;
- WG 33 on *Climate Change and Biologically-driven Ocean Carbon Sequestration* final report (edited by Nianzhi Jiao, Richard B. Rivkin, and Louis Legendre);
- Review paper by WG 37 members on "Evaluation of trade-offs in traditional methodologies for measuring metazooplankton growth rates: Assumptions, advantages and disadvantages for field applications". *Progress in Oceanography* 178: https://doi.org/10.1016/j.pocean.2019.102137;
- Special Issue of selected papers on "Understanding changes in transitional areas of the Pacific Ocean" (edited by Salvador Lluch-Cota, Phoebe Woodworth-Jefcoats, Sachihiko Itoh, M. Angelica Peña, Shingo Kimura and François Colas) from the PICES Transitional Areas Symposium held April 24–26, 2018 in La Paz, Baja California Sur, Mexico in Deep-Sea Research II, Vol. 169–170.

AGENDA ITEM 5
Updating BIO Action Plan

A draft Action Plan was submitted to Science Board and the Secretariat for review.

AGENDA ITEM 6
Best ECS presentations for BIO

PICES-2019 BIO Paper/Topic Sessions and Workshops, and selection of judges for BIO Best Presentation and Poster awards:

BIO sponsored the following sessions/workshops at PICES-2019:
- A 1-day Topic Session (S3): *Coastal ocean modelling in the North Pacific*;
- A 1-day Topic Session (S5): *Trends in ocean and coastal ecosystems and their services and its future*;
- A 1-day Topic Session (S8): *Creating More Effective Integrated Ecosystem Assessments (IEAs) in PICES Countries*;
- A 1½ -day Topic Session (S11): *Incorporating ecosystem variability and climate change into fisheries management: Progress and challenges for EBFM in the 21st century*;
- A 1-day Topic Session (S12): *Impacts of meso-/submeso- scale processes on heat/material transport and on marine ecosystems*;

- A ½ -day Topic Session (S13): *Implications of prey consumption by marine birds, mammals, and fish in the North Pacific*;
- A 1-day Workshop (W4): *Circulation, biogeochemistry, ecosystem, and fisheries of the western North Pacific marginal seas: Past and future of CREAMS (Circulation Research of East Asian Marginal Seas)*;
- A ½-day Workshop (W5): *Celebrating two decades of North Pacific CPR sampling, and future directions*;
- A 1-day Workshop (W8): *Synthesis of bio-acoustics programs for monitoring zooplankton and fisheries in the North Pacific*;
- A 1-day Workshop (W10): *PICES/ICES collaborative research initiative: Toward regional to global measurements and comparisons of zooplankton production using existing data sets*;
- A ½-day Workshop (W12): *Potential food competition between top predators and fisheries in the North Pacific*;
- A 1-day Workshop (W14): *New frontiers: The application of molecular approaches in marine ecology and fisheries science*;
- A 1-day Workshop (W17): *Scoping an IEA of the Northern Bering-Chukchi Seas LME*.

BIO was responsible for judging 21 ECS oral presentations and 12 ECS posters (including 3 General Posters). Volunteers were appointed to evaluate oral (Dr. Ju, Dr. Keister, Dr. Pena, Dr. Park and Dr. Sastri) and poster (Dr. Takahashi, Dr. Kimmel, Dr. Ju and Dr. Sastri) presentations. Rankings were compiled by the Chair before the Closing Ceremony. The Best Presentation Awards for a BIO-sponsored Topic Sessions were given to Dr. Phoebe Woodworth-Jefcoats (*The role of temperature in determining how marine fish will be differentially affected by climate change*) and Dr. Matthew Savoca (*Rorqual ingestion estimates for the Eastern North Pacific based on direct measures of feeding rates and prey quality*). The BIO Best Poster Award to Mr. Hyunjin Yoon (*Feeding ecology of chaetognaths in the Yellow Sea and the East Sea inferred from gut content and fatty acid analyses* See also Best Presentations at PICES-2019.

AGENDA ITEM 7
New ECS award

BIO Committee members reviewed the *Zhu-Peterson Early Career Scientist Award* (created 2019). The award honours Professor Mingyuan Zhu and Dr. William Peterson. Recipients of the award will be early career scientists recognized for innovative research at the frontier of science relevant to their field. Dr. Ju noted that nominations for the 2020 award were now open. There was some discussion among BIO members about the PICES definition of an early career scientist.

AGENDA ITEM 8
Progress reports and future plans of BIO active groups

a) PICES-ICES Section on *Climate Change Effects on Marine Ecosystems*

Dr. Angelica Peña gave an update on 2019 activities and accomplishments. Dr. Xiujuan Shan (China) has replaced Dr. Shin-ichi Ito (Japan) as Co-Chair representing PICES.

International Panel on Climate Change

The IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) Fourth Lead Author Meeting (March 4–9: Kazan, Russia) involved significant contributions from PICES S-CCME members: Dr. Anne Hollowed (PICES/USA) was selected as the lead author for Chapter 3, "Polar Regions"; Dr. Manuel Barange (ICES/FAO) was selected as the review editor for Chapter 5, "Changing ocean, marine ecosystems, and dependent communities". The final draft was submitted to the IPCC Technical Support Unit (May 31,

2019); underwent final government review (June through August 2019); the Summary for Policymakers, and the underlying report was approved at the 51st Session of the IPCC (September 20–24, 2019).

S-CCME members, Drs. John Pinnegar (ICES), Kristin Holsman (PICES), Shin-chi Ito (PICES), attended the IPCC AR6 Lead Author 2nd Meeting (July14–19: Kathmandu, Nepal). Dr. Pinnegar was one of the conveners for the session on "Scenarios for the Future Ocean" which featured a diverse community of researchers using and developing scenarios to carry out research and policy analysis related to climate change and sustainability.

A Special Issue based on selected papers from the 4th Symposium on "The Effects of Climate Change on the World's Oceans" was published in *ICES Journal of Marine Science* Vol. 76, Issue 5. Contribution from S-CCME include "*Recent advances in understanding the effects of climate change in the world's oceans*" by Hollowed *et al*. and "*Towards climate resiliency in fisheries management*" by Holsman *et al*. At the ICES Annual Science Conference (September 2019, Gothenburg, Sweden), a number of S-CCME members contributed Keynote presentations: Dr. Cisco Werner (PICES) and Dr. Manuel Barange (ICES); Theme Session D, "*Assessing ecosystem vulnerability to multiple drivers and pressures*" was co-convened by Dr. Holsman (PICES). At PICES-2019, Topic Session S5 "*Trends in ocean and coastal ecosystems and their services and its future*" was co-convened by S-CCME members Drs. Ito (Japan), Peña (Canada), and Holsman (USA); and Topic Session S11, "*Incorporating ecosystem variability and climate change into fisheries management*" was co-convened by Dr. Holsman.

For 2020, S-CCME members (Möllmann, Pinnegar, Holsman, and Ito) will participate in the IPCC WG II AR6 Lead Authors' Third Meeting (January 27–February 1, Faro, Portugal). S-CCME members will also meet in January 2020 at the Climate Change and European Aquatic Resources (CERES) final meeting. Drs. Hollowed (PICES/USA) and William Cheung (ICES/Canada) are members of the CERES Research Advisory Board. Other new projects and meetings for 2020 include: The Biodiversa – Scenarios of Marine Biodiversity and Evolution under Exploitation and Climate Change project (2019–20121) with 2 S-CCME members (Cheung, Peck); FutureMARES which is an EU proposal addressing LC-CLA-06-2019 "Inter-relationships between climate change, biodiversity and ecosystem services" and coordinated by Dr. Myron Peck. S-CCME member, Dr. Alan Haynie (PICES/USA) is on the Scientific Steering Committee for MSEAS-2020 on "Managing for sustainable use of the Earth's marine and coastal systems" (May 25–29, 2020, Yokohama, Japan).

- The S-CCME Phase 4 Implementation Plan (2021–2023) is being drafted.
- S-CCME requests the renewal frequency for S-CCME to be revised from 3 to 5 years citing that the frequency with which S-CCME members need to meet to develop new IPs is overtaxing.
- S-CCME requests a 1-day meeting following the MSEAS-2020 meeting (Yokohama, Japan) to coordinate these linked efforts with FishMIP and CMIP6..
- S-CCME has proposed a joint ICES/PICES WG (2020–2023) on Impacts of Warming on Growth Rates and Fisheries Yields to FIS.
- S-CCME requests a ½-day business meeting at PICES-2020.

b) Section on *Carbon and Climate*

Dr. Tsuneo Ono (S-CC Co-Chair) gave an update on S-CC activities. Dr. Alexander Kozyr (USA) has replaced Dr. James Christian (Canada), who has stepped down, as Co-Chair. Among the 2019 achievements was the completion of the PICES Special Publication 5: *Ocean Acidification and Deoxygenation in the North Pacific Ocean* (Christian, J.R. and Ono, T., Eds). S-CC participated in the Ocean Networks Canada workshop on "*Perspectives on ocean acidification sensors*" (February 7, 2018, Victoria, Canada). The workshop report was published in: Sastri *et al*. 2019. *Perspectives on in situ sensors for ocean acidification research*. *Front. Mar.*

Sci. 6: 683. Four members of S-CC are co-authors of the report. There was a presentation by S-CC at the GOA-ON 4th International Workshop in Hangzhou, China (April 14–17, 2019) and PICES provided funding support for an early career scientist to participate. As part of its planning activities, S-CC will support: a) a cross-regional analysis of OA in Asian marginal seas based on the data corrected for the PICES OA Special Publication; and b) Inter-comparison experiment for pH sensors for OA monitoring among PICES member countries. S-CC will not be proposing a session for PICES-2020 but recommends support of the proposed Topic Session on "Atmospheric *nutrient deposition and microbial and microbial community responses, and predictions for the future in the North Pacific Ocean*". The Section also requests support for an early career scientist and session chair for the ICES/PICES Theme Session on "*Taking stock on ocean acidification research for provision of future efforts*" at ICES ASC 2020.

c) Section on *Marine Birds and Mammals*

Dr. Kaoru Hattori and Dr. Patrick O'Hara (S-MBM Co-Chairs) updated the Committee on S-MBM 2019 activities. The Section co-convened a very productive PICES-2019 Topic Session (S13) on "*Implications of prey consumption by marine birds, mammals, and fish in the North Pacific*" which consisted of 6 oral presentations and 20 participants. Dr. Hattori also noted consistent difficulties gaining participation of members from China and Russia. Dr. O'Hara highlighted S-MBM participation in international symposia such as the upcoming World Seabird Conference (Hobart, Australia, October 2020) and noted strong linkages between several PICES-2019 sessions and S-MBM activities. S-MBM anticipates a scientific report ready for the PICES-2020 and requested a ½-day business meeting. Dr. O'Hara concluded the presentation with a draft of the 2021–2025 S-MBM Activity Plan.

d) WG 37: Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions*

Dr. Akash Sastri (WG 37 Co-Chair) presented a status report on WG 37 activities. Since its establishment in 2016, WG 37 has published two review publications: *Advances in biochemical indices of zooplankton production* (L. Yebra, T. Kobari, A.R. Sastri *et al. Advances Marine Biology* 2017, 76 https://doi.org/10.1016/bs.amb.2016.09.001) and more recently, *Evaluation of trade-offs in traditional methodologies for measuring mesozooplankton growth rates: assumptions, advantages and disadvantages for field applications* (T. Kobari, A.R. Sastri, L. Yebra, H. Liu, R.R. Hopcroft *Progress in Oceanography* Special Issue commemorating Dr. Bill Peterson 2019, 178 https://doi.org/10.1016/j.pocean.2019.102137). WG 37 held, and a Workshop (W10) on "*PICES/ICES collaborative research initiative: Toward regional to global measurements and comparisons of zooplankton production using existing data sets*" at PICES-2019 and a zooplankton production Practical Workshop Phase 2 on "*Production methodologies and measurements for in situ zooplankton*" on October 12–13, 2019, Hakai Institute, Quadra Island, British Columbia (see PICES Press 2020 Vol. 28, No. 1, pp. 12–13), preceding the Annual Meeting. The Phase 2 Practical Workshop Columbia (see PICES Press 2019 Vol. 27, No. 1, pp. 29–30) focused on biochemical methods for measuring secondary production rates. Similar to the successful Phase 1 Practical Workshop, the Phase 2 workshop consisted of lectures, coastal sampling and laboratory exercises and was co-sponsored by PICES, Hakai Institute and Ocean Networks Canada.

WG 37 proposed a 1-day workshop on "*Can we link zooplankton production to fisheries recruitment*?" for PICES-2020 and requests a 1-year extension toward completion of the WG final report.

e) PICES Special Project on Sea Turtle Ecology in Relation to Environmental Stressors in the North Pacific Region

Professor Taewon Kim (Korea) reported on the PICES Special Project on Sea Turtle Ecology (SEAturtle). summarizing the KIOST planning tasks for the conservation of large marine animals. Sea turtles are normally

associated with bycatch. Korea has four species; the project has deployed 8 tags on green turtles who generally moved around Jeju Island but some were also tracked around Japan. The report on this study was published in 2018 (S. Jang, G.H. Balazs, D.M. Parker, B.Y. Kim, M.Y. Kim, C.K.Y. Ng, T.W. Kim, *Chelonian Conservation and Biology* 17(2), 236-244). A kickoff meeting for SEAturtle was held at Jeju Island in the summer of 2019 (see PICES Press 2020 Vol. 28, No. 1, pp. 43–47) and the last day of the meeting was marked by the release of the first tagged turtle as part of the project. The SEAturtle is currently trying to expand its scope to include loggerhead turtles. Dr. Ju noted that there were only 3 PICES members in the Project Science Team membership. Dr. Hattori asked how S-MBM could support this project; Prof. Kim will present an update to S-MBM and seek their advice.

AGENDA ITEM 9
PICES data policy and inventory

BIO reviewed the data policy guidelines and inventory (excel file) and Dr. Ju instructed members to identify and add any data relevant to the Committee to the inventory.

AGENDA ITEM 10
Relations with other international organizations/programs

Dr. Lisa Miller, representing SOLAS (Surface Ocean Lower Atmosphere Study), presented a broad-scale description of SOLAS and the activities it supports; examples of the global scope of activities; and proposed a SOLAS co-sponsored Topic Session on atmospheric nitrogen deposition (*Atmospheric nutrient deposition and microbial community responses, and predictions for the future in the North Pacific Ocean*) for PICES-2020. Dr. Miller emphasized the relevance of the proposal given the very active nitrogen deposition projects currently underway in Korea, China and Japan and that the proposed session conveners are from Japan, Korea, China and Canada. She concluded by thanking PICES on behalf of SOLAS for sponsoring travel and meeting costs for an early career scientist.

Dr. Franz Mueter, representing ESSAS (Ecosystem Studies of Subarctic and Arctic Seas) program discussed the 2019 IMBeR Open Science Conference which took place in Brest, France in June 2019, with an ESSAS focus on the two arctic inflow shelves. He also introduced the upcoming ESSAS Annual Meeting on June 1–3, 2020, at Hokkaido University in Sapporo, Japan and emphasized the relevance of the meeting and its activities to PICES WG 39, FIS, HD, and FUTURE. ESSAS requests $7,500 from PICES to support travel to the meeting for early career scientists/students. He also briefly discussed a proposal for a PICES Working Group on Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi Sea the Bering-Chukchi LME (see Agenda Item 13).

BIO was provided a list of theme sessions for potential PICES co-sponsorship at ICES ASC 2020 . BIO gave highest ranking to:
1-*Top predators, food webs and ecosystem-based fisheries management*;
2-*Biomass, biodiversity, ecosystem services and potential fisheries in the mesopelagic zone*;
4-*Past, present and future of marine plankton assemblages and communities*;
10-*Advances and challenges in marine litter pollution*.

AGENDA ITEM 11
FUTURE Program

Dr. Ian Perry, FUTURE SSC liaison to BIO, reported on FUTURE activities for 2019 and beyond. He highlighted two recent achievements: a) a synthesis paper co-authored by FUTURE SSC members was published in *Frontiers in Marine Science* in June (Vol. 6, Article 333). The paper describes a FUTURE framework using several case studies as a conceptual framework to address climate change impacts in the North Pacific, and b) a FUTURE outreach video. FUTURE also contributed to PICES Special Publication 5 on Ocean Acidification and Deoxygenation in the North Pacific Ocean (J.R. Christian and T. Ono, eds).

Dr. Perry also noted that FUTURE program recommendations include: 8 points on how PICES will interface with the new UN Decade of the Ocean (requiring consensus and discussion from all PICES members); the 6 key UN Decade of the Ocean themes are related/relevant to PICES; and that 2021 will be a potentially good time for the next big FUTURE Open Science Meeting.

AGENDA ITEM 12
Progress report on WG 35 – North Pacific Ecosystem Status Report 3

Dr. Sinjae Yoo (Co-Chair WG 35) presented an update of activities. The two main objectives of the WG are: 1) to publish NPSER3; and 2) establish and online system to develop a database of Ecosystem Time Series Observations (ETSO). The NPSER consists of 12 regional centres: 12 coastal regional chapters and 2 open ocean chapters. All of the regional chapters except region 19 have been submitted and are under review. Review is undertaken by an Editorial Board composed of Science Board members and representatives which is currently delayed. Thus far, 4 reviewers have completed their reviews and NPSER is still waiting for the remaining reviews. There was also a delay on the synthesis chapter.

For NPSER1 and 2, the synthesis chapters were hard copy (400 and 500 pages long) but for NPSER3 the format has changed such that only the synthesis chapter will be printed and the regional chapters will be updated online as frequently as possible. Every 5 years the synthesis chapters will be printed and the regional chapters will be updated on the web. The new timeline proposes that the synthesis chapter will be printed before the inter-sessional Science Board meeting (April/May 2020). The manuscript for the synthesis chapter will be ready for printing by middle of March. The regional chapters will be prepared and completed with reviews by summer 2020 (including Region 19). Given the timeline, WG 35 is requesting an additional 1-year extension. Dr. Yoo identified the two major objectives of WG 35: 1) NPSER to be published; and 2) development of the ETSO system. Unfortunately, the new ETSO system has not worked, and the reasons why are not clear. WG 35 will submit recommendations about this data system next year.

AGENDA ITEM 13
Review proposals of new Expert Groups

Prof. Rui Zhang (China) presented a proposal for a new joint ICES/PICES WG on Ocean Negative Carbon Emissions (ONCE) (see ***BIO Endnote 3*** for details). This proposed WG will follow on the successes of the Joint PICES/ICES Working Group on *Climate Change and Biologically-driven Ocean Carbon Sequestration* (WG 33). Dr. Ju asked how the new PICES data policy will apply to the new proposed working group. Dr. Zhang was aware of the new PICES data policy and noted that data sharing should be fine as most of the proposed studies were about the open ocean and relatively easy to share.

Dr. Elizabeth Logerwell presented a proposal for a new WG on Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi LME (see ***BIO Endnote 4*** for details). She noted that 19 people attended the BIO Workshop (W17) on "*Scoping an IEA of the Northern Bering-Chukchi Seas LME*" with a goal of scoping the feasibility of a WG and to gauge the interest from science and arctic communities. The WS discussions centered on opportunities to partner with organizations outside of PICES; some potential co-sponsoring organizations included ICES, IASC, NOAA IEA, PAME and the Bering Sea Elders Group. Drs. Logerwell (USA) and Yury Zuenko (Russia) were identified as potential Co-Chairs and 25 potential members from all PICES member countries have been confirmed. Dr. Logerwell emphasized that the timing is good as LME 12 borders on LME 13 (subject of WG on Joint PICES/ICES/PAME Working Group on *an Integrated Ecosystem Assessment for the Central Arctic Ocean* (WG 39)) and that this is a great advantage for coordinating resources and relevant WG activities. She also noted that tangible deliverables would include journal articles and outreach activities.

AGENDA ITEM 14
Planning for PICES-2020

The theme of the next PICES Annual Meeting is "*How does 30 years of research on changing North Pacific ecosystems inform the UN decade of Ocean Science for sustainable Development Goals (SDGs)?*". BIO members discussed all the proposed topic sessions and ranked them according to relevance to BIO. BIO assigned the highest ranks to the following three topic sessions:

- *Managing for pathways of resilience in a changing climate: recent examples and emerging approaches;*
- *Applications of artificial intelligence to advance the understanding of North Pacific ecosystems;*
- *Impacts of climate change on aquaculture.*

BIO assigned the highest ranks to the following workshops:

- *Sea turtles and environmental stressors in the North Pacific;*
- *Can we link zooplankton production to fisheries recruitment?*

AGENDA ITEM 15
PICES-sponsored conference/symposia in 2019 and beyond

BIO discussed and reviewed four upcoming PICES-sponsored meetings: a) Marine Socio-Economic Systems (MSEAS-2020) II Symposium, May 25–29, 2020, Yokohama, Japan; b) ICES International Symposium on the Plastic in the Sub-Arctic and Arctic, April 21–23, 2020, c) FAO International Symposium on Fisheries Sustainability, November 18–21, 2019, FAO, Rome, Italy; d) PICES/ICES/NAFO International Shellfish Symposium, November 5-7, 2019, Tromsø, Norway.

AGENDA ITEM 16
Capacity Building

(1) An AP-NPCOOS/WG 37 PICES Spring School on "*Coastal ocean observatory science*"; Theme: "*What is the Deep Scattering Layer (DSL) in the coastal region?*", March 4–8, 2020, Kagoshima, Japan. There is PICES support for ECSs participation and the application portal is currently open at: https://meetings.pices.int/meetings/summer-schools/2020/Kagoshima/scope.

An international training course/school on Vulnerable Marine Ecosystem (VME) taxa identification in fall 2020 (organized by NPFC and PICES) was presented by Dr. Aleksandr Zavolokin from the North Pacific

Fisheries Commission. Dr. Zavolokin also spoke about NPFC's mandate and the joint NPFC/PICES Study Group for *Scientific Cooperation in the North Pacific Ocean*. The objective of the joint SG is to develop a broad framework to identify and prioritize areas of joint interest to both organizations. The tentative dates for the school would be September or October 2020, location TBD (contact is Dr. Tatiana Dautova). Dr. Ju emphasized that as this is capacity building exercise, the school should not overlap with the 2020 PICES Annual Meeting.

AGENDA ITEM 17
Documenting business meetings, topic sessions and workshops

Dr. Ju reminded BIO expert group (S-CCME, S-CC, S-MBM, WG 37) Co-Chairs that summary reports should be submitted to the Secretariat within a month of the Annual Meeting.

AGENDA ITEM 18
Other business

Dr. Ju reminded BIO committee members that he was stepping down as Chair. Dr. Akash Sastri was elected as the new Chair of BIO, replacing Dr. Ju and Prof. Wongyu Park was elected as the new Vice-Chair, replacing Dr. Sastri. Dr. Peña thanked Dr. Ju for his service on behalf of all the committee members.

AGENDA ITEM 19
Adoption of BIO report and recommendations to Science Board

BIO supports and recommends:

- Proposals for a PICES/ICES Working Group on Ocean Negative Carbon Emissions (ONCE) and Working Group on Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi Sea (NBS-CS);
- Proposals for a PICES Special Project on Sea Turtle Ecology (SEAturtle);
- WG 37 request for a 1-year extension to complete the WG final report.

BIO Endnote 1

BIO participation list

Members
Se-Jong Ju (Korea, Chair)
Kaoru Hattori (Japan)
Julie Keister (USA)
Taewon Kim (Korea)
Hye-Won Moon (Korea)
Wongyu Park (Korea)
Angelica Peña (Canada)
Akash Sastri (Canada)
Motomitsu Takahashi (Japan)

Members unable to attend

Canada: Janelle Curtis
China: Zijun Xu, Ping Zhuang
Japan: Atsushi Tsuda
Russia: Boris Kotenev, Alexei Orlov
USA: Debora Iglesias-Rodriguez

Observers

Kirill Kivva (Russia)
Elizabeth Loggerwell (USA)
Lisa Miller (SOLAS)
Franz Mueter (ESSAS)
Patrick O'Hara (Canada)
Tsuneo Ono (Japan)
Ian Perry (Canada)
Sinjae Yoo (Korea)
Aleksandr Zavolokin (Russia/Japan)
Rui Zhang (China)

BIO Endnote 2

BIO meeting agenda

1. Welcome, introductions, opening remarks
2. Adoption of agenda and appointment of rapporteur
3. Membership changes
4. Annual review of BIO activities
   a) 2019 Inter-sessional symposia/sessions/workshops/meetings
   b) Publications
5. Updating BIO Action Plan
6. Selection of Best ECS presentations for BIO
7. New ECS award

8. Progress reports and future plans of BIO active groups (S-CCME, S-CC, S-MBM, WG 32, WG 37, Special Project)
   a) S-CCME and S-CC will report to FIS and POC, respectively.
   b) S-MBM: Section on Marine Birds and Mammals (K. Hattori or P. O'Hara)
   c) WG 32: Working Group on Biodiversity of Biogenic Habitats (J. Curtis or M. Kiyota)?
   d) WG 37: Working Group on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions (A. Sastri or T. Kobari)
   e) Special Project on Sea turtle ecology in relation to environmental stressors in the Northwest Pacific regions (report by T. Kim or G. Balazs): Present on Sun. (Oct. 20)

9. PICES data policy and inventory
10. Relation with other international organizations/programs?
    ESSAS, IOCCP, SOLAS, IWC, *etc*.
11. FUTURE Program (Ian Perry on Wed.)
12. Progress report on WG 35 – North Pacific Ecosystem Status Report3 (Sinjae Yoo)
13. Review proposals of new Expert Groups (if any proposals submitted)

14. Planning for PICES-2020 (Qingdao, China; Oct. 2020)
    – Theme title: TBD
    – BIO-related sessions and workshops: discuss ranking and sponsorship (still no workshop proposed)
    – Proposed inter-sessional workshops: ranking and sponsorship (still none of workshops proposed)
    – Funding and prioritizing invited speakers. Provide feedback to SB
    # Please keep in mind the deadline of the submission of session and workshop proposals for 2020 is Oct. 26, 2019.

15. PICES-sponsored conference/symposia in 2019 and beyond
    a) MSEAS II, May 25–29, 2020, Yokohama, Japan
    b) ICES International Shellfish Symposium, Nov. 2019, Tromsø, Norway
    c) FAO International Symposium on Fisheries Sustainability, Nov. 2019, FAO, Rome, Italy
    d) ICES International Symposium on the Plastic in the Sub-Arctic and Arctic, Apr. 2020, Iceland

16. Capacity Building
    a) Summer school – AP-NPCOOS (co-sponsor w/WG 37);
    b) International course/school on Vulnerable Marine Ecosystem (VME) taxa identification in fall 2020 (organized by NPFC and PICES).

17. Documenting business meetings, topic sessions and workshops
    a) Business meeting summary (S-CCME, S-CC, S-MBM, WG 37)
    b) Topic Session/workshop summary: Conveners should submit outcome/summaries of their session/workshop to secretariat (hbatch@pices.int) by late-October.

18. Other business
    a) A new BIO Chair and Vice-Chair election at BM on Oct. 20, 2019;
    b) New ECS award: Peterson & Zhu ECS Award

19. Adoption of BIO report and recommendations to Science Board

BIO Endnote 3

Proposal for a new PICES/ICES Working Group on Ocean Negative Carbon Emissions (ONCE)

Group Name: Joint PICES/ICES Working Group on Ocean Negative Carbon Emissions (ONCE) – From Science to Applications

Reporting to: BIO, FUTURE

Term: October 2019 – October 2022

Linkage(s) to previous PICES Expert Groups or activities

The ONCE WG is linked to the previous PICES/ICES joint WG 33 on "Climate Change and Biologically-driven Ocean Carbon Sequestration" (https://meetings.pices.int/members/working-groups/disbanded/wg33), which proposed the potential ocean negative carbon emission idea of increasing the microbial carbon sink in the sea by reducing nutrient discharge from land, based on the naturally occurring marine carbon pumps. The ONCE WG has the objective of linking the science of ocean negative carbon emissions to applications.

Linkage(s) to other organizations and programs

The ONCE WG will be co-organized by PICES and ICES. The objectives of ONCE are within the scope, and will contribute to the scientific goals, of the two organizations (such as the FUTURE program of PICES). Ocean carbon cycling and negative emission are global issues which require co-ordinated international multi-disciplinary research. The success of WG 33 demonstrated the advantage of combining the efforts of scientists from PICES and ICES.

In PICES, the ONCE WG could be linked to the activities of the PICES Section on Carbon and Climate (https://meetings.pices.int/members/sections/S-CC) since the major goal of ONCE will be to understand the relationship between carbon and climate, and to apply this knowledge to practical issues.

Linkage/Contributions to the FUTURE program

The objectives of the ONCE WG will directly link with the scientific priorities of the PICES FUTURE program (https://meetings.pices.int/Members/Scientific-Programs/FUTURE), such as the effects of climate change on biological processes in the ocean and the responses and consequences of these effects on ecosystem services such as regulation of carbon. In addition, the outputs of the ONCE WG will help FUTURE to develop a better understanding of thresholds, buffers and amplifiers of the cumulative effects of multiple ecosystem stresses on ecosystem resilience.

Motivation and Goals and/or Background

Negative emissions is an approach to the goal of the Paris Agreement to limit global warming to 2.0°C or even 1.5°C by the end of this century. The ocean has a large capacity to sequester carbon and has absorbed approximately 25% of the CO_2 produced by fossil fuel combustion and cement production since the beginning of the industrial revolution. Ocean Negative Carbon Emission (ONCE) has the potential to contribute to negative emissions if the mechanisms and processes involved are properly understood. The majority of the organic carbon in the ocean is in the form of dissolved organic matter (DOM), which contains an amount of carbon equivalent to the total inventory of atmospheric CO_2 and whose refractory component is a form of sequestered carbon in the ocean. The previous PICES/ICES joint WG 33 on "Climate Change and Biologically-driven Ocean Carbon Sequestration" highlighted the importance of microbial processes in the production of refractory DOM in the ocean, and identified a potential ONCE technique based on the naturally occurring microbial carbon pump. However, there is a gap between this natural process and its potential application. In addition, our knowledge of other ocean carbon sequestration mechanisms and processes, such as the solubility pump, carbonate pump and the different components of the biological carbon pump, limit their potential application for mitigating climate change. The proposed new PICES/ICES joint Working Group will promote interdisciplinary exchange among different research communities by bringing together experts with backgrounds in science (biological, biogeochemical, chemical and physical oceanography) and engineering, to develop theoretical bases, provide guidelines, and evaluate the implementation of ONCE. The activities of the proposed WG will receive strong financial support from Xiamen University, China, and more funding is currently being sought from other Chinese sources. The WG members will use data from coastal and open ocean time-series and macrocosm facilities to assess proposed ocean negative carbon emission models. The WG has the long-term objective of providing advice for climate policy and practical implementation of ONCE for the scientific community, the public and governments.

Terms of Reference:

1. Identify current knowledge gaps in negative carbon emission in the inshore and offshore oceans, and propose new research directions linking scientific research and its applications to the enhancement of negative carbon emissions.
2. Plan the development of additional long-term time series stations for the observation of carbon sequestration in representative coastal and offshore waters;
3. Propose integrated experimental studies to better understand carbon sequestration under paleo-, current and future oceanic conditions;
4. Publish reviews, special sections and/or research papers to summarize and/or analyze the mechanisms and processes of negative carbon emission in the ocean;
5. Develop a proposal or program for an international project dedicated to ocean negative carbon emission;
6. Hold annual workshops and business meetings;
7. Organize a theme symposium by the end of the 3-year WG term;
8. Submit a final report summarizing the results of the WG.

Proposed membership:
Canada (2):
Douglas Wallace, Dalhousie University;
Curtis Suttle, University of British Columbia;

USA (3):
Farooq Azam, Scripps Institution of Oceanography;
Ronald Benner, University of South Carolina;
David Hutchins, University of Southern California;

Russia (1):
Pavel Tishchenko, Il'ichev Pacific Oceanological Institute, Far East Branch Russian Academy of Sciences;

Korea (1):
Jung-Ho Hyun, Hanyang University;

Japan (1):
Youhei Yamashita, Hokkaido University;

China (3):
Nianzhi Jiao, Xiamen University;
Rui Zhang, Xiamen University;
Jihua Liu, Shandong University;

Proposed leadership:
PICES Co-chair: Nianzhi Jiao (China) and Douglas Wallace (Canada)
ICES Co-chair: Louis Legendre (France) and Carol Robinson (UK)

BIO Endnote 4

Proposal for a new Working Group on
Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi Sea (NBS-CS)

Reporting to: BIO, FIS, HD, POC, and/or FUTURE

Term: Nov. 2019- Nov. 2022

Linkage(s) to previous PICES Expert Groups or activities (if any):
Complements other current or recent past PICES Expert Groups

- WG39 Joint PICES/ICES/PAME Working Group on Integrated Ecosystem Assessment for the Central Arctic Ocean
- WG 35 North Pacific Ecosystem Status Report
- WG 19 Ecosystem-based management science and its application to the North Pacific
- WG 28 Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors
- S-CCME Climate Change Effects on Marine Ecosystems
- S-MBM Marine Birds and Mammals

Complements WG 39 (WGICA)
This project would complement, not duplicate, the work of WG39 IEA of the Central Arctic Ocean (CAO). The two projects do not overlap geographically. The CAO is LME 13 in the map above, and the Northern Bering Sea – Chukchi Sea is LME 12. It is true that the WGICA considers adjacent shelf systems such as the

Chukchi Sea to the extent that ocean currents and migratory species cross from the shelf to the CAO basin. But the WGICA does not explicitly examine all components and processes in adjacent shelf areas. An IEA of the Northern Bering Sea – Chukchi Sea LME would complement the IEA of the CAO by providing better resolution and understanding of the processes that drive currents and migratory species into the CAO. As an inflow shelf, the Chukchi Sea provides essential sources of nutrients, freshwater and heat to the Arctic Ocean, affecting processes in adjacent shelf systems as well as the deep basin.

This project has some unique features that further distinguish it from WG39. Compared to the CAO, there is a wealth of scientific knowledge in the Northern Bering-Chukchi LME. These data come from surveys of oil and gas lease areas, studies of whale foraging areas, groundfish assessment surveys, oceanographic and plankton surveys and Integrated Ecosystem Surveys. In addition, there are a number of indigenous Alaskan and Russian communities that are ready and interested in providing specialized Indigenous and Traditional Knowledge unavailable from other sources about characteristics and changes of the Northern Bering – Chukchi Sea LME.

The Northern Bering – Chukchi LME is a relatively shallow, shelf system and is therefore expected to have different key elements and processes from the deep basin of the Central Arctic Ocean. Each project will also carry forward different management implications from the knowledge gained. One key difference with management implication is that the CAO is largely outside the EEZs of the Arctic nations, whereas the Northern Bering-Chukchi LME is in the US and Russian EEZs.

In addition, PICES countries are engaged through the Arctic Observing Network (AON), the Sustaining Arctic Observing Networks (SAON) and the Arctic Observing Summit (AOS).

Linkage(s) to other organizations and programs (if any):
Co-sponsoring Organizations
ICES (TBC; support has been expressed)
IASC (TBC; support has been expressed)
NOAA IEA (TBC; support has been expressed)
Protection of the Arctic Marine Environment (PAME), Arctic Council (TBC; support has been expressed)
Bering Sea Elders Group

A preliminary list of potential partners for this Working Group:

- Alaska Seagrant – Nome office
- Arctic Monitoring and Assessment Programme, AMAP (Arctic Council)
- Arctic Marine Biodiversity Observing Network (AMBON)
- Arctic Observing Summit
- Arctic Observing Network (AON)
- Association of Village Council Presidents (AVCP) and associated Federally recognized Tribes
- Bering Sea Elders Group
- Conservation of Arctic Flora and Fauna, CAFF (Arctic Council)
- Distributed Biological Observatory (DBO)
- Ecosystem Studies of Subarctic and Arctic Seas (ESSAS)
- Interagency Arctic Research Policy Committee (IARPC)
- International Arctic Science Committee (IASC)
- Inuit Circumpolar Council (ICC)
- Kawerak, Inc. and associated Federally recognized Tribes
- Maniilaq Association and associated Federally recognized Tribes
- National Park Service – Kotzebue and Nome regions; Berengia
- Native Village of Kotzebue
- Northwest Arctic Borough
- North Slope Borough Department of Wildlife Management
- Oceans North
- Pacific Arctic Group (PAG)

- The Pew Charitable Trusts
- Protection of the Arctic Marine Environment, PAME (Arctic Council)
- S-CCME (PICES)
- Sustaining Arctic Observing Networks
- United Nations FAO
- University of Alaska International Arctic Research Center (IARC)
- Western Alaska Landscape Conservation Cooperative
- World Wildlife Fund (WWF)
- Co-management entities (Eskimo Walrus Commission, Ice Seal Committee, Beluga Committee, Alaska Eskimo Whaling Commission, Kuskokwim Intertribal Fisheries Commission; Migratory Bird Commission)

In addition, this project provides an opportunity to partner with Arctic peoples to apply multiple knowledge sources towards evaluating future impacts, risk, and adaptation measures in a changing Arctic.

Linkage/Contributions to the FUTURE program (if any):

Supports the FUTURE Science Plan
An Integrated Ecosystem Assessment can help address two of FUTURE research themes: How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future? How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems? With ocean warming and loss of sea ice the traditional PICES area of interest in the Bering Sea is being extended northward and becoming more connected to the Arctic north of Bering Strait.

Motivation and Goals and/or Background

Prolog
This proposal is the result of W17 "Scoping an IEA of the Northern Bering-Chukchi Seas Large Marine Ecosystem (LME)", held October 16, 2019. The workshop was chaired by Libby Logerwell (USA), Kirstin Holsman (USA), Raychelle Daniel (USA, The Pew Charitable Trusts) and Yutaka Watanuki (Japan). There were 19 attendees representing PICES member nations (USA, Japan, Russia, China and Canada), partner organizations (ICES and IASC), funding agencies (North Pacific Research Board), international collaborators (IMR Norway) and Indigenous organizations (Bering Sea Elders Group). Plenary and breakout group discussions accomplished an effective scoping of an Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi Sea LME. The scoping entailed:

- Review of recent research, scope of Indigenous Knowledge available, activities and priorities related to an IEA of Arctic Ecosystems
- Review of the scientific interest, community interest, data availability and overall feasibility of conducting such an IEA for the Northern Bering-Chukchi Sea region
- Assessment of the opportunities to partner with other organizations to address the issues identified above

The participants of the workshop unanimously agreed to pursue a new Working Group to conduct an Integrated Ecosystem Assessment of the Northern Bering Sea – Chukchi Sea (NBS-CS) LME. In particular, participants from WG39 (WGICA) on the Central Arctic Ocean, PAME, and ICES, noted that:

- A PICES WG on the Northern Bering-Chukchi Sea region would provide detailed assessment of the Pacific Arctic gateway, and would be a complement to the Atlantic gateways IEAs supported through ICES, all of which are linked through the PICES Central Arctic Ocean WG
- It would also provide detailed information that will inform understanding of connectivity of climate and ocean processes, species movements, shelf foodweb dynamics, fishing, trade, subsistence and food security, and human activities beyond the focal scope of WG39/WGICA but of critical importance to the CAO (and therefore identified as a needed component of future analyses).

- In turn a PICES WG on the NBS-CS would be informed by the findings of WG39/WGICA beyond the scope of the new WG but of increasing importance, especially for the NBS where multiple Pacific stocks are increasingly redistributing poleward under warming conditions.

Background

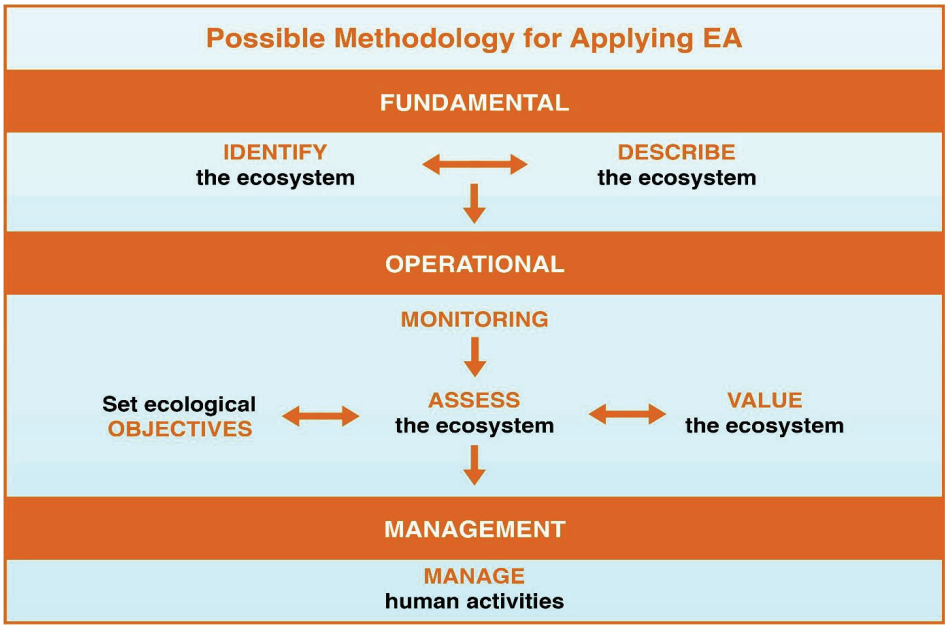
Why now?

The Northern Bering Sea-Chukchi Sea (NBS-CS) region is experiencing unprecedented ocean warming and loss of sea ice as a result of climate change. Seasonal sea ice declines and warming temperatures have been more prominent in the northern Bering and Chukchi seas as almost all other portions of the Arctic. Chronic and sudden changes in climate conditions in this Arctic gateway are increasingly impacting marine species and food-webs and expanding opportunities for commercial activities (shipping, oil and gas development and fishing), with uncertain and potentially wide-spread cumulative impacts. There are strong concerns about the impacts of climate change and industrial activities, and these impacts may be particularly pronounced in Arctic indigenous communities dependent on the health and stability of the ecosystem. The combination of unprecedented, rapid change and increased interest in the Arctic in general and the NBS-CS specifically make this an opportune time for a synthesis of issues and knowledge. An Integrated Ecosystem Assessment (IEA) can accomplish this synthesis.

Conceptual frameworks

Arctic Council Protection of the Marine Environment (PAME) Ecosystem Approach

The Arctic Council has developed a framework for implementation of the Ecosystem Approach to management (EA) of human activities in Arctic marine and coastal environments. The EA framework consists of six related elements (see figure). While they are numbered, the elements do not necessarily need to be sequential although they are eventually linked in an iterative and adaptive operational management cycle. Monitoring is an essential component of EA as illustrated in the schematic representation of the framework.

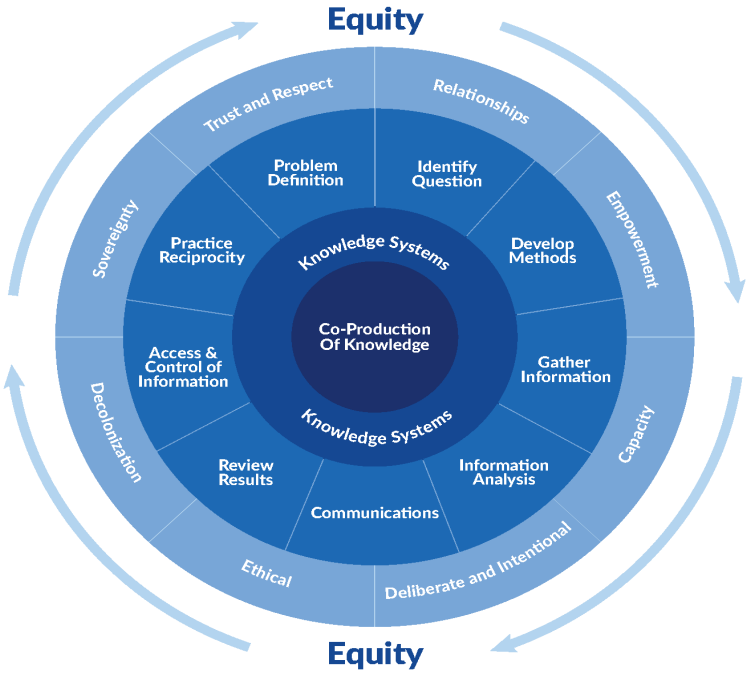


Integrated Ecosystem Assessment.

Integrated Ecosystem Assessments (IEA) synthesize understanding regarding all components of an ecosystem, including humans, to inform the decision- making process and provide Ecosystem- Based Management advice. While IEAs are policy relevant they are not policy prescriptive. A key element of each step of the IEA process (see figure) is collaboration and co-production of knowledge. IEAs can be useful for coordinating synthesis, consideration of multiple perspectives, informing management decisions, and evaluating tradeoffs, risk, and cumulative impacts.

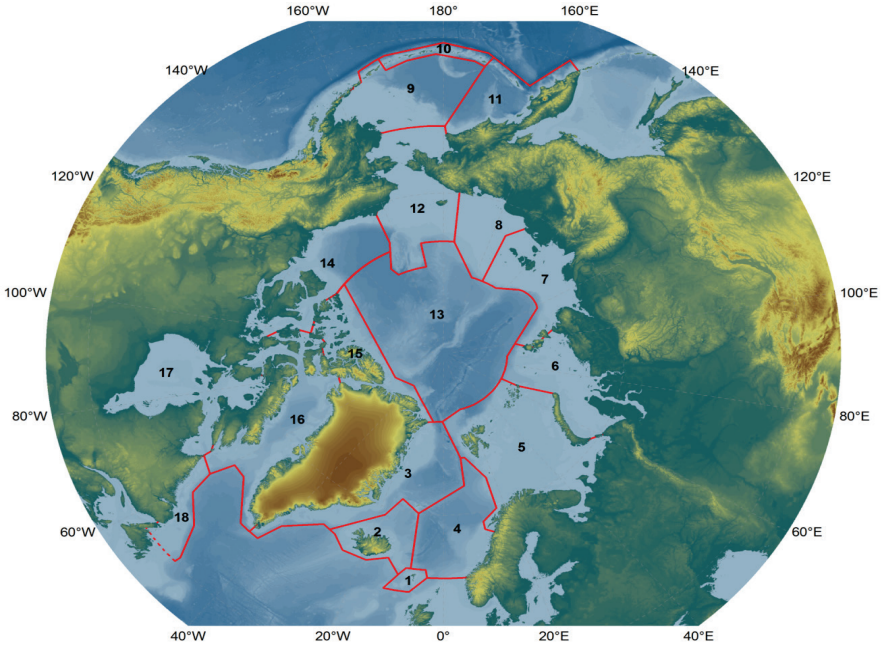
Indigenous Peoples Knowledge Systems and the co-production of knowledge approach

A strong theme in discussions at EA workshops is that Indigenous Peoples knowledge systems are important to different aspects of EA from developing guidelines to implementing the approach. Another recurring theme is the importance of communication, participation and inclusivity. EA benefits from including rightsholders, knowledge and stakeholders in the different stages of the process. This includes co-production of knowledge, which can provide a more comprehensive and holistic understanding of the Arctic ecosystems and the changes that are occurring. An inclusive process will help build interest, expand participation and create settings for those who live and operate in the Arctic to be part of the EA process. “Communicate and engage early and often” is the message from Indigenous Peoples and local Communities.



The Northern Bering Sea – Chukchi Sea LME

The 18 LMEs in the Arctic (see figure) provide a delineation and boundaries, which are useful for implementation of the EA in the Arctic. The LME boundaries define areas of coherent ecological and geophysical processes and provide an appropriate scale for assessing the structural and functional integrity of ecosystems, including the separate and cumulative impacts of human activities. The Northern Bering Sea – Chukchi Sea LME that is the focus of this proposal is Area 12 in the figure below.



Data sets and knowledge available

A preliminary list of the data sets and knowledge potentially available:

Survey	Nation(s)
Aerial Surveys of Arctic Marine Mammals (ASAMM)	US
Arctic Marine Biodiversity Observation Network (AMBON)	US
Arctic Integrated Ecosystem Survey	US
Arctic Ecosystem Integrated Survey	US
Chukchi Sea Acoustics, Oceanography, and Zooplankton (CHAOZ)	US
Chukchi Sea Environmental Studies Program	US
Chukchi Sea Ecosystem Observatory	US
Chukchi Sea Offshore Monitoring in the Drilling Area—Chemical and Benthos study and Hannah Shoal	US
Distributed Biological Observatory	US, Korea, Japan, Canada, Russia, China
K-PORT Project for Understanding and Utilizing Environmental Change in the Polar Regions	Korea, US and Canada
Indigenous Knowledge/Local and Traditional Knowledge	Russia and US
Local Environmental Observer Network	Canada and US
AFSC Groundfish Assessment Program	US
Outer Continental Shelf Environmental Assessment Program	US

Oshoro Maru surveys	Japan
Russian-American Long-term Census of the Arctic (RUSALCA)	Russia and US
Shell Oil and Gas Lease surveys	US
TINRO surveys	Russia
Western Arctic Shelf–Basin Interactions (SBI) Project	US
MV Xue Long (Snow Dragon) surveys	China

Relevance to other integrative and international projects

Fisheries Experts of the Central Arctic Ocean (FisCAO)

Scientific experts on fish stocks in the central Arctic Ocean from the Kingdom of Norway, the United States of America, Canada, the People's Republic of China, the Republic of Korea, Japan, Iceland, the European Union, and the international scientific organizations ICES and PICES, meet on an *ad hoc* basis to develop information supporting diplomatic negotiations to prevent unregulated commercial fishing on the High Seas of the central Arctic Ocean. One of their recent products is a strategy for monitoring indicators of fish stocks and ecosystem components. A key component of the strategy is using existing national programs that monitor adjacent shelf areas (such as the NBS-CS) to provide an early warning of changes in the adjacent CAO that would merit a survey effort in those, international waters. An IEA of the NBS-CS as proposed for this WG could provide such an early warning.

Integrated Ecosystem Assessment of the Northern Bering Sea

The North Pacific Research Board, which funded the recent (2017-2019) Integrated Ecosystem Research Project (IERP), a series of ecosystem at-sea surveys of the Chukchi Sea, will next fund an IERP for the Northern Bering Sea. The IEA of the NBS-CS proposed here can provide information on connectivity between the two IERP regions (NBS and CS). It can also provide a knowledge gap analysis useful for developing the call for proposals and/or evaluating proposed projects.

United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

The United Nations has proclaimed a Decade of Ocean Science for Sustainable Development (2021-2030) to support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean. As mandated by the UN General Assembly, the Intergovernmental Oceanographic Commission (IOC) of UNESCO will coordinate the Decade's preparatory process, inviting the global ocean community to plan for the next ten years in ocean science and technology. Our new WG could contribute to efforts of the science and sustainable develop community to define priorities and plan for the global ocean science agenda, develop new science and technologies needed to achieve the Decade's objectives as well as connect ocean science activities with the 2030 Agenda for Sustainable Development.

Relevance to PICES

Of interest to PICES member countries

An IEA of the Northern Bering – Chukchi Sea LME would obviously be of interest to the US and Russia. Both nations conduct fish assessment and ecosystem surveys in the region; and both have commercial fisheries adjacent to the region. Japan, China and Korea have also been carrying out surveys in the Northern Bering and Chukchi Seas. These nations consider themselves to be stakeholders in the Arctic because of tele-connections to fisheries, migratory seabirds, pollution, loss of sea ice and climate change.

Audience and communication

There will be a diverse audience for the knowledge generated by this WG. We plan to communicate to scientists, communities, NGOs, intergovernmental forums and students (elementary – college). We also plan to communicate to managers although we emphasize that our results can inform management but will not be policy prescriptive.

Supports the FUTURE Science Plan
An Integrated Ecosystem Assessment can help address two of FUTURE research themes: How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future? How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems? With ocean warming and loss of sea ice the traditional PICES area of interest in the Bering Sea is being extended northward and becoming more connected to the Arctic north of Bering Strait.

Terms of Reference:
General Terms of Reference

- Convene an interdisciplinary and international working group membership
- Include Arctic peoples and Indigenous Knowledge systems
- Identify and consult with partners and institutions

Specific Terms of Reference/Timeline
3-year plan
The first activity will be to define the scope of the project (goals, definitions, opportunities). This work was accomplished during Workshop 17. Thus, the product will be a detailed workshop report. Expected completion: December 2019.

Year 1

- Kawerak, Inc. and partner organizations conduct a cultural awareness training workshop for members of the WG
- Determine approach and methodology for conducting an IEA in the Northern Bering – Chukchi Sea LME.
- Compile an inventory of scientific data sets and indigenous knowledge available
- Compile an inventory of institutions and programs active in the region.

Year 2

- Describe the key physical, biological and human elements of the ecosystem
- Develop shared conceptual models including both Indigenous Knowledge and science; and review of hypotheses for ecosystem dynamics
- Identify potential indicators of the above key elements
- Describe the goals & targets
- Describe the objectives & values

Year 3

- Assess ecosystem status and trends
- Identify potential impacts/risks at the LME-scale; and at the local scale with emphasis on human use and Indigenous Knowledge
- Knowledge gap analysis

Extended to 5-year plan
Should PICES and other cooperating organizations support continued work, we anticipate proposing the following for years four, five or beyond:

- More detailed assessment of impacts and risks at local and ecosystem scale
- Description of interactions between local and ecosystem scale
- Development of ecosystem model(s)

Deliverables
Year 1

- Inventory of metadata, knowledge, institutions and programs relevant to the Northern Bering Sea-Chukchi Sea LME. PICES or ICES Report.

Year 2

- Ecosystem description from both Indigenous world views and science (shared conceptual models), indicators and hypotheses. PICES or ICES Report. Contribution to Arctic Report Card and or ecosystem status report.
- Report on Ecological Objectives (co-produced with PAME)
- Report on Ecological Values Workshop (co-produced with PAME)

Year 3

- Integrated Ecosystem Assessment for the Northern Bering Sea-Chukchi Sea LME. PICES or ICES Report. Contribution to NPESR. PAME-AMAP-CAFF Report. Contribution to Arctic Report Card
- Journal articles
- Outreach activities

Audience and communication

There will be a diverse audience for the knowledge generated by this WG. We plan to communicate to scientists, communities, NGOs, intergovernmental forums and students (elementary – college). We also plan to communicate to managers although we emphasize that our results can inform management but will not be policy prescriptive.

Proposed membership:

First Name	Last Name	Country	Institution	Expertise
Matthew	Asplin	Canada	ASL Environmental Sciences Inc.	Physical oceanography
Changun	Xu	China	Third Institute of Oceanography, Ministry of Natural Resources	Fish/fisheries
Taka	Hirata	Japan	Hokkaido University	Biological oceanography
Yutaka	Watanuki	Japan	Hokkaido University	Seabirds
Shigeto	Nishino	Japan	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Physical oceanography
La	Hyoung Sa	Korea	Korean Polar Research Institute	Zooplankton, acoustics
Kirill	Kivva	Russia	Russian Federal Research Institute of Fisheries and Oceanography	Fish/fisheries
Aleksey	Somov	Russia	Pacific Scientific Research Center	Fish/fisheries
Andy	Whitehouse	USA	NOAA Alaska Fisheries Science Center	Food web modeling
Matthew	Baker	USA	North Pacific Research Board	Fish/fisheries
Lyle	Britt	USA	NOAA Alaska Fisheries Science Center	Fish/fisheries
Lee	Cooper	USA	International Arctic Science Committee; University of Maryland Center for Environmental Science	Benthos
Raychelle	Daniel	USA	The Pew Charitable Trusts	Indigenous/Traditional Knowledge
Lisa	Eisner	USA	NOAA Alaska Fisheries Science Center	Biological oceanography
Megan	Ferguson	USA	NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory	Marine mammals
Jackie	Grebmeier	USA	Pacific Environmental Group; University of Maryland Center for	Benthos

First Name	Last Name	Country	Institution	Expertise
			Environmental Science	
Chris	Harvey	USA	NOAA Northwest Fisheries Science Center	Integrated Ecosystem Assessment
Alan	Haynie	USA	NOAA Alaska Fisheries Science Center	Economics
Mellisa	Heflin	USA	Bering Sea Elders Group	Indigenous/Traditional Knowledge
Kirstin	Holsman	USA	NOAA Alaska Fisheries Science Center	Integrated Ecosystem Assessment
Henry	Huntington	USA		Indigenous/Traditional Knowledge
Katrin	Iken	USA	Arctic Marine Biodiversity Observing Network (AMBON); University of Alaska	Benthos
Kathy	Kuletz	USA	US Fish and Wildlife Service	Seabirds
Carol	Ladd	USA	NOAA Pacific Marine Environmental Laboratory	Physical oceanography
Franz	Mueter	USA	Arctic Marine Biodiversity Observing Network (AMBON); University of Alaska	Fish/fisheries
Eriksen	Elena	Norway	ICES	Integrated Ecosystem Assessment

Proposed Leadership:
Co-chair: Libby Logerwell (USA)
Co-chair: Yury Zuenko (Russia)