Report of Working Group on *Climate and Ecosystem Predictability*

The third business meeting of Working Group 40 (WG 40) on *Climate and Ecosystem Predictability* was held on October 20, 2019 in Victoria, Canada. There were 10 WG 40 members in attendance plus 15 additional participants, including a number of members of the CLIVAR Pacific Region Panel (***WG 40 Endnote 1***). The meeting started with a short business meeting where progress in the past year and plans for the coming year were discussed, including workshop and topic session proposals for PICES-2020. The rest of the day was devoted to science talks and discussion from members of WG 40 and the CLIVAR Pacific Region Panel to encourage exchange of information and collaboration between the groups. Below are the agenda items (***WG 40 Endnote 2***) and related notes from the meeting.

WG 40 participants at PICES-2019 in Victoria, Canada. Back row, left to right: Jim Christian, Mike Jacox, Mercedes Pozo Buil, Samantha Siedlecki, Art Miller, Yukiko Imada, Jing-Jia Luo, Ryan Rykaczewski, Xiaopei Lin, Jing Li. Front row, from left: Caihong Fu, Samantha Stevenson, Vladimir Kulik, Xuebin Zhang, Antonietta Capotondi, Yu Kosaka, Shoshiro Minobe, Baolan Wu, Masami Nonaka, Matthieu Lengaigne, Emanuele Di Lorenzo, Jerome Vialard. Missing from photo: Michael McPhaden, Janet Sprintall, Andrew Wittenberg

AGENDA ITEM 1
WG 40 meeting

Update on ICES WGS2D

Collaboration with the ICES Working Group on Seasonal to Decadal Marine Ecosystem Forecasting (WGS2D) is embedded in the terms of reference of WG 40. We have maintained dialogue with that group over the past two years with an eye toward mutual benefits and collaboration. While WG 40 is set to finish its term in 2020, WGS2D will be renewed for three more years. Chair Mark Payne has expressed interest in collaborating with PICES beyond the WG 40 lifetime, potentially through the contributions of each group to the UN Ocean Decade theme "a predicted ocean". WG 40 members feel there is potential benefit to collaboration between the groups in this context, though it would be focused on methods (both scientific and management/stakeholder engagement) rather than specific applications.

Updates from FUTURE

WG 40 Co-Chair and FUTURE Scientific Steering Committee member Ryan Rykaczewski presented an update from FUTURE. In the past year FUTURE published a synthesis paper describing their Social-Ecological-Environmental Systems (SEES) framework (*Frontiers in Marine Science*, 2019, Vol. 6, Article 333). A meeting is planned during PICES-2019 (evening of October 23) for WG 40, WG 41, and WG 36 to meet with FUTURE and develop one or more case studies that map onto the SEES framework. Several potential ideas were presented including an analysis of ENSO impacts across the North Pacific.

Update on June 2019 Inter-sessional workshop in Qingdao and journal Special Issue

WG 40 held an inter-sessional meeting in Qingdao, China in June 2019 (see PICES Press, 2020, Vol. 28, No. 1, pp. 51–53). The aim of the workshop was to make progress toward a synthesis of marine ecosystem prediction in the North Pacific. Attendees included WG 40 members as well as a number of local scientists. From the workshop a plan was developed to put together a special issue in a peer-reviewed journal, and subsequently a proposal was submitted to *Frontiers in Marine Science* for "Climate and Marine Ecosystem Predictability". We are awaiting approval of the special issue, which will draw submissions from the POC/FUTURE-sponsored Topic Session (S15) on "*Advances in North Pacific marine ecosystem prediction*" at this year's PICES Annual Meeting. The expected timeline for the issue is for abstract submission by November 30 and manuscript submission opening December 15 with a deadline of March 31, 2020.

Planning for next year

Entering the final year of WG 40, we had some discussion of products and plans for the coming year. Fangli Qiao is working to develop a website for hosting forecasts relevant to the PICES community and expects it to be online in the coming months, at which point there will be further discussion about what type of material can be contributed and by whom. PICES-2020 was also discussed with respect to potential WG 40-sponsored workshops and/or topic sessions. FUTURE is planning to lead a workshop to explore socioeconomic impacts of extreme events using the SEES framework, and WG 40 will participate in that workshop. We are also proposing to have a related topic session on the predictability of extremes and related implications for management (WG 40 *Endnote 3*). This session idea was selected because it (i) addresses WG 40's fourth term of reference (past topics sessions have addressed other TORs), (ii) capitalizes on high interest in ocean extremes within PICES and in the broader science community, and (iii) links predictability through to ecosystem impacts and the implications for management and society.

AGENDA ITEMS 2 and 3

Joint meeting of WG 40 and CLIVAR Pacific Panel

The bulk of the day was spent on a session of science talks and discussion held jointly with members of the CLIVAR Pacific Panel. Three opening talks provided general context for the working group and predictability across the North Pacific, and subsequent talks highlighted a wide range of techniques and applications for marine ecosystem prediction. Speakers and titles are listed below:

- Emanuele Di Lorenzo: *Motivation and development of WG 40*
- Mike Jacox: *Mechanisms of predictability in the eastern North Pacific*
- Shoshiro Minobe: *Mechanisms of predictability in the western North Pacific*
- Antonietta Capotondi: *Forecasting with Empirical Models: How important is ENSO for US West Coast warming?*
- Tongtong Xu: *Forecasting with Empirical Models: Toward a unified platform for assessing predictability along the eastern and western Pacific coastlines*
- Samantha Siedlecki: *Processes that drive variability of hypoxia in the coastal ocean: examples from the west coast of the U.S.*
- Ryan Rykaczewski: *Predicting interannual anomalies in biogeochemical conditions in the California Current*

- Xiaopei Lin: *AMO Induced Multidecadal Variability in the Western Pacific Ocean*
- Jing-Jia Luo: *Use of Machine Learning techniques in forecasting applications: Successes in ENSO predictions*
- Yu Kosaka: *The North Pacific pacemaker effect on ENSO and its Mechanisms*
- Xuebin Zhang: *Mechanisms of Marine Heat Waves in the Tasman Sea in the Presence of Global Warming*
- Matthieu Lengaigne: *Mechanisms driving the projected weakening of summer primary productivity of the Arabian Sea under climate change: New insights from CMIP5*

WG 40 Endnote 1

WG 40 participation list

PICES members

Antonietta Capotondi (USA, CLIVAR Co-Chair)
Michael Jacox (USA, PICES Co-Chair)
Shoshiro Minobe (Japan, CLIVAR Co-Chair)
Masami Nonaka (Japan, PICES Co-Chair)
Ryan R. Rykaczewski (USA, CLIVAR Co-Chair)
James Christian (Canada)
Emanuele Di Lorenzo (USA)
Caihong Fu (Canada)
Vladimir Kulik (Russia)
Samantha Siedlecki (USA)

CLIVAR Pacific Region Panel members

Antonietta Capotondi (USA, Co-Chair)
Matthieu Lengaigne (France, Co-Chair)
Yukiko Imada (Japan)
Yu Kosaka (Japan)
Jing Li (China)
Xiaopei Lin (China)
Michael McPhaden (USA)
Janet Sprintall (USA)
Samantha Stevenson (USA)
Jerome Vialard (France)
Andrew Wittenberg (USA)
Xuebin Zhang (Australia)

PICES members unable to attend

China: Ying Bao, Fei Chai, Jinqiu Du
Japan: Akinori Takasuka
Korea: Chan Joo Jang, MinHo Kwon, Chung Il Lee
Russia: Yury Zuenko

Observers

Steven Bograd (FUTURE SSC Co-Chair/USA)
William Merryfield (Canada)
Arthur Miller (USA)
Mer Pozo Buil (USA)

WG 40 Endnote 2

WG 40 meeting agenda

WG 40 meeting

1. WG 40 business
   - Update from FUTURE
   - Updates on inter-sessional meeting and special issue
   - Update on ICES WGS2D and potential collaboration
   - WG40 plans for coming year

Joint Meeting of WG40 and CLIVAR Pacific Panel

2. Welcome and introduction
3. Science talks and discussion
4. Adjourn

WG 40 Endnote 3

Proposal for a Topic Session on
"*Predictions of extreme events in the North Pacific and their incorporation into management strategies*"
at PICES-2020

Duration: 1 day

Convenors: Samantha Siedlecki (USA), Ryan Rykaczewski (USA), Jing-Jia Luo (China)

Potential Invited Speakers: Clarissa Anderson (USA), Alistair Hobday (Australia), Feng Zhou (China), Debby Ianson (Canada)

Publication: At minimum, a PICES Press article

Marine ecosystems of the North Pacific are susceptible to episodic, extreme events of various types, including marine heatwaves, periods of hypoxia/anoxia or corrosive conditions, and harmful algal blooms (HABs). There is rising concern that these events may become more common and/or severe in the future. Extreme events can have a marked impact on ecosystem resources and societal use of the coast environment with consequences for recreation, human and ecosystem health, aquaculture productivity, and the distribution, composition, and productivity of marine fisheries. While our ability to predict ecosystem changes and societal impacts has improved in recent years with improved understanding of coupled physical, biological, and social dynamics, the episodic nature of extreme events and the rarity at which they have been observed challenge attempts to forecast their occurrence. However, the severe ecological and societal consequences of these extreme events make them desirable targets for predictions that enable proactive management.

PICES WG 40 aims to identify, diagnose, and quantify predictable response in North Pacific marine ecosystems that arise from regional and large-scale climate processes. In this session we will seek contributions that highlight advances in the prediction of extreme events (*e.g.*, temperature, oxygen, pH, HABs), the characterization or identification of mechanisms responsible for their individual or co-occurrence, and the strategies to incorporate those predictions into management. This topic is relevant to the first three terms of reference of WG 40, but also to ToR #4 (exploring integration of predictions in the management of ecosystem services), which has received somewhat less attention in our previous activities. This proposed session is intended to advance the ToR of WG 40 and build on strong momentum from (1) the ECCWO session "*From prediction to projection: the role of seasonal to decadal forecasts in a changing climate*", (2) the PICES-2018 Topic Session "*Ecological responses to variable climate changes and their*

applicability to ecosystem predictions", (3) the CLIVAR–PICES 2019 workshop "*Towards an integrated approach to understanding ecosystem predictability in the North Pacific*", (4) the PICES-2019 Topic Sessions "*Marine heat waves in the North Pacific: Predictions and impacts in coastal regions*," "*Coastal ocean modelling in the North Pacific*," and "*Advances in North Pacific marine prediction*", and (5) a planned FUTURE-sponsored workshop on social impacts of extremes at PICES-2020. Outside of PICES-associated meetings, this proposed session also leverages efforts of NOAA's Marine Prediction Task Force (MPTF) whose lifespan matches that of WG 40 (2017–2020) and whose intent is to improve seasonal forecasts for management of living marine resources.

Co-sponsorship

We seek POC and FUTURE co-sponsorship for this topic session. We envision this session being offered in coordination with a FUTURE-sponsored workshop exploring the social impacts of extreme events in the context of the SEES framework.