

Report of the Section on *Climate Change Effects on Marine Ecosystems*

The meeting of the Section on *Climate Change Effects on Marine Ecosystems* (S-CCME) was held from 18:00 to 21:00 h on November 4, 2016, in San Diego, USA. S-CCME Co-Chairs, Drs. Anne B. Hollowed and Shin-ichi Ito, welcomed all participants (*S-CCME Endnote 1*). Dr. Hollowed chaired the meeting and began with a review of the agenda (*S-CCME Endnote 2*). No additional changes/additions were offered and the agenda was adopted.

AGENDA ITEM 2

Membership

The membership will be updated based on a transition in the Section's needs and activities as well as due to the fact that some members are now retired, such as Dr. Helen Joseph. Drs. Nancy Shackell from the Department of Fisheries and Oceans Canada, was nominated and has agreed to serve on S-CCME in her place. Dr. Michael Foreman retired and Angelica Peña has been nominated to serve in his place. Confirmation of Dr. Foreman's replacement was approved during the PICES Annual Meeting. Dr. Harald Loeng has retired and Randi Ingvaldsen has been nominated as his replacement. Three new members (representing ICES) were added to S-CCME: Dr. Sara Gainluca (UNIP), Valerio Bartolino (Sweden) and Mikael van Deurs (DK).

- A. Requests were made to the U.S. delegation to add Drs. Kirstin Holsman and Alan Haynie to the Section. S-CCME Co-Chairs nominated Jose Fernandes (UK, PML), Trond Krisitiansen (Norway, NIVA), Hamon Katell (The Netherlands, DLO-LEI) and Mark Payne (DK, DTU-Aqua) to be ICES members of the Section.

The S-CCME Co-Chairs discussed ways to increase the engagement of the climate/ocean science community in ICES. They noted that PICES has a standing committee focused on physical oceanography and climate (POC). POC provides an opportunity for professional development at PICES meetings. ICES typically does not have physics-focused theme sessions. Therefore, the physical oceanographic community (particularly scientists creating and/or downscaling Global Climate Models) seldom has enough physical scientists assembled an ASC. The S-CCME/ICES Co-Chairs recommended that membership include a core suite of leading climate/oceanography leaders who might be a draw for others to ICES meetings. Potential candidates would include Jonathan Tinker (Met Office, UK), Daniela Matei (MPI, Germany), and Charles Stock (GFDL, NOAA, USA). Coordination in the development of theme sessions for the ICES ASC with WGS2D, WGIPEM, WGOOFE and other groups with physical, biogeochemical modelers is also recommended.

AGENDA ITEM 3

Activities

S-CCME activities are contributing to the overall goals and objectives of S-CCME as well as to the PICES and ICES Science Plans. This strategic initiative is co-chaired by Drs. Anne Hollowed (USA, PICES), Shin-ichi Ito (Japan, PICES), Myron Peck (Germany, ICES) and John Pinnegar (UK, ICES). A detailed, 3-year (Phase 3) plan will be submitted to PICES next spring and is not included in this update. It will be made available to ICES SCICOM as soon as it has been submitted. It contains slight modifications (additions) to the S-CCME mission in light of the success of previous activities identifying and aligning (to the fullest extent possible) climate change research activities in regional nodes across the northern hemisphere and elsewhere. A roadmap of future activities highlights comparative/synthetic products for uptake in the next IPCC assessment report.

Activities 2016/17

1. June 2016: **An ICES/PICES inter-sessional workshop on “Economic modelling of the effects of climate change on fish and fisheries”** (WKSICCME_Econ), held in Brest, France (See *S-CCME Endnote 3*).
2. August 2016: **A CLIVAR/PICES workshop on ENSO predictability** that ICES/SICCME co-sponsored (via travel funds to Mark Payne). Dr. Payne reported that “the California Current Community is further ahead than us, in that they have a long history of thinking about physical–biological connections, and already have some operational forecast systems running (*e.g.*, J-SCOPE). On the other hand, our (SICCME) thinking is much further advanced, and our potential prediction horizons are much longer (years in Europe, months in the Pacific).” There was also a strong desire expressed to link the ICES and PICES working groups together, but the idea of proposing a joint theme session at the next Symposium on “*The effects of climate change on the world’s oceans*” in 2018 in Washington, DC, was mooted.
3. September 2016: **ICES/PICES sponsored Theme Session I on “Seasonal-to-decadal prediction of marine systems: Opportunities, approaches and application” at ICES ASC in Riga, Latvia**. Seasonal to decadal prediction of marine systems: opportunities, approaches and applications. Co-convened by Mark Payne (ICES/Denmark), Desiree Tommasi (PICES/USA), Alistair Hobday (Australia).
4. September 2016: **An ICES/PICES Workshop on “Phase 1: Modelling effects of climate change on fish and fisheries” (WKSICCME1)**. This was a full-day open workshop to review regional models and preliminary results on the ICES side. It was held in conjunction with the ICES ASC in Riga, Latvia, and co-convened by John Pinnegar (ICES/UK), Myron Peck (ICES/Germany), Mark Payne (ICES/Denmark), Anne Hollowed (PICES/USA). (See *S-CCME Endnote 4*).
5. October 2016: **41st Annual Groundfish Forum plenary presentation of S-CCME activities**. Myron Peck was invited to discuss potential risks and benefits of climate change to the fisheries sector. At this global event, S-CCME activities and regional research nodes were presented.
6. November 2016: **PICES Workshop W5, on S-CCME modelling updates**. This was a full-day open workshop to review regional models and preliminary results on the PICES side. It was held in conjunction with the PICES-2016 in San Diego, USA, and co-convened by Anne Hollowed (PICES/USA), John Pinnegar (ICES/UK), Shin-ichi Ito (PICES/Japan) (See *S-CCME Endnote 5*, [PICES Press 25\(1\):18–23](#))
7. November 2016: **ICES/PICES Topic Session (S7) on “New stage of ocean acidification studies: Responses of oceanic ecosystems including fisheries resources” at PICES-2016** considered over 20 years of progress on ocean acidification studies. Co-Convened by Tsuneo Ono (S-CC/Japan), Jun Kita (Japan), Debby Ianson (Canada), John Pinnegar (ICES/UK). Invited speakers: John Pinnegar (UK), Georg Waldbusser (USA), Steve Widdicombe (UK).
8. November 2016: **Climate change and fisheries and aquaculture stakeholder engagement workshop**. The Hague (Netherlands) hosted by Wageningen Economic Research (LEI). This event was part of the EU H2020 Project CERES (Climate change and European Aquatic Resources), involving many (European) S-CCME members (including Myron Peck, John Pinnegar).
9. December 2016: **ICES/PICES Workshop on “Understanding the impacts and consequences of ocean acidification for commercial species and end-users” (WKACIDUSE)**, at ICES HQ, Copenhagen (See *S-CCME Endnote 6* for ToRs). Chaired by Silvana Birchenough (ICES/UK), Catriona Clemmesen-Bockelmann (BioAcid, Germany) and Tsuneo Ono (PICES/Japan). S-CCME was represented by John Pinnegar (ICES/UK).
10. December 2016: **Scoping Meeting for the IPCC Special Report on Climate Change, the Oceans, and the Cryosphere**, at Monaco. Manuel Barange (FAO), William Cheung (Canada), and Shin-ichi Ito (PICES/Japan) attended from S-CCME.

Planned Activities (looking forward)

1. March 2017: A **S-CCME side-event (March 4) to the PICES/ICES/FAO Symposium on “Drivers of dynamics of small pelagic fish resources”**, Victoria, Canada, has been organized to allow ICES and PICES participants to review our accomplishments, and to discuss and update our Implementation Plan. The outcome of this meeting will set the stage for PICES and ICES research on the effects of climate change on marine ecosystems for the period 2018–2021.
2. March 2017: **PICES/ICES/FAO Symposium on “Drivers of dynamics of small pelagic fish resources”** – S-CCME will hold two workshops: Workshop 4 on “*Modeling migratory fish behavior and distribution*” convened by Shin-ichi Ito (Japan) and Enrique Curchitser (USA) and Workshop 5 on “*Recent advances in the life stage ecophysiology of small pelagic fish: Linking laboratory, field and modeling studies*” convened by Myron Peck (Germany), Kirstin Holsman (USA), Shin-ichi Ito (Japan) and Laure Pecquerie (France).
3. March 2017: Galway, Ireland. SICCME members will meet at the **CERES Annual Meeting** to review progress on future scenarios for EU fisheries as well as vulnerability assessments. CERES is coordinated by Myron Peck (Univ. Hamburg) with many S-CCME members (including John Pinnegar, Cefas; Mark Payne, DTU). Anne Hollowed, (NOAA) and William Cheung (UBC, Canada) will attend as members of the Research Advisory Board (RAB).
4. May 2017: **31st Wakefield Symposium on “Impacts of a changing environment on the dynamics of high-latitude fish and fisheries”** (May 9–12, 2017, Anchorage, Alaska). This symposium will examine the impacts of the environment, especially climate change and variability, on the dynamics of Arctic and Subarctic species of commercial, subsistence, and ecological importance. It will focus on the effects of warming, loss of sea ice, ocean acidification, and oceanographic variability on the distribution, phenology, life history, population dynamics, and interactions of these species and how a better understanding of these effects can inform the assessment and management of fish and invertebrate. PICES is a co-sponsor of this event. S-CCME is represented on the scientific steering committee (Anne Hollowed, NOAA; Mark Payne, DTU Aqua; Franz Mueter, University of Alaska Fairbanks).
5. June 2017: **ESSAS Open Science Meeting on Subarctic and Arctic Science** (June 11–15, 2017 Tromsø, Norway). The Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) is a regional program of the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project. Its objectives are to understand how climate variability and climate change affect the marine ecosystems of Subarctic and Arctic seas and their sustainability, and in turn, how changes in these marine ecosystems affect humans. The title of the OSM is “*Moving in, out and across the Subarctic and Arctic marine ecosystems: shifting boundaries of water, ice, flora, fauna, people and institutions*”. S-CCME is represented on the scientific steering committee by Ken Drinkwater (IMR), Alan Haynie (NOAA), Shin-ichi Ito (University of Tokyo), and Franz Mueter (University of Alaska Fairbanks).
6. July 2017: A **3-day workshop on “Regional climate change vulnerability assessment for the large marine ecosystems of the northern hemisphere”** (WKSICCME-CVA) at ICES HQ, Copenhagen, is requested by the ICES Secretariat as an activity of S-CCME (*S-CCME Endnote 7*). Task teams have been or are in the process of being formed to conduct vulnerability assessments in various regions around the world, including many Large Marine Ecosystems within the ICES and PICES member countries. This workshop will compare and contrast various vulnerability assessment approaches as well as drafting short statements on climate change impacts and vulnerability for regional ecosystem overviews produced at ICES and potentially other organizations. Several PICES members will attend.
7. September 2017: **ICES ASC 2017** (September 18–21, 2017, Fort Lauderdale, USA). ICES/PICES Theme Session A on “*Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries, and fishery dependent communities*” Proposed convenors: Jon Hare (USA); John Pinnegar (UK); Myron Peck (Germany); Shin-ichi Ito (Japan) (See *S-CCME Endnote 8*). The format will allow for suites of regionally focused papers that address modeling approaches, environmental change, representative fishing scenarios, implications to fisheries, and implications to human communities.

8. September 2017: S-CCME has requested an open session slot at ICES ASC 2017 (Wednesday 15:00–16:30 – 1½ hours) to discuss progress on modelling nodes and to get general updates from both ICES and PICES partners. Another important element is to discuss ongoing efforts to incorporate and align political, social and economic trajectories of change into future climate change scenarios being tested in various programs around the world. This will form a strong link with the Strategic Initiative on the Human Dimension (SIHD).
9. September 2017: **PICES-2017** (September 22–October 1, 2017, Vladivostok, Russia) Topic Session on “*Can short-term forecasts inform long-term climate projections and vice-versa?*” (**S-CCME Endnote 9**).
10. May 2018: The 4th International Symposium on “*The Effects of climate change on the world’s oceans*” co-sponsored by PICES/ICES/IOC will be held in Washington, DC, USA (2013/3/SSGHIE04). Jason Link, (ICES/USA), Shin-Ichi Ito (PICES/S-CCME/Japan), and NN (IOC) will be the lead convenors. S-CCME representation on the scientific steering committee includes Anne Hollowed (PICES/USA), Myron Peck (ICES/Germany), John Pinnegar (ICES/UK), Angelica Peña (PICES/USA), and Kirstin Holsman (PICES/USA). Plans are well underway, including finalized text for the mission statement/call for papers and announcement to convenors of potential theme sessions.

AGENDA ITEM 4

Funding updates

- A. EU H2020 project “Climate change and European aquatic RESources” (CERES) started work in March 2016 and addresses H2020-BG-2015-2 on ‘Blue Growth’. The kick off meeting was held April 6–8, 2016, Palma, Majorca. It is a 4-year project (2016–2019), coordinated by the University of Hamburg (Myron Peck) and involves scientists and industry partners from 14 countries. (See <http://ceresproject.eu>.)

CERES will involve and closely cooperate with industry and policy stakeholders to:

1. Provide regionally and industry relevant, short-, medium- and long-term future projections of key environmental variables for European marine and freshwater ecosystems;
2. Integrate the resulting knowledge on changes in productivity, biology and ecology of wild and cultured animals (including key indirect/food web interactions), and scale up to consequences for shellfish and fish populations and assemblages as well as their ecosystems and economic sectors;
3. Anticipate responses and assist in the adaptation of aquatic food production industries to underlying biophysical changes, including the development of early warning methods, new operating procedures, infrastructures, location choice and commercial markets;
4. Assess relative exposure, sensitivity, vulnerability and adaptive capacity within the European fisheries and aquaculture sectors;
5. Consider market-level responses to changes (both positive and negative) in commodity availability as a result of climate change;
6. Apply innovative risk-assessment methodologies that encompass drivers of change, threats to fishery and aquaculture resources, barriers to adaptation and likely consequences if mitigation measures are not put in place;
7. Formulate viable autonomous adaptation strategies (solutions) within the industries to circumvent/prevent perceived risks or to access future opportunities;
8. Formulate policy guidelines (solutions) and highlight management challenges where established governance structures may hinder successful adaptation to long-term climate change;
9. Effectively communicate these findings and tools to potential end users and relevant stakeholders.

The total budget for CERES will be €5.58 million and the project will run over 48 months (2016–2019).

- B. EU H2020 project “CLIMEFISH” has been funded under exactly the same call as CERES (see above). In ClimeFish, 21 institutes from 16 countries will work together, and the consortium is led by Michaela Aschan (University of Tromsø, Norway). (See <http://climefish.eu/>.)

ClimeFish has eight specific objectives:

1. To investigate the effects of climate change on fisheries and aquaculture at European and regional scales, and to collect and harmonize relevant data which will be made available in the H2020 Open Research Data Pilot;
 2. To develop novel forecasting models to simulate and analyse changes in distribution and production in the fisheries and aquaculture sectors;
 3. To identify risks and opportunities based on analysis of market and non-market costs and benefits of affected ecosystem services; propose potential mitigation strategies;
 4. To develop early warning methodologies for these risks, including a traffic-light system;
 5. In co-creation with stakeholders, develop case-specific Management Plans that mitigate risks and utilize opportunities associated with anticipated effects of climate change on aquatic production, based on ecosystem and results-based management approaches;
 6. In co-creation with stakeholders, develop guidelines, good practice recommendations and a voluntary European standard outlining how to develop this type of Management Plans in the future;
 7. In co-creation with stakeholders, develop the ClimeFish Decision Support Framework. This contains the ClimeFish Decision Support System and other decision support resources, such as models, datasets, sample runs and guidelines;
 8. To provide training and dissemination for industry, policy makers, scientists and other stakeholders; to ensure active utilization of the developed tools and guidelines beyond the project lifetime in close collaboration with the European Climate Adaptation Platform (Climate- ADAPT).
- C. NOAA has funded a new comprehensive Bering Sea climate change project: the Alaska CLimate Integrated Modelling, ACLIM, (http://www.afsc.noaa.gov/News/BS_climate-change-study.htm). This 3- year project (2015–2017) will utilize a multi-model climate projection framework that will allow scientists to understand the implications of different sources of uncertainty (*e.g.*, scenario uncertainty, parameter uncertainty, process uncertainty, and structural uncertainty) in projections of climate change impacts on fish and fisheries in the Bering Sea.
- D. NOAA’s Climate Program Office has funded several climate-related research projects in New England. A call for proposals for similar work in the California Current was released in the fall 2016.
- E. The Nereus Program, in collaboration with the NIPPON Foundation and the University of British Columbia, has been funded to conduct a study to improve multi-decadal scale predictions of global ocean fisheries.
- F. The Science and Technology Ministry of China has a project titled “Projecting climate impacts to the coastal zone in China”.
- G. Ken Drinkwater, Franz Mueter and Sei-Ichi Saitoh have started a 3-year research project on “Synthesizing climate change effects on fish and fisheries in Subarctic/Arctic seas”.

AGENDA ITEM 5

Other business

- B. A 1-year Study Group on *Climate and Ecosystem Predictability*, chaired by Nicholas Bond, was established at PICES-2015. Anne Hollowed is a member and has looked for ways to ensure the products are complimentary to the overarching activity of S-CCME (especially with respect to Terms of Reference 2–4 http://www.pices.int/members/study_groups/SG-CEP.aspx).
- C. PICES and ISC established a joint Working Group on *Oceanographic Conditions on Distribution and Productivity of Highly Migratory Species* (WG 34) at PICES-2015. The WG intends to produce a habitat model for North Pacific albacore, which will have a finer-scale resolution than the ecosystem models that currently exist for the central North Pacific region of S-CCME modelling efforts. WG 34 will also identify

the underlying mechanisms for this, and other commercially important species. The habitat model developed could be coupled to climate change model outputs for forecasting. The proposed WG products will be beneficial for S-CCME efforts.

S-CCME Endnote 1

S-CCME participation list

Members

Kenneth Drinkwater (Norway/ICES)
Alan Haynie (USA)
Anne B. Hollowed (USA, Co-Chair/PICES)
Kirstin Holsman (USA)
Shin-ichi Ito (Japan, Co-Chair/PICES)
Sukgeun Jung (Korea)
Sukyung Kang (Korea)
Suam Kim (Korea)
Jacquelynne King (Canada)
Franz Mueter (USA)
Angelica Peña (Canada)
John Pinnegar (UK/ Co-Chair/ICES)
Xiujuan Shan (China)
Motomitsu Takahashi (Japan)
Cisco Werner (USA)
Phoebe Woodworth-Jefcoats (USA)

Observers

Steven Bograd (USA, FUTURE SSC Co-Chair)
John Stein (USA, GC)
Gavin Fay (USA)
Elliott Hazen (USA, SG-CERP Chair)
Tyler Eddy (Canada)
Albert Hermann (USA)
Kelly Kearney (USA)

And others



Participants of Workshop 5 at PICES-2106. Front row, from left: Alan Haynie (USA), Albert Hermann (USA), Cisco Werner (USA), Sukyung Kang (Korea), Phoebe Woodworth-Jefcoats (USA), John Pinnegar (UK), Angelica Peña (Canada); middle row, from left: Shin-ichi Ito (Japan), Michio Kawamiya (Japan), Anne Hollowed (USA), Jacquelynne King (Canada), Kelly Kearney (USA), Ken Drinkwater (Norway), John Stein (USA), Gavin Fay (USA), Kirstin Holsman (USA), Elliott Hazen (USA), Tyler Eddy (Canada), Motomitsu Takahashi (Japan), Lingbo Li (USA), Sukgeun Jung (Korea), Suam Kim (Korea); back row, from left: Steven Bograd (USA), Franz Mueter (USA), and Jon Hare (USA).

*S-CCME Endnote 2***S-CCME meeting agenda**

1. Welcome and introductions
2. Membership
3. Activities
4. Funding updates
5. Other business

S-CCME Endnote 3

**PICES/ICES S-CCME inter-sessional workshop on
 “Economic modelling of the effects of climate change on fish and fisheries”
 (WKSICCME_Econ)**

The ICES/PICES Workshop on “*Economic modelling of the effects of climate change on fish and fisheries*” (WKSICCME_Econ) was convened June 3-4, 2016, in Brest, France. The workshop arose out of the August 2015 meeting of the Strategic Initiative (Section) on *Climate Change Effects on Marine Ecosystems* (SICCME/S-CCME) workshop in Seattle, USA, and an awareness of the need to develop economic and social pathways to include in different efforts to model the impacts of climate change on fish and fisheries. The workshop was chaired by Alan Haynie (USA), Sophie Gourguet (France), John Pinnegar (UK), Lisa Pfeiffer (USA), and Jörn Schmidt (Germany) and followed the ‘Understanding marine socio-ecological systems’ (MSEAS) symposium which was held the previous week in Brest. Associating this workshop with MSEAS significantly reduced its cost, as virtually all participants attended the MSEAS meeting earlier in the week. The workshop was funded by NOAA and hosted by IFREMER.

Approximately 35 people from a broad group of ICES, PICES, and other countries participated in the workshop. The workshop included a balanced group of biologists, economists, and other social scientists with members having a wide variety of experiences in interdisciplinary projects and in contributing to fisheries and marine resource management in North America, Europe, and elsewhere.

As articulated in the terms of reference for the workshop, the meeting was held primarily to address the following three goals: a) identify the socioeconomic data and features of a suite of representative future fishing and ecosystem scenarios that could be employed for use in evaluating climate change effects on fish and fisheries; b) identify how fisheries management policies will interact with climate change and identify how researchers can best evaluate what management tools are most likely to be resilient to climate change effects on fisheries; and c) identify suites of bio-economic and spatially explicit models of fishery behaviour that can be used to project the implications of different climate models on commercially important marine fish stocks in the northern hemisphere.

Workshop participants addressed these and a variety of related questions. The workshop was a success and identified the means for ongoing collaboration, common assumptions that can be made across projects, and the need for additional research on the further development of common scenarios. Individual integrated modeling projects have made great progress developing socioeconomic scenarios which will be compared, refined, and further coordinated in 2017. We expect that collaborations from this workshop will result in several peer-reviewed publications and addition international collaboration in coming years.

S-CCME Endnote 4

**ICES/PICES Workshop on
“Phase 1: Modelling effects of climate change on fish and fisheries”
(WKSICCME1)**

The ICES/PICES Strategic Initiative (Section) on *Climate Change Effects on Marine Ecosystems* (SICCME) convened a 1-day Workshop on “Phase 1: Modelling Effects of Climate Change on Fish and Fisheries” on September 24, 2016, Riga, Latvia, to discuss progress on projection modelling of climate impacts on fish and fisheries. The workshop was attended by 16 scientists from 6 countries. The workshop was chaired by Anne Hollowed (USA/PICES), Myron Peck (Germany/ICES), John Pinnegar (UK/ICES) and Mark Payne (Denmark/ICES). It was organized as a Principal Investigator meeting to discuss ongoing modelling efforts by different regional modelling nodes. The meeting is part of the roadmap of activities defined at a previous workshop in Seattle Washington, USA (August 2015). The roadmap includes identifying regional modelling nodes, aligning common future scenarios (*i.e.*, representative fishing pathways, broader “PESTLE” scenarios, *etc.*), producing and comparing projections within and among regions, and publishing results soon enough (late 2018) for uptake by writing teams of the sixth Assessment Report of the IPCC. This WKSICCME1 workshop discussed: i) ongoing regional projects, ii) common future scenarios, iii) the global ‘FishMIP’ program, and iv) advancements in short-term environmental and biological forecasting:

- i) Several newly funded regional projects were reviewed. These included the National Oceanic and Atmospheric Administration’s Climate Coastal and Ocean Climate Applications (COCA) program (an umbrella of several projects - NW Atlantic from the mid-Atlantic Bight through the Gulf of Maine), the Alaska Climate Integrated Modeling (ACLIM) project (southeastern Bering Sea) and the Climate change and European aquatic RESources (CERES) project (all European Seas from the Mediterranean through the Barents/Norwegian seas). Activities associated with the U.S. National Aquatic Climate Change Research Program and the Global Climate Change Effects on Fisheries and Aquaculture team working on NEMURO (NW Pacific, Japan coast) were presented. A list of regional modelling nodes in the ICES area was assembled. A sister workshop at the up-coming PICES Annual Meeting will provide updates on regional modelling, with emphasis on teams in the NE and NW Pacific.
- ii) Future marine resource management scenarios are being developed and an example was provided within the EU CERES project. Workshop discussions underscored that short-, medium- and long-term developments in governance, social, technological and economic drivers may be just as important to fisheries as climate-driven changes in habitats and species. In combination with outputs from physical/ biogeochemical modelling, storylines are being developed and used to generate a set of combinations of environmental and socio-economic projections for the fishery sector. A summary of ongoing efforts to create representative fishing pathways in other projects (*e.g.*, ACLIM – Bering Sea) was also provided.
- iii) Efforts to harmonize and compare global and regional model projections of climate impacts on fish and fisheries were discussed. The FishMIP, a network of scientists, includes 15 different models (10 global and 5 regional). Some of the specific global (*e.g.*, BOATS) and regional/global (*e.g.*, POEM2) and regional (EwE) modelling tools were presented along with the protocol to harmonize input and output variables (*e.g.*, 39 forcing variables used as input for the various models). This protocol may be useful to some ICES and PICES modellers. Most of the modelling teams in the northern hemisphere planned to use scenarios based on Representative Concentration Pathway (RCP) 8.5 and/or 4.5. Given the outcome of the Conference of the Parties 21, several modelling teams are considering adding RCP 2.6.
- vi) Advances in high-resolution Global Climate Models and higher-resolution, dynamically downscaled products available to the community were discussed. The continual increase in the short-term (months to years) predictive skill of ocean habitats (*e.g.*, sea surface temperature) in some ocean regions will help complete the portfolio of projection tools and techniques available to fisheries scientists to address short-, medium- and long-term physical changes in ocean habitats.

S-CCME Endnote 5

**PICES-2016 Workshop (W5) on
“Phase 1: Modelling effects of climate change on fish and fisheries”**

The PICES/ICES Section (Strategic Initiative) on *Climate Change Impacts on Marine Ecosystems* (S-CCME/SICCME) convened a 1-day FIS-sponsored workshop on November 4 at PICES-2016 in San Diego, USA. The workshop was attended by 46 scientists from eight countries. A similar workshop (WKSICCME Phase 1) was held in conjunction with the ICES Annual Science Conference in Riga, Latvia on September 24, 2016.

W5 was chaired by Drs. Anne Hollowed (USA, PICES), Shin-ichi Ito (Japan, PICES), and John Pinnegar (UK, ICES). It was organized as a Principal Investigators’ meeting, providing an opportunity for scientists to discuss the progress of ongoing regional projection modeling nodes. The meeting is part of the roadmap of activities defined at a previous workshop held in Seattle, USA (August 2015, [PICES Press Vol. 24 No. 1](#), pp. 20–23). The roadmap includes identifying regional modeling nodes, aligning common future scenarios, producing and comparing projections within and among regions, and publishing results by late 2018 for uptake by writing teams of the sixth Assessment Report of the Intergovernmental Panel on Climate Change and possibly by the Special Report on Climate Change and Oceans and the Cryosphere (SROCC). W5 focused discussions around four topics: i) ongoing regional projects, ii) common future scenarios, iii) advancements in the development of shared socioeconomic scenarios, and iv) issues related to global model selection and bias corrections.

S-CCME relies on ICES and PICES member countries to provide funding to support the projection modeling that forms the foundation of the Section. It was exciting to learn that many new programs have been funded and are actively striving to meet the goal of providing projected impacts of climate change on marine ecosystems in time for upcoming national and international reviews. These existing or emerging research projects hold great promise for the success of S-CCME.

Discussion

The workshop group held an open discussion session on best practices for model selection. The group was divided in its opinions regarding best practices and the debate was lively. The group also identified two inter-sessional activities for 2017. S-CCME’s first meeting will occur on March 5, 2017 in Victoria, British Columbia, Canada. The focus of this workshop will be to review and update the S-CCME/SICCME Implementation Plan. This activity will ensure that S-CCME/SICCME remains on the cutting edge of research efforts focused on projecting the impacts of climate change on marine ecosystems and the communities that depend on them. The second meeting will be a 3-day workshop from July 19–21, 2017 at ICES headquarters (Copenhagen, Denmark). This workshop will provide a forum for the discussion of climate vulnerability assessments.

S-CCME Endnote 6

**ICES/PICES SICCME (S-CCME) Inter-sessional Workshop on
“Understanding the impacts and consequences of ocean acidification for commercial species and end-users”
(WKACIDUSE)**

Co-Chairs: by Silvana Birchenough (ICES/UK), Catriona Clemmesen-Bockelmann (BioAcid, Germany) and Tsuneo Ono (PICES/Japan)

WKACIDUSE will meet at ICES Headquarters in Copenhagen, Denmark, 5–8 December 2016 to:

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

S-CCME Endnote 7

PICES/ICES SICCME (S-CCME) Inter-sessional Workshop on
“Regional climate change vulnerability assessment for the large marine ecosystems of
the northern hemisphere”
(WKSICCME-CVA)

July 19–21, 2017, ICES Headquarters, Copenhagen, Denmark

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Background

Climate change and ocean acidification pose significant risks to some marine species and the communities that depend on those species. Rapid assessment methods have been developed to assess these risks to marine life and humans. These assessments use qualitative ranking of risks based on a synthesis of data derived from existing climate change projections and expert knowledge of the sensitivity of species or human communities to projected changes in environmental conditions. These rapid vulnerability assessments typically involve an evaluation of the relative exposure and sensitivity of an organism to climate change and methods utilized vary depending on data availability. These vulnerability assessments can also be used to identify key gaps in on-going research and to identify potential risks to marine life and coastal communities. Task teams have been or are in the process of being formed to conduct vulnerability assessments in various regions around the world including many LMEs within the ICES and PICES member nations. Our main goals for this 3-day workshop are to:

- A. Compare and contrast various vulnerability assessment approaches used for fisheries and aquaculture including their strengths and weaknesses;
- B. Discuss opportunities for comparative studies looking at the relative vulnerability of species in different Large Marine Ecosystems (LMEs);
- C. Discuss best practices for extending vulnerability assessments of marine fish and invertebrates to vulnerability of coastal communities and identify a suite of representative concentration pathways for use in vulnerability assessments in the northern hemisphere;
- D. Identify opportunities for operationalizing vulnerability assessment methods to enable updates (*e.g.*, release of CMIP6 scenarios) and automating exposure assessments;
- E. Draft short statements on climate change impacts and vulnerability for regional ecosystem overviews produced at ICES and potentially other organizations.

S-CCME Endnote 8

**Proposal for an ICES/PICES Theme Session A on
“Projected impacts of climate change on marine ecosystems, wild captured and cultured fisheries,
and fishery dependent communities” at ICES ASC 2017**

Convenors:

Jon Hare (ICES/USA)

John Pinnegar (ICES/UK)

Myron Peck (ICES/Germany)

Shin-ichi Ito (PICES/Japan)

Climate change is expected to impact marine ecosystems throughout the world; however, the severity of these impacts will vary regionally. This theme session seeks examples of the types of regional impacts that are expected in the near term (2020–2040) and longer term (2080–2100). We also seek papers that describe the relative exposure of marine organisms to changing environmental conditions and those that address the ecological as well as socioeconomic implications of shifting spatial distributions and changes in population productivity (growth, reproductive success, and mortality).

Also encouraged are projects that compare outcomes from different projection modeling platforms, discuss the range of uncertainties (scenario, parameter, and structural) associated with regional climate projections, and address ecological realism and uncertainty.

There is growing recognition that projections of the implications of climate change on fisheries and fishery-dependent communities require the incorporation of representative fishing pathways (RFPs) to fully depict the range of possible mitigation scenarios that could be considered by managers. Regional examples of the selection process for establishing RFPs and the performance of the RFPs relative to status quo are encouraged. This theme session will allow researchers to compare results, evaluate harvest control rules, and discuss challenges encountered in developing multi-model ensembles of impacts on fish and fisheries.

We envision a 2-day session with a keynote speaker starting each day. We will include a 30 minute discussion period after each half-day session and schedule lightning sessions for poster-presenters to introduce their work.

S-CCME Endnote 9

**Proposal for a Topic Session on
“Can short-term forecasts inform long-term climate projections and vice-versa?”
at PICES-2017**

Duration: 1 day

Co-Convenors: Jackie King (Canada), Masami Nonaka (Japan)

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 biophysical models. We are especially interested in papers that demonstrate how information regarding parameter uncertainty can be transferred to longer term projection models.