# PICES/ICES WGFCCIFS REPORT 2009

ICES OCEANOGRAPHY COMMITTEE

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# Report of the Joint PICES/ICES Working Group on Forecasting Climate Change Impacts on Fish and Shellfish (WGFCCIFS)

21 June 2009

Victoria, British Columbia, Canada

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CIEM Conseil International pour l'Exploration de la Mer
PICES

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## Contents

## Executive summary

The ICES/PICES Working Group on Forecasting Climate Change Impacts on Fish and Shellfish (WGFCCIFS) met in Victoria, Canada, on 21 June 2009.

The main objective of this meeting was to agree to the structure of the science symposium organised under the auspices of the WG in April 2010 (Sendai, Japan). This included finalising the scientific sessions, the invited speakers list, outputs of the conference, financial status and other logistical issues (item f of the 2008/2/OCC09 ICES resolution). The relationship between the WGFCCIFS and other ICES expert groups (mainly SGCC, WGCCC, WGIAB and WGLESP) was discussed, and Dr J. Alheit was identified as the contact between WGFCCIFS and other ICES expert groups.

Links with PICES committees were also discussed and developed, as were synergistic efforts by United Nations agencies and the World Bank. While these discussions addressed several items in the WGFCCIFS Terms of Reference, the group felt that the bulk of the WG task cannot be undertaken until after the 2010 Symposium in Sendai, which will provide a forum for discussing frameworks and methodologies for forecasting impacts of climate change on the growth, distribution and abundance of marine life. The group agreed to initiate some writing assignments during the summer of 2009 (mainly collation of existing methodologies relevant to the objectives of the WG), and to meet again the day after the Sendai Symposium to summarize the results presented and to agree to a timetable for the delivery of the WG objectives to ICES and PICES.

# 1 Opening of the Meeting

The Chairs Anne Hollowed, Manuel Barange, Suam Kim and Harald Loeng welcomed the participants (Annex 1) to the meeting. Anne Hollowed reviewed the goals of WGFCCIFS meeting.

# 2 Adoption of the Agenda

The agenda (see Annex 2) was briefly discussed and adjusted and adopted by participants.

# 3 Status of the Japan Symposium

One of the ToRs of WGFCCIFS was to plan a symposium to bring together scientists to discuss climate change impacts on fish and shellfish. Members of WGFCCIFS have planned a symposium on Climate Change Effects on Fish and Fisheries: "Forecasting Impacts, Assessing Ecosystem Responses, and Evaluating Management Strategies" that will take place in Sendai Japan on 26–29 April 2009.

## 3.1 Workshop Theme descriptions

Working group members reviewed the workshop themes (see Appendix 3). In general, workshop participants approved the workshop themes for release. Upon review, the group recognized that the Plenary session theme descriptions overlapped with the parallel theme sessions the following days. The group felt that this overlap was intentional because the Plenary sessions were designed to attract synthesis projects that have a broad regional scope. Ken Drinkwater suggested that that all of the topics in the parallel sessions should be covered by keynotes in the first two Plenary sessions. This would introduce each of the topics in the parallel sessions and allow all of the Symposium participants to hear an expert on each topic discuss what the critical issues were in those particular fields. If the participants could not attend a particular session because of a conflict, they would at least be exposed to the topic. In addition, it may be possible to find one keynote speaker who could cover two of the topics in the parallel sessions. The group agreed that this was a good approach and decided that Co-Chairs from the Parallel Theme Sessions will provide recommendations to the following Plenary Sessions:

- Plenary 1: A1, A2, B1 B2 and D2
- Plenary 2: C1 , C3, D1, D2
- Plenary 3: D1, C2, and D2

Session D2 could address concepts for both Plenary 1 and 2. Alex Bychkov (PICES Secretariat) reported that there are sufficient funds to support two invited speakers per session as well as the proposed invited speakers for Plenary 1 and 2. He suggested that additional time can be made for contributed talks by extending Plenary Sessions 1 and 2 and starting the Welcome Reception at 19:00.

This concept was approved by the group. **Anne Hollowed requested that final edited theme descriptions be submitted by Friday, 26 June 2009.**

The group reviewed the list of invited speakers. Keith Brander and Suam Kim recommended that we write the new IPCC co-chairs to request a recommendation for a person involved in the IPCC writing team to attend the meeting to give a talk on what the IPCC needs and what questions a group like the FCCIFS could address. The group agreed that this was an excellent idea. K. Brander will draft a letter for this purpose. **Anne Hollowed requested that final lists of invited speakers should be submitted by 1 July 2009.** A final list of nominations was selected after the working group meeting (Appendix 4)

The group acknowledged that it would be useful to post a definition of climate change and climate variability on the website. **James Overland volunteered to develop these definitions.** He will provide the text to Alex Bychkov who will post the definitions on the symposium website.

### 3.2 Logistics, organization issues

Shin-ichi Ito gave a presentation on the venue for the FCCIFS symposium in Sendai. The Plenary meeting room will accommodate 280 scientists. The group acknowledged that it may be necessary to reserve a room for overflow if more than 280 scientists plan to attend. Dr. Ito will look into our options for accommodating overflow if a large number of scientists register for the symposium.

### 3.3 Report on symposium budget

Alexander Bychkov (PICES Secretariat) gave a presentation on the status of fund raising activities for the symposium. At the current time there are sufficient funds to accommodate 2 invited speakers for each Plenary and Parallel Theme session. WG participants noted that it may not be desirable to have two invited speakers during the Parallel Theme sessions because of time constraints. The group felt that the recommendation of Ken Drinkwater (see above) might address this issue. In addition it was noted that additional speakers could be accommodated by extending the meeting to 18:00 each day. **Dr Bychkov will work with Shin-ichi Ito to assess whether the start time for the poster sessions could be changed to accommodate a later end time for the Parallel Theme sessions.**

## 4 Review of relationship to other ICES Expert groups

One of the Terms of Reference for the WGFCCIFS was a review of the relationship of the planned work for WGFCCIFS relative to other activities of ICES and PICES. To address this ToR several scientists provided overviews of activities that would complement the activities of WGFCCIFS.

Jurgen Alheit provided an overview of the activities of ICES working groups and study groups that would complement the activities of the WGFCCIFS. e noted that the working groups:

1 ) SGCC - Steering Group on Climate Change (Luis Valdez and Jurgen Alheit co-chairs)

2 ) WGCCC - ICES/GLOBEC Working Group on Cod and Climate Change

3 ) ICES/PICES/GLOBEC-SPACC Workshop on Changes in distribution and abundance of clupeiform small fish in relation to climate variability and global change

The group discussed ways to improve collaboration between these groups. In particular, it was noted that the WGFCCIFS could provide written contributions for the

report that is being prepared by the SGCC. **J. Alheit will work with the FCCIFS co-chairs to identify opportunities for collaboration**.

Anne Hollowed provided an overview of the PICES activities that are likely to contribute to the FCCIFS activities. She noted that three standing committees within PICES are likely to support the activities of FCCIFS: BIO – Biological Oceanography Committee; POC – Physics Oceanography and Climate Committee; and FIS – Fisheries Committee. Of these, the POC working group (WG20) on "evaluating climate change projections" is particularly relevant to the work of FCCIFS. M. Foreman is a member of POC and WG20 and will ensure strong communication with FCCIFS.

James Overland provided an overview of the FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) science program. FUTURE is a newly approved science program within PICES. The program will have three science foci:

- SOFE: Status, outlooks, forecasts and engagement
- AICE: Anthropogenic influences on coastal ecosystems
- COVE: Climate, ocean variability and ecosystems

Of these the FCCIFS program will have strong contributions to COVE and SOFE. PICES anticipates that WGFCCIFS will contribute to all three of the science foci but will have the strongest links with SOFE and COVE.

Ken Drinkwater provided an overview of the Ecosystem Studies of Subarctic Seas program. This program has elected to become a program within the IMBER umbrella organization. This program encourages comparative studies of ecosystems within the sub-arctic seas. The ESSAS program provides funding for comparative ecosystem studies what will be relevant to WGFCCFIS.

Shin-ichi Ito discussed a proposal that has been submitted to SCOR titled "coupled climate-to-fish-to-fishers models for understanding mechanisms underlying low frequency fluctuations in small pelagic fish". This project is likely to contribute case studies that will be relevant to the WGFCCIFS effort.

Manuel Barange discussed recent developments within FAO, the World Bank and UNEP, among other regional/ global stewardship organizations. These organizations are particularly interested in models and decision support tools that provide information on the socio-economic implications of and adaptations to climate change on fish and fisheries.

Myron Peck gave a presentation on the research activities of the ICES ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea. The presentation highlighted an ensemble model comparison for future trajectories of the Baltic cod stock in light of climate change scenarios combined with different management (fishing mortality) options. The seven models had vastly different complexities (from single-species stock assessment, to multi-species VPAs, to ecosystem models (ECOPATH). Each model was forced using a 50 yr time-slice of future temperature and salinity conditions (2048–2100). This was an excellent example of research fitting to session D1 (measuring uncertainty) and the approach of downscaling from a Global Climate Model, to a Regional Climate Model and to a Regional Circulation Model.

# 5 Discussion of workplan for other terms of reference

WGFCCFIS members reviewed the following ToR associated with WGFCCIFS:

- Discuss frameworks and methodologies for forecasting the impacts of climate change on the growth, distribution and abundance of marine life with particular emphasis on commercial fish and shellfish;
- Review the results of designated case studies to test methods;
- Establish techniques for estimating and communicating uncertainty in forecasts;
- Evaluate strategies for research and management under climate change scenarios, given the limitations of our forecasts.

WGFCCIFS members agreed that the Symposium will provide a forum for discussing frameworks and methodologies for forecasting impacts of climate change on the growth, distribution and abundance of marine life. Meeting participants felt that we should not finalize reports until after the symposium. It was noted that some writing assignments could be initiated during the summer. These written contributions could be included in the SGCC report. In particular Keith Brander volunteered to write a short summary of the advantages of experimental approaches for assessing the expected impacts of climate on fish and shellfish. The group also noted that we should not set our goals too high. For example, the group may elect to provide storylines of expected changes in fish and fisheries rather than quantitative forecasts.

## Annex 1: List of participants

| Name | Country/ Organization Rep. | E-mail |
|---|---|---|
| Denman, Ken | Canada | Ken.Denman@ec.gc.ca |
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## Annex 2: Agenda

**FCCIFS Working Group Meeting**

**21 June 2009**

**Esquimalt Room, Victoria Conference Center**

**Victoria, British Columbia, Canada**

| Time | Topic | Action Items |
|---|---|---|
| **09:00** | Introductions | Review Terms of Reference and Agenda |
| **9:15 – 10:30** | Status of the Japan symposium | a) Themes, invited speakers, programme in general –including deadlines and processes- (Hollowed)<br>b) Logistics, organisation issues (Ito).<br>c) Report on budgets and what this would afford (Bychkov)<br>d) Editor for Climate Change from Nature magazine, is very keen on doing something with our symposium. (Manuel)<br>e) Special Issue ICES J. Mar. Sci. (Bychkov) |
| **10:30-10:50** | Coffee Break | |
| **10:50- 12:00** | | ▪ Continue discussions of workshop logistics |
| **12:00- 13:00** | Lunch | ▪ |
| **13:00-15:00** | Review of existing programs | ▪ Identify and analyze the work of other ICES Expert Groups on issues related to climate change impacts related to commercial fish and shellfish Group presentations: activities relevant to the WG. (Alheit, 20 minutes)<br>▪ Identify and analyze the work of other PICES Expert Groups on issues related to climate change impacts related to commercial fish and shellfish Group presentations: activities relevant to the WG. (Hollowed and Ito, 20 minutes)<br>▪ Review of ESSAS (Drinkwater, 10 min)<br>▪ PICES FUTURE (Overland, 20 min)<br>▪ SCOR Proposal for a working group on Coupled climate-to-fish-to-fishers models for understanding mechanisms underlying low frequency fluctuations in small pelagic fish (Ito – Barange, 15)<br>▪ BASIN program (P. Wiebe – 10 min)<br>▪ Others |
| **15:00-15:20** | Coffee Break | |
| **15:20 -16:20** | Structure of the WG report | Generic Discussion of Report: timeline, drafting guidelines, key questions, allocation of writing responsibilities, links between symposium and report.<br>a. Discuss frameworks and methodologies for forecasting the impacts of climate change on the growth, distribution and abundance of marine life with particular emphasis on commercial fish and shellfish;<br>b. Review the results of designated case studies to test methods;<br>c. Establish techniques for estimating and communicating uncertainty in forecasts; |

| | | |
|---|---|---|
| | | d. Evaluate strategies for research and management under climate change scenarios, given the limitations of our forecasts; |
| **16:20 – 17:00** | Near Term program planning | ▪ FAO, World Bank, UNEP, IOC etc. efforts to raise the profile of fisheries in climate change forums (Barange, 15 minutes)<br>▪ Other programs |
| **17:00-17:30** | Long range planning | Millennium Assessment, IPCC AR5, other assessments. Planning for coordinated international program on forecasting climate change impacts on fish and shellfish. SCOR, IMBER, FAO? |

# Annex 3: Theme Session Descriptions

## Plenary Session 1: Forecasting impacts: from Climate to Fish

**Conveners: Ken Drinkwater (Norway), Harald Loeng (Norway) and Yasuhiro Yamanaka (Japan)**

This session seeks papers on the impacts of future climate change on the physical oceanography, biogeochemistry, and food webs of the world oceans. This includes contributions on appropriate methods for determining impact projections and estimating levels of uncertainty as well as actual development of ecosystem scenarios. Presentations will be considered on downscaling from global models and the problems involved to produce regional future climate and physical oceanographic scenarios; scenarios of climate-induced changes in nutrient dynamics and other biogeochemical processes; changes in ecosystem community structure and function from phytoplankton and zooplankton through to fish populations. These include changes in production and distribution and their influence upon bio-diversity.

## Plenary Session 2: Forecasting impacts: from fish to markets

**Conveners: Jacquelynne King (Canada) and Manuel Barange (United Kingdom)**

Climate change direct impacts on marine populations will alter the provision of food from our oceans to our markets. At the same time the on-going process of economic globalization will modify or exacerbate the vulnerability of fish production systems to climate change at global, regional and local level. Policy and management agencies will require scientific advice on the potential impacts that climate change (and its associated economic developments) will have on the availability of fish populations to fisheries, markets and consumers. This session will focus on changes in marine population dynamics as they relate to fisheries (e.g. impacts on catchability or maximum sustainable yield), to processing and market demands (e.g. changes in size-at-age), to market forces (e.g. changes in price and trade) and to food security (e.g. collective vulnerability analysis). We invite papers that forecast these types of changes, quantify the uncertainty of these forecasts in risk assessment frameworks useful to resource managers, and/or explore the interactivity between the ecosystem and market dynamics.

## Session A1: Downscaling variables from global models

**Conveners: Michael Foreman (Canada) and Jason Holt (United Kingdom)**

Analyses and summaries recently presented in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) indicate that many of the dramatic changes observed in the circulation and physical characteristics of the oceans over the past century will continue in the future. As one of the major limitations of the global climate models that are used to estimate these future projections is their relatively coarse resolution, statistical or dynamical downscaling is often needed to provide sufficient spatial detail in the variables of interest. In this session, we solicit presentations that address the downscaling of global climate model variables relevant to marine ecosystems. Papers describing downscaling techniques and/or their application to particular regions or variables are welcome. Presentations that analyze global climate models projections, or results from higher-resolution regional ocean, or coupled atmosphere-ocean, models that are forced by, and take their boundary conditions from, global climate models, are also encouraged.

## Session A2: Species-specific responses: changes in growth, reproductive success, mortality, spatial distribution, and adaptation

**Conveners: Myron A. Peck (Germany) & Richard J. Beamish (Canada)**

Climate is now recognized as a major factor affecting the productivity of key species in world fisheries. The mechanisms that link climate to fish productivity need to be better understood to ensure that natural and green house gas induced climate changes are incorporated into the management of fisheries. Population-level changes in commercially and ecologically important marine fish species may result from climate-driven changes in organismal-level vital rates (e.g. changes in growth, reproductive success and mortality). Furthermore, expansion, contraction and/or shifts in the distribution of fish stocks will result from changes in suitable habitats (habitats the allow connectivity among life stages, life cycle closure and successful recruitment). The extent of climate-driven changes will be mediated by the capacity for individual species (or populations) to adapt to changes in important abiotic and biotic factors. Adaptations could include both changes in the phenology of important life history events (e.g., migration, spawning) and/or physiological changes (e.g., thermal reaction norms of key traits such as growth, increased tolerance to lowered pH / ocean acidification). This theme session provides a forum for presentations focusing on the response of key fish and fisheries species worldwide to climate change by: 1) documenting historical, long-term fluctuations in abundance and distribution, 2) discussing processes underlying current changes, and/or 3) projecting future impacts in light of adaptive capacity. Key fisheries species include those utilizing marine habitats during any portion of their life cycle and that are commercially or ecologically important marine resources.

## Session B1: Assessing ecosystem responses: impacts on community structure, biodiversity, energy flow, and carrying capacity

**Conveners: Akihiko Yatsu (Japan) and Thomas Okey (Canada)**

Assessing effects of climate change on marine ecosystems (i.e. biological communities) is a major challenge, mainly because (1) future changes in physical forcing such as water temperature will exceed historically observed values, and (2) biological responses or adaptations to these changes are highly uncertain, particularly over a long time period. Changes in geographic ranges, vertical distributions, phenologies, population structures, and productivities will differ among individual species thereby altering the connectivity of ecosystem components. Processes that could be influenced include: predator-prey relationships, direct and indirect competition, species assembly, community structure, biodiversity, energy flow, and carrying capacity. This session invites retrospective analyses on changes in freshwater, coastal, and offshore ecosystems/communities, outcomes of experimental studies on species interactions under climate-change-related conditions, and conceptual and numerical modelling of ecosystems relevant to climate change.

## Session B2: Comparing responses to climate variability in nearshore, shelf and oceanic regions

**Conveners: Jürgen Alheit (Germany) and Vladimir Radchenko (Russia)**

Over the last two decades, convincing evidence has been collected that global and regional climate variability is a strong driving force of changes in marine ecosystems (and the fish and shell fish populations embedded in them). Climate drivers influence nearshore, shelf and oceanic regions, however, the same climate signal may be correlated with different responses of marine populations among these regions, due to the different mechanisms by which climate variability impacts these communities and the role of human activities in modifying these mechanisms, particularly in nearshore areas. Whereas the effect of climate variability has been intensely studied in single marine systems or on single species/species groups across different systems, comparisons of climatic influences on coastal and oceanic systems are generally lacking. As marine ecosystems are not amenable to experimental investigations with respect to climate effects, comparative analyses are the best way to enhance our knowledge on the response of ecosystems and their populations. Ecosystem regime shifts and teleconnection patterns in the reaction of distant marine ecosystems towards climate impacts are important phenomena which help us to better understand responses to climate variability. The goal of this session is to discuss the interactions, ramifications, and potential connections between climate variability and marine ecosystems. Contributions are requested which demonstrate the impact of climate variability with a view to future climate change.

## Session C1: Impacts on fisheries and coastal communities

**Conveners: Keith Brander (United Kingdom) and Suam Kim (Korea)**

Climate change has had an impact on fisheries and coastal communities throughout history, due to environmentally driven fish stock fluctuations, changes in species distribution, extreme events and changes in sea-level. The survival of coastal communities depended on being able to cope with such changes, by altering their fishing practices or switching to alternative livelihoods. In many cases communities did not survive or suffered economic hardship and emigration. Although some adaptability can be expected in response to anthropogenic climate change the new situation is different in a number of ways: The expected rate of change is rapid and in one direction; most fisheries are already under pressure from overfishing, habitat degradation and other sea and coastal uses; new pressures arise from sea-level rise and ocean acidification. This session seeks papers that provide forecasts of expected impacts of climate change on the coastal fish stocks and the communities that depend on them as well as strategies for survival under a changing climate.

## Session C2: Evaluating Human Responses, Management Strategies, and Economic Implications

**Conveners: Jake Rice (Canada) and Kevren Cochrane (Italy)**

Humans depend on the oceans for many goods and services essential to their well being. As terrestrial and marine ecosystems change in response to climate, these dependencies are expected to become even greater, particularly but hardly exclusively for food security. This session will focus on how society, at a range of scales from community to population, might adapt to the changes expected in the oceans, and in the goods and services on which they depend so that optimal benefits may be obtained without unacceptable increases in the risks to the systems. Contributions from social scientists, economists, and policy experts are welcomed, as well as from natural scientists interested in strategies for sustainable use of marine resources in the face of changing human needs as well as changing ocean conditions. Just a few decades in the future, societies and governments may face very difficult choices about the proper balance between provision of food security and conservation of marine biodiversity for an even bigger human population confronted with changing, possibly declining, aquatic and terrestrial food production. The proper balance between established uses of oceans and coastal regions and new uses such as wind and tidal power must also be faced. This session is intended to open an expert dialogue on these important questions, through a mixture of conceptual, analytical, and case-history presentations.

## Session D1: Measuring uncertainty, identifying key unknowns and communicating risk

**Conveners: Chairs: Franz Mueter and Carl O'Brien**

Predicting the responses of populations and ecosystems to future climate under global climate change is associated with large uncertainties arising from at least three major sources: (1) uncertainty about future climate trajectories (short-term variability and long-term trends), (2) uncertainty about the functional relationships linking climate to population and ecosystem characteristics (structural or model uncertainty), and (3) uncertainty about the parameters describing these relationships (parameter uncertainty). This session explores approaches to quantifying the full range of uncertainty when predicting biological responses to climate variability, identifying the key uncertainties affecting predictions, and communicating the associated risks to decision makers. We seek contributions that focus on ecosystem-level or population-level responses, in particular responses of fish and shellfish populations, and on the affected fisheries. We encourage submissions that use novel approaches to dealing with uncertainty and risk in the context of climate variability, as well as papers that adapt established approaches such as model averaging or decision-analytic tools.

## Session D2: Contemporary and next generation climate and oceanographic models, technical advances and new approaches

**Conveners: Jonathan Hare (USA), Shin-Ichi Ito (Japan)**

The projection of marine ecosystem response to future climate scenarios is needed to assess and implement marine ecosystem management. The marine ecosystem is part of the earth system and prediction of ecosystem responses requires integrated knowledge from physical, chemical, and biological perspectives as well as from marine, terrestrial and atmospheric perspectives. The earth system is complex with nonlinear feedbacks (including biological to physical), regime shifts, and, in some cases, thresholds beyond which change is irreversible. Therefore, the uncertainties of climate and oceanographic models cause uncertainties of the projection of marine ecosystem response not only directly but also through complex feedback mechanisms. To reduce the uncertainties of the marine ecosystem projection, we must understand the mechanisms controlling climate systems and the linkages to marine ecosystems. Specific species responses to future ecosystem conditions are required by natural resource managers, and these require specific information (e.g. environments in coastal area during the short spawning period) as well as information regarding change of the ecosystem as a whole (e.g., total primary production, food-web dynamics). These issues are not part of climate modelling, but mechanistic links between the biological, physical, and chemical systems must be identified and incorporated into coupled population-ecosystem-climate models. Technical advances and new approaches are essential to achieve the goal of producing better projections of marine ecosystem response to future climate scenarios. This session will focus on climate and oceanographic models and technical advances and new approaches. Presentations that focus on modelling of climate and ecosystem interaction are also welcome.

## Plenary Session 3: Sustainable strategies in a warming climate

### Conveners: Anne Hollowed (USA) and Michael Schirripa (USA)

Many nations have adopted a goal of building sustainable fisheries. Traditionally, this goal has been pursued through the adoption of precautionary harvest policies that are based on the expected productivity of the stock in a future environmental state. However, these harvest policies seldom explicitly consider how possible future climate change may modify critical aspects of the productivity of the stock. At the single species level, climate change could significantly influence the carrying capacity, the reproductive potential as well as the spatial distribution of the stock. At the multispecies level, climate change may alter the abundance of competitors and predators of species targeted for fishing. Societal changes in the consumption of fish and policies regarding marine ranching and aquaculture may also change the economic factors governing fisheries. This session seeks papers that explore the future of fish and fisheries under a changing climate. We welcome examples of management strategies that could be applied to sustain fisheries under a changing climate and techniques for assessing and forecasting the performance of harvest policies under changing climate. This session is also open to new and novel modelling techniques designed to take into account an uncertain future and/or non-equilibrium conditions in fish, fishing fleets, management, and the marketing of seafood products. This could range from how future fishing vessels may be outfitted to best adapt to a changing climate to how traditional management benchmarks and concepts (maximum sustainable yield, minimum stock size threshold, etc.) could be modified or updated to take climate change into account. Inventive ways to circumvent or adapt to the forecasted impacts of climate change and the uncertainty surrounding it are also of interest.

## Annex 4: Theme Session Invited Speakers

Table 1 Provides a list of nominations for invited speakers. This list was finalized after the working group meeting.

**Table 1. Nominations for invited speaker**

| Session | Last | First | Institution | Nation |
|---|---|---|---|---|
| P1 | Yatsu | Akihiko | Seikai National Fisheries Research Institute, FRA | Japan |
| | Trendberth | Kevin | NOAA, NCAR | U.S.A. |
| P2 | Allison | Eddie | WorldFish | Malaysia |
| | Sumaila | Rashiid | University of British Columbia | Canada |
| A1 | Allen | Icarus | Plymouth Marine Laboratory(PML) | U.K. |
| | Lowe | Jason | Hadley Centre | U.K. |
| | Wang | Muyin | University of Washington | USA |
| A2 | Pörtner | Hans-Otto | Alfred Wegener Institute (AWI) | Germany |
| | Pinnegar | John | CEFAS | UK |
| B1 | Fulton | Beth | CSIRO Marine and Atmospheric Research | Australia |
| | Polovina | Jeff | Pacific Island Fisheries Science Center | U.S.A. |
| B2 | Dulvy | Nick | Simon Fraser University | Canada |
| | Sundby | Svein | Institute of Marine Research | Norway |
| C1 | Cochrane | Kevern | Food and Agriculture Organization, FIMF | Italy |
| | Perry | Ian | Department of Fisheries and Oceans Canada | Canada |
| C2 | McCay | Bonnie | Rutgers the State University | U.S.A. |
| | Kurien | John | Centre for Development Studies | India |
| D1 | Frid | Chris | School of Biological Sciences, University of Liverpool | U.K. |
| | Peterman | Randall | Simon Fraser University | Canada |
| D2 | Gnanadesikan | Anand | NOAA | U.S.A. |
| | Kawamiya | Michio | JAMSTEC | Japan |
| P3 | Zhang | Chang | Pukyong National University | Korea |
| | Plagányi-Lloyd | Éva | CSIRO Marine and Atmospheric Research | Australia |

## Annex 5: WGFCCIFS draft resolution for the meeting in 2010

The **Joint PICES/ICES Working Group on Forecasting Climate Change Impacts on Fish and Shellfish** [WGFCCIFS], chaired by A. Hollowed, USA, Manuel Barange, UK, Suam Kim, Korea, and Harald Loeng, Norway will meet in Sendai, Japan on 30 April 2010 (a day after the international symposium "Climate change effects on fish and fisheries") to:

a ) Review the results of the conference in light of the terms of reference of the WGFCCIFS, in particular regarding:

   i. frameworks and methodologies for forecasting the impacts of climate change on marine ecosystems, with particular emphasis on the distribution, abundance and production of commercial fish and shellfish;

   ii. methodologies applied in designated case studies;

   iii. techniques for estimating and communicating uncertainty in forecasts;

   iv. strategies for research and management under climate change scenarios, given the limitations of our forecasts.

b ) Continue promote research on climate change impacts on marine ecosystems by scientists in ICES and PICES member nations through coordinated communication, exchange of methodology, and organization of meetings to discuss and publish results;

c ) Produce publications that are relevant to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change;

d ) Publish report(s) summarizing work.

WGFCCIFS will report by 1 September 2010 for the attention of the ICES Climate Change Steering Group, SCICOM, and by 1 October 2010 to the PICES FIS and POC Committees.

### Supporting Information

| | |
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| Priority: | The work of the WGFCCIFS is essential to ensure that ICES and PICES will be able to provide guidance on the potential impacts of climate change on marine ecosystems and the response of commercial fish and shellfish resources to these changes. |
| Scientific justification and relation to action plan: | The work done within ICES and PICES on Climate Change and fisheries has been diverse and has included: a) guidance on methods for selection of IPCC scenarios for use in projections; b)techniques for downscaling IPCC scenarios to local regions, c) development of coupled ecosystem models for use in evaluating climate induced shifts in environmental conditions, d) literature documenting relationships between climate forcing and marine fish and shellfish distribution and production, and e) stock assessment techniques for evaluating management strategies to mitigate the impacts of change. A challenge facing ICES and PICES is the need to integrate all of this research to provide stakeholders with quantitative estimates of the potential impact of climate change on marine life throughout the world. This challenge calls for the establishment of an interdisciplinary research team composed of experts from around the world who will focus attention on the development of common and standardized frameworks for forecasting climate change impacts on marine life with particular emphasis on commercially |

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| | important fish and shellfish. ICES and PICES should act now to ensure that our research communities develop the capibilities to provide quantitative contributions to the next IPCC reports and to provide guidance for management under climate change scenarios.<br>Several case studies will be identified by the Steering Group based on their potential for contributing to methodological development and the opportunity for comparison of marine species and community responses to climate forcing in different ecosystems. Members of the working group will be responsible for encouraging the development of regional interdisciplinary teams responsible for the production of forecasts. Members of the working group will provide guidance to the regional teams by providing a framework for the development of the forecasts and communication of new advances in analytical tools. A major contribution of the working group's effort will be presentation and discussion of results at a science symposium in 2010 and publication of results in a peer reviewed journal by 2011. The timing for the publication is critical because the future IPCC AR5 report is slated for release in 2013. |
| Resource requirements: | No specific resource requirements beyond the need for members to prepare for and participate in the meeting. |
| Participants: | These would include climatologists, oceanographers, ecologists, stock assessment scientists, ecosystem modellers, fisheries managers and economists. Participation is sought from members of PICES and ICES as well as scientists from the southern hemisphere. Potential working group members: James Overland, USA (ESSAS, PICES POC), Shin-ichi Ito, Japan (ESSAS, PICES POC), Michael Foreman, Canada (PICES POC), Sang-Wook Yeh, Korea (PICES WG 20), Thomas Okey, Canada (PEW trust), Richard Beamish, Canada (NPAFC, PICES FIS), Daniel Duplisea, Canada (ICES), Jason Holt, United Kingdom (QUESTFISH, ICES), Keith Brander, Denmark (ICES, IPCC ecosystem writing team), Jürgen Alheit, Germany(ICES, GLOBEC SPACC), Ken Drinkwater, Norway (ESSAS; ICES)]. |
| Secretariat facilities: | This group is likely to have high demand on the computing resources of the Secretariat, but no additional software/hardware is anticipated beyond that which is currently available. |
| Financial: | PICES invitational travel for 4 scientists. |
| Linkages to advisory committees: | An obvious very close link with the ICES Climate Change steering committee and the PICES FUTURE Scientific Steering Committee. |
| Linkages to other committees or groups: | Methodological issues are within the mandate of this Group but for the purpose of this meeting this issue is not on the agenda. Fish stock assessment methods for forecasting and conducting management strategy evaluations will be discussed, as will various eocsystem modelling approaches. Techniques for selecting and downscaling climate change scenarios for use in forecasts will also be discussed. Knowledge of the mechanisms underlying commercial and other species and community responses to shifts in oceanography will be critical to the formation of forecasts. |
| Linkages to other organizations: | ICES and PICES will seek widened participation for this group including contact with relevant academic and intergovernmental organisations including fisheries managers and FAO for this meeting. |