

Strategic Initiative on Climate Change Impacts on Marine Ecosystems (SICCME)

This draft resolution was approved in 2011 (no updates were introduced in 2012)

2012/2/SCICOM10 The **ICES-PICES Strategic Initiative on Climate Change Impacts on Marine Ecosystems (SICCME)**, chaired by Anne Hollowed* (USA, PICES), Suam Kim* (Rep. Korea, PICES), Manuel Barange* (UK, ICES), and Brian MacKenzie* (Denmark, ICES), will conduct activities over the period 2012 to 2014, coordinated by a core group to:

- a) Foster collaborative research between ICES and PICES to investigate the impacts of climate change on marine ecosystems, under the ICES-PICES strategic framework for cooperation;
- b) Communicate and advance our understanding of climate change and its impacts on marine ecosystems by organizing theme sessions, workshops and conferences over the next 3 years;
- c) Define and foster research activities needed to understand, assess and project climate change impacts on marine ecosystems for sustaining the delivery of ecosystem goods and services;
- d) Define and quantify the vulnerability of marine ecosystems to climate change, including the cumulative impacts and synergetic effects of climate and marine resource use;
- e) Build global ocean prediction frameworks, through international collaborations and research, building on ICES and PICES monitoring programs;
- f) Synthesize knowledge achieved through experts groups, workshops and symposia in reports, publications and other high level communications;
- g) Provide state-of-the-art scientific advice to the scientific community, global and national advisory bodies such as the IPCC and IPBES, on the impacts of climate change on marine ecosystems.

The first meeting will be at the ICES-PICES-IOC 2nd International symposium on Climate Change in the World's Oceans, Yeosu, Korea, May 2012. Subsequent meetings will be scheduled at the 2012 and 2013 ICES ASC and PICES Annual Meetings. Additional communication will occur intersessionally via email, Skype, etc.

Supporting information

Priority

High. ICES has several strategic research plans and documents related to understanding and investigating the impacts of climate change on marine ecosystems, and wants to strengthen collaborative ties with PICES. This initiative will address both issues and contribute to a joint ICES-PICES of becoming the leading international organization providing science and advice related to the effects of climate change and variability on marine resources and ecosystems.

Scientific justification ICES and PICES have been investigating climate change impacts on marine ecosystems in the north Atlantic and Pacific since several years. However the two communities recognize that their efforts could benefit from increased collaboration and interaction. The ICES SSIG ended in December 2010 and the PICES WG-FCCIFS will end December 2011. Both PICES and ICES recognize that great strides in new science have emerged from collaborative work between their two organizations. Therefore, they requested the formation of a science plan that outlines a structure for continued collaborations focused on climate change. Within ICES, our plan would be consistent with a Strategic Initiative. To avoid confusion with the previous ICES SICC, we will refer to this proposal as the ICES-PICES Strategic Initiative on Climate Change effects on Marine Ecosystems (SICCME). The remainder of this text provides a roadmap for long-term continuation of collaborative research on climate change through the formation of an ICES-PICES SICCME.

Goals

Never in the history of PICES or ICES has there been a more serious need for cooperation on a marine science issue of global significance. ICES and PICES must *respond to the need for credible, objective and innovative science advice on the impacts of climate change on marine ecosystems*. This advice will foster management and policies that will preserve these resources and habitats for the benefit of future generations. To achieve this overarching goal, the following actions should be addressed.

- i) Define the research activities needed to understand, assess and project climate change impacts on marine ecosystems with sufficient spatial and temporal resolution to plan strategies for sustaining the delivery of ecosystem goods and services and the preservation of biodiversity. When possible predictions should include quantifying estimations of uncertainty.
- ii) Define and quantify the vulnerability of marine ecosystems to climate change, including the cumulative impacts and synergetic effects of climate and marine resource use.
- iii) Build global ocean prediction frameworks, through international collaborations and research, building on ICES and PICES monitoring programs.
- iv) As the leading northern hemisphere international organizations, ICES and PICES will direct the ICES-PICES SICCME to draw on the network of marine scientific expertise to make a valuable contribution to advancing science towards resolving these challenges.

Objectives:

The success of this strategic initiative rests on:

- i) Advancing the scientific capacity on the three main challenges identified above by engaging the PICES and ICES scientific community in focused workshops, theme/topic sessions and symposia that target key uncertainties and technical barriers that impact the predictive skill of ocean models used to project the impacts of climate change.
 - ii) Effectively communicating this capacity to clients, Member Countries, stakeholders and the broader scientific community.
 - iii) Facilitating an international effort to design data collection networks at the spatial and temporal scales
-

-
- needed to monitor, assess and project climate change impacts on marine ecosystems.
- iv) Facilitating international collaboration to design and implement comparative analysis of marine ecosystem responses to climate change through modelling and coordinated process studies.

Key Questions

The overarching goal of the initiative will be to answer the following linked questions.

- i) How will the physical, chemical and biological components of regional marine ecosystems of the northern hemisphere change under future climate scenarios?
- ii) How will marine biodiversity change (and thus biodiversity conservation objectives) as a result of pressures on the physiology, behavior and ecology of individuals, populations and ecosystems within the PICES and ICES regions.
- iii) How will the demand for, and delivery of, ecosystem services change in response to anthropogenic and climate change driven changes to ecosystems?
- iv) How will societies that depend on ecosystems services respond to climate-driven changes in ecosystem services, and which responses are consistent with an ecosystem approach to management?

Resource requirements	Secretariat support for running theme sessions, workshops, and conferences
Participants	8–10 core members (including Jurgén Alheit, Germany; Harald Loeng, Norway; and Jon Hare, USA, representing ICES, and a similar number representing PICES. Up to 40 participants at SICCME events.
Secretariat facilities	Assistance with organising workshops
Financial	See category 4 resolution, 2011/4/SCICOM01.
Linkages to advisory committees	SCICOM
Linkages to other committees or groups	SSGEF;SSGHIE.
Linkages to other organizations	EC, EEA, Regional Seas Conventions, IPCC, FAO, IOC, World Bank, large marine science programs (e. g., IMBER)

Annex 1

Science Plan for ICES-PICES Strategic Initiative on Climate Change effects on Marine Ecosystems

1 Vision

ICES and PICES will become the leading international organization providing science and advice related to the effects of climate change and variability on marine resources and ecosystems.

ICES and PICES will develop the scientific basis for evaluating the vulnerability, status and sustainability of marine systems under changing climate conditions. Collaborative research within ICES and PICES will facilitate the development, maintenance and evolution of a network of regional interdisciplinary research teams that will share research approaches on a global scale to foster laboratory, field and modelling activities that will provide data at the spatial and temporal scales needed to monitor, assess and project climate change impacts on marine ecosystems.

2 Background

Recent reviews have provided compelling evidence that global warming is occurring and greenhouse gases are very likely contributing to this trend (Arctic Climate Impacts Assessment, ACIA 2005; 4th report of the Intergovernmental Panel on Climate Change, IPCC AR4 Report 2007). Since then, the marine science community has endeavoured to address the paucity of information regarding impacts on marine ecosystems and to provide new science in time for consideration by the future IPCC review panels.

New studies show that climate change will impact marine ecosystem productivity, habitat quality and quantity (Arrigo *et al.* 2008, Cheung *et al.* 2009, Durner *et al.* 2008, Nye *et al.* 2008, Phillipart *et al.* in press). These changes will affect biodiversity, and the phenology, spatial distribution, interactions, and vital rates of marine biota resulting in changes in the quantity, quality and availability of marine resources for human use (Mueter and Litzow *et al.* 2008, Sundby and Nakken 2008, A'mar *et al.* 2009, Hunt *et al.* In Press). The ripple effect of these changes will be felt around the world (Barange *et al.* 2010). The timeline for projections (20-100 years) requires the development of mechanistic scenarios of future bio-physical couplings as well as scenarios for expected changes in anthropogenic trends in marine resource use including fishing technology, markets, demand, and consumption in light of trends in marine policy (Allison *et al.* 2009, Merino *et al.* 2010, Stock *et al.* 2010, Fulton *et al.* in press, Kim *et al.* 2010). Interdisciplinary research teams will be required to develop science-based advice to decision makers (Pláglyani-Lloyd *et al.* in press, Rice and Garcia in press).

Although the IPCC reports provide concise assessments of the evidence for and projections of the impacts of climate change on the planet, there remains a need for coordinated research to understand climate change effects on specific regions of the globe. Research coordination is especially needed to understand climate change effects on regional marine ecosystems. The North Pacific Marine Science Organization (PICES) and the International Commission for Exploration of the Sea (ICES) have emerged as the leading organizations responsible for scientific advice on marine issues in the northern hemisphere.

In the early 2000s, ICES and PICES independently initiated efforts to develop frameworks for assessing and projecting climate change impacts on marine resources and the ecosystems that support those resources. In 2007, ICES formed the Steering Group on Climate Change [SGCC] to overview the research, services

and operational issues related to Climate Change supported by ICES expert groups, to assess the quality and adequacy of the assessment process, and to manage the start up transit of ICES toward the establishment of a program in Climate Change. The life time of the group was 3 years, ending in Dec/2010. The group was renamed as the Strategic Initiative on Climate Change in 2009 (Res 2009/2/SSGEF01). The final report of that group (“Report of the Science Strategic Initiative on Climate Change”, SCICOM May 2010 Doc 15) described international collaborative efforts (listed later under ICES-PICES joint activities) and the following activities:

- the coordination and production of a multi-authored, peer-reviewed ICES CRR report on Climate Change in the North Atlantic
- the drafting of an ICES position paper on Climate Change in the North Atlantic
- the steering and promotion of theme sessions and workshops on climate change topics during the recent ICES ASC

During the same period PICES initiated a series of workshops and joint scientific symposia focused on forecasting the implications of climate change on marine ecosystems including:

- 2004 POC Topic Session: the impacts of climate change on the carbon cycle of the North Pacific
- 2004 CCCC topic session: The impacts of large-scale climate change on North Pacific marine ecosystems.
- 2006 Symposium on Climate Variability and Ecosystem Impacts in the North Pacific.
- 2006 FIS Workshop: Linking climate to trends in productivity of key commercial species in the subarctic Pacific.
- 2006 POC Workshop: Evaluation of climate change projections.
- 2007 POC/CCCC/MONITOR Topic Session Operational forecasts of oceans and ecosystems.
- 2007 BIO/FIS/POC Topic Session: Phenology and climate change in the North Pacific: implications of variability in the zooplankton production to fish, seabirds, marine mammals and fisheries (humans).
- 2007 POC/CCCC Workshop Climate scenarios for ecosystem modelling.
- 2007 CCCC/CFAME workshop: Climate forcing and marine ecosystems.
- 2009 POC/BIO Topic Session: Anthropogenic perturbations of the carbon cycle and their impacts in the North Pacific.

- 2009 POC/FUTURE Topic Session: Outlooks and forecasts of marine ecosystems from an earth system science perspective: Challenges and opportunities.
- 2009 POC workshop: Exploring the predictability and mechanisms of Pacific low frequency variability beyond inter-annual time scales.

ICES and PICES collaboratively sponsored joint scientific workshops, theme sessions and symposia focused on forecasting the implications of climate change on marine ecosystems including:

- 2008 Organization of the ICES-PICES-IOC symposium on climate change in the world's oceans in Gijon, Spain.
- 2009 Co-convening an ICES/PICES Theme Session on "Climate impacts on marine fish: discovering centennial patterns and disentangling current processes" Berlin, Germany.
- 2010 Co-convening of the ICES- PICES-FAO symposium on Climate Change Effects on Fish and Fisheries which was held in April in Sendai, Japan.
- 2010 Co-convening an ICES/PICES Theme Session on "Responses to climate variability: comparison of northern hemisphere marine ecosystems", Nantes, France
- 2010 Co-convening an ICES/PICES Topic Session on "Impact of climate variability on marine ecosystems: understanding functional responses to facilitate forecasting. Portland, OR, USA.
- 2011 Co-convening an ICES/PICES intersessional workshop on "Reaction of northern hemisphere ecosystems to climate events: A comparison.2-6 May, Hamburg, Germany.
- 2011 Co-convening an ICES/PICES intersessional workshop on "Biological consequences of a decrease in sea ice in Arctic and sub-Arctic Seas", 22 May, Seattle, WA.
- 2011 Co-convening an ICES/PICES Theme Session on "Atmospheric forcing of Northern hemisphere ocean gyres and their subsequent impact on adjacent marine climate and ecosystems. 19-23 September, Gdansk, Poland
- 2011-2012 Organization, planning and implementation of the ICES-PICES-IOC symposium on climate change in the world's oceans in Yeosu, Korea in 2012.

These meetings revealed that the scale and complexity of climate change issues required a more formal partnership between the ICES and PICES organizations. Soon after the ICES-PICES-IOC symposium in 2008, the governing bodies of both PICES and ICES formally recognized the benefits of collaboration with respect to climate change research and approved the formation of the first joint ICES-PICES working group on Forecasting Climate Change Impacts on Fish and Shellfish (WG FCCIFS). That group was jointly chaired by two members of the ICES and PICES groups and was responsible for organizing the ICES-PICES-FAO symposium in Sendai and a forthcoming special volume of ICES Journal of Marine Science.

The life time of the ICES SSIG ended in December 2010 and WG-FCCIFS will end December 2011. Both PICES and ICES recognize that great strides in new science have emerged from collaborative work between their two organizations. Therefore, they requested the formation of a science plan that outlines a structure for continued collaborations focused on climate change. The terminology for longer-term research efforts differs between the two organizations. Within ICES, our plan would be consistent with a Strategic Initiative. Within PICES, our plan would be to create a Section. To avoid confusion with the previous ICES SICC, we will refer to this proposal as the ICES-PICES Strategic Initiative on Climate Change effects on Marine Ecosystems (SICCME). The remainder of this document provides a roadmap for long-term continuation of a collaborative research on climate change through the formation of an ICES-PICES SICCME.

Goals

Never in the history of PICES or ICES has there been a more serious need for cooperation on a marine science issue of global significance. ICES and PICES must *respond to the need for credible, objective and innovative science advice on the impacts of climate change on marine ecosystems*. This advice will foster management and policies that will preserve these resources and habitats for the benefit of future generations. To achieve this overarching goal, the following actions should be addressed.

- i. Define the research activities needed to understand, assess and project climate change impacts on marine ecosystems with sufficient spatial and temporal resolution to plan strategies for sustaining the delivery of ecosystem goods and services and the preservation of biodiversity. When possible predictions should include quantifying estimations of uncertainty.
- ii. Define and quantify the vulnerability of marine ecosystems to climate change, including the cumulative impacts and synergetic effects of climate and marine resource use.
- iii. Build global ocean prediction frameworks, through international collaborations and research, building on ICES and PICES monitoring programs.

As the leading northern hemisphere international organizations, ICES and PICES will direct the ICES-PICES SICCME to draw on the network of marine scientific expertise to make a valuable contribution to advancing science towards resolving these challenges.

3 Objectives

The success of this strategic initiative rests on:

- i. Advancing the scientific capacity on the three main challenges identified above by engaging the PICES and ICES scientific community in focused workshops, theme/topic sessions and symposia that target key uncertainties and technical barriers that impact the predictive skill of ocean models used to project the impacts of climate change.
- ii. Effectively communicating this capacity to clients, Member Countries, stakeholders and the broader scientific community.
- iii. Facilitating an international effort to design data collection networks at the spatial and temporal scales needed to monitor, assess and project climate change impacts on marine ecosystems.
- iv. Facilitating international collaboration to design and implement comparative analysis of marine ecosystem responses to climate change through modelling and coordinated process studies.

4 Key Questions

The overarching goal of the initiative will be to answer the following linked questions.

- i. How will the physical, chemical and biological components of regional marine ecosystems of the northern hemisphere change under future climate scenarios?
- ii. How will marine biodiversity change (and thus biodiversity conservation objectives) as a result of pressures on the physiology, behavior and ecology of individuals, populations and ecosystems within the PICES and ICES regions.
- iii. How will the demand for, and delivery of, ecosystem services change in response to anthropogenic and climate change driven changes to ecosystems?
- iv. How will societies that depend on ecosystems services respond to climate-driven changes in ecosystem services, and which responses are consistent with an ecosystem approach to management?
- v. What are the most significant key sources of uncertainty in projections of climate-ecosystem projections? Is it possible to design monitoring, process-oriented or laboratory studies to reduce this uncertainty?
- vi. What research is needed to understand the interactive nature of climate and resource exploitation on marine ecosystem functioning?

5 Relation of the Initiative to ICES and PICES Strategic Plans

The Science Plan for an ICES-PICES SICCM is responsive to both PICES and ICES Missions. In the case of PICES, a strategic plan for climate change research would respond to all aspects of the new FUTURE research plan by providing assessments of the current and future assessments for the Status Outlooks Forecasts and Engagement (SOFE) Advisory Panel (AP). Members of the ICES-PICES SICCM would conduct research that would advance our understanding of climate change impacts on marine ecosystems which is consistent with the mandate for the Climate, Oceanographic Variability, and Ecosystems (COVE) AP. With respect to the Anthropogenic Influences on Coastal Ecosystems (AICE) AP, the ICES-PICES SICCM would draw from, and contribute to, new science. Members of the ICES-PICES SICCM would utilize information on expected trends in anthropogenic forcing on coastal ecosystems to develop scenarios for use in projecting the implications of climate change on marine ecosystems. Likewise, the output from projection models could be used by others to address issues such as placement of marine protected areas and marine spatial planning. Modelers attempting to project the future food production from sea ranching and aquaculture could utilize products from the ICES-PICES SICCM. Thus, the research of the ICES-PICES SICCM would sit at the intersection of all three of the FUTURE Advisory Panels (Figure 1). The research of ICES-PICES SICCM would also be directly responsible to the standing committees of PICES through its focus on climate change impacts on physical oceanography (POC), fish and shellfish (FIS), marine ecosystems (BIO), and in a more limited regional aspect on marine environmental quality (MEQ). Clearly SICCM serves as a cross-cutting research effort that aligns the different aspects of the PICES community around a highly visible research issue that is of crucial importance to decision makers and the public.

This ICES-PICES SICCM plan is also responsive to the ICES overarching goal ‘To advance the scientific capacity to give advice on human activities affecting, and affected by, marine ecosystems’. Members of the ICES-PICES SICCM will oversee the development and testing of projection models. No single modelling approach has emerged as the best for forecasting. Therefore we will follow the example of the IPCC and encourage the formation of model ensembles that apply different approaches to project the future status of marine ecosystems under different management strategies. As such, the ICES-PICES SICCM will integrate climate change research and fishery science within the wider ecosystem context to provide advice on the Principles of Sustainable Development under a changing climate. The talents

and creativity of all scientists within the ICES community will be needed to develop current and future projections of the implications of climate change on marine resources and to develop strategies to respond to these changes. The ICES-PICES SICCM is particularly responsive to the SCICOM Steering Groups on: Ecosystem Function (SSGEF), Human Interactions on the Ecosystem (SSGHIE), and the Sustainable Use of the Ecosystem (SSGSUE). The SICCM will draw from and contribute to the ICES PICES Initiative to Review Recent Advances in Stock Assessment Models Worldwide (SISAM).

The proposed ICES-PICES SICCM will work closely with emerging working groups that are tasked with providing research products to address focused tactical or strategic issues related to climate change. Members of the ICES-PICES SICCM will include scientists who are experts in climate change related research, therefore, it is likely that some members of the ICES-PICES SICCM will also serve as members of working groups proposed to address a specific issue relevant to climate change research. This type of cross-cutting research is encouraged because it provides an opportunity for members of the ICES-PICES SICCM to share the larger vision for climate change related research in a more focused setting. Joint membership will allow the ICES-PICES SICCM to stay abreast of current science, methods and techniques related to climate change. The recent relationship between WG-FCCIFS and PICES WG-20 (Working Group on Evaluations of Climate Change Projections) serves as an excellent example of how this cross-cutting activity would occur. The WG-FCCIFS was established to improve our understanding of and our capability to forecast the implications of climate change on marine fish and shellfish populations. WG-20 was established to review techniques for downscaling IPCC class models for use in predicting impacts on ocean ecosystems. The two groups worked closely together to produce two papers for the Sendai symposium volume that applied an interdisciplinary approach to forecasting (e.g., Mueter et al. in press, King et al. in press). We expect that similar partnerships and collaborations will emerge on issues related to impacts on coastal communities and other human dimensions. If approved, ICES and PICES will task the ICES-PICES SICCM to establish a longer term and ongoing research activities related to improving our understanding of, and our ability to predict, climate change impacts on marine ecosystems. We will work continue to work closely with ICES and PICES working groups to ensure a smooth exchange of information between groups.

The ICES-PICES SICCM proposes an ambitious new research effort that will focus on an issue that is of global significance. The world needs our advice and we stand ready to devote our time and energy to provide answers to the pressing societal questions of future food security, sustainable management strategies under a changing climate. To provide these answers ICES and PICES must improve their understanding of the mechanisms linking climate and physics to marine ecosystem vulnerability, status, trends and function. Improving understanding must include sustained monitoring and targeted field studies to assess model skill and validate key parameters and functional relationships. This will require strong partnerships with national and international research organizations. The ICES-PICES SICCM will assist ICES and PICES and their member nations by communicating and integrating PICES and ICES research into national and international research organizations that could contribute to a coordinated global research effort on climate change. Potential research partner organizations include such the Food and Agriculture Organization, the Intergovernmental Ocean Commission (IOC), the Integrated Marine Biogeochemistry and Ecosystem Research program (IMBER), the Scientific Committee on Oceanic Research (SCOR), and the World Bank. In the near term, the activities of the ICES-PICES SICCM will help to identify opportunities to coordinate field and modelling research to maximize the opportunity for regional comparisons and testing responses of living marine resources to climate change. Scientific collaborations will be facilitated through working group meetings, workshops, and topic/theme sessions at annual meetings or symposia. Members of the SICCM will strive to identify and respond to funding opportunities to leverage funding to maximize the utility of the research.

6 Structural Issues

The ICES – PICES SICCM will be jointly managed by ICES SCICOM and PICES Science Board (Figure 1). The Co-Chairs of the ICES-PICES SICCM will make annual reports to the ICES steering groups SSGEF and SSGHIE, and the PICES standing committees FIS, POC

and BIO. The ICES-PICES SICCM will also report to PICES FUTURE's advisory panels SOFE, COVE and AICE. The initiative will facilitate new interest and thinking, at all ecosystem levels from physics to fish and fish to markets. It is not intended to set up new structures, rather it will work within the structural framework of ICES and PICES to engage and inspire the scientific community to direct their intellect to improving our ability to predict climate change impacts, to communicate these impacts to decision makers and to assess the performance of management strategies under a changing climate.

The ICES-PICES SICCM will identify approaches and operational practices that will facilitate and encourage development of integrated scenarios of climate impacts on marine systems by engaging scientists from diverse backgrounds, including: climatology, oceanography, ecology, fisheries, technology, social-science, and markets. Members of the ICES-PICES SICCM will include representatives with expertise in each of these areas. The SICCM will strive to co-convene a major international symposium that will showcase the accomplishments of ICES and PICES scientists working on climate change related activities on a biennial basis (Figure 1). Selected papers from the symposium will be published in scientific journals such as the ICES Journal of Marine Science. This will have the dual impact of raising the visibility of the ICES Journal and it will provide a venue for scientists from other regions to share results and ideas. By scheduling the symposium on a regular schedule, scientists will be able to plan collaborative research to take advantage of the opportunity to meet. Ideally the venue for the symposium will rotate between locations on the Atlantic and locations on the Pacific. This will maximize the opportunity for participation by young scientists who might otherwise be unable to attend. The 2-3 year time step for symposia will facilitate contributions to the IPCC reporting schedule. The IPCC publishes reports on approximately a 5 year time step. We expect that the new science published in symposium volumes will be cited by the IPCC, and that the new scenarios provided by the IPCC will be used by members of the ICES-PICES SICCM to force regional ocean circulation models. The proposed 2-3 year time step for the ICES-PICES SICCM symposia ensures this complimentary relationship is preserved.

In the intervening period between symposia, members of the ICES-PICES SICCM will conduct semi-annual virtual meetings that utilize the internet meeting software. If a sufficient number of members plan to attend an inter-sessional meeting, an in-person meeting of the ICES-PICES SICCM may be scheduled as well. During virtual or in-person meetings, members will plan inter-sessional workshops, and topic/theme sessions for the PICES or ICES annual meetings. Inter-sessional workshops and topic/theme sessions will provide venues to plan, discuss, and coordinate international collaborative research that will advance our understanding of climate change effects on marine ecosystems.

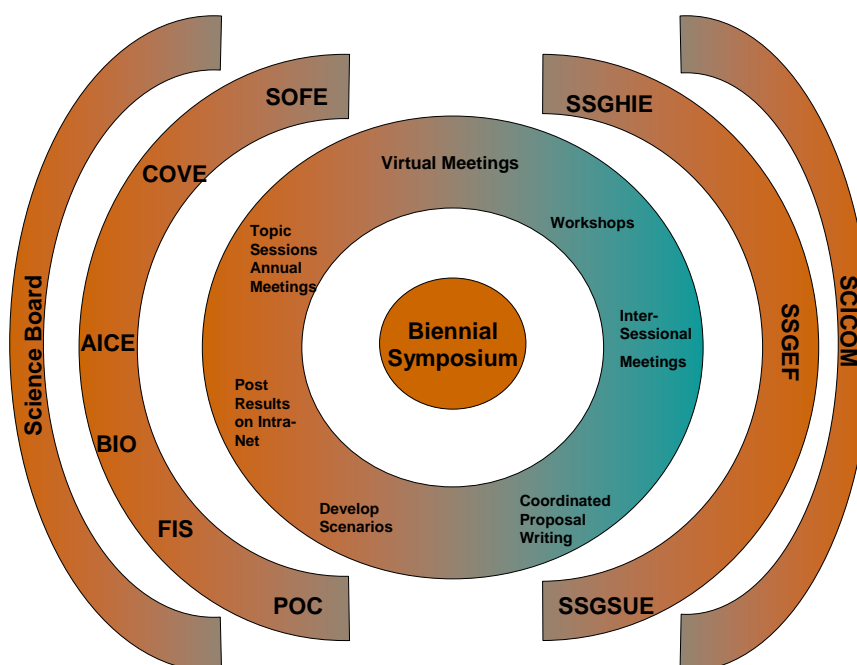


Figure 1: A conceptual model of the Strategic Initiative on Climate Change and Marine Ecosystems showing concentric circles that represent how members of the initiative will conduct their research and report to ICES and PICES.

Members of the ICES-PICES SICCME will be drawn from PICES and ICES. The travel costs associated with sending large numbers of scientists to two meetings each autumn can be high. Therefore, the PICES-ICES SICCME will strive to rotate their sponsored theme/topic sessions between the PICES and ICES Annual Meetings. This would not limit co-sponsorship of a theme/topic session during an “off-cycle” year.

It is expected that selected members of the PICES-ICES SICCME will report to the PICES and ICES scientific steering bodies annually. They will report on the activities of the working group and they will submit proposals for topic/theme, intersessional or biennial symposiums.

Sound science necessitates collaborative integrative research on a global scale. The framework shown above will facilitate opportunities for this type of work and will lead to regular publications of results in the peer-reviewed literature.

As scientists develop scenarios and models to project the implications of climate change they will inevitably identify key sources of uncertainty. Left unaddressed this uncertainty will propagate through the projections. We anticipate that the activities of the SICCME will raise awareness of the need for long term spatially resolved ocean monitoring data and focused field and laboratory studies to address these issues. These recommendations will be communicated to PICES TCODE and other interested steering committees within ICES and PICES.

There is a long list of potential clients who would be interested in the products of the ICES-PICES SICCME. The SICCME will develop a strategy to ensure that new findings are communicated to the governing bodies of ICES and PICES to keep the organizations updated on new findings, initiatives and opportunities. The SICCME will work with the FUTURE SOFE AP to develop a strategy to ensure that National and International science organizations are aware of opportunities for global collaboration.

All indications at present suggest that there will be an increasing demand for marine resources as the population continues to grow through 2050. Understanding the limits of marine ecosystem extraction will necessitate simulations of climate impacts on marine systems and scenarios for resource extraction. Successful implementation of this initiative will position PICES and ICES to be the leading group to respond to this demand. Following the IPCC model, we anticipate that once the projection models have been fully reviewed, and properly tested, that the scenarios for ecosystem change under different climate scenarios will be made available through PICES and ICES websites.

7 Benefits

The proposed ICES-PICES SICCME will have the following anticipated benefits:

- Increased understanding of physical, chemical and biological linkages and ecosystem responses to anthropogenic and climate forcing;
- Coordinated monitoring and descriptions of the current state of ecosystems;
- Projections of future states of northern hemisphere marine ecosystems and their associated uncertainty;
- More robust quantitative and qualitative forecasts, with specified uncertainty, of ecosystem responses to climate change and increasing human influence;
- IPCC-like reports on responses of northern hemisphere marine ecosystems to climate change;
- Quantification of the benefits and risks associated with different management strategies;
- Increased marine science capabilities in ICES-PICES member countries;

These benefits were also listed in the PICES the FUTURE science plan. The FUTURE program established the vision and the plan for a climate change research program, the ICES-PICES SICCME provides the foundation of working scientists that will ensure that work is completed and delivered in a manner consistent with the goals and objectives of SICOM and PICES Science Board. The pace of discovery, innovation and progress will be accelerated through adoption of this initiative that will facilitate rapid exchange of information between ICES and PICES scientists. The formation of the ICES-PICES SICCME will expand opportunities for use of the comparative approach by extending our partners to other regions in the northern hemisphere.

8 Timeline

4th Quarter 2011: Finalise SICCME core group membership.

Jan 2012: Start-up

May 2012: Convene session at ICES-PICES-IOC Climate change effects on the world's ocean (Korea); organize theme session(s) for 2012 ASC

Sept. 2012, Bergen - SICCME meeting; lead theme session(s); propose new theme sessions for 2013 or 2014 ASC. Propose symposium for 2015.

Oct. 2012, Hiroshima(?) – PICES ASC

Sept. 2013, ICES ASC

Oct. 2013, PICES, ASC

9 Budget - 2012

Task	Cost (DKK)
Travel and accommodation for the SICCOME planning meeting in Yeosu, Korea in 2012	4 trips (2 from Europe, 2 from the western Pacific)
Hosting and secretarial support for the theme session in conjunction with the symposium in Yeosu, Korea 2012	Covered by PICES and ICES HQ
Travel for chairs and invited experts to intersessional Workshop in 2012	2 trips (TBD) covered by PICES
Travel to working group meetings held during PICES and ICES Annual Science Conferences	
SUM	

10 References

Arrigo, K.R., van Dijken, G., and Pabi, S., 2008. Impact of a shrinking Arctic ice cover on marine primary production. *Geophys. Res. Lett.* 35, 19603.

A'mar, Z.T., A. E. Punt, M. W. Dorn. 2009. The evaluation of two management strategies for the Gulf of Alaska walleye pollock fishery under climate change. *ICES J. Mar. Sci.* 66(7): 1614-1632.

Allison, E.H., L. Perry, McBadjeck, W. N. Adger, K. Brown, D. Conway, A. S. Halls, G. Pilling, J. D. Reynolds, N. C. Andrew, N. K. Dulvy. 2009. Vulnerabilities of national economies to the impact of climate change on fisheries. *Fish and Fisheries* 102: 173-195.

Barange, M., I. Allen, E. Allison, M.-C. Badjeck, J. Blanchard, B. Drakeford, N.K. Dulvy, J. Harle, R. Holmes, J. Holt, S. Jennings, J. Lowe, G. Merino, C. Mullon, G. Pilling, L. Rodwell, E. Tompkins, F. Werner. 2010. Predicting the impacts and socio-economic consequences of climate change on global marine ecosystems and fisheries: the QUEST_Fish framework. In *Coping with Climate Change in Marine Socio-ecological Systems*. Ed. by Ommer, R. et al., Blackwell FAR Series.

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., and Pauly, D. 2009. Projecting global marine biodiversity impacts under climate change scenarios. *Fish and Fisheries*, 10: 235-251.

Durner, G.M., Douglas, D.C., Mielson, R.M., Amstrup, S.C., McDonald, T.L., Stirling, I., Mauritzen, M., Born, E.W., Wiig, Ø., DeWeaver, E., Serreze, M.C., Belikov, S.E., Holland, M.M., Maslanik, J., Aars, J., Bailey, D.A., Derocher, A.E., 2009. Predicting 21st-century polar bear habitat distribution from global climate models. *Ecol. Monogr.* 79, 25–58.

Fulton, E.A., in press. Interesting times: Winners and losers and system shifts under climate change around Australia. *ICES Journal of Marine Science*.

Hunt, Jr., G. L.; K. O. Coyle, L. Eisner, E. V. Farley., R. Heintz, F. Mueter, J. M. Napp, J. E. Overland, P. H. Ressler, S. Salo P. J. Stabeno, In Press. Climate impacts on eastern Bering Sea food webs: A synthesis of new data and an assessment of the Oscillating Control Hypothesis. *ICES Journal of Marine Science*.

IPCC. 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Ed. by R. K. Pachauri, and A. Reisinger. IPCC, Geneva. 104 pp.

Kim, S. 2010. Fisheries development in northeastern Asia in conjunction with changes in climate and social systems. *Marine Policy*, 34: 803-809.

- King, J. R., V. N. Agostini, C. J. Harvey, G. A. McFarlane, M. G. G. Foreman, J. E. Overland, E. Di Lorenzo, N. A. Bond, and K. Y. Aydin. In press. Climate forcing and the California Current Ecosystem. *ICES Journal of Marine Science*.
- Merino, G. M. Barange, C. Mullon 2010. Climate variability and change scenarios for a marine commodity: Modelling small pelagic fish, fisheries and fishmeal in a globalized market. *J. Marine Systems* 81:196-205.
- Mueter, F. J., N. A. Bond, J. N. Ianelli, A. B. Hollowed. 2011. Expected declines in recruitment of walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea under future climate change. *ICES Journal of Marine Science*.
- Philippart, C.J.M. R. Anadón, R. Danovaro, J.W. Dippner, K.F. Drinkwater, S.J. Hawkins, T. Oguz, G. O'Sullivan and P.C. Reid. 2011. Impacts of climate change on European marine ecosystems: Observations, expectations and indicators. *Journal of Experimental Marine Biology and Ecology*. (in press)
- Plaganyi-Lloyd, E., S. Weeks, M. Gibbs, T. Skewes, E. Poloczanska, A. Norman-Lopez, L. Blamey, M. Soares, W. Robinson. In Press. Assessing the adequacy of current fisheries management under changing climate: a southern synopsis. *ICES Journal of Marine Science*.
- Rice, J., S. Garcia. In Press. Fisheries, Food Security, Climate Change and Biodiversity: Characteristics of the Sector and Perspectives on Emerging Issues. *ICES Journal of Marine Science*.
- Stenevik, E.K., Sundby, S., 2007. Impacts of climate change on commercial fish stocks in Norwegian waters. *Mar. Policy* 31, 19-31.
- Stock, C.M. Alexander, K. Brander, N. Bond, W. Cheung, E. Curchister, T. Delworth, J. Dunne, A. Gnanadesikan, S. Griffies, M. Haltuch, J. Hare, A. B. Hollowed, P. Lehodey, J. Link, K. Rose, R. Rykaczewski, J. L. Sarmiento, F. Schwing, R. Stouffer, G.A. Vecchi, F. Werner (2011) On the use of IPCC-class models to assess the impact of climate on living marine resources. *Progress in Oceanography*.
- Sundby, S., Nakken, O., 2008. Spatial shifts in spawning habitats of Arcto-Norwegian cod related to multidecadal climate oscillations and climate change. *ICES J. Mar. Sci.* 65, 953–962.