ICES/PICES WORKSHOP ON 'MODELLING EFFECTS OF CLIMATE CHANGE ON FISH AND FISHERIES' (WKSIC-CME1)

Executive summary

Guideline for the production of executive summaries

The ICES-PICES Strategic Initiative (Section) on Climate Change Impacts on Marine Ecosystems (SICCME) convened a 1-day workshop on 24th September in Riga, Latvia to discuss progress on projection modelling of climate impacts on fish and fisheries. The workshop was attended by 16 scientists from 6 nations. The workshop was chaired by Anne Hollowed (USA, PICES), Myron Peck (Germany, ICES), John Pinnegar (UK, ICES) and Mark Payne (DK, ICES). The workshop was organized as a PI meeting to discuss ongoing modelling efforts in different regions. The meeting is part of the roadmap defined at a previous workshop in Seattle WA, USA (August 2015) which includes alignment of common future scenarios (i.e., representative fishing pathways, broader "PESTLE" scenarios, etc.), production and comparison of projections within and among regions and publication of results soon enough (late 2018) for uptake by writing teams of the IPCC Assessment Report 6. This SICCME1 workshop discussed i) ongoing regional projects, ii) the develop common future scenarios, iii) the global 'FishMIP' program and iv) advancements in short-term environmental forecasting.

i) Several projects making projections of climate impacts on fish and fisheries were reviewed. These projects included 'COCA' (several projects, NW Atlantic from the mid-Atlantic Bight through the Gulf of Maine), 'ACLIM' (NE Pacific, Gulf of Alaska) and 'CERES' (all European Seas from the Mediterranean through the Barents / Norwegian Seas). Other updates were provided included activities in the US National Aquatic Climate Change Research Program. A list of modelling teams by region was assembled which will be extended after updates are provided at the next workshop organized as part of the PICES ASC.

ii) Common future scenarios are being developed and an example was provided within the European CERES project. Short-, medium- and long-term developments in governance, social, technological and economic drivers may be just as important to fisheries and aquaculture as climate-driven changes in habitats and species. In combination with outputs from physical / biogeochemical modelling, these storylines will be 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 fisheries pathways in other projects (e.g ACLIM) was provided.

iii) Previous efforts to harmonize and compare model projections of climate impacts on fish and fisheries have been championed by FishMIP, a network of scientists including 15 different models (10 global and 5 regional). Presentations on FishMIP including a description of some of the specific global (e.g. BOATS) and regional (e.g. POEM2) modelling tools as well as the protocol to harmonize input and output variables now (e.g. 39 forcing variables used as input for the various models). This protocol will be useful to the ICES PICES SICCME.

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

skill of short-term (few months to few years) in some ocean regions will help complete the portfolio of projection tools (including short-, medium- and long-term) available to fisheries scientists.

Opening of the meeting

The 1-day workshop was opened with a presentation by John Pinnegar (UK, ICES) and Anne Hollowed (USA, PICES) that extended a warm welcome on behalf of ICES, PICES to the participants (see Annex 1). Each participant briefly introduced themselves and their expertise. The goals and terms-of-reference of the workshop were reviewed (see Annex 2) and the agenda (see Annex 3) was discussed. The terms of reference were adopted and the presentations and discussion commenced.

1 Presentation / Session Summaries

Topic 1 – Ongoing Projects Examining Climate Impacts on Fish and Fisheries

i) CERES – Climate Change and European Aquatic Resources (Myron Peck)

Myron Peck provided a brief overview of the CERES (Climate Change and European Aquatic Resources – H2020 BG2) project. The four-year (2016-2020) project has 26 European partners from 17 countries including 7 SME (industry partners). The goal is to provide bottom-up (industry driven) and top-down (policy) recommendations and solutions for how fisheries and aquaculture can adapt and potentially benefit from climate change. Physical projections (RCPs 4.5 and 8.5) will be made with different, downscaled regional models (POLCOMS-ERSEM from the NE-Atlantic to the Mediterranean Sea, NORWECOM in the Barents and Norwegian Seas, BSCOBI in the Baltic Sea, and E-Hype for European freshwater / rivers). Physical changes are linked to direct (physical) and indirect (e.g. biological) impacts on the productivity of key aquaculture species (e.g. salmon, shellfish, seabream, seabass, trout, cod, carp, etc.) and the distribution and productivity of fisheries (mixed pelagic, mixed demersal, bluefin tuna, etc.). Biological consequences of climate change will feed into bioeconomic models and biological / socioeconomic vulnerability assessments (Figure X)

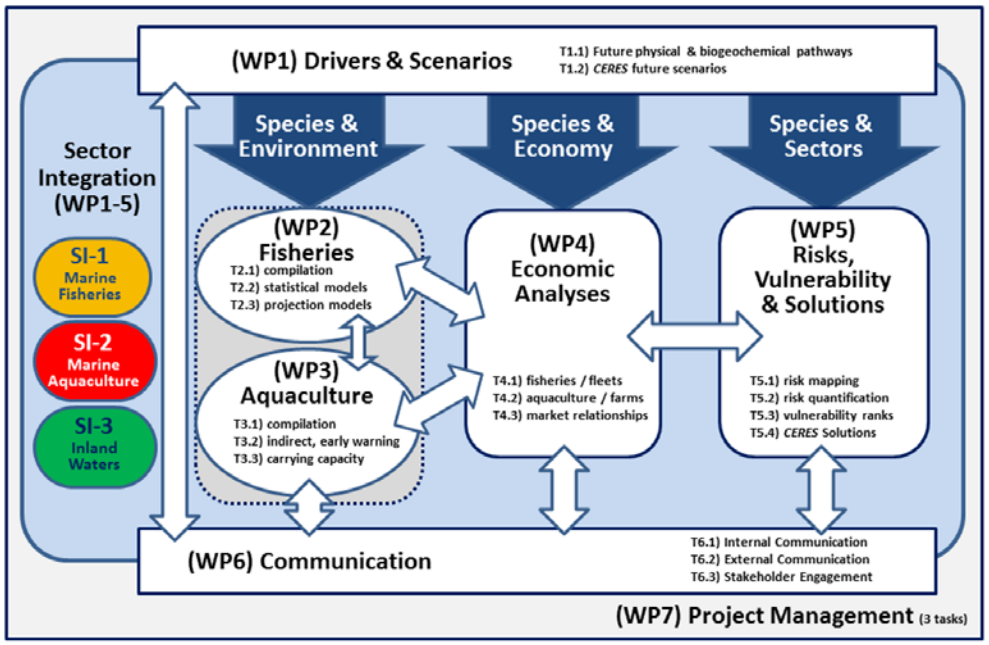

Figure 1: Diagram of the project structure of CERES. WP = workpackage, T = Task.

Stakeholder engagement includes both common-framing of future scenarios to be tested and mind-mapping (Bow-Tie analysis) to help envision perceived risks and mitigation strategies. The scenarios include four different "storylines" of the future and were discussed at length in the afternoon of the workshop (see summary of the presentation by John Pinnegar). Tools produced include vulnerability assessments by species/region which take into account both biological and industry exposure, sensitivity and adaptive capacity. A list of biological and bio-economic models used in CERES is provided (Table 1).

Table 1: List of biological or bioeconomic models used within the EU Project CERES to project climate change impacts on various commercially important species / groups to aquaculture and fisheries.

Model	Person	Contact
Barents / Norwegian Seas		
NOBA Atlantis	Cecilie Hansen	cecilieha@IMR.no
Gadget	Daniel Howell	daniel.howell@imr.no
Norwecom.E2E**	Geir Huse	geir.huse@imr.no
POEM2.0**	Suse Niiranen	susa.niiranen@su.se
North Sea (and NE Atlantic)		
Atlantis	Alexander Keth & Myron Peck	Alexander.Keth@uni-hamburg.de
FishRent	Sarah Simons	sarah.simons@ti.bund.de
SIMFish	Hamon Katell	katell.hamon@wur.nl
DBEM	Jose Fernandes	ja.fernandes.sp@gmail.com
ERSEM-DEB	Lorna Teal	lorna.teal@wur.nl
Baltic Sea		
Atlantis	Rasmus Nielsen	rn@aqua.dtu.dk
EwE**	Suse Niiranen	susa.niiranen@su.se
Bay of Biscay (and Eastern Channel)		
ISIS-Fish	Stephanie Mahevas	Stephanie.Mahevas@ifremer.fr
IBM DEB	Martin Huret	Martin.Huret@ifremer.fr
Mediterranean Sea		
FLBEIA	Patricia Reglero	Patricia.Reglero@ba.ieo.es
MAFESTO	Francesc Maynou	maynouf@icm.csic.es

** not directly funded by CERES but likely available for regional model comparisons made elsewhere (e.g. Fish-MIP).

ii) COCA - Coastal and Ocean Climate Applications (Kathy Mills, Malin Pinsky)

NOAA has funded 7 projects using 5 million over three years. Kathy Mills presented one project designed to evaluate the social-ecological vulnerability of fishing communities to climate impacts, assess how different climate adaptation strategies influence vulnerability and social outcomes, identify factors that affect the ability of fishermen and fishing communities to adapt, and finally, communicate results to fishing communities and to science and management audiences. Projections relevant to both local and regional spatial scales as well as short to long time scales (10-, 25-

and 80-yr). Integrated assessments are conducted at regional scales (Cinner et al., 2013; Johnson and Welch 2010) and conducts a vulnerability assessment using four categories which incorporate expert judgement as outlined by Hare et al. (2016). Projections utilize CMIP5 ensemble, RCP 4.5 and 8.5. Exposure based on mean and variance of SST, SSS, air T, precipitation, pH, SLR, ocean currents, etc.) (Figure 2). At the local scale, the project has selected four communities where more quantitative assessments will be conducted. Constraints on potential adaptation strategies (e.g travel further to fish, target wider range of fish, increase efficiency of operations) are examined using expert groups and community focus groups based on established frameworks (e.g. Moser and Ekstrom, 2010; Leith et al., 2014) including a perception of fishers' capacity / willingness to change. A second, closely related project funded by NSF Coastal SEES is examining American lobster (*Homarus americanus*) in the Gulf of Maine region.

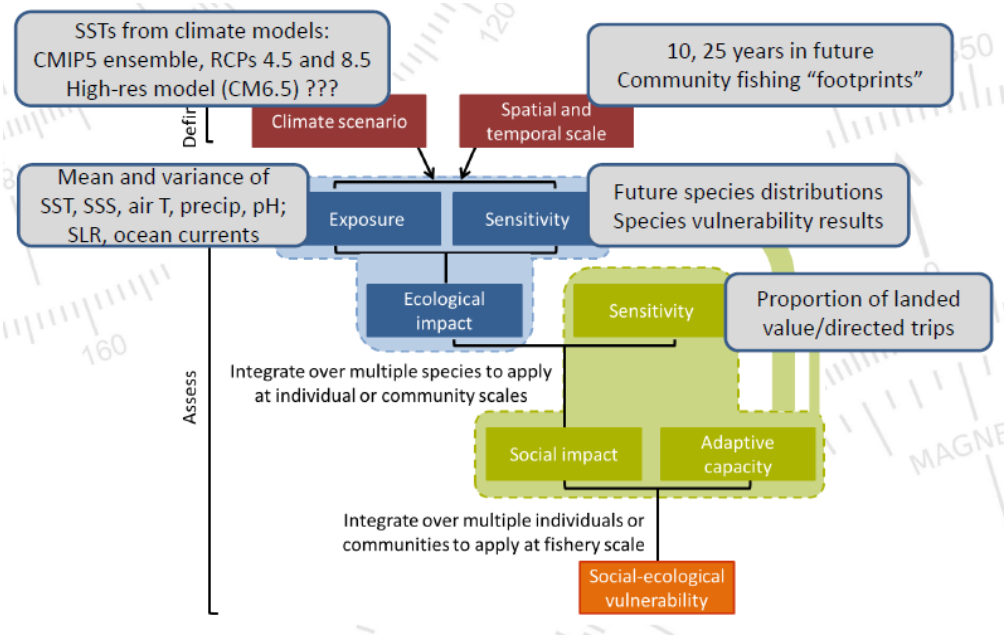

Figure 2: Conceptual framework of social-ecological vulnerability assessment to be conducted. The two-stage process includes: i) defining climate scenarios and spatial, temporal scales, and ii) assessing biological/ecology vulnerability followed by social vulnerability. Subsequently, the economic consequences of each of the top five most vulnerable species will be analysed.

Malin Pinsky continued discussing COCA-funded projects by summarizing some projects underway in collaboration between Rutgers and NOAA GFDL. The earth system models have increased resolution (most highly resolved is the 0.1 x 0.1° ocean CM2.-6 run) which is needed to capture warming in coastal areas such as the Gulf of Maine. An ongoing project has produced downscaled projections of ocean physics at 7-km scale resolution (regional ROMS model). A suite of ongoing projects examining historical and projecting future changes in fish and fisheries is underway (e.g. ocean-adapt-rutgers.edu). Various tools (e.g. physiological-based models) are employed in an attempt to reveal the processes and mechanisms behind those changes, particularly disentangling fishing from climate impacts.

iii) ACLIM – Alaska Climate Change Integrated Modeling (Kirstin Holsman, Alan Hainey)

Kirstin Holsman discussed the progress made during the first year of the three-year ACLIM project, a NOAA AFSC & PMEL and University of Washington collaboration. The project examines fisheries management approaches, evaluates performance of additional "climate-ready approaches" and generates prediction of future fishable biomass to provide a multi-model comparison of how Alaska fisheries and management may adapt to climate change. Three scenarios (RCP 2.6, 4.5, 8.5) are run using downscaled hydrography from 7 GCMs (11 runs). These runs will be used to drive each of five, climate enhanced biological models including CE-SSM, CEATTLE (multi-species model with walleye pollock, pacific cod and arrowtooth flounder), Ecosim, Size-spectrum, and FEAST (most complex, ecosystem model). Each of these is run with up to five fishing scenarios (status quo, by-catch, MSY, no fishing and maximum economic yield). This is one of the few studies examining uncertainty at four different levels: Global Climate Models x Future Scenarios x Biological Models x 5 Fishing Scenarios (see Figure 3).

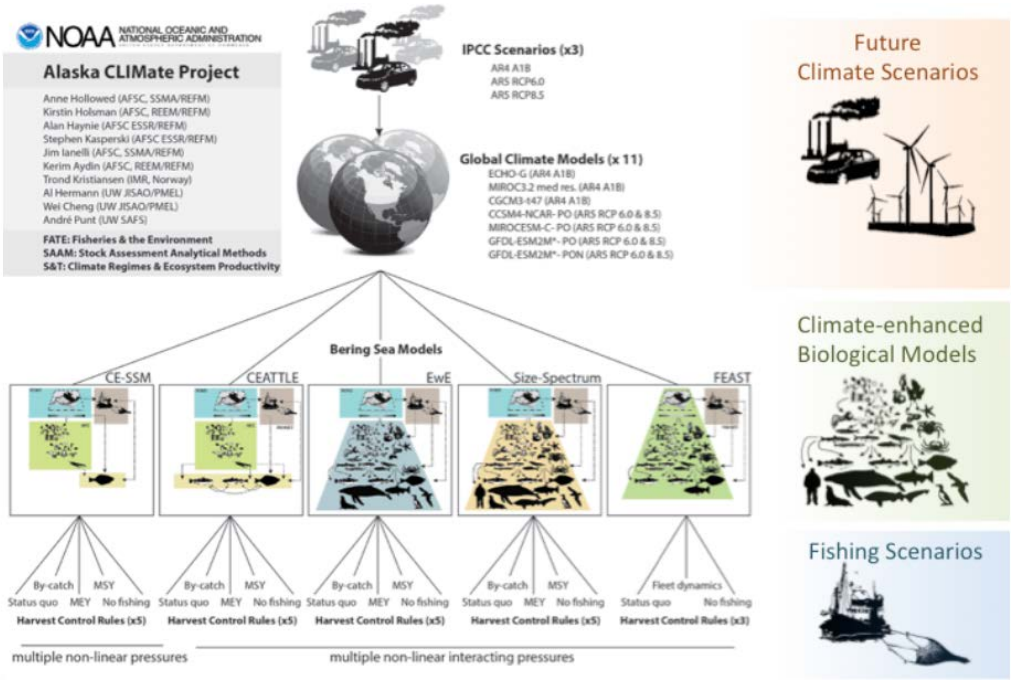

Figure 3: Illustration of the 3 IPCC scenarios, 11 climate models, 5 climate-enhanced biological models and five fishing scenarios being examined in ACLIM (from Kirstin Holsman).

Alan Hainey reported on a socioeconomics workshop was recently conducted as part of the ACLIM project. The website for FishSET (Spatial Economics Toolbox for Fisheries) was also presented along with specific activities on fisher's behaviour in the Gulf of Alaska particularly with regard to pollock fishing grounds (Hainey and Pfeifer, 2013).

iv) Other relevant Projects

Anne Hollowed provided a series of updates on climate modelling in the NE and NW Pacific region. First, the National Aquatic Climate Change research program (contact Nancy Shackell – NOAA) is underway which includes activities on Ocean Acidification, regional model downscaling Program and creating vulnerability indices for coastal regions as well as species. The Norwest Atlantic programs include comprehensive overviews of impacts including physical trends and projections. One goal is to broaden / develop use of biogeochemical models as management tools and

incorporate climate change into the stock assessment process / examine effects of seasonal differences, etc. Finally, recent advancements made on the end-to-end model NEMURO.FISH were discussed based on slides prepared by Shin-ichi-Ito and colleagues. Current efforts running different iterations of the nutrient, phytoplankton, zooplankton and fish within this end-to-end model.

Malin Pinsky provided an overview of other (non-COCA funded) project in his group including multi-species (community assembly modelling) and cumulative impacts of fishing and climate. Finally, an interesting example of fisher responses (trip report data) was provided allowing a reconstruction of intrinsic rates of growth from catch data. An example was provided for scallops harvested from Georges Bank and elsewhere in the northwest Atlantic.

Topic 2: Fish-MIP

Eric Galbraith provided an update on the Fish Model Intercomparison Project (Fish-MIP) which is a part of the Inter-sectoral Impact Model Intercomparison Project (ISIMIP - www.isimip.org). FishMIP has gathered a wide selection of existing fish models (regional + global), subjected them to common forcing, compared models to assess structural and parameterization bias and uncertainties, and is assessing the range of future responses and underlying mechanisms. The network now includes 10 different global models working and 5 different regional models. A FishMIP protocol is now available which outlines the 39 forcing variables used as input for global and regional marine fisheries models. All models are driven by common GCMs (available at ISIMIP server). Outputs are netcdf format and include: 1) Biomass , 2) Catch, 3) Species Distribution, and 4) Ecosystem parameters. Biomass and catch are further subdivided into: Total; by functional group / size class / commercial species; Spatial / temporal 2D / 3D. Ecosystem parameters include: Species richness; Functional richness; Mean trophic level; other food-web properties; production, growth rates. Preliminary results with the BOATS model suggest extremely large differences among runs using different GCMs.

FishMIP is currently analyzing first round of simulations, preparing publications on methods and projections. The most recent is a paper on methodological protocols for inter-model comparison (Tittensor et al. submitted). The group will prepare a contribution to the 1.5 degree report, perform a cross-sectoral comparisons within ISI-MIP and is planning on pre-industrial simulations and historical hindcasts. The group is considering strategies for future fishing scenarios and has an interest in developing testbed regions of high resolution circulation models (e.g. ROMS) to move beyond limitations of coarse-grained ESMs.

Fish-MIP model example 1: In the Barents and Norwegian Seas, a 2-D size-structured food web model (POEM2.0) has been constructed which has been linked offline to the biogeochemical models COBALT (Charlie Stock, NOAA GFDL) for the global application and HYCOM-NORWECOM for application in the Barents Sea. POEM2.0 is a size structured model making use of information on relative sizes of predators and prey (e.g. Barnes et al. 2008). Models based on size-spectra have become an increasingly popular approach to examining how fishing impacts on marine ecosystems (e.g. Blanchard et al. 2014). They are making comparisons between HYCOM – NORWECOM and NOBA Atlantis. Susa Niiranen summarized previous and ongoing efforts to project climate-driven changes at the ecosystem level within the Baltic Sea and Barents / Norwegian Seas. In the Baltic Sea, the Ecopath with Ecosim (EwE) model was used to provide climate projections of changes to the food web (with em-

phasis on cod, herring sprat). The GCM and scenarios examined were ECHAM5-r1-A1B, ECHAM-r3-A1B, ECHAM-A2. Historical changes in species composition and strength of predator-prey coupling were correlated with changes in temperature and salinity. These physical factors were used to drive future states of the food web.

Fish-MIP model example 2: Eric Galbraith presented the BiOeconomic Allometric Trophic Size-spectrum (BOATS) model (Caroza et al. 2016) which provides spatially-explicit projections of change in carrying capacity and fisheries yields across the world's oceans. It is a relatively simple model developed using first principles. Key attributes of the model include: 1) total energy constrained by photosynthesis, 2) trophic transfer, 3) metabolic consumption of energy, 4) growth is resolved, 5) recruitment is projected, 6) all commercial species are included, and 7) there is no explicit feeding relationships. Despite having simple assumptions, the ensemble average global fisheries harvest and trends in fished biomass since the 1950's match well with observations (Figure 2)

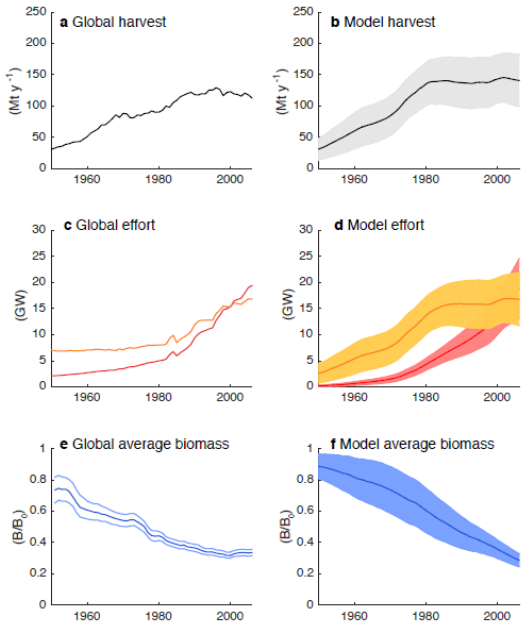

Figure 2: Observed A, C, E) and modelled BOATS (B, D and F) fisheries harvest, global fishing effort and average biomass versus time. This figure is from Galbraith, Carozza and Bianchi (In Review).

Topic 3: Defining Future Scenarios for climate-impact studies on fisheries

An important element of the ICES-PICES SICCME activities in 2016 and 2017 is defining future scenarios to be used by regional modelling teams. Alan Hainey provided an overview of the ICES-PICES workshop in Brest (June 2016) to develop fisheries scenarios for climate modelling. A paper is being drafted from the workshop which will define various scenarios. The group agreed to focus on matching climate-fish models to specific economic and social science models. Three breakout groups focused on the questions of which socio-economic indicators and models could be used in climate-fish models. Although efforts are well underway to integrate economic and social data into models, concern was expressed about the lack of this activity in poorer, southern hemisphere countries (due primarily to a lack of data).

John Pinnegar summarized the PESTLE (Political, Environmental, Social, Technological, Legal and Economic) scenarios that have been created for the EU BG2 project CERES which will hopefully be utilized, to the extent possible, in other climate projection modelling efforts. Without defining common future scenarios, it will be extremely challenging to compare estimates from projects across studies and regions. Moreover, short-, medium- and long-term developments in governance, social, technological and economic drivers may be just as important to fisheries and aquaculture as climate-driven changes in habitats and species.

A template was created in the CERES project to allow stakeholder groups to create a suite of exploratory, future socio-political scenarios, drawing on recent outputs and developments from the Intergovernmental Panel on Climate Change (IPCC). In combination with outputs from physical / biogeochemical modelling, these storylines will be used to generate a set of combinations of environmental and socio-economic projections for the fishery and aquaculture sectors. Stakeholders and CERES team members will further discuss and agree on plausible changes in a diverse array of parameters needed for specific analyses conducted in fisheries and aquaculture including bio-economic modelling and ecological risk assessment and adaptation strategies.

Engagement of fishers and aquaculture business owners is particularly important in order to gain 'on the ground' information on social factors / constraints. A coherent and consistent set of assumptions and development trajectories will be established, using these socio-political storylines as a 'starting point' and employed in subsequent activities throughout the 4-year project. CERES partners will use this initial material as the basis for discussions/engagement with the wider stakeholder community (including members of an industry "reference user group" (RUG) that attends project meetings and provide critical feedback on CERES activities). A series of face-to-face interviews will be carried out, whereby stakeholders will be asked to map out how they conceive the future might look for their sector, farm or fishing fleet under each of the coherent storylines. They will be asked to consider possible barriers to successful adaptation, any exogenous factors that might influence development trajectories under particular scenarios, any issues that should be elaborated further in subsequent work-packages of the CERES project. The personal visions resulting from the stakeholder engagement and the underlying storylines originally envisaged will be combined and collated in the finalized standard socio-political scenarios in February 2017) that will be used in all subsequent work-packages of the CERES project.

Van Vuuren & Carter (2014) provided a suggestion for mapping the previous generation of IPCC SRES (Special Report on Emission Scenarios) storylines onto the new framework of Regional Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs), and this approach has been taken on board in CERES and hopefully adopted, to the extent possible, in other regions. According to these authors: (i) an SRES 'A2' (National Enterprise) world broadly corresponds with the combination RCP 8.5 and SSP3; (ii) an SRES B2 or A1B (Local Stewardship) world corresponds with the combination RCP 6.0 and SSP2; (iii) an SRES B1 (Global Sustainability) world corresponds with the combination RCP 4.5 and SSP1, and (iv) an SRES A1FI (World Markets) world corresponds with the combination RCP 8.5 and SSP5.

An 8-page 'Glossy Report Card' was constructed based on the 49 personal 'visions' provided by participants at the CERES 'kick-off' meeting (April 2016) but also recently published quantitative information concerning the five SSPs of the IPCC. A forthcoming special issue of the scientific journal Global Environmental Change contains

research papers outlining the logic behind each of the five SSPs as well as a series of overview papers that talk about human population, GDP and economic growth, urbanisation, land and energy use trajectories etc. Specifically, the most important sources that were consulted during the construction of the CERES 'report card' were the general SSP narrative provided by O'Neill et al. (2014; 2016) and additional information on SSP1 (van Vuuren et al., 2016), SSP2 (Fricko et al., 2016), SSP3 (Fujimori et al., 2016), SSP4 (Calvin et al., 2016) and SSP5 (Kriegler et al., 2016) as well as an economic overview of energy and land-use by Riahi et al. (2016). The four fisheries scenarios being used in CERES are shown in Figure X

Figure X: Four draft socio-political storylines (scenarios) for European fisheries elaborated by partners and stakeholders in the EU (BG2) project CERES. These storylines will map onto the physical / biogeochemical model runs (RCPs) being provided by other CERES project partners.

The importance of management scenarios in terms of future tradeoffs and limitations to global fisheries was highlighted in a talk by Dan Ovando who presented the 'Upside', a bio-economic model designed to investigate the effects of fisheries reform on future biomass, harvest, and profit trajectories to 2100. In early 2016, a paper was published in PNAS that highlighted the global potential for fisheries given management reform (Costello et al., 2016) by exploring changes in catch, biomass and profit in three future scenarios: i) business as usual (BAU), rights-based fishery management (RBFM) and maximising catch (F_{MSY}). The model has been expanded to explore the effects of climate change (RCP4.5, 8.5) on harvest control rules and fishing alloca-

tions. This was done primarily through investigations of how climate change will influence the carrying capacity of marine ecosystems and stock productivity in the future—changes that have already been observed in many of the world's oceans. A result from current model set-up is that the net climate effect on trajectories of profit, biomass, catch was low (although significant effects were found for some species) and that good management in the near term is much more important than adaptive policies in the future.

Topic 4: Capacity building for near-term environmental projection

Jonathon Tinker presented ongoing projects and tools available at the UK Met Office Hadley Centre for historical, short-term forecasting and long-term projection of physical attributes of the NE Atlantic. Large-scale climate model projections are too coarse and inappropriate for the North Sea, hence a variety of higher-resolution models are being utilized. In one example, a model of high complexity and resolution (GLOSEA5) was initialized with observations for all components of the system and used to create an ensemble of predictions of atmospheric conditions (e.g. NAO), to quantify the effect of various uncertainties (from initial state, model formulation, internal variability, etc.). A second element of the presentation was on seasonal forecasting. Predicted and observed NAO were significantly related ($r = 0.62$). This forecast would provide a few months lead time on water temperatures. Finally, model runs for the most recent UK Climate Assessment Report were presented. Previous climate assessments (UKCP09) reported estimates of in situ changes in shelf sea hydrodynamics from only one projection while the latest (2016) report includes ensemble estimates of uncertainty (Tinker et al., 2016). The warming projected in 2069-2089 in comparison to 1960-1989 is both spatially and seasonally heterogeneous with magnitudes between 1.5 and 3.5°C. Those projections include surface and bottom temperature and salinity, stratification, potential energy anomaly and surface minus seabed temperature.

The skill of short-term (a few months to a few years) forecasting of environmental conditions is increasing. The increase comes from three main paths: 1) model improvements (as discussed above), 2) advances in observation systems, and 3) data assimilation techniques. In terms of making near-term forecasts, data assimilation is the most important aspect of skill whereas aspects of which model and scenario is used become more important as one projects further into the future. Translating physical forecasts into biological forecasts is a challenge. In some regions, probabilistic forecasts are being made. An example of this is the seasonal tuna forecast currently made for the Gulf of Australia (significant skill at decade scale in that region) and long-line seasonal closures in SE Australia. A second example was provided for decadal-scale forecasting of spawning distribution for blue whiting the NE Atlantic. in An ongoing program "J-Scope" is examining predictability of sardine habitat in the California Current.

A new ICES working group has been started (WGS2D (Working Group on Seasonal-to-Decadal Prediction of Marine Ecosystems) which will have its first meeting 12-16 June 2017 in Copenhagen, DK. Similar activities are ongoing in PICES-CLIVAR group on Climate and Ecosystem Predictability (SG-CEP, Nick Bond chair). That group had its first meeting spring 2016. Advancements in short-term forecasting skill mesh well with the medium- to long-term projection modelling be conducted by regional (and global) modelling teams in SICCME, FishMIP, ACLIM, COCA and other projects.

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Annex 1: List of participants

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Fig. 1) Group photo of participants of the ICES-PICES SICCME-1 workshop in Riga, Latvia, September 24, 2016. From left to right: Malin Pinsky (USA), Susa Niiranen (Sweden), John Pinnegar (UK), Jonathan Tinker (UK), Eric Galbraith (Spain), Mark Payne (Denmark), Anne Hollowed (USA), Kirstin Holsman (USA), Sarah Stein (USA), Alan Haynie (USA), Kristin Kleisner (USA), Kathy Mills (USA), Myron Peck (Germany) and Dan Ovando (USA). Not pictured: Brian MacKenzie (Denmark), Merrick Burdon (USA).

Annex 2: Agenda

Agenda:

09:30 Introduction from the chairs – aims and objectives of the meeting (John Pinnegar / Anne Hollowed)

09:45 Round table – who we are and what do we do?

10:00 Introduction to H2020 project CERES (Myron Peck)

10:30 Coffee and Tea Break

10:45 Participants – 10 minutes each, describe your project (with a few slides), what scenarios are being tested (climate and socio-political), results and conclusions. (Chaired by Mark Payne)

12:30 Lunch Break

13:15 Introduction to FishMIP (Eric Galbraith)

13:30 Introduction to other ongoing programmes in USA (Anne Hollowed)

13: 50 ACLIM (Kirstin Holsman/Alan Haynie)

14:10 COCA (Malin Pinsky /)

14:30 Scenarios – brief discussion about climate change scenarios (available physical model outputs) and socio-political storylines. [Jon Tinker and John Pinnegar]

15:00 Coffee and Tea Break

15:30 Near-term climate predictions - where management and climate models meet (Mark Payne)

16:00 Discussion – challenges in comparing suites of single species climate enhanced projection models, multispecies climate enhanced projection models, full food web (e.g., EcoSIM), and dynamic spatially explicit ecosystem models. (Chaired by Myron Peck)

16:30 Identify new analytical approaches that could be used in other regional nodes [Chaired by Anne Hollowed]

17:00 How to contribute to the forthcoming IPCC Special Report on the 'Oceans & Cryosphere' (2018) and to the 6th IPCC Assessment Report. Chaired by John Pinnegar]

17:30 End

Annex 3: WKSICCME1 terms of reference for the workshop

2015/2/SSGEPD06 The **ICES/PICES Workshop on Phase 1: Modelling Effects of Climate Change on Fish and Fisheries** (WKSICCME1), chaired by Anne Hollowed*, USA; John Pinnegar*, UK; Myron Peck*, Germany; and Mark Payne*, Denmark, will meet in Riga, Latvia, 24 September 2016 (back-to-back with the ASC 2016) to:

a) Meet with other SICCME investigators in ICES member countries to review progress on projected impacts of climate change on fish and fisheries.

b) Identify new analytical approaches that could be used in other regional nodes.

c) Review challenges in comparing suites of single species climate enhanced projection models, multispecies climate enhanced projection models, full food web (e.g., EcoSIM), and dynamic spatially explicit ecosystem models that would be used to project the implications of a and b on commercially important marine fish stocks in the northern hemisphere.

WKSICCME1 will report by 4 November 2016 (via SICCME) for the attention of SCICOM.

Supporting Information

Priority	This activity will contribute towards the first ICES thematic area: Understanding Ecosystem Processes and Dynamics (SSGEPD) and their response to change. Our focus will be on responses of fish and fisheries to climate change. To assess this, the group will identify scenarios for future use of marine ecosystems, especially commercial fishing. Consequently, the activities of WKSICCME1 are considered to have a very high priority to ICES.
Scientific justification	In August 2015 SICCME convened a workshop in Seattle to map out an international effort to project the implications of climate change on fish and fisheries ahead of the next IPCC assessment, scheduled for 2020 (although submissions would be required in 2018/2019). The group identified 15 global regions with sufficiently developed modelling expertise that could be part of the SICCME research initiative. The group also agreed to work closely with the FISH-MIP research group to ensure that the efforts are complimentary and not duplicated. The central focus of the SICCME effort is to understand the vulnerability of commercially important species, their predators and prey to changing climate conditions and consequently to determine likely impacts for fisheries and aquaculture. This is critical to ICES and PICES plans to provide climate-informed options for mitigation of, and management of harvested resources under a changing climate. This proposal calls for a one day workshop to be held immediately prior to or afte the ICES annual meeting in Riga, Latvia in 2016 (WKSICCME1). This ICES region workshop will allow researchers a chance to compare initial results, evaluate harvest control rules and discuss challenges encountered in developing multi-model ensembles of impacts on fish and fisheries for the SICCME project. The format will allow breakout groups for intra-disciplinary discussions as well as plenary sessions focussing on interdisciplinary research. By the time of this workshop, the outcome of EU H2020 call BG2-2015 ('Forecasting and anticipating effects of climate change on fisheries and aquaculture') will be known and consequently European SICCME members will be better informed with regard to resources available for the model-intercomparison studies proposed.

Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible. The workshop requests ICES endorsement, participation by ICES scientists, and some secretarial assistance (e. g., email communication, workshop publicity on website, etc.).
Participants	The workshop will be attended by ca. 20–25 members and guests from both ICES and PICES.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups	The workshop contributes directly to SICCME objectives and activities, and to the activities of SSGEPD.
Linkages to other organizations	The workshop is a joint activity with PICES.