

# ICES SYMPOSIA REPORT 2015

ICES CM 2015/GEN:01

**EU FP 7 Project SOCIOEC**

Brussels, Belgium, 17–18 February 2015

**Effects of Climate Change on the World's Oceans**

Santos, Sao Paulo, Brazil, 23–27 March 2015

**Oceans Past V**

Tallinn, Estonia, 18–20 May 2015

**Marine Ecosystem Acoustics**

Nantes, France, 24–28 May 2015

**PICES meeting 2015**

FIS Topic Session (S3)

Qingdao, China, 22 October 2015

**MYFISH Symposium**

Targets and Limits for Long-term Fisheries Management

Athens, Greece, 27–30 October 2015



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International Council for  
the Exploration of the Sea

Conseil International pour  
l'Exploration de la Mer

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## 1 Socio-economic effects of management of the future CFP (SOCIOEC)

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### **Venue and dates: Brussels, Belgium, 17–18 February 2015**

The final symposium of the EU FP 7 Project SOCIOEC took place on 17–18 February at the Royal Flemish Academy of Belgium for Sciences and the Arts, Brussels. The program was organised in four sessions.

The opening session included key note presentations on the motivation for the project, its place in the research context of the EU framework programme and a call for open feedback to attendees.

The first theme session represents the basic contribution of the project to a more integrative impact assessment (IA). It addresses among others the topics of incentives and governance constraints that were already highlighted as challenges in the opening session. The session comprises a key note and discussion from Birgit de Vos, leader of the SOCIOEC work package on incentives, four presentations from different EU case studies applying these concepts and a panel discussion on the future of impact assessment.

The second theme session, the longest of the Symposium, represents the core topic of the project: how to improve social and economic impact assessment and turn it to a more integrative impact assessment. It addresses among others the topics of impact assessment methodology improvements. The session comprises a key note and discussion from Loretta Malvarosa, leader of the SOCIOEC work package on impact assessment, an initial set of presentations on IA results from project case studies, an extra key note from the non EU SOCIOEC case study (by case study leader Gunnar Haraldsson) and seven additional presentations from different invited experts, divided into two parallel blocks: one centred on management measures and the other on methodology proposals.

Finally, theme session three presents the most important new management measure of the 2014 Common Fisheries Policy reform, the landing obligation (LO). The topic is introduced by Dominic Rihan, from DG Mare, with a keynote speech on the implementation of the LO, while three presentations from the project illustrate social and economic impacts and a final panel attempts to identify the next steps.

## 2 Third International Symposium on “Effects of Climate Change on the World’s Oceans”

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**Venue and dates: Santos, Sao Paulo, Brazil, 23–27 March 2015**

**Conveners: Manuel Barange (ICES, UK), Jacquelynne King (PICES, Canada), Luis Valdés (IOC, Spain) and Alex Turra (OIUSB, Brazil)**

Over 280 participants assembled in Santos, Sao Paulo, Brazil for the Third International Symposium on “*Effects of Climate Change on the World’s Oceans*”. This symposium was jointly convened by ICES (International Council for the Exploration of the Sea), PICES (North Pacific Marine Science Organization) and IOC (Intergovernmental Oceanographic Commission of UNESCO) and locally organized by the Oceanographic Institute, University of Sao Paulo (OIUSB). Participants from 38 countries contributed 336 oral and poster presentations in Theme Sessions and Workshops. The symposium was organized by four Co-conveners: Manuel Barange (ICES, UK), Jacquelynne King (PICES, Canada), Luis Valdés (IOC, Spain) and Alex Turra (OIUSB, Brazil). Several members from each organization formed the Scientific Steering Committee, which set the symposium’s Scientific Program: Nicholas Bates (IOC, Bermuda/USA), Silvana Birchenough (ICES, UK), Maria de Fatima Borges (ICES, Portugal), John Gunn (IOC, Australia), Lina Hansson (IAEA, Monaco), Brian R. Mackenzie (ICES, Denmark), Shoshiro Minobe (PICES, Japan), Angelica Peña (PICES, Canada), Fangli Qiao (PICES, PR China) and Yunne-Jai Shin (IOC, France/South Africa).

This symposium bridged research in physical and natural sciences to the human dimensions of climate change impacts, with a focus on coastal communities, management objectives and governance adaptation. Twelve Sessions (see list provided) covered the latest developments in predicting changes in biodiversity, phenology, fisheries and ecosystems as well as in the physical systems that sustains these, and highlighted the risks and opportunities that climate change will bring to coastal communities and to society at large. Each day began with a Plenary Session that featured Plenary Speakers (see list provided) to represent each of the Theme Sessions that ran in parallel for the remainder of the day. Prior to the symposium, five Workshops were held, and their reports are also presented in this issue of PICES Press.

Symposium participants were honoured with a Keynote Address from Dr. Chris Field (Carnegie Institution for Science, USA), Co-chair of Working Group II of the Intergovernmental Panel on Climate Change Fifth Assessment Report (2014). Dr. Field set the scope for the symposium by mapping the potential impacts of climate change to socioeconomic processes (adaptation, mitigation, governance) through assessment of risk and uncertainty of vulnerability, exposure and hazards.

Presentations in Theme Sessions highlighted the advancements that have been made in modelling and understanding climate change impacts on physical processes. There are now global low resolution models that can provide foundations for generating hypotheses of climate change effects, some of which are already being applied to net primary production and zooplankton models. Ocean models continue to improve in process understanding, resolution and dynamics. However, region specific ocean models remain poorly developed in many regions.

The diversity of biological science in Theme Sessions provided participants with a wide range of research linking climate change impacts to marine organisms and ecosystems. One of the immediate linkages is the change in ocean chemistry, with con-

tinued overwhelming evidence of ocean acidification. However, coastal regions are subject to significant pH variability and thus some species may be adapted to ocean acidification. The symposium saw exciting work on the acclimation and genetic adaptation to ocean Acidification, deoxygenation and temperature increases. This does not remove the dangers of these impacts, because any adaptation has costs, but indicates a more complex picture than previously accepted. Changes in process seasonality and intensity are readily observed, however the transfer of energy up through food webs will be determined by species' plasticity, life history strategies and their adaptation to non-linear physical processes, such as upwelling. As our understanding of processes improve, so does our understanding of species' distributional changes in response to climate change. We are beginning to get a higher level of detail in species' responses, and migrations will not be homogenous or always consistent, as they interact with habitat preferences, tolerances and other ecosystem interactions.

The symposium benefitted from significant input of social scientists, with two Theme Sessions that focused on a socio-economic aspect of climate change impacts on oceans. Social scientists are integrating physical and biological research results to human uses and reliance on marine ecosystems to help identify management options. The most effective policies will be those that outline transition and adaptive responses. Presentations explored pathways of adaptation of societies to climate change and identified the disproportional impact on poor coastal societies in the developing world. In some places, tools are made available for societies to quantify their level of risk and thus how to tailor local-specific responses. An area for future research in climate change impacts on the oceans will be the inclusion of human impacts, such as changes in land-use and population growth, as additional considerations.

The award for Best Presentation went to PICES' very own Shin-ichi Ito (University of Tokyo, Japan) for his presentation, "*Importance of advection to form a climate and ecological hotspot in the western North Pacific*". The Best Poster award was presented to Colleen Suckling (Bangor University, UK) for her poster, "*Metabolic responses of two species of brachyuran crustaceans to ocean acidification and reduced salinity*". There were a number of outstanding presentations by early career scientists, and awards for best presentations were given to: Rebecca Asch (Princeton University, USA) for her presentation, "*Projected mismatches between the phenology of phytoplankton blooms and fish spawning based on the GFDL Earth System Model (ESM2M)*"; Johanna Yletyinen (Stockholm Resilience Centre, Sweden) for her presentation, "*Understanding marine regime shifts: detecting possible changes in structures and functions in coastal and pelagic food webs*"; Emily Howells (New York University Abu Dhabi, United Arab Emirates) for her presentation, "*Adaptation of coral symbioses to extreme temperatures*"; and Philipp Brun (Technical University of Denmark, Denmark) for his presentation, "*The predictive potential of ecological niche models for plankton in the North Atlantic*". All symposium presentations (with author's permission) are available for viewing at the PICES' website (<http://www.pices.int/2015climate-presentations.aspx>).

Selected papers from oral and poster presentations from the symposium and workshops will be included in a special issue of the ICES Journal of Marine Science scheduled for publication in 2016. In addition, it is anticipated that selected sessions and workshops will develop their own proposals for special volumes.

We would like to say "*Obrigados*" to the local organizers, the OIUSB, for providing the logistics and social activities to support this symposium. They brought a Brazilian 'easy-going' attitude to the event, and made everything happen smoothly. The venue selected by the local organizers allowed participants to readily catch talks from

different parallel sessions and the social events brought everyone together to keep the discussions flowing -- along with the drinks and food! The convenors would like to acknowledge the PICES Secretariat, for their assistance in the planning and coordination of all that is required to run an international symposium. Many individuals dealt with the details of organizing this symposium and deserve our gratitude: Adolf Kellermann (ICES), Alexander Bychkov (PICES), Julia Yazvenko (PICES) and Michel M. de Mahiques (OIUSB). In addition to PICES, ICES and IOC sponsorship, the following organizations and agencies made financial or in-kind contributions to the symposium:

- Coordination for the Improvement of Higher Education Personnel (Brazil)
- Brazilian National Council for Scientific and Technological Development (Brazil)
- São Paulo Research Foundation (Brazil)
- Fundação de Estudos e Pesquisas Aquáticas (Brazil)
- Government of Brazil
- International Atomic Energy Agency, Ocean Acidification International Coordination Centre
- Integrated Marine Biogeochemistry and Ecosystem Research
- Laboratório de Hidrometeorologia -IAG-USP Programa SIHESP/FAESP
- Ministry of Education, Brazil
- National Oceanic and Atmospheric Administration (USA)
- North Pacific Research Board (USA)
- Office Naval Research (Brazil)
- Scientific Committee on Oceanic Research
- Surface Ocean-Lower Atmosphere Study

The support of these sponsors made it possible to convene an international symposium of such high quality and enabled the participation of young scientists and scientists from countries with economies in transition. Finally thank you to all those that participated: Presenters, Session and Workshop Chairs, and to the Scientific Steering Committee that helped to provide an excellent Scientific Program.

#### **Symposium Theme Sessions**

1. Role of advection and mixing in ocean biogeochemistry and marine ecosystems
2. Ocean acidification
3. Changing ocean chemistry: From trace elements and isotopes to radiochemistry and organic chemicals of environmental concern
4. Regional models for predictions of climate change impacts: methods, uncertainties and challenges
5. Coastal blue carbon and other ocean carbon sinks
6. Climate change in the seasonal domain: Impacts on the phenology of marine ecosystems and their consequences
7. Evolutionary response of marine organisms to climate change
8. Climate change impacts on marine biodiversity and resilience
9. Impact of climate change on ecosystem carrying capacity via food-web spatial relocations

10. Forecasting climate change impacts on fish populations and fisheries
11. Impacts on coastal communities
12. Linking climate change to marine management objectives

**Symposium Plenary Speakers**

- Eddie Allison (School of Marine and Environmental Affairs, University of Washington, USA)
- Arne Biastoch (GEOMAR Helmholtz Centre for Ocean Research, Germany)
- Paulo H.R. Calil (Institute of Oceanography, University Federal de Rio Grande, Brazil)
- Lynda Chambers (Bureau of Meteorology, Phillip Island Nature Parks, Australia)
- Margareth Copertino (Universidade Federal do Rio Grande, Brazil)
- Jean Pierre Gattuso (Laboratoire d'Océanographie de Villefranche, France)
- Patrick Lehodey (Space Oceanography Division, CLS, France)
- Lisa Levin (Scripps Institution of Oceanography, USA)
- Coleen Moloney (University of Cape Town, South Africa)
- Phillip Munday (James Cook University, Australia)
- Laura Richards (North Pacific Marine Science Organization)
- Micha Rijkenberg (Royal Netherlands Institute for Sea Research, The Netherlands)



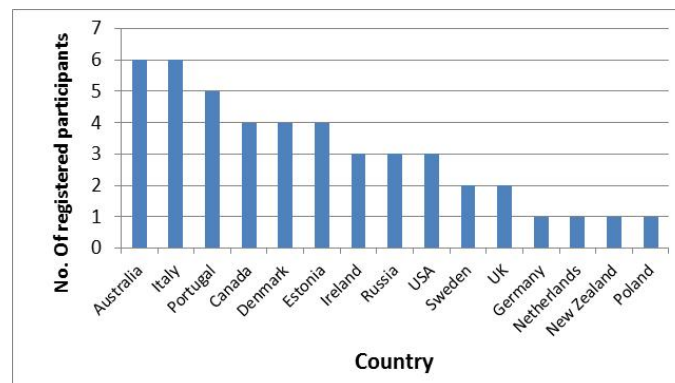
### 3 Oceans Past V: Multidisciplinary perspectives on the history of human interactions with life in the ocean

**Venue and dates: Tallinn, Estonia, 18–20 May 2015**

**Conveners: Alison MacDiarmid (New Zealand) and Brian MacKenzie (Denmark)**

The Oceans Past series of conferences are a platform for dissemination and discussion of new research findings in the fields of historical marine ecology, and fisheries and maritime history. The conference held this year in Tallinn was the fifth event since 2005. It was organised by the international Oceans Past Initiative (OPI) – a global research network for marine historical research. OPI's goal is to enhance knowledge and understanding of how the diversity, distribution and abundance of marine life in the world's oceans has changed over the long term to better indicate future changes and possibilities. The conference was supported by the International Council for the Exploration of the Seas (ICES), with additional in-kind and financial support and local organisation provided by the University of Tartu and Tallinn University. The conference served as a platform for ICES WGHIST and assisted to publically launch a new EU COST initiative called Oceans Past Platform (OPP) coordinated by Prof. Dr. Poul Holm, Trinity College, Ireland.

The conference had 46 registered participants, and 8 of these were younger scientists whose travel was partly supported by ICES. The participants at the conference, and more generally those working in historical marine ecology, are both natural and social scientists (e. g., ecologists, oceanographers, economists, historians, archaeologists), and the field is highly interdisciplinary. The participants came from 15 different countries, including those from Europe, North America and Oceania/Asia (Figure 1).



**Figure 1. Geographical distribution of registered participants for the Oceans Past V conference, Tallinn, Estonia, 18–20 May 2015.**

During the conference 52 talks and posters and five key note addresses were presented. The conference format with just a single session over three days enabled full involvement and strong interaction among the participants. The main topics of presentations included those related to both the social and ecological aspects of long-term change in the oceans and how those changes affect and are affected by both societies and nature. Topics included:

- cultural backgrounds and contexts associated with development of both commercially and recreationally exploited species

- legal frameworks for fishery management, development of regulations
- policies for adapting to and preventing future expected changes to marine populations and ecosystems

Most presentations focused on commercially and recreationally exploited species, including direct human impacts (fishing, eutrophication) on target species, and effects of climate change/variability. Additional presentations focused on human impacts on non-target species and habitats (e. g., benthos, sharks), on historical development of aquaculture and invasive species (e. g. their historical impacts on populations, food-webs, and ecosystems). Ten manuscripts were submitted to the ICES Journal of Marine Science for peer review and possible publication.

The five keynote addresses spanned a wide range of issues and included:

- The evolution of bottom trawling impact on demersal fish populations and the benthic ecosystem (Adriaan D. Rijnsdorp, Ole R. Eigaard, Niels T. Hintzen, Georg H. Engelhard)
- To See the Sea: Using interactive installation art to visualize scientific data (Caitilin de Berigny)
- Fish is woman's business too – looking at marine resource use through a gender lens (Kathleen Schwerdtner Mánéz)
- Historical evidence opens new swordfish recovery perspectives in the northwest Atlantic (Brian R. MacKenzie, Karen E. Alexander, William B. Leavenworth, Stefan H. Claesson, W. Jeffrey Bolster, Andrew Cooper)
- Historical ecology of sharks – Reconstructing population changes, ecosystem consequences and societal value (Heike K. Lotze)

Geographically, most presentations addressed case studies in the NE Atlantic, Mediterranean, and NW Atlantic, although some presentations addressed cases in the south Pacific and Indian Ocean (Australia, New Zealand). A feature of most presentations was their dependence mainly on written records of catches, distributions, sizes, and fishing regulations; relatively few studies were based on archaeological finds, paleo-oceanographic data, or stable isotopes although these sources have much to offer historical studies. The organisers of the next Oceans Past conference should attempt to broaden the range of disciplines contributing papers.

An overview paper presented at the close of the conference considered that the historical ecological community needs to further process (model) the available data to derive ecologically meaningful properties such as biomass and consumption rates by predator populations (trophic impacts). As the available historical data often does not fit well to standard statistical or modelling procedures, especially those used in routine stock assessments, then data-limited methodologies need to be considered, often with customized analysis solutions designed for each case. The overview paper also identified a gap in present knowledge regarding the timing of marine fish declines, especially in Europe, and as a factor in driving overseas colonization. In the discussions that followed there was general agreement that to be relevant to modern day fisheries or ecosystem management and policy development, there needs to be increased understanding of relative importance of different demographic, technological, economic, and cultural drivers on the patterns, intensities and trajectories of human activities affecting the ocean. Historical ecology and marine history needs to improve the application of this knowledge to developing recovery, adaptive, and preventative solutions.

Synergies with other research initiatives: The conference had strong participation and collaboration with members of ICES WGHIST. In addition, the first day of the first COST OPP meeting was held concurrently with the final day of the conference and the OPP meeting continued for an additional 2 days after the conference. A new research initiative was announced at the conference by Prof. Poul Holm. This initiative is a five year project (Norfish; 2016–2020) funded as an ERC Advanced Grant of 2.5 million euro to Prof. Holm. The research aims to understand the restructuring of the North Atlantic fisheries, fish markets and fishery-dependent communities between AD 1400 and 1700. The core questions are: What were the natural and economic causes of the fish revolution? How did marginal societies adapt to changing international trade and consumption patterns around the North Atlantic? How did economic and political actors respond? The answers will help explain the historic role of environment and climate change, how markets impacted marginal communities, and how humans perceived long-term change.

These three initiatives (ICES WGHIST, COST OPP, Norfish) and other ongoing projects, could potentially disseminate new results at the next Oceans Past conference to be held in Lisbon, Portugal in late 2017.

## 4 Marine Ecosystem Acoustics: Observing the Ocean interior across scales in support of integrated management

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**Venue and dates: Nantes, France, 25–28 May 2015**

**Conveners: Verena Trenkel (France), Nils Olav Handegard (Norway) and Tom Weber (USA)**

The primary aim of the symposium was to bring together scientists and ideas from various fields to facilitate and catalyse interdisciplinary interactions, with acoustics as the central tool, to further the development of marine ecosystem acoustics. This was the 7th ICES sponsored Symposium on Fisheries Acoustics and Technology investigating aquatic ecosystems.

The symposium was attended by 214 participants from 31 countries. During the symposium 94 talks including three key note talks and 87 posters were presented, followed by lively debates. The conference was supported by ICES, Ifremer, IRD, Nantes City Council, and the Region Pays de la Loire.

The Symposium was organized around three main themes:

- Recent developments in acoustic sensor and platform technologies: 35 oral presentations
- Acoustic characterization of aquatic organisms, ecosystem structure, and ecosystem processes: 41 oral presentations
- The contribution of acoustics to integrated ecosystem assessments and management: 15 oral presentations

### **Recent developments in acoustic sensor and platform technologies**

A new generation of compact, low-power acoustic instruments are being deployed on a wide variety of new platforms including moorings, ocean-going robotic vehicles, fishing vessels and fishing trawls and tags on fish. From the discussions it was evident that this work is largely in early stages of development, and will be an active area of research in fisheries acoustics in the next decade. The primary challenge in the use of these platforms is how the data from these new platforms are going to be used for science and management advice. There is a need for studies examining the advantages and limitations of the data produced with new platforms and their potential applications.

Passive and active acoustics are being combined to study animals in relation to their trophic environments. The increase of anthropogenic sound in the water is a concern and is being monitored using networks of stations equipped with hydrophones. Automated algorithms such as machine learning algorithms are now available for real time data analysis and noise identification.

The use of multibeam and omnidirectional (azimuthally) sonars for quantitative estimates of fish, such as school biomass estimates, was discussed by several contributors. Efforts to reach these quantitative estimates has led to work on calibration issues, on software to perform schools extraction using image processing approaches, and the impact of fish swimming behaviour and orientation on the acoustic measurements.

The potential for broadband systems is widely being explored. Several challenges related to these new systems clearly remain including the generation of new tech-

niques for calibration, range performance issues, and susceptibility to noise. Among the expected improvements from these new systems are better identification of targets for both scientific purposes and to better avoid by-catch on commercial fishing vessels.

#### **Acoustic characterization of aquatic organisms, ecosystem structure, and ecosystem processes**

The presentations highlighted progress in the application of acoustic methods to studying organisms ranging from zooplankton to fish using multi-frequency acoustics, optical and various capture technologies. Mesopelagic organisms, or the ubiquitous deep sea sound scattering layers (SSLs), is drawing increasing attention in the acoustic community. Acoustic detection/identification of various targets in distinct environments was being attempted using different acoustic methods and data analysis techniques. Progress continues to be made with respect to target strength (TS) measurements of a diversity of species using in situ, experimental and modelling approaches.

Acoustic instrumentation is being used to observe fine scale processes in situ or in controlled mesocosm experiment as well as at large scales. The applications ranged from behavioural processes and distribution patterns within marine protected areas and in the vicinity to subsea structures to behavioural changes in fish exposed to noise and other anthropogenic stressors. The talks highlighted the complexities in the species in the mesopelagic region and difficulties in converting scattering to biomass.

#### **Contribution of acoustics to integrated ecosystem assessments and management**

Acoustic stock estimates result from the combination of various parameters including target strength, length distribution, age-length keys, identification of echotraces and spatial distribution of backscattered energy. The session presented methods to combine different sources of information and their corresponding errors and in particular, Bayesian approaches. Catchability of the stock to the surveys was also considered. A major issue discussed was the correlation between error sources. A number of studies combined several observation methods and habitat modelling to improve abundance or biomass estimates. For example, school counting using sonar data were combined with echosounder or sonar data for estimating school size/density. Several studies considered the relationship between biotic and abiotic conditions and local abundance/distributions which has consequences both for management and survey design. The final set of talks dealt with acoustic and other data collected during ordinary fishing operations.

The proceedings of the symposium will be published in the ICES Journal of Marine Science in 2016.

## 5 PICES meeting 2015. FIS Topic Session (S3)

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### **Eastern–western approaches to fisheries: resource utilization and ecosystem impacts**

**Venue and dates: Qingdao, China, 22 October 2015**

**Conveners: Gordon H. Kruse (USA), Shijie Zhou (Australia), Xianshi Jin (China), Jacquelynn King (Canada), Mitsutaku Makino (Japan), Marie-Joëlle Rochet (France)**

#### **Background**

FUTURE endeavours to develop a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services and marine-dependent social systems. Although climate change has garnered much deserved attention so far, the direct and indirect interactions of human society on marine ecosystems and the services they provide are also of great concern. Fisheries are major contributors to global food security, while also posing threats to some ecosystem services. Rising demand for seafood and increasing concerns about the ecosystem effects of fishing create a fisheries management dilemma. Improved understanding about how human activities alter marine ecosystem structure and function is central to exploring options to procure food security in the future. In North America and Europe, emphasis is placed on conservative catch limits for fisheries that are highly selective for large-sizes of certain species. In Asia, a wide spectrum of fish species and sizes enter seafood markets, and less emphasis is placed on constraining catches. Both approaches affect ecosystem structure and functioning. By comparing approaches, can East and West learn from each other? Although questions about how to increase fisheries production while reducing environment impacts are not new, new ideas have entered the debate. For example, “balanced exploitation” advocates sustainable removal levels that strive to maintain natural balance among species, stocks, sexes, and sizes, thus preserving biodiversity. Yet, fisheries are commercial enterprises that must supply consumers with seafood at a profit. Also, fishing represents a diversity of lifestyles that span small-scale, artisanal fishers to large multinational corporations. This topic session provides a forum to compare and contrast alternative fishing strategies for sustainable global food security. Presentations are sought on the effects of fishing on ecosystem structure and function, cultural practices and institutional programs to manage bycatch and discards, better utilization of fishery resources, diversification of seafood products and markets, economic considerations, and many facets of human dimensions. Seafood industry representatives from Eastern and Western cultures will be invited to contribute their perspectives.

#### **Summary of presentations**

This was a very successful and well-attended topic session that addressed differences among Eastern and Western styles of fishing. The comparisons among PICES countries in the Northwest and Northeast Pacific were greatly enriched by three presentations from ICES countries. The session was highlighted by three invited speakers.

Invited speaker, Xianshi Jin, gave an overview of the history of fishery resource utilization in China since the 1950s. Chinese fishery production increased slightly during the 1950s to the mid-1980s, and then experienced rapid increase over the ensuing three decades. In 2014, a total of 64.6 million t were landed, with 14.8 million t from

marine capture fisheries, 18.1 million t from mariculture, 29.4 million t from freshwater culture and 2.3 million t from freshwater capture fisheries. Since the 1950s, there was a significant decline in landings from marine capture fisheries and an increase in mariculture. Unlike many other countries with significant fishery discards, there are essentially no discards in Chinese marine capture fisheries, as algae, jellyfish, small-sized fish, and other taxa are landed for sale. Declining marine capture fisheries have suffered from overfishing, pollution, coastal development, climate change, and various ecological disasters (algal blooms, jellyfish outbursts, etc.). Significant changes in fish community composition in coastal waters has resulted, with a relative increase in low-valued species. Small yellow croaker, a valuable species, experienced age/size truncation, faster growth rates, decline in maximum size, and increase in mortality. Xianshi Jin identified a pressing need to conserve coastal resources including the need for ecosystem-based fishery management approach. To date, the management response has been limited to some seasonal closures, a vessel scrapping program, and some other measures. More aggressive efforts include restocking programs, sea ranching, and expansion of mariculture.

Invited speaker, Shijie Zhou, explained that fishing intensity and selectivity affect not only yield, but also the ecosystem. The implications depend on the model being used to explore the effects. For instance, size-spectrum model simulations suggest that selective harvests have more negative effects on community structure and produce lower yields than a more balanced approach to fishing. Ecosystem models indicate that balanced harvest results in higher yield and lower stock depletion than selective harvests. Interestingly, highly selective fishing on the lowest and most productive trophic level results in the least impact on community structure. Holling-Tanner models involving three trophic levels show that balanced harvest in which fishing mortality is proportional to the intrinsic population growth rate produces the highest catch. On the contrary, a balanced harvest in which catch is proportional to current growth, as well as a strategy that fishes only on the primary consumer, results in the least adverse effects on trophic structure. Interestingly, a non-selective fishing policy in which catch is proportional to biomass produces modest yields, but the most adverse effects on trophic structure. Effects of alternative approaches on single-species were also considered. Considering the effects within one species, a minimum size limit leads to high yields, but truncated size structure. Catch in proportion to abundance results in low yield and truncated age structure. A balanced harvest (catch in proportion to growth) provided low yield, but maintained size structure. And, finally, slot selection (catch of a narrow size/age range) produced the highest yields and extended age structure.

Invited speaker, Marie-Joëlle Rochet, talked about the landing obligation in the new European Union (EU) Common Fishery Policy, which was launched in January 2014. Among the changes, landing quotas were replaced with catch quotas and minimum landing sizes were replaced with minimum conservation reference sizes (MCRS). Fish of the quota species smaller than MCRS must be landed and used for purposes other than non-human consumption. Discards have been a problem in the EU for the long term, as they account for a large proportion of the catch of some stocks. However, discard rates vary among vessels, seasons, species, fisheries, countries, and areas. For a variety of reasons, full implementation of the new landing obligation has been delayed until 2017. For pelagic fisheries, which have generated low levels of discards, the limits are in force and fishing is proceeding as usual. For demersal fisheries, definition of target species and fisheries, setting of catch quotas, and MCRS are still being worked out. Pilot trips have been conducted, and preliminary results indicate that

fishing selectivity might be difficult to improve in many instances, and some skippers and crew may be reluctant to comply with the new regulations. Ultimately, the outcome of the new Common Fishery Policy will depend upon the ability of member states to enforce regulations.

Contributed talks provided additional interesting contrasts in eastern and western approaches. For example, Zuozhi Chen talked about the marine fish stocks in the northern South China Sea (NSCS). More than 1500 fish species occur in the NSCS of which about 100 are commercially exploited by about 600 000 fishermen with total landings of 3.6 million t. Trends over the past 50 years include a large increase in fishing power, declining catches, and major changes in catch composition toward smaller fish. The current fishery is plagued by overcapacity, overfishing, harvests of juvenile fish, illegal fishing, and habitat destruction.

In contrast, Gordon Kruse talked about highly selective commercial groundfish fisheries in the eastern Bering Sea (EBS). In 2013 total marine fishery landings off Alaska equalled 2.6 million t, accounting for 59% of all U.S. landings. Catches from the EBS are dominated by walleye pollock, followed by Pacific cod, several flatfish fisheries, and smaller fisheries for rockfishes and other species. Although fisheries are highly selective, they are managed using an ecosystem-based fishery management approach, which include license limitations, individual fishery quota programs, scientifically based catch limits, prohibition of discards for fisheries for pollock and cod, ban on forage fish fisheries in federal waters to preserve their ecosystem benefits, strict controls on bycatch and prohibited species, and area closures to protect sensitive habitats and areas required by feeding Steller sea lions. Many ecosystem indicators are monitored to evaluate performance relative to fishery and ecosystem objectives.

Richard Law considered the theoretical basis for exploiting the natural productivity of aquatic systems, noting that more biomass is available by exploiting small fish than large fish. He contrasted major commercial fisheries, which are driven by economic markets for large fish with small, artisanal fisheries. He found that selectivity for large fish leads to lower yields in biomass, as well as more size truncation, lower stock resilience, and more fisheries-induced evolution. However, if fishing mortality is constrained to match productivity, then it partially substitutes for natural predation, and results in higher yields and fewer adverse fishery impacts. Interestingly, this is predicted to emerge naturally in a small-scale fishery, when fishers are able to change gear to increase their biomass yield and are not constrained by minimum-size regulations.

Shengle Yin discussed a case study for selection of coastal aquaculture sites based on environmental, conservation and socio-economic considerations in the U.K. The approach involved both a hydrodynamic model of currents and tides, as well as a questionnaire approach. Optimal sites were identified that avoided special conservation areas, as well as shipping channels required for navigation.

Xinyu Guo examined annual variability in Japanese common squid off Japan using a physical oceanographic model. A number of factors were considered, including changes in the parent stock, water temperature, and different assumptions about advection. The parent stock turned out to be the most influential factor.

Hyun Kim developed a length-based production value-per-recruit analysis for the small yellow croaker fishery in Korean waters. It was argued that this length-based model is better than age-based models in data-limited situations, because aging is expensive and fish prices are based on length, not age.



Minkyoung Bang examined changes in characteristics of walleye pollock among high and low biomass periods. Among other changes, during high biomass periods, fish were smaller, length at 50% maturity was larger, and condition factor was lower.

Hee Joong Kang developed an ecosystem-based acceptable biological catch (ABC) for consideration in Korea. In addition to traditional population-level factors used to set single-species ABC that provide for sustainability, the proposed approach applies a species risk index developed from considerations of biodiversity, habitat quality and socio-economic benefits.

Remaining talks considered a diversity of approaches. Vladimir Kulik examined the effects of fishing on ecosystem structure of the north-eastern part of the Okhotsk Sea using an ecosystem inverse linear model. Binduo Xu talked about optimal sampling designs for an assessment survey with multiple objectives, and Juri Hori considered the effect of changes in marine ecosystems on human well-being using online questionnaire conducted in China, Indonesia, Korea, Japan, and the U.S.

In addition to the 14 oral presentations, presenters of the 4 posters gave 2-minute overviews of their posters during the topic session. The presentations elicited excellent question and answer dialogues, and the session also included three lively discussion sessions.

## List of papers

### Oral presentations

**Xianshi Jin (Invited).** The marine fisheries resource utilization, ecosystem impacts and fisheries management in China

**Zuozhi Chen.** Exploitation and management of fisheries resources in northern South China Sea

**Gordon H. Kruse.** An ecosystem-based fishery management approach toward sustainable groundfish resource utilization in the eastern Bering Sea

**Binduo Xu.** Optimization of sampling design for a fishery-independent survey with multiple objectives

**Shengle Yin.** Selection of suitable coastal aquaculture sites with environmental and socio-economic consideration: A case study in the Menai Strait, UK

**Juri Hori.** Effects of changes in marine ecosystem services on human well-being: International comparison of human well-being structure

**Shijie Zhou (Invited).** Alternative fishing strategies and their consequences

**Richard Law.** Exploiting the natural productivity of aquatic ecosystems

**Vladimir V. Kulik.** The effects of fishing on ecosystem structure of the Northeastern part of the Okhotsk Sea

**Xinyu Guo.** Modeling interannual variations of Japanese common squid (*Todarodes pacificus*) resources around Japan

**Hyun A Kim.** Management of small yellow croaker, *Larimichthys polyactis* stock in Korean waters using a length-based production value-per-recruit analysis

**Minkyoung Bang.** Changes in ecological characteristics of walleye pollock *Gadus chalcogrammus* in accordance with the biomass fluctuation

**Marie-Joëlle Rochet (Invited)** The Landing Obligation in the European Union Common Fisheries Policy: Can a regulation focused on resource utilization address broader management objectives such as limited environmental impacts, economic development, and food supply?

**Hee Joong Kang.** Acceptable Biological Catch in the ecosystem-based TAC management

**Poster presentations**

**Saang-Yoon Hyun.** Assessment of Korean pollock population under data-limited situation

**Tetsuichiro Funamoto.** Stock assessment system in Japan

**Yunlong Chen.** Redistribution of anchovy (*Engraulis japonicus*) wintering stock under climate change scenarios in the Yellow Sea

**Chongliang Zhang.** Efficacy of fishery closure in rebuilding depleted stocks: accounting for trophic interactions

## 6 MYFISH symposium: Targets and Limits for Long-term Fisheries Management

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**Venue and dates: Athens, Greece, 27–30 October 2015**

**Critical challenges in incorporating ecosystem, economic, social and institutional consideration into fisheries management targets and limits**

**Anna Rindorf, Cathy Dichmont, James Thorson, Anthony Charles, Lotte Worsøe Clausen, Poul Degnbol, Dorleta Garcia, Niels T. Hintzen, Alexander Kempf, Phillip Levin, Pamela Mace, Christos Maravelias, Coilín Minto, John Mumford, Sean Pascoe, Raul Prelezo, André E. Punt, David Reid, Christine Röckmann, Robert Stephenson, Olivier Thebaud, George Tserpes and Rüdiger Voss**

Best quality scientific approaches to fisheries management advice and implementation under potentially conflicting objectives were the main topic of the final Myfish symposium held in Athens (Greece) on 27–31 October 2015. The event, held under the auspices of the International Council for the Exploration of the Sea (ICES), brought together experts from across the world to discuss targets and limits for successful long term fisheries management. The ICES/Myfish symposium brought together 80 high-level experts from 12 European countries, Canada, the USA, Chile, New Zealand, Australia and Japan presenting a total of 46 presentations and 6 posters. At the symposium, successful case studies from the different geographical areas were presented and discussed to assess possible future implementation in European fisheries management.

Long term targets and limits are extensively used in fisheries management advice to operationalize the way fisheries management reflects societal priorities on ecosystem, economic, social and institutional aspects. This study reviews reflections over the literature and studies presented in October 2015 at the international ICES/Myfish symposium on targets and limits for long term fisheries management. The symposium gathered 80 representatives from management, industry, NGOs and science. Participants were solicited through plenary presentations, group discussions and free text comments. The review gathers this input filtered through the authors' perspectives to highlight interdisciplinary methods relevant to the inclusion of ecosystem, economic, social and institutional aspects in identifying targets and limits, the role of targets and limits in a changing world, conflicting objectives, the need for collaboration and communication in research and management and the institutional structure required for implementation of management with diverse objectives. We end by identifying 10 critical challenges to the inclusion of social targets/limits in ecosystem based fisheries management (summarised in Table 1).

**Table 1. Key challenges to including all four pillars of sustainability within operational fisheries management.**

|    | CHALLENGE   |
|----|---|
| 1  | Extend the collaboration between ecological, economic and social scientists   |
| 2  | Define agreed ecosystem, economic and social indicators with clear links to management measures   |
| 3  | Investigate the role of ranges of MSY/PGY as a tool for the incorporation of mixed fisheries, ecosystem issues and possibly economic considerations |
| 4  | Embrace the fact that trade-offs also are a political process.  |
| 5  | Design and implement an institutional framework where these considerations are given a transparent weight in management decisions                   |
| 6  | Approach the challenge of distinguishing between 'uncertainty' and 'variability' as well as communicating this distinction to stakeholders.         |
| 7  | Address changes in spatial distribution in both scientific advice and institutional set ups.  |
| 8  | Develop and use of decision support tools to facilitate communication   |
| 9  | Ensure that management is adaptive as well as participatory in nature, linking social systems with natural systems.                                 |
| 10 | Develop and maintain trust, interaction, common grounds and common language in the collaborative process with all stakeholders                      |