

Fishing technology in the 21st century: integrating fishing and ecosystem conservation

Christopher W. Glass, Stephen J. Walsh, and Bob van Marlen (Conveners)

C. W. Glass: Northeast Consortium, Institute for the Study of Earth Oceans and Space, University of New Hampshire, Durham, NH, USA. S. J. Walsh: Fisheries and Oceans Canada, PO Box 5667, St John's, NL, Canada. B. van Marlen: Netherlands Institute for Fisheries Research, PO Box 68, NL-1970 AB IJmuiden, The Netherlands. Correspondence to C. W. Glass: tel: +1 603 862 0122; fax: +1 603 862 0243; e-mail: chris.glass@unh.edu

Introduction

The ICES Symposium "Fishing technology in the 21st century: integrating fishing and ecosystem conservation", was held in Boston, 30 October–3 November 2006 at the Seaport Hotel, and was hosted by the Gulf of Maine Research Institute (USA).

The meeting centred on four interrelated themes: (i) ecosystem-sensitive approaches to fishing; reconciling fisheries with conservation through improvements in fishing technology; (ii) the current status of mobile and static sampling gears used in resource surveys; (iii) fishers' responses to management measures and their socio-economic effects; (iv) a fishery forum on integrating fishing and ecosystem conservation: the way forward.

This was a truly global event that attracted 289 attendees from government and non-governmental organizations, scientists, academics, students, industry representatives, and fishers from more than 30 countries. In all, 146 papers were submitted, of which 63 were selected for verbal presentations and 83 were presented as posters. Ultimately, 54 manuscripts were submitted for review.

Objective and scope

The objectives of the Symposium were to: (i) address biological and socio-economic issues relating to bycatch and discards from commercial fishing operations and the impact of fishing gears on sensitive habitats; and (ii) address the performance and effectiveness of fishing gears used in fishery-independent resource and ecosystem surveys. Collectively, these issues have not been addressed in any international symposium. The need to do so was made more urgent by the nature of global fisheries, where many stocks have collapsed and there is a clear and pressing need to protect biodiversity and improve on the ability to estimate the state of the resources. This symposium took a fresh look at methods to reduce bycatch and discarding in commercial fishing operations, explored practical solutions to prevent destruction of sensitive habitat, and investigated new methods to increase the performance and catching efficiency of survey fishing gears used to estimate resource abundance. Basic to understanding the impact of commercial fishery operations is an understanding of industry perspectives on the effectiveness of technical measures such as mesh size, gear exclusion, and regulations and their role in conservation, including socio-economic consequences of introducing new technical measures. A key issue that the symposium

sought to address was how to obtain, quantify, and integrate industry responses to declining stocks and increasing management regulations into fishery- and ecosystem-based management advice.

The overarching goal of the symposium was to: (i) provide a forum for global synthesis of the scientific knowledge of fishing technology and its effects on the ecosystem, including bycatch reduction, ecosystem-sensitive fishing, sensitive habitat impacts, and the precision of resource surveys used in stock assessment; (ii) review and discuss advances in technology and analytical methods used to study or mitigate these effects; and (iii) provide a forum for discussion on how perceptions and decisions of fishers and resource managers affect the success of achieving sustainable use and successful management of fishery resources.

Submissions were invited for the following four theme sessions and associated subthemes.

Session 1: current status of mobile and static sampling gears used in resource surveys

Papers were encouraged on the following subthemes:

- (i) Studies on survey gear design and use, including innovations in meeting ecosystem survey requirements;
- (ii) Studies on fish behaviour, gear rigging, and fishing strategies that affect survey trawl catchability, including vertical and horizontal herding and escapees, bridle angles, effect of tow duration, groundgear choice, bottom contact, and speed over ground and through water;
- (iii) Studies of the effectiveness of standardization and quality control programmes, which focus on survey gear construction, rigging, and repairs, in minimizing variation in catchability;
- (iv) Studies that use fish behaviour, and performance and geometry/stability data from instrumentation, to estimate catchability, raising catch per unit effort (cpue) to abundance estimation;
- (v) Studies that deal with the requirements for intercalibration of survey gears and survey vessels, encouraging focus on experimental design and statistical analysis of data, including precision of intercalibration factors.

Session 2: ecosystem-sensitive approaches to fishing: reconciling fisheries with conservation through improvements in fishing technology

Papers were encouraged on the following subthemes:

- (i) Studies that deal with the development of effective and acceptable fishing gear modifications to reduce unwanted bycatch and discards, including minimizing gear interactions with marine mammals and seabirds, while maintaining target catches;
- (ii) Studies that document alternative fishing strategies (fishing behaviour, management, or gear design) that mitigate negative impacts of fishing, while allowing continued access to fisheries resources;
- (iii) Studies that estimate survival and survivability of aquatic species following fishing gear encounters, including estimation of mortality rates from current fishing gears and studies that aim at reducing injury, minimizing stress, and improving survival;
- (iv) Studies of new and developing fishing gears and technologies, e.g. "smart trawls" aimed at reducing environmental impact, while maintaining capture efficiency;
- (v) Studies that quantify the magnitude of ghost fishing and that address mechanisms to reduce its occurrence.

Session 3: fishers' responses to management measures and their socio-economic effects

Papers were encouraged on the following subthemes:

- (i) Studies that examine the conditions under which measures to reduce discards, including technical devices, can be successfully implemented;
- (ii) Studies that evaluate the success of gear-based technical measures in improving the management of exploited fisheries;
- (iii) Studies that investigate and integrate the biological and socio-economic perspectives of fishers using modifications in technology (technological creep) and fishing practices to increase the capture efficiency of their fishing gears;
- (iv) Studies that evaluate perception and adaptation strategies of fishers to declining stocks and increasing management regulations, including the transfer of effort to under- and/or unexploited species and areas; factors influencing rule compliance and socio-economic consequences to spatial and temporal regulatory control;
- (v) Studies using analytical frameworks and methodological solutions to integrate fishers' knowledge with resource assessment and management.

Session 4: fishery forum on integrating fishing and ecosystem conservation—the way forward

The overarching goal of this, the final session of the symposium, was to provide a forum for discussion on how perceptions and decisions of fishers and resource managers affect the success of

achieving sustainable use and successful management of fishery resources.

The rationale for such a session centred on attempts by fishery scientists to provide accurate annual estimates of the state of fish resources and the marine ecosystem. This information is fed into an advisory process, and fishery managers set total allowable catches (TACs) and conservation-orientated measures. Fishers experience the state of resources at sea daily and often perceive changes in the resource differently. It is critical that fishers' detailed knowledge of the resource be incorporated into the scientific advice given to fishery managers. The forum had an invited panel led by a moderator. Its goal was to create dialogue with a global perspective among leaders from the fishing industry, academia, and science and conservation organizations, and to set the stage for a final plenary discussion about the way forward on integrating fishing and ecosystem conservation, taking into consideration lessons learned and challenges and obstacles to implementation. The goal of the forum was to arrive at a consensus on the future direction of harmonizing fishing and ecosystem conservation.

The symposium

On Day 1, in his presentation "How can a survey gear catch reflect the biological situation in the sea?", keynote presenter John-Willy Valdemarsen (Institute for Marine Research, Bergen, Norway) gave a detailed overview of the development of survey trawls and techniques, and highlighted areas where he felt more research was needed. In addition, he identified an assortment of tools and experimental protocols that he considered necessary for effective survey in support of stock assessment and population estimation. Most notably, he identified the need for increased emphasis on studies of fish behaviour, which he considered essential to the development of survey trawls with the desired characteristics of minimal escapement and non-selectivity.

On Day 2, Simon Jennings, Lead Scientist for Ecosystem Interactions at Cefas (Lowestoft, UK) provided an assessment of the extent to which gear technologists (who made up the largest contingent of participants at the symposium) could contribute significantly to the developing field of ecosystem approaches to fishery management. His presentation "When, where, how and with whom will gear technologists most effectively support an ecosystem approach to fisheries?" issued a challenge to researchers in this field to be more critical of their research and attempt to make it more directly applicable to overall management needs.

On Day 4, Poul Degnbol, Scientific Advisor, Directorate-General for Fisheries and Maritime Affairs (European Commission, Brussels Belgium), challenged the conventional thinking of the scientific community and urged participants to help end the "death spiral of fisheries micro-management", as he termed the current policy of forever trying to 'catch up to fishers' adaptability in finding new and more efficient ways to fish. Interestingly, he identified collaborative research involving the scientific and fishing communities as potentially important in helping break this cycle.

On Day 5, Siri Ekmaharaj (SEAFDEC, Thailand), in his presentation "Responsible fishing technologies and sustainable coastal fisheries management in Southeast Asia", provided an overview of the challenges facing the fishing and scientific communities in Southeast Asia and how education, information transfer, and

collaborative research can promote better and more effective fishing practices.

Posters were set up on the first day, grouped by the session themes, and were available for viewing for the duration of the symposium. A small group of steering committee members and other invited scientists were asked to study the posters and to provide critical summaries. These were integrated into the proceedings by a volunteer participant in a formal presentation during the proceedings of the relevant session, outlining the highlights of each poster.

Discussion sessions

Note that papers presented at the symposium but not published in these proceedings are available at the symposium's website, <http://ices2006boston.org/schedule.php>.

The single, most tangible measure of a symposium is the published proceedings, as presented here. However, this reflects only a small proportion of the papers presented, either verbally or as posters, and takes no account of the extensive discussions and comments of participants, who included leading experts in the field, particularly about individual presentations. Following the example set by a small number of other symposia [most notably *ICES Marine Science Symposia*, "Fish behaviour in exploited ecosystems", Bergen, Norway, June 2003 (Fernø *et al.*, 2004)], the conveners noted that the ultimate measure of success of such a meeting is the extent of its reach, beyond the presentations or these published proceedings. We believe that the wealth of up-to-date information, the exchange of experience, and the interactions that took place during the symposium will enrich future work in the field, but more importantly, that attendees should take more away from the symposium than they brought to it. The conveners were acutely aware that the real substance of an issue is often exposed and solutions explored during discussions between participants. To this end, participants were encouraged to engage in vigorous discussion, because this is likely to have the most profound impact on the symposium's success and on the direction of future research. At the end of each day's proceedings, time was allocated for collective discussion of the day's proceedings, but also on the key issues and research areas that were missing or, more importantly, on topics for future research. These discussion sessions form an invaluable record of the state of our science and scientific thinking. Synopses of the discussions are presented in this volume as four individual summaries prepared by the session Chairs and rapporteurs. Complete and unabridged audio recordings of the discussion sessions can be downloaded at the symposium website <http://www.ices2006boston.org>. A brief synthesis of the main points is presented here in the form of general conclusions.

Conclusions

- (i) The symposium opened with a session on advances in survey gear, survey technology, and techniques, and it was generally concluded that much work remains to be done in this field. In addition, it was concluded that survey initiators are now being asked to answer an ever-wider range of questions and this, in turn, poses significant challenges to the scientific community. New tools and methodologies are currently under development, and this will help address gaps in our collective knowledge base.

- (ii) This 2006 symposium focused largely on conservation engineering/gear technology, gear selectivity, and bycatch reduction studies, and the papers falling into this category comprised almost 40% of all submissions.
- (iii) Despite the number of papers and considerable scientific work in the field of conservation engineering/gear technology, there was general concern over the lack of take-up or implementation of new fishing gears and strategies in commercial fisheries. However, gear technology development and improvement play important roles in sustainable harvesting, and the future challenges are to see their effective and widespread implementation in the commercial fisheries and to encourage development of tools to evaluate their performance.
- (iv) Considerable effort has been directed towards developing environmentally friendly fishing gears. Many issues remain to be resolved, most notably partial loss of target species, and it is apparent that solutions need to be tailored to individual fisheries. It is also becoming increasingly obvious that expectations of such gears' structure and performance need to be realistic and clearly definable.
- (v) Although a number of presentations described and documented new and more sustainable fishing gears or practices, there is a widely held concern about the lack of real and tangible innovation on display. It is not clear if this signals a lack of innovative thinking within the scientific community or merely reflects the widely held belief among managers and regulators that simpler measures, such as area closures or other effort reduction strategies, are better and more effective than so-called "endless tinkering" with gear types.
- (vi) A recurring theme throughout the symposium was the need for increased information on fish behaviour, not only in relation to fishing and survey gears, but also in response to changing environmental conditions. Although there have been considerable advances in this area recently, partially in response to recommendations from other symposia, much remains to be done, particularly about fish sensory systems, life histories, and the factors affecting variability in the behaviour of individuals.
- (vii) Considerable discussion focused on the need for better communication, not only between partners involved in research activities but also, perhaps more importantly, the need for better communication of positive fishing practices to showcase sustainability efforts and successes. In this regard, the World Wildlife Fund (WWF) Smart Gear competition is an exemplary initiative that harnesses funding from non-governmental sources, promotes innovative thinking, provides financial incentives, and actively promotes adoption of new gears in commercial use.
- (viii) Many presentations were based on the results of collaborative ventures between the fishing industry and the scientific community. Collaborative research has become a vital component in fostering communication and has been instrumental in bringing together the unique problem-solving and creative mindsets of fishers and scientists. It was widely recognized that such ventures should continue where they already exist and be promoted where they do not.

- (ix) Discussion concerning collaborative research identified the need for greater industry involvement in surveys, for continuing involvement of industry in gathering baseline data in support of ecosystem approaches to management, for real-time monitoring at sea, and for participation of industry in auditing the effectiveness of new fishing gears and strategies.
- (x) The theme of outcome-based regulation or results-based management emerged from Poul Degnbol's keynote address and was reiterated often. This argues for management approaches that delegate the burden of proof for achievement of policy objectives to industry and requires the industry to assume greater responsibility for its own activities.
- (xi) This symposium attracted participants from more than 30 countries but, despite this impressive global representation, there was a notable lack of participation from areas such as South America, Africa, India, Russia, and China, possibly the result of funding constraints. There is, however, much to be learned from scientists and industry from these areas. Although the organizers here were extremely successful in attracting a broad and diverse participation, it is clear that future symposia should redouble efforts to reach out to those areas that were under-represented here.
- (xii) A unique feature of this symposium was the participation of a large contingent of fishers from the northeast US and from other countries. Their contributions were undeniably valuable to the discussions, particularly one presentation on the collaborative progress being made by the fishers involved in the research. The symposium organizers welcome the continuing involvement of the fishing industry in meetings such as this, and urge everyone involved in collaborative research to facilitate and propagate this in the future.
- (xiii) Conveners and participants identified the need for revisiting the topic of Integrating Fishing and Ecosystem Conservation in Boston in 2016, 10 years on from this event.

Symposium awards

Several awards were presented at the conclusion of the symposium: Best Oral Presentation was awarded to Michael Breen, FRS Marine Laboratory, Aberdeen, and Best Poster Presentation was awarded to Bram Couperus, Institute for Marine Resources and Ecosystem Studies, IJmuiden. Best Student Oral Presentation was awarded to Ingrid Bouwer Utne, Norwegian University of Science and Technology, Trondheim, and Best Student Poster was awarded to Anukorn Boutsen, Tokyo University of Marine Science and Technology, Tokyo, Japan.

Acknowledgements

The conveners thank the International Council for Exploration of the Sea (ICES) for supporting and facilitating this symposium, particularly Adi Kellerman for his guidance in the initial planning stage, and the Gulf of Maine Research Institute for graciously and effectively hosting the symposium. The conveners acknowledge the financial support from the Northeast Consortium as the premier sponsor and from the other symposium co-sponsors: Gulf of Maine Research Institute, Portland, Maine (USA), National Fisherman (USA), Massachusetts Institute of Technology Seagrant (USA), NOAA Fisheries (USA), Marine Fisheries Institute Massachusetts (USA), the Food and Agriculture

Organization of the United Nations (FAO; Rome), and Manomet Center for Conservation Sciences (USA).

In addition, the symposium's success was the result of the many contributions and hard work of:

(i) The Scientific Steering Committee consisting of conveners Christopher W. Glass (USA), Stephen J. Walsh (Canada), Bob van Marlen (the Netherlands), together with a Steering Committee consisting of John Annala (USA), Bundit Chokesanguan (Thailand), Poul Degnbol (Denmark), Steve Eayrs (Australia), Norman Graham (Norway), Michel Kaiser (Wales), David Reid (Scotland), and Wilfried Thiele (Italy).

(ii) The keynote speakers were John-Willy Valdermarsen (IMR, Bergen, Norway), Simon Jennings (CEFAS, Lowestoft, UK), Poul Degnbol (Denmark), and Siri Ekmaharaj (SEAFDEC, Thailand).

(iii) Session Chairs, rapporteurs, and facilitators. Session 1: Dave Reid (FRS, Aberdeen, UK), John Annala (GMRI, Portland, Maine), Shale Rosen (GMRI, Portland, Maine), and Mike Pol (Massachusetts Division of Marine Fisheries, USA); Session 2: Michel Kaiser (University of Wales, Bangor, UK), Norman Graham (IMR, Bergen, Norway), Craig Rose (Alaska Fisheries Science Center, USA), and Peter Weibe (Woods Hole Oceanographic Institute, USA); Session 3: Andrew Rosenberg (University of New Hampshire, USA), Chris Glass (University of New Hampshire, USA), and Chris Manning (University of New Hampshire); Session 4: Stakeholder Forum, Jerry Fraser (Moderator, Editor-in-Chief, *National Fisherman*, USA), Chris Glass (Northeast Consortium, USA), and Chris Manning (Northeast Consortium, USA).

(iv) The Stakeholder Forum panellists, Captain Paul Howard (Executive Director, New England Fisheries Management Council), Norman Graham (Institute of Marine Science, Bergen, Norway), Paul Starr (independent consultant and fisheries scientist), Bundit Chokesanguan (Southeast Asian Fisheries Development Centre), and Michael Andersen (Danish Fisherman's Union).

(v) The local organizing committee from the Gulf of Maine Research Institute in Portland, Maine, under the leadership of John Annala, including Anne Holland, Kathi Higgins, Roz Annala, Shale Rosen, and Catherine Salerno.

(vi) The staff of the Northeast Consortium under the direction of Chris Glass, including Laurinda Sousa-Smith, Troy Hartley, Rachel Gallant, Chris Manning, and Rollie Barnaby.

Special thanks are also due to the Editorial Committee: Christopher Glass, Stephen Walsh, Bob van Marlen, and Guest Editor Tissa Amaratunga; Laurinda Sousa-Smith (Northeast Consortium, University of New Hampshire) who acted as editorial coordinator, and to *ICES Journal of Marine Science* Editor Pierre Pepin for the long hours spent coordinating the submissions and the activities of 101 independent scientific reviewers.

The Symposium Handbook with abstracts and a selection of symposium PowerPoint presentations are available on the symposium website <http://www.ices2006boston.org>. Audio files of general discussion at the end of each day's proceedings are also posted.

Reference

- Fernø, A., Løkkeborg, S., and Hollingworth, C. E. 2004. Fish behaviour in exploited ecosystems. *ICES Journal of Marine Science*, 61: 1029–1242.