

Theme Session O

Experiences in including economic and social information to fishery analysis and advice: why, how, and by whom?

ICES CM 2009/O:01

Participatory modelling in EU fishery management: western horse mackerel and the Pelagic RAC

Troels Jacob Hegland and Douglas Clyde Wilson

In 2006, the stakeholders on the Pelagic Regional Advisory Council (RAC) of the EU contacted scientists with expertise in western horse mackerel and asked them to assist the RAC in developing a long-term management plan for that particular stock unit. The Pelagic RAC wished to explore ways of developing management plans through stakeholder consensus, rather than waiting for a plan to arise from ICES. This paper takes a social science perspective and reports on the process that followed. The paper contributes to the knowledge of best practices for interactive processes between scientists and stakeholders, specifically in relation to processes of participatory modelling under circumstances of high uncertainty. Although the process was to some extent characterized by the different perspectives of scientists and stakeholders, the participants—from both science and industry—considered the process a considerable success. Notably, however, some of the scientists were critical of the way their work was utilized in the political process following the actual development process. Although the Pelagic RAC in some ways stands out as a particularly favourable case for scientist/stakeholder cooperation, the process could still serve as an inspiration for stakeholders, scientists, and policy-makers wishing to do similar exercises in other settings. Based on interviews, meeting observations, and survey material, this paper discusses issues such as scientist/stakeholder interactions, the role of ICES, funding and planning, as well as science/management discrepancies.

Keywords: European Union (EU), Pelagic Regional Advisory Council (RAC), Common Fisheries Policy (CFP), horse mackerel, long-term management plan, participatory modelling.

Contact author: Troels Jacob Hegland, Innovative Fisheries Management, IFM—an Aalborg University Research Centre, Aalborg University, Fibigerstræde 13, room 85, DK - 9220 Aalborg Ø, Denmark [tel: +45 9940 8441, mobile: +45 6171 8482, fax: +45 9894 4833, e-mail: tjh@ifm.aau.dk, web: www.ifm.aau.dk, Skype name: troelshegland].

ICES CM 2009/O:02

The endangered community: analysing societal impacts of fishery management

Ir. L. van Hoof

The sustainability of fisheries and fishing communities is determined by social and economic factors, as well as by biological and environmental conditions. Management plans for European fish stocks will have social impacts on fisheries and fishing communities which will vary geographically, sectorally, and temporally, with different impacts being experienced in the short, medium, and long term. Whereas increasingly ecological and economical data are becoming available and are, for example, managed under the EU Data Collection Regulation, data on communities and their social fabric are at best piecemeal. We will present a general framework for conducting assessments of social impacts of fishery policies on the catching and onshore sectors, and their associated communities, and use the experiences with the application of this framework in selected cases in the UK to evaluate the evaluation process of fishery management policies.

Keywords: fishing communities, societal impact, fishery management evaluation.

Contact author: Luc van Hoof, Institute for Marine Resources and Ecosystem Studies, PO Box 68, 1970 AB, IJmuiden, The Netherlands [tel: +31 317 487173, fax: +31 317 487326, e-mail: Luc.vanhoof@wur.nl].

ICES CM 2009/O:03

A model for simulating trading of fishery quota

L. Richard Little, André E. Punt, Bruce D. Mapstone, Gavin A. Begg, Barry Goldman, and Ashley J. Williams

Individual transferable quotas (ITQs) have long been proposed as a way of increasing the profitability of fisheries by introducing a rights-based tradable permit system that fosters stewardship of the resource, breaking the cycle of overcapitalization and overexploitation. Under ITQs, fishers receive a share of total allowable catch (TAC) and are free to use it or sell it. In this paper we develop a model to simulate trading of fishery quota in an ITQ market. We build on a multispecies population and vessel dynamics model developed for common coral trout (*Plectropomus leopardus*) and red throat emperor (*Lethrinus miniatus*) in the Coral Reef Fin Fish Fishery (CRFFF), a \$AU 50 million fishery operating on the Great Barrier Reef of Australia, where an ITQ fishery management system has been operating since 2004. The model considers initial quota allocation to vessels, seasonal fish prices and individual variable costs, fishing efficiency, and experience. Vessel operators can either purchase or sell quota of either species, if it was in their interest to do so to maximize profit. This depends on the cost each vessel incurs per day fishing, seasonal fish prices, and historical catch rates experienced by the vessel operator, which in turn depends on the catchable biomass of the species and the vessel's own fishing efficiency. Results reveal projected fishing effort trajectories under a range of TAC levels for coral trout and red throat emperor. Results also reveal the profitability of the fishery under a range of management options. In general, as the TAC for the primary targeted species, coral trout, increased, so too did the effort. Fishing effort under the current TAC arrangement decreased, mimicking the actual effort level since 2004. Effort dynamics were also more sensitive to the coral trout TAC, the more valuable primary target species, compared with the TAC of the less valuable red throat emperor. Discarding of red throat emperor was also high when the ratio of coral trout TAC to red throat emperor TAC was high. The results help managers in understanding the implications of their quota-related decisions, illustrate what might be expected with trading in a multispecies quota system and indicate what to expect in the CRFFF as that multispecies ITQ system matures.

Keywords: individual transferable quota, ITQ, vessel dynamics, coral reef fish, simulation modelling.

Contact author: Richard Little, CSIRO Marine and Atmospheric Research, PO Box 1538, Hobart, TAS, 7001, Australia [tel: +61 3 6232 5006, fax: +61 3 6232 5053, e-mail: Rich.Little@csiro.au].

ICES CM 2009/O:04

Policy uptake of social science knowledge: what can social scientists learn from the natural scientists' experience?

Douglas Clyde Wilson

The landscape is changing for social science knowledge in marine policy. Receptivity has never been as high because of the repeated failures of policies that have failed to consider economic and social realities. However, the challenges are also great. For many years our basic message has been to empower local actors through higher quality fishing rights and participatory governance and this message has arguably begun to be reflected in an emerging consensus among policy-makers. The advent of the ecosystem approach, however, presents new challenges. Complex new governance arrangements must address interactions between fishery and non-fishery interests, particularly through marine spatial planning and integrated coastal-zone management. We need to be able to supply timely social and economic knowledge addressing multiple needs at multiple scales from communities to large marine ecosystems. The natural sciences have had a very mixed experience in advising policy-making, from being entirely ignored to making a real difference in the quality of the policies. A number of large studies have now been completed on the conditions under which natural science knowledge has been taken up in an effective way in policy-making. I review this research in search of lessons relevant to social science. Three goals need to be addressed: we need to learn to better ensure the credibility of our results; we need to learn to focus

our work on things that policy-makers can actually use; and we need to build the broader legitimacy of social science as a part of marine management.

Keywords: science and technology studies, social science, marine management.

Contact author: Doug Wilson, Innovative Fisheries Management—an Aalborg University Research Centre, Department of Development and Planning, Room 85, Fibigerstræde 13, 9220 Aalborg Ø, Denmark [www.ifm.dk, <http://aalborg.academia.edu/DougWilson>].

ICES CM 2009/O:05

The FcubeEcon model

Ayoe Hoff, Hans Frost, and Clara Ulrich Rescan

This paper presents an extension, using economic policy considerations, of the original Fcube framework. Fcube was introduced in 2006 as a novel approach to the problems of discards, illegal landings, and/or quota underutilization inherent in mixed-fishery management based on single-species assessments and quotas. The Fcube framework focuses on management from a fishery- and fleet-based perspective as opposed to a single-stock perspective. The original framework, however, bases its management decisions on a combination of fleet harvest potentials and fish stock preservation considerations. As an extension to this, the FcubeEcon bases its management decision on the two former criteria combined with economic optimization considerations for the harvesting agents, recognizing that fishery management have a significant impact on human behaviour as well as on ecosystem development, and must be based on solutions that take into account the behaviour and economic interests of humans, as well as resource preservation. The model framework is presented together with an application to the demersal fishery in the North Sea.

Keywords: Fcube, economics, optimization.

Contact author: Ayoe Hoff, University of Copenhagen, Institute of Food and Resource Economics, Division of Fisheries Economics and Management, Rolighedsovej 25, DK-1958 Frederiksberg C, Denmark [e-mail: ah@foi.dk].

ICES CM 2009/O:06

Northern hake long-term management plan evaluation including fishers' reactions to management advice and enforcement strategies

Dorleta Garcia and Raúl Prellezo

Management strategy evaluation results critically depend on the specification of the operating model. In order to have realistic results, the key processes and uncertainties of the system need to be incorporated in the simulation algorithm. A critical factor in the system is the implementation of the management advice. In general, however, little is known about the reaction of the fishery to the management advice and usually it is assumed that the advice it is perfectly implemented. This was the case in the evaluation of the northern hake long-term management plan carried out in 2009. In this work we extend the algorithm used to evaluate the northern hake long-term management plan, explicitly simulating the implementation of the management advice. We define a private benefit function for the fleet which incorporates the revenue, with a dynamic price function, the variable and fixed costs, the effort of the enforcement agency, the perceived probability of being controlled, and the fine function. In each step, we assume that the effort performed by the fleet corresponds to the effort that maximizes the private benefit function. Results reveal how a better understanding of the reality and the benefits obtained from it spreads along the assessment system, improving the management advice. It also helps in designing enforcement strategies more compatible with the precautionary principle.

Keywords: operating model, stock assessment, enforcement effort, northern hake.

Contact author: Raúl Prellezo, Azti-Tecnalia, Txatxarramendi Ugarteia Z/G. Sukarrieta 48395. Spain [e-mail: rprellezo@azti.es].

ICES CM 2009/O:07

Modelling the fleet dynamics of a small-scale mixed fishery

Philippe E. Ziegler

The small-scale coastal scalefish fishery in Tasmania, southeastern Australia, exhibits complex population and fishery dynamics as a result of a high diversity of fishing gears and target species. In addition, many fishers readily adapt their operations in response to changes in spatial and temporal species availability and the economic situation. Despite strong interactions between the different components of scalefish fishery, stock assessments and fishery management have typically dealt with the fishery at a single-species level. The aim of this study is to predict the allocation of fishing effort and understand the underlying fishers' choices. Initially, fishing tactics (characterized by fishing gear, target species, location, and month) and vessel groups (characterized by their fishing activities) were identified through multivariate analyses of catch and effort logbook records for the 15 gear types used in the fishery. Then, random utility models were applied to the monthly fishing data to model the observed effort allocations in respect to choice of fishing tactic and location. Finally, the outcome of this analysis was compared with information from an industry survey, where fishers were interviewed directly about short-term decision-making and key drivers of their fishing activities, particularly addressing the relative importance of fish availability, fishing tradition, management arrangements, and economic factors.

Keywords: fishery dynamics, technical interactions, fishing intention, interviews, random utility model.

Contact author: Philippe Ziegler, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 49, Hobart 7000, Australia [e-mail: pziegler@utas.edu.au].

ICES CM 2009/O:08

The joint dynamics of fish stocks and fishing fleets: testing hypotheses in the Bay of Biscay

M.-J. Rochet, F. Daurès, S. van Iseghem, and V. M. Trenkel

Indicators are being developed for ecosystems, and tools for diagnosing the economic status of a fishery are readily available, but integrated assessment tools are still mostly lacking. This presentation will bring together indicators of both stock status, assessed based on abundance and average size, and economic indicators—effort, wages, and profitability. Catch describes the interaction between the two components and can be summarized by the contributions (share of each fleet in the removal from each stock) and dependencies (share of each stock in the production of each fleet). The analysis focuses on two questions: (i) What is the influence of stock status on the performance of fleets? (ii) What is the influence of fleet status on the dynamics of fish stocks? To address these questions, we build a model of the fleet-stock year-to-year dynamics, and analyse its qualitative properties (stability and press-perturbation). From this analysis, assumptions on the joint dynamics of the fish community and fleets can be derived and tested based on indicator time-series. In the Bay of Biscay, species diversity is high. Many resources are exploited by a large variety of fleets, and few of the fleets target single species. So the Bay of Biscay provides an appropriate case study with a diversity of stocks and fleets. The approach is applied to the French fleets for which detailed economic data are available. It is found that over the 2000–2007 period, effort drove catch and stock status whereas stock status did not seem to determine catch. The two-way link between effort and profit was ambiguous.

Keywords: qualitative modelling, indicators, ecosystem approach to fishery management, economic indicators.

Contact author: M.-J. Rochet, Ifremer, rue de l'île d'Yeu, BP 21105, 44311 Nantes Cedex 3, France [e-mail: mjrochet@ifremer.fr].

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Mapping for reasons: combining social research and GIS mapping of fishing locations to understand the behavioural pattern of small-scale fisheries in the Dover Strait, UK/France

Yoshitaka Ota, Ludovic Dupuis, and Roger Just

This paper considers the use of GIS mapping and qualitative social research on small-scale fisheries. It argues that combining those research methods are highly advantageous for comprehending various mobility patterns of fishers and the socio-cultural reasons behind them. The paper presents different 'fishers maps' which depicts fishing locations of both UK and French small fisheries operating in the Dover Strait, and their geographical attributes, which also include social and economic weights (values). These maps were created as a part of an interdisciplinary project for marine resource management, Channel Habitat Atlas for Resource Management (CHARM), and they appealed strongly to other disciplinary interest as a result of their visual comprehension and commensurability with other scientific data that are also mapped. Moreover, those maps also had much appeal from both stakeholders and scientists as a tool to initiate dialogue between the two parties. However, they are limited to entail the intricate relationships between fishers and the sea, which is guided by individual environmental knowledge and crafted social skill embedded in their selection of fishing points. This is a crucial point for conducting an applied social research on fishery management, because conservationists and environmental agencies may have difficulty in comprehending environmental issues in etic scale and consequently recent management schemes (particularly for marine resource) are inclined to be solely dependent upon space-oriented (marine protected areas) policies. The problem is that what is often inscribed in a GIS visual presentation are temporally emerging patterns of mobility, which do not take into account long-term constructions of the fishers' decisions towards their use of the marine space.

Keywords: local knowledge, small-scale fisheries, stakeholder, anthropology.

Contact author: Yoshitaka Ota, Policy Research Department, Ocean Policy Research Foundation, Japan [e-mail: y-ota@sof.or.jp].

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A novel survey method to assess fishery stakeholders' preferences and support for policies to conserve European eel (*Anguilla anguilla*)

Robert Arlinghaus, Malte Dorow, Ben Beardmore, and Wolfgang Haider

The reasons for the alarming decline in the European eel (*Anguilla anguilla*) population are unknown. Conservation action is nevertheless needed, and is also demanded by European legislation. To understand fishery stakeholders' preferences for various eel conservation tools and thereby inform eel conservation planning, an innovative survey method, the maximum difference conjoint, was applied to recreational anglers in northern Germany. Results were used to develop a decision-support tool to predict stakeholders' support for eel conservation policies. Recreational anglers preferred moderately more restrictive eel harvest regulations but strongly opposed any form of effort and gear limitation. They strongly favoured tighter constraints on other sources of eel mortality (e.g. commercial fishing, cormorants, hydro power) along with increased stocking efforts rather than increased regulation of recreational eel angling. Overall, however, anglers were supportive of management portfolios that included regulation of recreational fishing along with regulation of other eel mortality sources, provided some success in terms of increased eel escapement was guaranteed. This result was unexpected given the pronounced aversion towards tighter eel angling regulations, highlighting the suitability of our nested survey approach to understand stakeholder trade-offs for complex resource conservation problems. Our results suggest that implementation of successful eel conservation policies must consider joint regulation of all sectors that potentially affect eel stocks negatively. Otherwise, management conflicts are very likely. The application of the social survey technique presented in this paper is encouraged in other

fishery conservation contexts, where biological reasons for declining resources are uncertain and multiple stakeholder interests must be considered.

Keywords: eel management, management decision-support tool, stakeholder analysis, survey method.

Contact author: Robert Arlinghaus, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department of Biology and Ecology of Fishes, Müggelseedamm 310, 12587 Berlin, Germany [e-mail: arlinghaus@igb-berlin.de].

ICES CM2009/O:11

Assessing the economic viability of the French fishing fleets in the Bay of Biscay from 2000 to 2007

F. Daurès, S. van Iseghem, E. Leblond, and C. Brigaudeau

Management and monitoring of fisheries requires the availability of time-series of economic indicators. Traditionally, wages and profits are monitored as they are considered key components for the understanding of fishers' behaviour and fleet dynamics. Furthermore, an ecosystem approach to fisheries can then be applied by integrating economic and ecological indicators and trying to highlight the interactions between these two components. Such an integrated analysis of the joint dynamics of the fish community and fleets has been undertaken for the Bay of Biscay where exploitation is characterized by a large diversity of species and fleets. Economic indicators were calculated for the period 2000–2007 using data collected by IFREMER under the Data Collection Regulation (DCR). Given the specific context of increasing fuel prices, the results demonstrated negative relationships between profits and wages and large differences in profitability between fleets, opposing coastal and larger vessels. These first results raise issues on the relevance of these traditional economic indicators and the definition of reference points to provide a diagnostic of the economic status of fisheries. This study also highlights the difficulties in estimating economic indicators given the weakness of the data sources and the specific structure of the fleet, where most of the vessels are less than 10 m. Finally, the use of data made available under the DCR for such integrated analysis is discussed.

Keywords: economic indicators, ecosystem approach to fishery management, data collection.

Contact author: Fabienne Daurès, Ifremer, Centre de Brest, BP 70, 29280 Plouzané, France [e-mail: fdaures@ifremer.fr].

ICES CM 2009/O:12

Incorporating stakeholders' knowledge to stock assessment: how?

Samu Mäntyniemi, Päivi Haapasaari, and Sakari Kuikka

In this paper we present a method by which the knowledge of stakeholders can be taken into account in stock assessment. The approach consists of a structured interview process followed by quantitative modelling of the answers. The outcome is a set of probability models, each describing the views of different stakeholder. Graphical representations of the models can be used to explore and communicate the differences and similarities between the views of stakeholders. Individual models are then merged to a large model by using the techniques of Bayesian model averaging, and this model is conditioned on stock assessment data. As a result, the model can be used to give management advice where the views of interviewed stakeholders have been taken into account with a weight determined based on how well the views are supported by the observed data. The individual stakeholder models can also be analysed separately to see whether the different views imply different advice or not.

Keywords: participatory modelling, Bayesian statistics, uncertainty, model averaging.

Contact author: Samu Mäntyniemi, Fisheries and Environmental Management Group (FEM), Department of Biological and Environmental Sciences, PO Box 65, FIN-00014, University of Helsinki, Finland [tel: +358 9 191 58710, fax: +358 9 191 58257, e-mail: samu.mantyniemi@helsinki.fi].

ICES CM 2009/O:13

Participatory modelling to enhance understanding and consensus within fishery management

Päivi Haapasaari, Samu Mäntyniemi, and Sakari Kuikka

An important factor influencing fishers' compliance with fishery regulation is a feeling of legitimacy of the policy. Legitimacy includes belief that the management is based on reliable advice. This requires a two-way process rather than a one-way flow of information. We involve stakeholders in the development of biological models for the Baltic Sea herring fishery and the evaluation of policy advice using these models. The study concentrates in factors behind the negative biomass trend and poor growth rates of the herring stocks. Alternative model structures are built based on current knowledge of the stakeholders. A "meta-model" is built as a synthesis of the different stakeholder models. This is compared with a model provided by biological research and discussed with the stakeholders. Differences between the views are analysed: how well the scientific model covers the views of the stakeholders, and how the inclusion and linking of additional variables help the stakeholders link the different risk components to their own argumentation. Using a model as an interactive forum can enhance common understanding about the fishery system and consensus about management actions. Participatory approach to modelling may reduce criticism about the use of models in natural resource policy advice where the assumptions and uncertainties are difficult to communicate. It may be a way to involve stakeholders in decision-making processes, including a demand for increased transparency and understanding.

Keywords: Baltic Sea herring, Bayesian modelling, legitimacy, participatory modelling, stakeholders.

Contact author: Päivi Haapasaari, Fisheries and Environmental Management Group (FEM), Department of Biological and Environmental Sciences, PO Box 65, FIN-00014, University of Helsinki, Finland [tel: +358 9 191 57950, fax: +358 9 191 58257, e-mail: paivi.haapasaari@helsinki.fi].

ICES CM 2009/O:14

Synthesizing biological, economic, and sociological knowledge using Bayesian Belief Networks to support broadly based fishery policy: the case of devising a new Baltic salmon management plan

Polina Levontin, Soile Kulmala, Päivi Haapasaari, and Katja Parkkila

In order to develop a new management plan for Baltic salmon fisheries the European Commission had asked for a comprehensive impact assessment. This analysis comprised several studies carried out by scientists from relevant disciplines and included biological and ecological assessment, economic analysis of the commercial fishery sector, a separate socio-economic data analysis of the recreational fisheries, and, finally, a sociological impact assessment aimed at understanding stakeholder perspectives and possible commitment to a new management plan. In order to synthesize the findings from these disparate studies a Bayesian belief network (BBN) methodology is used. BBN is a tool that can support decision-making by allowing a computation of utilities of different decisions in the light of diverse sources of evidence. In addition, BBN provides a convenient way to summarize information in one model that represents the management problem that includes all of the evidence available. We demonstrate how this methodology can be used to support decision-making in fisheries that relies not just on stock assessments but also on a broader range of expert opinion, data, and research from ecological, economical, and sociological fields.

Keywords: Baltic salmon, bioeconomic modelling, Bayesian belief network, fishery management, recreational fisheries, impact assessment, uncertainty.

Contact author: Päivi Haapasaari, Fisheries and Environmental Management Group (FEM), Department of Biological and Environmental Sciences, PO Box 65, FIN-00014, University of Helsinki, Finland [tel: +358 9 191 57950, fax: +358 9 191 58257, e-mail: paivi.haapasaari@helsinki.fi].

ICES CM 2009/O:15

FishSmart: a stakeholder-centred approach to improve fishery conservation and management

Michael J. Wilberg, Thomas F. Ihde, David H. Secor, and Thomas J. Miller

Fisheries management often limits an effective and meaningful exchange of information and ideas between stakeholders and managers. Our objective was to develop a process that allows stakeholders to develop recommendations to improve the fishery through voluntary measures and provide management recommendations that they supported. We developed a “stakeholder-centred” process that facilitated explicit goal-setting and iterative evaluation of options acceptable to stakeholders. An initial application involved angler, tournament, commercial, management, recreational industry, and conservation stakeholders for the southeastern United States king mackerel (*Scomberomorus cavalla*) fishery. The stakeholder workgroup developed objectives for the fishery, options that could be used to achieve the objectives, and performance measures to gauge whether objectives were reached. Objectives included traditional and non-traditional goals such as maintaining high and stable catches and retaining the opportunity to catch large fish, and options included voluntary changes in fishing practices and mandatory regulations. Stakeholders were an integral component in developing a model to allow them to compare how well their options met their objectives. Based on the results of the decision analysis, stakeholders developed a consensus suite of recommendations, including more conservative length and bag limits than those initially recommended by management. The immersion of stakeholders in reviewing the available science and developing the model led to recognition that more conservative management was necessary to achieve their objectives. This project demonstrated that stakeholders can be included in a meaningful participatory process that can improve fishery management, but inclusion requires increased time and an effort to provide science without jargon or condescension.

Keywords: decision analysis, *Scomberomorus cavalla*, recreational fishery management, stakeholder participation.

Contact author: M. J. Wilberg, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, PO Box 38, Solomons, MD 20688, USA [tel. +1 410 326-7273, fax: +1 410 326-7318, e-mail wilberg@cbl.umces.edu].

ICES CM 2009/O:16

Implications of fishing cost information asymmetry in a non-cooperative fishery: strategic signalling vs. biased knowledge

Mika Rahikainen, Marko Lindroos, and Veijo Kaitala

Gaps in the knowledge of economic performance of fishing fleets have strategic implications. They can be positive or negative depending on whether a country possesses or does not possess economic information, and whether the information is asymmetric or asymmetric and uncertain. Asymmetric information creates problems because a country can, by giving flawed information about fishing costs, manipulate the reaction of another country not possessing equivalent information. We studied the implications of information asymmetry as particular parameter sets in a deterministic empirical setting. Optimal fishing strategies were calculated using non-cooperative Nash equilibrium. Cost data have a strategic value and there are incentives to conceal them in non-cooperative fisheries. A country with perfect information will not gain the highest profits by signalling correct cost information to another country. Instead, it would be rational to cheat and signal lower costs than the actual ones irrespective of cost asymmetry between the countries. The value of possessing perfect information can be tens of millions of Euros in a single fishery over a 10-year period. Another type of case develops when a country has biased or uncertain knowledge of its own fishing costs. In these situations, management schemes are likely to be suboptimal. Moreover, the probability of excessive fishing pressure will be an order of magnitude higher in the presence of asymmetric and uncertain fishing cost information, compared with the case when cost information is asymmetric but not uncertain.

Keywords: asymmetric information, fishing costs, game theory, herring, North Sea.

Contact author: Mika Rahikainen, Department of Biological and Environmental Sciences, University of Helsinki, PO Box 65, FIN-00014 University of Helsinki, Finland [tel: +358 9 191 57733, fax: +358 9 191 57694, e-mail: mika.rahikainen@helsinki.fi].

ICES CM 2009/O:17

Fisheries economics and long-term management plans

Ralf Döring

Long-term management or recovery plans are one of the main instruments in the Common Fisheries Policy (CFP). From the point of view of fishery economics these plans may give fishers a longer term perspective comparable with a management system with the possibility of yearly very variable quotas. The CFP demands impact assessments for all new management plans. The Scientific, Technical and Economic Committee for Fisheries (STECF) assessed a few plans with a common approach by biologists and economists. These evaluations show the problems with such an integrated approach, especially with respect to modelling and long-term predictions. In this paper the economics behind long-term management plans and the rationality of such plans from an economic viewpoint are described. Then the biological backgrounds of the harvest control rules of two plans (the North Sea and the Baltic cod) are analysed from an economic perspective. After this overview on the contents of the plans, the problems with integrated modelling work in impact assessments are discussed. So far, economists mainly use the EIAA model developed by the Danish Institute for Food and Resource Economics (ROI, Copenhagen) for predictions on economic consequences of quota decisions. For future analysis this model has to be extended to deal with impact assessments. Finally, an outlook is given on how an integrated modelling work may be organized, referring to the new structure of the Institute of Sea Fisheries in Hamburg.

Keywords: long-term fishery management, integrated modelling, fishery economics.

Contact author: Ralf Döring, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany [tel/fax: +49 40 38905 177/263, e-mail: ralf_doering@web.de].

ICES CM 2009/O:18

The importance of considering social information in fishery analysis and advice: the North Sea RAC experience

Nicki Holmyard

The North Sea Regional Advisory Council (NSRAC) considers that the use of social, as well as economic and biological information is vital in order to give balanced and considered advice on fishery management issues. It argues that sustainability can only be achieved by balancing all three. Although social fabric data are available in all European countries, it is patchy, not collected on a regular basis, and not available in a common format. The NSRAC Socio-Economic Development Group developed a protocol that established a process by which the NSRAC can give consideration to the socio-economic implications of its policy advice related to communities, fisheries, and fishery-related sectors, including recreational fishing. The aim was to increase NSRAC confidence in the policy proposals and advice advanced to the European Commission. It also undertook a scoping study of socio-economic aspects of North Sea fisheries and fishing communities, in conjunction with the North Sea Women's Network, to define further research that could provide NSRAC with measurable tools to give balanced policy advice. This study recommended the development of a social data frame, the mechanics of which are covered in a separate paper by Luc van Hoof and for changes to the Data Collection Regulations to include an annual social indicator requirement. The paper considers the importance of considering social information in fishery governance, looks at the type of information that could be collected within annual data collection regimes, and discusses how its incorporation into an easily accessible data framework could add an important new dimension to fishery management plans and analysis.

Keywords: sustainability, policy advice, Data Collection Regulations, social information.

Contact author: Nicki Holmyard, NSRAC Socio-economic Development Group, Polfearn, Taynuilt, Argyll PA35 1JQ, Scotland, UK [tel: +44 7711 272637, e-mail: nicki.holmyard@virgin.net].

ICES CM 2009/O:19

Integrated bio-socio-economic analysis and advice for fishery management: a reflection

Anthony Charles

For many decades, there have been calls for the inclusion of human-related information into fishery analyses, and particularly into the advice provided to fishery managers. Over time, the tools to facilitate such bio-socio-economic analysis have been developed, including a focus on integrated “fishery system” analysis. The need for, and the move toward, a more integrated and interdisciplinary approach to fisheries is well accepted, and indeed, the rapid acceptance of the ecosystem approach to fisheries exemplifies this. However, although it is widely agreed that incorporating social and economic information and dynamics into fishery analysis is a positive move, building such aspects formally into the advice provided to fishery managers is more widely debated. It is thus worth examining where the priorities should lie for focusing, and alternatively for broadening, how advice is developed and provided. In modern approaches to fishery management, this must include assessments of the multiple objectives being pursued, both by society and by individual resource users. On the latter point, a related focus is to better predict fisher behaviour, fleet dynamics, and response to fishery regulations. Incorporating this knowledge into fishery advice may improve the feasibility and likelihood of success in fishery management initiatives. This presentation reviews and discusses the wide range of past experiences in building social and economic considerations into integrated fishery analysis and into the provision of fishery management advice. Recommendations for the future are provided that take into account the benefits and the challenges involved in these efforts.

Keywords: fishery systems, bio-socio-economic analysis, integrated fishery models, fishery management, ecosystem approach to fishery, management advice.

Contact author: Anthony Charles, Saint Mary’s University, Halifax, Nova Scotia, Canada B3H 3C3 [tel: +1 902 420 5732, e-mail: tony.charles@smu.ca].

ICES CM 2009/O:20:

The design of hybrid individual incentive mechanisms for bycatch reduction

Alan C. Haynie

After salmon bycatch levels reached record levels in 2006 and 2007 in the Bering Sea pollock fishery, the North Pacific Fishery Management Council (NPFMC) began consideration of a hard cap that would close the fishery if it were reached. The NPFMC asked for input from economists at the National Marine Fisheries Service (NMFS) on individual bycatch accountability mechanisms, including individual salmon bycatch quotas and fees. Because bycatch and salmon abundance are partially correlated, the optimal method to reduce bycatch will both prevent an excessive level of bycatch and protect salmon at periods of lower bycatch encounters that are present at times when stocks are weak and protection most important. Because NMFS was legally unable to impose fees for the secondary purpose of protecting salmon at low abundances, the NPFMC presented industry with a choice: a fixed hard cap of 47 591 salmon or a hard-cap of 68 382 salmon with an industry-operated individual incentive programme that would “provide at least as much protection as the hard cap”. Here we feature characteristics of programmes that will protect salmon during high and low encounter periods and the specifics of programmes proposed by industry. We discuss the efficiency and effectiveness of these programmes and discuss the importance of having individual bycatch quota under a hard cap which could otherwise erode benefits in the rationalized fishery. The NPFMC passed a plan amendment that will go in place in 2011 that will allow for the implementation of a hybrid incentive system, potentially protecting salmon at all abundance levels.

Keywords: bycatch, incentive programmes, bycatch quota, bycatch fee.

Contact author: Alan C. Haynie, NOAA Fisheries/NMFS, Alaska Fisheries Science Center—F/AKC2, 7600 Sand Point Way NE, Bldg 4, Seattle, WA 98115, USA [tel: +1 206 526 4253, e-mail: Alan.Haynie@noaa.gov].

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What would be the economic consequences of altered recreational eel (*Anguilla anguilla*) angling regulations in light of the European eel recovery action plan?

Malte Dorow, Ben Beardmore, Wolfgang Haider, and Robert Arlinghaus

In the response to the current eel (*Anguilla anguilla*) decline in Europe, the European Union (EU) has implemented a pan-European eel recovery action plan. Accordingly, each member state is expected to develop a management plan for the recovery of eel populations. In addition to other possible management options, more restrictive recreational eel fishing regulations are being discussed. Prediction of eel anglers' preferences for potential management actions and the associated economic impacts are important steps in the management development process. Because eel angling is a non-tradable product we sent out a mail survey with a discrete choice task to keen eel anglers ($N = 378$) fishing in northern Germany to estimate regulation preferences and the associated economic welfare changes in response to modified restrictions. Anglers preferred slightly-to-moderately stricter regulations, such as an increase in the size limit and a reduction in the bag limit. In contrast, they strongly disliked regulations that would limit their access to the resource (seasonal closure, rod limit). From an economic perspective, the implementation of some simple tools such as moderately increased minimum size limits or slightly reduced bag limit would increase economic welfare. Considerable welfare losses of several of several million Euros per year would be associated with the highly restrictive eel angling regulation scenarios. Managers must be aware that changes in the level of angling regulation restrictions bring different economic effects which must be considered in the decision-making process in the attempt to achieve balanced management measures in a multiple stakeholder scenario such as the eel management.

Keywords: eel management, discrete choice experiment, economic welfare analysis.

Contact author: Malte Dorow, State Research Centre for Agriculture and Fishery Mecklenburg-Vorpommern, Institute for Fishery, Fischerweg 408, 18069 Rostock, Germany [e-mail: m.dorow@lfa.mvnet.de].

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Modelling fishing exploitation with individual-level socio-economic information in the Tasmanian rock lobster fishery

K. Hamon, L. R. Little, and O. Thebaud

The current goals for natural resource management of marine ecosystems require substantial change. The response of economic operators to modified management regulations is a major issue, especially for limited access fisheries. The joint analysis of fleet and biological responses, by dynamic models, is an expanding research field as a result of its possible contribution to evaluation of management procedures. The Tasmanian rock lobster fishery has undergone major changes in the allocation of fishing rights since being placed under an individual transferable quotas (ITQ) system in 1998. The implementation of this system has led to modifications of fishing strategies, oriented toward the search for higher first-sale prices by new seasonal and spatial patterns of fishing effort allocation. These changes have also been influenced by the market, mainly determined by international trade. As a case study, a bioeconomic evaluation of the effects caused by introducing access rights to fish stocks in the coastal area of the Tasmanian rock lobster fishery

has been modelled. Although the evolution of fishing effort allocation of the rock lobster fleet corresponds to the expected impacts of an ITQ system, the individual heterogeneity in spatial and seasonal effort allocation among fishers is hidden when working at the fleet level. An agent-based modelling approach is used to capture the individual behaviour of fishers operating in the Tasmanian rock lobster fishery, with operators maximizing their utility depending on socio-economic factors.

Keywords: agent-based model, ITQ.

Contact author: Katell Hamon, Ifremer, France [e-mail: Katell.hamon@ifremer.fr].

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Baltic Sea Regional Advisory Council as facilitator between science, industry, and policy

R. Aps, H. Lassen, and I. Liiv

This paper explores the performance of the Baltic Sea Regional Advisory Council (BS RAC) as a boundary organization producing recommendations to the European Commission on fishery issues under the Common Fisheries Policy (CFP), balancing stakeholders' interests in transformation of science-based advice into management recommendations as an important element in setting the TACs for fish stocks in the Baltic Sea. The BS RAC acts as a facilitator between the fishing industry, scientists, and decision-makers both in improving the dialogue and in encouraging research agendas that reflect the interests and needs of fishing industry. BS RAC acts as translator of scientific information produced by ICES, putting general findings into fishery-specific practical language. Today, the management concepts are changing and the BS RAC has to adjust to meet challenges such as (i) developing the recommendations based on the concepts of maximum sustainable yield (MSY) and maximum economic yield (MEY) and (ii) defining the Baltic fishery as a spatial resource with aim of securing the fishing industry's interests in the context of the coming age of maritime spatial planning (e.g. the NATURA 2000 sites).

Keywords: EU CFP, Baltic Sea RAC, boundary organization, boundary work.

Contact author: Robert Aps, Estonian Marine Institute, University of Tartu, 10A, Maealuse Str., 12618 Tallinn, Estonia [tel: +3725062597, fax: +3726718900, e-mail: robert.aps@ut.ee].

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Holistic evaluation of management strategies: can gear modification increase haddock yield within legal constraints?

Dorothy J. Dankel, Nikki Jacobson, Dan Georgianna, and Steven X. Cadrin

Georges Bank haddock is a recently recovered fish stock in the New England groundfish fishery. However, this stock cannot be optimally exploited owing to federal constraints under the Magnuson-Steven Act and the bycatch of overfished stocks, such as cod and yellowtail flounder. The "Ruhle trawl" and "separator trawl" are examples of recent advances in gear technology that have been shown to significantly increase haddock-to-bycatch ratios. We explore policy situations regarding the use of the new trawls. This study models the groundfish fishery by applying a mixed-stock yield model which incorporates technological interactions. We also developed a socio-economic model that quantifies the amount of employment and profit expected for management scenarios associated with three trawl types. By bridging the biological and socio-economic models, we are able to view the fishery as a system that more accurately represents stakeholder views. Our model can aid policy-makers in examining fishing gear trade-offs and the resulting biological and socio-economic consequences of different management actions within the constraints of the Magnuson-Stevens Act.

Keywords: multispecies, Georges Bank, groundfish, technological interactions, Ruhle trawl, separator trawl, fishery policy options, stakeholder views.

Contact author: Dorothy J. Dankel, Institute of Marine Research and University of Bergen, Institute of Marine Research, PO Box, 1870 Nordnes, 5817 Bergen, Norway

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Fleet spatial dynamics in Portuguese fish trawlers—modelling the individual decision to return to previous fishing grounds

Beatriz Mendes, Paulo Fonseca, Aida Campos, Tereza Pilar-Fonseca, and Manuel Afonso-Dias

The development of spatial management tools in fisheries, including the implementation of stock-recovery plans and regionalization of scientific advice, requires a good understanding of fleet spatial dynamics, including an analysis of fishers' behaviour. Within this study, the individual fishers' decision to return to the fishing ground of the previous trip was modelled for a number of fishing units engaged in the Portuguese coastal trawl fishery, using econometric discrete choice models. For this purpose, geo-referenced information of a total of 1356 fishing trips was extracted from Portuguese vessel monitoring system (VMS) data and collated with commercial landings (by species, in weight and value) using GeoCrust 2.0 software. The results revealed that tactical decisions are based on trade-offs between landing revenues and associated costs. Fleet spatial distribution was found to be heavily dependent on the fishers' expectations (and therefore fishing profits) of landings for the main target species, horse mackerel and cephalopods. Distance to fishing grounds, an indicator of overall fuel consumption, was also found to be an important variable when modelling the decision to return to previous fishing grounds. The models employed were found to adequately describe the fishing activity, with the proportion of successfully predicted choices ranging from 0.66 to almost 0.95 according to the different datasets, as was the case of vessels targeting cephalopods. This may indicate a higher commitment of these vessels towards the target species and, consequently, to their fishing grounds.

Keywords: bottom trawlers, VMS, conditional logit, discrete choice model, spatial distribution, Portuguese continental coast.

Contact author: Beatriz Mendes, INRB/L-IPIMAR, Av Brasília, 1449-006 Lisbon, Portugal [tel: +351 213 027 000, fax: +351 213 015 948, e-mail: bmendes@ipimar.pt].

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Scientists as facilitators: an objective technique to illustrate the zone of stakeholder consensus

Dorothy Jane Dankel, Mikko Heino, and Ulf Dieckmann

The ICES Study Group on Management Strategies (2008) suggests that ICES scientists can act as educational facilitators during the dialogue process with stakeholders. Facilitation can be useful during many stages, especially when disseminating the results of alternative management strategies. ICES scientists are becoming more and more involved in developing management strategies together with stakeholders. However, building a consensus between different stakeholder groups is seldom straightforward or easy. It is well known that inherent conflicts between objectives in fishery management (e.g. yield maximization vs. conservation interests) often create problems for managers, scientists, and stakeholders. Yet, some seemingly contrasting objectives may be compatible (e.g. economic yield and ecosystem preservation) and could promote stakeholder consensus. The purpose of this study is to outline a quantitative approach to define fishery management objectives using stakeholder-specific utility functions. By doing this, we develop a quantitative technique to illustrate a "zone of consensus", which we here define as the set of management regulations that allow all stakeholders to reach at least a certain proportion (e.g. 90%) of their maximum achievable utility. To achieve this, we link a biological model with a socio-economic model, both calibrated for a capelin fishery and a cod fishery. Second, we define multiple objectives in a quantified utility function for each stakeholder group. Finally, we conduct simulations that calculated the resulting stakeholder groups' utility for different levels of harvest and minimum sizes. Our results illustrate that low harvest rates and minimum-size regulations that select for bigger fish represent a management consensus zone among five modelled stakeholders. We suggest a new route towards deriving appropriate management regimes with focus on compatible management goals to promote a new paradigm of stakeholder consensus in fishery management.

Keywords: fishery management, stakeholders, stakeholder integration, utility functions, stakeholder preferences, population modelling, stakeholder consensus, management objectives, consensus building, ecosystem preservation.

Contact author: Dorothy J. Dankel, Institute of Marine Research, Institute of Marine Research, PO Box 1870 Nordnes, 5817 Bergen, Norway [tel: +47 55 90 65 30, fax: +47 55 23 86 87; e-mail: dorothea@imr.no].

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Fleet segmentation of the Portuguese coastal trawl fishery: a contribution to fishery management

Tereza Pilar-Fonseca, Aida Campos, Paulo Fonseca, and Manuel Afonso-Dias

The shift in the Common Fisheries Policy towards fleet- and area-based management requires not only the integration of fine-scale biological information about the stocks and their habitats, but also economic data, associated with an in-depth knowledge of fleet short- and long-term behaviour (i.e. vessel tactics and strategies). Within this context, fleet segmentation and identification of métiers and/or landing profiles (LPs) are a fundamental step towards promote effective and sustainable management. For this purpose, LPs for Portuguese coastal fish trawlers were defined over a 12-year time-series of landings (1996–2007), based on the relative importance of target and bycatch species of daily fishing trips. Temporal and spatial patterns of activity were addressed and the correspondence between LPs and fishing units was also investigated. Preliminary estimates of effort, landings- and values-per-unit-effort were carried out for a number of target species using landed quantities and associated landing frequencies. The identification of vessels targeting homogeneous groups in terms of species composition, as well as the corresponding spatiotemporal boundaries, allows for better estimation of species-directed effort, thereby contributing to the improvement of conservation and management policies.

Keywords: fleet segmentation, exploitation patterns, vessel monitoring system data, bottom-trawl coastal fleet.

Contact author: Tereza Fonseca, INRB/L-IPIMAR. Av Brasília, 1449-006 Lisbon, Portugal [e-mail: tfonseca@ipimar.pt].

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Potential of further economic and social information to re-rank the management options evaluated by natural sciences: the case of the Basque fleets in the Bay of Biscay

Leyre Goti

Using monetary valuations of single-stock management outcomes (catch and prices) and economic optimization by the fishers (including a variety of costs and revenue measures) there have been many recent advances in projects such as the EU FPVI AFRAME. In an attempt to clarify further relevant economic aspects involved in a multifleet context, not only for the main actors (the fishers) but also for a larger set of stakeholders, an array of wider contributions from economic science is displayed in order to better characterize the multiple interactions between humans and fisheries. The scope of the analysis is thus extended to broader human groups (consumers, citizens) and broader biological magnitudes (trophic chains, ecosystems) through a closer economic examination of fishery systems aspects such as employment, income distribution, nutrition, and environmental issues. Concepts such as the burden of conservation, economic equality, and the economic and social criteria behind the establishment of property rights are taken into consideration and used to present a series of basic social and economic trade-offs that shed light on the missing factors in evaluating management options. An example is presented for a reduced fleet and area (the Basque industrial fleet in the Bay of Biscay), which, like most fisheries, displays a rich background for picturing this series of concepts that should be taken into account in biological assessments.

Keywords: economic and social trade-offs, multifleet management.

Contact author: Leyre Goti. Address: AZTI-TECNALIA, Marine Research Division, Txatxarramendi Ugarte 2/g, 48395 Sukarrieta, Spain [tel: +34 946029400, fax: +34 946870006, e-mail: lgoti@azti.es].

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Bioeconomic expectations for New England groundfish

Nikki Jacobson and Steve Cadrin

New England groundfish are harvested in mixed-stock fisheries and are managed under a single fishery management plan. In this study, a mixed-stock projection model is used to evaluate management actions regarding fishing effort through yield, spawning-stock biomass (SSB) and economic yield for seven New England groundfish stocks. This model provides long-term and short-term evaluations for the components in a mixed fishery as well as the assemblage. The approach incorporates the dynamic aspects of single-species projections with technological interactions for mixed-stock evaluations. The computational approach updated a traditional static, mixed-species yield-per-recruit model with more recent data from large-mesh fisheries and extended the model to include spawner–recruit relationships and estimate spawning-stock biomass and profit. Performances of equilibrium and non-equilibrium expectations were evaluated. Given the sensitivity of short-term projections to transient conditions and retrospective consistency of stock assessments, long-term expectations of mixed-stock maximum sustainable yield, maximum economic yield and optimal levels of fishing effort may be the most relevant application of mixed-stock projections of New England groundfish. The equilibrium analysis provides single-stock estimates of fishing effort reference points for the assemblage that are consistent with recent evaluations of the management plan.

Keywords: mixed-species, bioeconomic.

Contact author: Nikki Jacobson, NOAA/UMass CMER Program, School for Marine Science and Technology, 200 Mill Road, Suite 325, Fairhaven, MA 02719, USA [tel: +1 508 910 6394, e-mail: jacobson.n@gmail.com].

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Fishery-based indicators of management impact: assessing relevance and robustness using a bioeconomic simulation model

Sigrid Lehuta, Stéphanie Mahévas, Pierre Petitgas, Pascal Le Floc'h, Dominique Pelletier, Paul Marchal, and Etienne Rivot

Indicators are widely used in fishery management decision processes as measures for monitoring ecosystem status or management performance. In the current context, the shift to an ecosystem-based approach to fishery management requires the completion of usual population or community indicators with indicators reflecting state and dynamics of fishing activity as well as economic viability. However, it is difficult for decision-makers to select relevant indicators among the numerous existing ones. In addition, the complexity of the mechanisms involved (numerous interactions between environmental conditions, fish population, and fleet dynamics among others) makes the unequivocal interpretation of indicator variations seldom possible using only statistical models. We propose to resort to the ISIS-Fish fishery dynamics model to assess the sensitivity of model-based metrics and select robust and relevant fishery indicators. ISIS-Fish was set up for the Bay of Biscay pelagic fishery to evaluate the potential of various management actions for anchovy stock rebuilding. The population submodel reproduces major processes of anchovy population dynamics in space and time. To take fishers' behaviour into account while modelling fleet dynamics, we considered a discrete choice model using economic interest, fishers' habits, and management constraints within a random utility modelling framework. Applying sensitivity analysis methods, simulation designs were built crossing a variety of management scenarios and uncertainty hypotheses. Consequently, a list of resulting candidate metrics referring both to population and fishing activities were computed and statistically analysed. Metrics that were the most sensitive to management and the most robust to uncertainties were considered to be relevant and selected for assessing management impact on the fishery.

Keywords: anchovy, bioeconomic model, fishery, fishery status, indicator, sensitivity analysis.

Contact author: Sigrid Lehuta, Ifremer, Département EMH, rue de l'Île d'Yeu, B.P. 21105, 44311 Nantes Cedex 03, France [tel : +33 2 40 37 41 65, e-mail: slehuta@ifremer.fr].

ICES CM 2009/O:34 Poster

Sequential elimination: using a combination of data and process to choose robust harvest control rules for Fraser River sockeye (*Oncorhynchus nerka*)

Tatiana Tunon and Gottfried Pestal

The expanding mandate of fishery management keeps introducing ever more complex objectives, making purely quantitative optimization approaches intractable and unwieldy for stakeholder processes characterized by highly diverse participants with competing ecological and socio-economic objectives. A practical approach for this setting is the collaborative equivalent of hierarchical goal programming: (i) Develop a hierarchy of goals, each expressed as a performance measure, benchmark, and risk tolerance. (ii) Apply resulting constraints in sequence, rather than simultaneously. This sequential elimination has been successfully applied in the collaborative development of robust harvest control rules for Fraser River sockeye (*Oncorhynchus nerka*). A sample hierarchy was to eliminate all options which were not expected to achieve stock-specific minimum abundance goals, then eliminate from the remaining options any with high year-to-year variability of total allowable catch, and finally work through a facilitated debate on the trade-offs associated with the remaining options. This approach demonstrated several procedural benefits: (i) It progressively narrows the options, so participants see explicitly when and how their stated goals influence the outcome. (ii) It avoids the confrontational step of assigning weights to different objectives (as in a multi-objective value function), but still allows participants to express priorities through the order in which constraints are applied. (iii) Goal hierarchies tend to be quite shallow, because many aspects of socio-economic objectives can be mapped as different benchmarks on the same fundamental performance measures. (iv) Discussions shift from trying to identify targets for competing objectives to establishing common ground on outcomes to avoid (i.e. benchmarks).

Keywords: stakeholder process, hierarchical goal programming, Fraser River, sockeye salmon

Contact author: Tatiana Tunon, SOLV Consulting Ltd [e-mail: ttunon@solv.ca].