ISSN 1198-6727

Fisheries Centre
Research Reports
2005 Volume 13 Number 2

Innovation and Outlook in Fisheries: An assessment of research presented at the 4th World Fisheries Congress

Fisheries Centre, University of British Columbia, Canada

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Edited by
Ratana Chuenpagdee and Alida Bundy

Fisheries Centre Research Reports 13(2)
113 pages © published 2005 by

The Fisheries Centre,
University of British Columbia

2202 Main Mall
Vancouver, B.C., Canada, V6T 1Z4

ISSN 1198-6727

FISHERIES CENTRE RESEARCH REPORTS 13(2)
2005

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CONTENTS

A Research Report from the Fisheries Centre at UBC

This research was supported by a Research Development Initiative Grant (#820-2003-2025) from the Social Sciences and Humanities Research Council of Canada to Ratana Chuenpagdee (Principal Investigator) and Alida Bundy (Co-investigator), through collaboration with Aqualink and the Fisheries Centre.

AQUALINK

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FISHERIES CENTRE RESEARCH REPORTS ARE ABSTRACTED IN THE FAO AQUATIC SCIENCES AND FISHERIES ABSTRACTS (ASFA)

ISSN 1198-6727

DIRECTOR'S FOREWORD

What a good idea it is!

Most conferences whether large or small are not being evaluated (they are themselves supposed to be evaluating the progress in the field). The editors' idea, though, was to evaluate the 4th World Fisheries Congress, which likely provides as good as any indicator of the state of fisheries science. They identified areas of research that are definitely "hot" and "in" in their parlance, and marine protected areas, as a tool to mitigate the ravage to ecosystems due to excessive fishing are an example of a topic that is "in". They also identified areas which are less hot, which are "out". But the practitioners will probably disagree, thus I shall not give any examples.

Be that as it may, this volume, an evaluation of the papers and themes addressed at the 4th World Fisheries Congress, represents the first such exercise in fisheries and the first I know of in any field of science. I can only congratulate the members of the *AQUALINK* team for daring in conducting this exercise and I hope that the pointers it provides will be heeded.

PREFACE AND ACKNOWLEDGMENTS

This report is a product of two related workshops. The first was the 'Innovation and Outlook in Fisheries' workshop, held on May 2-7, 2004 in Vancouver, British Columbia, Canada, to coincide with the 4th World Fisheries Congress. The second was the follow-up workshop on 'Creating a Positive Future for Fisheries Worldwide', held in Halifax, January 13-15, 2005. Both workshops were organised by *AQUALINK*, a network of international, interdisciplinary scholars interested in aquatic resources, through funding from the Social Science and Humanity Research Council (SSHRC), Research Development Initiative (RDI) program, as a one-year grant to Drs. Ratana Chuenpagdee and Alida Bundy, principal investigators and members of *AQUALINK*.

The report demonstrates two key points. First, a systematic assessment of current fisheries research, as conducted and presented in the first six papers, is a useful exercise that can illuminate whether the directions of current research correspond well with the global concerns and challenges. Further, the evaluation of papers' contributions and impacts to reconciling fisheries with conservation offers perspectives for future research, leading to further discussion and development of interdisciplinary research programmes. The second point is less evident, but equally important. This report is a result of the collaboration between graduate students, newly established scholars and senior researchers from a range of disciplines and background. Such cross-generational exchange generated through this project is unique and has great potential as a model for better understanding and effective learning.

All contributors to this volume are members of *AQUALINK*, and have received support from their respective institutions to participate in the workshops. We thank Professor Daniel Pauly for the extended support from the Fisheries Centre, University of British Columbia, and also for serving as an advisor to the project together with Professors Anthony Davis and Rashid Sumaila. More importantly, we thank all workshop participants and the panellists for their contributions to the paper evaluation and the discussion at the workshops.

Many *AQUALINK* members made considerable effort to conduct the study and to prepare the report. We are particularly grateful to all lead authors and co-authors of this volume. Also, we appreciate the assistance of Vicky Lam, William Cheung and Janice Doyle in the production of this report. Other *AQUALINK* members not presented at the two workshops provided support in other ways, and for that we are thankful.

AQUALINK continues its mission and commitment to promote interdisciplinary research and activities, as well as to serve as a global network for graduate students and newly established scholars interested in issues related to aquatic sciences. For more information about *AQUALINK* and how to become a member, please visit our website: http://fisheries.ubc.ca/aqualink/index.htm

EXECUTIVE SUMMARY

Every year, scientific meetings are held, often at great expense, providing researchers the opportunity to present and exchange their research ideas. Much of this research will eventually be further disseminated, perhaps published as scientific papers in peer-reviewed journals. These meetings usually have themes which the scientific papers address, with the end goal of furthering knowledge within that theme. In fisheries, concerns about the state of the world's oceans, the collapse of fish stocks and changed ecosystems due to exploitation dominate current debate. Thus, these issues are often highlighted in many meetings occurring globally. Yet it is not clear that we are getting any closer to finding solutions, particularly in balancing the use of resources with conservation. Are we making progress? Are scientific results being communicated, and effectively used in policy and management decisions?

One of the most prominent fisheries meetings is the World Fisheries Congress (WFC), the fourth and latest of which was held in Vancouver in May 2004. The WFC is an event that takes place every four years and is attended by international fisheries scientists and students from the natural sciences and social sciences disciplines. It also attracts representation from fisheries managers, industry, fisheries stakeholders, and interested members of the public. 'Reconciling fisheries with conservation' was chosen as the theme of the 4WFC to address current global concerns in fisheries. We thus used it as an opportunity to address the questions posed above.

This report documents a systematic analysis and assessment of the current state of the science of natural systems, economics, social dimensions and policy with respect to reconciling fisheries with conservation. The assessment was conducted by *AQUALINK*, a network of international, interdisciplinary scholars involved in research concerning all aspects of aquatic resources. The analysis was designed to examine the extent to which existing tools, approaches, methods and concepts used in fisheries science and management address the current and emerging challenges of understanding and managing aquatic ecosystems, and whether they would lead to reconciling fisheries with conservation. The underlying goal was to document innovation in research that is likely to contribute to a positive outlook for fisheries of the world. The contribution of 223 papers presented at the 4WFC was evaluated by *AQUALINK* using a set of templates developed prior to the meeting. The data from these templates were entered into a database allowing a global analysis of the research presented at the meeting.

The results of the analysis are presented here as separate papers on natural systems, economic, social and policy issues and tools and approaches, all co-authored by groups of *AQUALINK* members. Each group was given the freedom to approach their analysis in the way best suited to the topic, hence the papers have different styles, although all of them discuss the presentations from the 4WFC in the wider context of their subject area. This work may be the first to systematically examine the contributions at a major fisheries conference and report on the success of these contributions. It points to areas where further research, in support of reconciling fisheries with conservation, should be focussed.

A global overview of the results is first presented in "Reconciling Fisheries with Conservation". Fisheries science roots are in the natural sciences and this was reflected in the number of papers that addressed natural science issues. However, many papers also discussed policy and management in particular, but also social and economic issues, and almost 50% of the papers integrated one or more of these topics to some degree. This speaks to a shift in fisheries science from a single discipline, natural science based approach to a more integrated, interdisciplinary approach with a greater focus on policy and management. Given the context in which fisheries now operate and the great need for "better management", this is a very positive development. The location of the 4WFC in a developed country probably biased the representation of research locations since *AQUALINK*'s analysis showed that half of the research was located in developed countries, and only 17% was specified as occurring in developing countries. However, over 60% of the papers were considered as having a medium to high overall impact on reconciling fisheries with conservation.

It is clear from "An Analysis of How Natural Sciences Are Addressing Fisheries Within the Context of Conservation" that excellent scientific research is being conducted and that fisheries issues are being approached from a variety of perspectives. Furthermore, the unifying message of the 164 papers on natural systems was that ample scientific expertise exists to address reconciling fisheries with conservation. Science is not the issue. One key message delivered was the need to include stakeholders in data collection and interpretation as well as decision-making. Equally critical to the success of scientific approaches to fisheries is communication and outreach: 51% of the natural systems papers indicated the success of the research, but only 9% made an attempt to communicate their results to the general public.

Ecosystem approaches to fisheries management is a hot topic and papers covered many issues including biodiversity, species at risk, resiliency, ecosystem modelling, ecosystem indicators and fisheries management. Of the ecosystem modelling papers, over 50% used Ecopath with Ecosim (EwE). However, an ecosystem-based approach requires a multiplicity of methods including single species, multispecies and ecosystem approaches. Alternative non-market accounting is also an essential component to ecosystem-based management as the alteration of food web structure can lead to ecosystem shifts and alternative stable states. Methods to resolve conflicting objectives include multi-criterion analysis, a suite of quantitative and qualitative methods for environmental risk assessment, and the Management Strategy Evaluation methodology. Important to all of these approaches are transparency in process, explicit objectives, and wide stakeholder involvement.

People involved in fisheries are finally being recognised as the key to good fisheries management, as noted in "How are We Performing in the Social Aspects of Fisheries Science?" The present management era is marked by the emergence of approaches involving multiple stakeholder groups, co-management, and the precautionary principle. Almost 30% of the papers at the 4WFC addressed the social aspects of reconciling fisheries with conservation. Resource allocation was the most frequently tackled social issue, followed by stakeholder conflict. Stakeholders were involved in approximately 24% of all the studies, although mostly as research subjects, rather than as part of the research or decision making process. While some papers emphasised the need to empower fishing communities to conserve their traditional livelihoods, others criticised the temptation to naively romanticise life in poor communities with over-exploited resources. Recreational fishers, fishers' organizations, indigenous communities, subsistence fishers, women, and children in these papers were not well represented in the research presented. Despite the rhetoric extolling the benefits of participation and communication when incorporating social factors into fisheries research, papers considering social aspects made no greater effort to find innovative ways of communicating research results to the public than did the other papers presented at the 4WFC.

The two sessions that focused on economic issues are discussed in "Economics Discussion at the 4th World Fisheries Congress". One session dealt with fisheries trade, the other with valuation of fisheries resources. Understanding the marketing and trading system of fisheries products, at local, national and global scales, can develop a better understanding of the root-causes of world fisheries problems related to human consumption and utilization of fish and fisheries products. Some papers attempted this from a developing world perspective, discussing fish supply and demand and the structure of trade. Fish export has become a significant source of foreign exchange earnings in developing countries, although some barriers (e.g., high cost of food safety compliance) limit their ability to export fish products in the global market. However, the rising fish trade has accelerated concerns for food security of the poor and the environmental impacts of resource uses. In the economic valuation session, three aspects were emphasised: the role of discounting and future generations, economic values in large vs. small-scale fishing sectors, and within the community at large, and economic loss caused by pollution. This paper concluded with a discussion of the role of economics more generally in reconciling fisheries with conservation. Of note are the economic value of biodiversity and recreational fisheries.

There are various tools available to reconcile fisheries with conservation, as described in "Tools to Reconcile Fisheries with Conservation: Insights from the 4th World Fisheries Congress". These tools include protected areas, aquaculture, habitat improvement and stock enhancement. The paper first gives some background information on these tools, then goes on to discuss the content of the papers presented at the 4WFC. There were relatively few papers on protected areas, which, given their potential benefits is

surprising. The goals of the protected areas discussed were protection of ecosystems, biodiversity conservation and the reduction of fishing mortality. Some of the drawbacks and challenges to establishing protected areas are presented. Aquaculture, potentially a very valuable tool for addressing conservation issues, received little focus at the 4WFC. Most presenters concerned themselves with the ecological impacts of farming, particularly its negative effects on water quality. While there are many negatives associated with aquaculture, particularly the culture of piscivorous fish, there is significant room for growth in the vein of aquaculture research. From the papers dealing with habitat improvement and stock enhancement, it was concluded that habitat improvement or stock enhancement alone are unlikely to be effective fishery management tools, unless the root causes of the ecological threats, such as over-capacity and pollution, are mitigated. Furthermore, they failed to address the ecological risks associated with habitat improvement and stock enhancement.

Based on the papers presented at the 4WFC, scientists are increasingly linking their research to policy issues, as discussed in "Talking Management and Policy at the Scientific Meeting". An analysis is given of the policy issues that these papers addressed, the role of international conventions and the roles of science in management and policy decisions. Interestingly, the analysis indicated that scientific information, to a large extent, was used in the policy and decision-making process, but researchers also reported that best sciences were not used universally. Scientific uncertainties will always exist, however, and should not preclude decision-making. Furthermore, when science is not used in management and policy decisions, it may be due to the difficulties in translating technical scientific results, often presented as academic research, into management, or to the wider public. The analysis also showed that politics can prevent the full incorporation of good sciences into fisheries management decisions. This can be resolved partly through meaningful participation and involvement by resource users and other stakeholders.

"Roles of Communities and Stakeholders in Reconciling Fisheries with Conservation" provides an overview of discussions held in two "extra-mural" sessions that focused on fishing communities and other stakeholders, particularly fish and seafood consumers. The first was the 'Forum on Reconciling Fisheries with Conservation within the Fishing Community' where three overarching themes of the day's discussion included rights and allocation, communication, and the interconnectedness of ecosystems and environmental issues. The second session was the 'Forum on Sustainable Seafood Movement'. Here, environmental advocates, seafood suppliers, public relations experts, and a chef discussed the role of consumer choices in fisheries conservation. Speakers and participants highlighted the conceptual framework and strategies underpinning the movement and the challenges it continues to face.

Two papers report on a one-day workshop "Innovation and Outlook in Fisheries" held immediately after the 4WFC by *AQUALINK*. "Results from Panel Discussions: Priority Areas for Research Identified at the Fourth World Fisheries Congress" reports on two panel discussions, "Been There, Done That" and "The New Frontier". In the first, senior, established scientists were asked to identify important areas of current research in fisheries science, and evaluated the effectiveness of the Congress in addressing these concerns. Panellists agreed that there is a clear need to resolve long-standing issues of ownership and property rights in marine fisheries and that participatory management, which takes advantage of local community knowledge and cooperation, has been overlooked as a means to achieve sustainable fisheries despite numerous success stories from the developing world. The "New Frontier" panel identified more multidisciplinary research as a priority for the future and stressed that scientists and managers must be amenable to a more bottom-up approach to management than has been traditionally applied, at least in the developed world.

"To Boldly Go Where No One Has Gone Before" reports on the group discussions that were held after the panel discussions. Here there was an opportunity for all participants to flesh out ideas that they may have developed during the 4WFC and the workshop. Each group was asked to first derive a list of research issues and topics that need to be addressed in order to reconcile fisheries with conservation, then explore some of these in detail. Many issues were identified as important for reconciling fisheries with conservation, but perhaps the largest was communication. The identification of participatory, inclusive approaches to fisheries management with greater emphasis on bottom-up approaches to management was consistent among all groups. None of the groups focused on science issues alone and where ecosystem-

based management or marine protected areas were discussed, it was mostly in relation to their social implications.

The final paper in the report, “Creating a Positive Future for Fisheries and Coastal Communities Worldwide,” based on the follow-up workshop in Halifax in January 2005, looks explicitly to the future. The authors go beyond reconciling fisheries with conservation and ask “what science and research is required to create a positive future for fisheries and coastal communities?” They first present the underlying concerns in fisheries and fishing communities and the main challenges faced in their management. Next, they evaluate the effectiveness and applicability of existing principles and tools employed to address fisheries problems. Emphasizing a focus on the human dimensions of an ecosystem-based approach to fisheries management, they propose a research program that focuses on issues such as social justice, comprehensive values, business and power, governance and ethics, as possible means towards a positive future for fisheries and fishing communities worldwide.

RECONCILING FISHERIES WITH CONSERVATION: OVERVIEW OF PAPERS PRESENTED AT THE 4TH WORLD FISHERIES CONGRESS

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ABSTRACT

Many fisheries around the world have been characterised as being in crisis due to problems such as overfishing, bycatch, and habitat damage. Globally, efforts to address these problems have been implemented through international conventions and agreements, as well as through initiatives by local and national governments and environmental organizations. The scientific community discusses the pressing issues concerning fisheries regularly at various meetings. One such venue is the World Fisheries Congress held every four years since 1992. The fourth and latest Congress took place in Vancouver in May 2004 under the theme 'Reconciling Fisheries with Conservation'. This paper presents an overview of a systematic assessment of the papers presented at the Congress in terms of their contributions to address the congress theme. Of the total 223 papers evaluated, 51% were related to fisheries in developed countries. Although the majority of the papers addressed bio-ecological aspects of fisheries more than social and economic aspects, about 65% of the papers made explicit policy recommendations. In terms of contributions to reconciling fisheries with conservation, about 17% of the papers were considered to have a high contribution, 46% medium-high, 22% medium contribution, and the rest to have a low contribution.

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INTRODUCTION

Globally, fisheries are in crisis! This type of urgent statement appears in policy documents at national and intergovernmental levels (see, for example, a document prepared by Nixon (1997) for general distribution to Canadian Parliamentarians). Concerns regarding fisheries and ocean ecosystems have been discussed at important global venues, including the Earth Summit in Rio de Janeiro (1992) and the World Summit on Sustainable Development in Johannesburg (2002). The United Nations Environment Program selected the oceans theme for the World Environment Day 2004 - "*Wanted! Seas and Oceans – Dead or Alive*." Several agreements and conventions have been ratified to support governments' initiatives to address the problems with fisheries resources. Of particular significance is the Food and Agriculture Organization (FAO)'s Code of Conduct for Responsible Fisheries, aiming to set principles and international standards for responsible fisheries (FAO, 1995). These principles include ecosystem-based management, participatory decision-making, quality and safety of fishery products, integration of fisheries with coastal management, and international cooperation in management and compliance. Such urgency is echoed by many environmental organizations through their reports, campaign, education and awareness programs that promote sustainable fishing practices and ocean conservation.

This dire global fisheries situation has occurred despite decades of fisheries research globally and from different disciplines, including biology, ecology, economics, anthropology, sociology and policy. Given all this effort, why has this occurred and what research is needed to turn this situation around? Possible reasons include a lack of innovation in fisheries research and failure to identify the necessary questions that will lead to change. This paper and others in this volume attempt to provide some insights to the problems faced in fisheries and to identify research and initiatives required to effectively address these problems.

We took advantage of the 4th World Fisheries Congress (4WFC), held in Vancouver on 2-6 May 2004, to conduct a systematic evaluation of current fisheries research. The WFC is an event that takes place every four years and attended by fisheries scientists from the natural sciences, and to a lesser extent, from the social sciences disciplines. It also attracts managers, industry, fisheries stakeholders, students and interested public from all over the world. The theme of the 4WFC, "Reconciling Fisheries with Conservation", and the wide range of sessions suggested the current need to address fisheries problems from different perspectives.

In this paper, we first provide a brief overview of the current global fisheries situation. Next, we describe the method used to assess the contribution of research, as presented at the 4WFC, to reconciling fisheries with conservation. This is followed by a summary of the assessment results, presented as a 'demographic' of the papers, e.g., geographical coverage, topics addressed, time period, type of system, etc. We end this paper with an overall evaluation of the importance of the papers in reconciling fisheries with conservation and for the future of fisheries. The detailed analysis concerning different aspects of the research, that is, those pertaining to natural system, social, economic and management and policy is covered in the following papers in this volume.

A BRIEF OVERVIEW OF FISHERIES RESEARCH AND MANAGEMENT

Fisheries resources have long been exploited through the development of fishing gears, technology, increased capacity and industrialization of fishing. The first big boom occurred during the 1950s, with rapid development of fishing technology, particularly in shipbuilding. The second boom came after the declaration of the Exclusive Economic Zone (EEZ) in the late 1970s when many resource adjacent countries developed national fishing fleets. Fishing pressure has increased in many parts of the world, and resulted in declining biomass and the 'post-modernization bust' experienced today. One of major consequences of this large increase in fishing power is the 'fishing down the food web' phenomenon, where top predators are fished out of the ocean, replaced by animals lower down on the food chain, with a decrease in total catch and productivity (Pauly *et al*., 1998). This and other evidence of the ecosystem impacts of fishing such as bycatch issues and discarding (Alverson *et al*., 1994), habitat damage (Watling and Norse, 1998), and overall ecological impacts (Jennings and Kaiser, 1998, Hall, 1999, ICES, 2000, Chuenpagdee *et al*., 2003), support the need for alternative management frameworks, particularly ecosystem-based fisheries management.

Traditionally, fisheries research has focused on the biological and ecological aspects of fisheries, providing information for fisheries management. For decades, fisheries have been assessed and managed on a single-species basis, using models such as the logistic growth model (Schaefer, 1957) and the dynamic pool model (Beverton and Holt, 1957), aiming mainly to achieve maximum sustainable yield (MSY) and optimum allocation of fishing effort. Recently, there has been an increasing interest in applying other approaches such as multispecies and ecosystem-based models (e.g., Pikitch *et al*., 2004, Sainsbury *et al*., 2004, ICES 2000, Walters and Bonfil 1999, among others), and incorporating environmental effects into fisheries models (see Bundy *et al*., 2005a). Increasingly, food web interactions and trophic mass balance models, such as Ecopath with Ecosim, EwE[1], are employed to enhance our understanding of fisheries ecosystems and their dynamics. Despite advanced knowledge, assessment ability and management capacity, many fisheries stocks have collapsed and overfishing has occurred worldwide (Pauly *et al*., 1998; Jackson *et al*., 2001; Myers and Worm, 2003).

Parallel to this "classic" approach to fisheries science, social science research explores the human dimensions of fisheries. Natural resource economics has contributed to fisheries analysis since the 1950s (Gordon 1953) and many fisheries economics models have been developed to assist managers in their decisions on resource use policies and regulations (see Liu *et al*., 2005). The advancement in this discipline has placed issues related to allocation, subsidies, optimal capacity, game theory and property rights as part of the common discourse in fisheries, extending from an examination of economics behind overcapacity (Clark, 1973, Clark *et al*., 2004, Ero, 2004) to intergenerational discounting method to incorporate future generations in management considerations (Sumaila and Walters, 2005). Similarly, many anthropological and social studies have provided insightful information and understanding of the social and cultural aspects of fishers, fishing communities and their relationship to fisheries resources and ecosystems (Berkes, 2004, Olsson and Folk, 2004, Davis, 1991). Concerns regarding fishers' involvement in management are particularly noted and have resulted in extensive research on fisheries co-management and community-based management (see for example, Berkes, 1994, Jentoft and McCay, 1995, Sen and Nielson, 1996). Research on local ecological knowledge has also increased during the past few years (Ruddle, 1993, Neis and Felt, 2000, Davis and Wagner, 2003, Haggan *et al*., 2003, Castilla and Defeo 2001) and has the potential to improve fisheries science and management.

Efforts to address world fisheries problems occur at national and international arena. In March 1995, FAO convened a ministerial conference on fisheries and issued 'The Rome Consensus on World Fisheries,' which was adopted by 63 ministries attending the meeting. The document called for actions to eliminate overfishing, rebuild fish stocks, minimise wasteful fishing practices, develop sustainable aquaculture, rehabilitate fish habitats, and develop fisheries for new and alternate species based on principles of scientific sustainability and responsible management[2]. The concerns raised in the document were addressed in the FAO Code of Conduct for Responsible Fisheries, which has now been widely implemented. An international meeting in Reykjavik in October 2001 resulted in the 'Declaration on Responsible Fisheries in the Marine Ecosystem', which, among other things, put a great emphasis on ecosystem considerations in fisheries management[3]. National responses vary, as the difficulties in addressing these issues, such as the reduction of overcapacity and the application of ecosystem-based management to fisheries, are acknowledged by scientists and managers. More recent discussion concerns the promotion of ecosystem-based management for fisheries, and is supported by organizations such as the Pew Ocean Commission (2003) and World Wildlife Fund (Ward *et al*., 2002), scientific communities (Pikitch *et al*., 2004) and governmental and intergovernmental bodies (e.g., National Research Council 1999, ICES 2000). In Canada, Europe and Australia, ecosystem approaches to fisheries management are also being pursued, although it is unclear whether people are considered as part of the ecosystem. In developing countries, like in Southeast Asian region, the discussion has been initiated, particularly in relation to the realisation of the FAO Code of Conduct (SEAFDEC, 2003).

In addition to addressing ecosystem concerns in fisheries, other global initiatives have been implemented to address issues such as social justice, livelihood and employment, and food security. For instance, principles stated in the United Nations Convention of the Sea (UNCLOS) and the Universal Declaration of Human Rights aim to address social justice for nations' rights over oceans and their resources and for human rights respectively. Also noteworthy is the sustainable livelihood approach (SLA), which integrates

[1] www.ecopath.org
[2] www.fao.org/DOCREP/006/AC441E/AC441E00.HTM
[3] ftp://ftp.fao.org/fi/DOCUMENT/reykjavik/y2198t00_dec.pdf

natural social, physical, financial and human components in the formulation of policy, institutions and processes, based on sustainability concept and within the context of vulnerability, poverty and livelihood assets[4]. Governance approaches to fisheries have also been recently discussed as a possible path to solution, such as those prescribed by Kooiman *et al.* (2005), which aims at addressing the diversity, complexity and dynamics of both fisheries and human systems through interactions between all stakeholders.

The current situation in the world fisheries is generally well recognised. Our knowledge about fisheries, ecosystems and human dimensions, acquired through a wide range of disciplinary and interdisciplinary research, continues to increase. Efforts to address the problems are initiated and implemented at all levels of governments and by various institutions. The evaluation of current research, as performed and presented in this paper, is a useful way to gauge the progress made in addressing global fisheries problems.

METHOD

Assessing fisheries research at the 4WFC

The World Fisheries Congress takes place every four years and each congress theme addresses the pressing issues in fisheries at that time. The first WFC, held in Athens, Greece, in 1992, focused on "*The State of the World's Fisheries Resources*". Australia hosted the second meeting in Brisbane in 1996 with "*Developing and Sustaining World Fisheries Resources: the State of Science and Management*" as the theme. In 2000, the third congress was held in Beijing, China, to address the issue of '*Feeding the World with Fish in the Next Millennium – the Balance between Production and Environment*'. The theme of the fourth WFC was '*Reconciling Fisheries with Conservation*'. The succession of congress themes essentially suggests that, since its inception in 1992, the WFC has been concerned with the sustainability of the world fisheries resources, and have facilitated broad discussion among scientists and managers to address their various aspects. As such, the forum offers an opportunity for exchange and discussion about current research and for presentation of innovative ideas in fisheries science for promoting fisheries and ecosystem sustainability.

Four main questions posed within the theme 'Reconciling Fisheries with Conservation' at the 4WFC were: (1) What should we care about when attempting to reconcile fisheries with conservation? (2) Who owns the fish and what are they worth to society? (3) Can we get more fish or benefits from fishing while reconciling fisheries with conservation? and (4) How can we manage aquatic ecosystems to achieve the reconciliation of fisheries with conservation?

The 4WFC was organised into plenary presentations with seven keynote speakers, 39 sessions with over 200 paper presentations, evening roundtable discussions, a stakeholder forum, a special session on seafood choices movement, and poster sessions, which included about 700 poster presentations. Given that the congress takes place every four years, it is considered one of the most important gatherings of people interested in fisheries, and thus offers an excellent 'research' opportunity to assess the progress made in fisheries research and management. It is under this premise that we embarked on the exercise to systematically evaluate the contributions of current research, management and policies in reconciling fisheries with conservation, as presented at the 4WFC.

The exercise was conducted as part of the 'Innovation and Outlook in Fisheries' workshop organised by *AQUALINK*[5]. *AQUALINK* is a network of international, interdisciplinary, early to mid-career researchers and graduate students who share interests and concerns about aquatic ecosystems and sustainable fisheries and livelihoods. The workshop was designed to assess the extent to which existing tools, approaches, methods and concepts used in fisheries science and management address the current and emerging challenges of understanding and managing aquatic ecosystems, and whether they would lead to reconciling fisheries with conservation. The underlying goal of the workshop was to document innovation in research that is likely to contribute to positive outlook for fisheries of the world.

[4] www.livelihoods.org
[5] http://fisheries.ubc.ca/aqualink/index.htm

An 'evaluation template' (Appendix 1) was developed by members of *AQUALINK*. The template contained three main sections on general information, context and detail, and summary. Each section consisted of various types of questions, such as multiple-choice, open-ended and rating. In the first section, information about the fisheries and the system was recorded, including study location, type of ecosystem, fishery and habitats, species level, time period, geographic scale, as well as objectives of the study and the method(s) employed. In the second section, details about the paper were captured under five topics, i.e., natural systems, social, economics, approaches and tools, and management and policy. Special features of each paper were noted in the last section in relation to their objectives, methods, results, education component and dissemination. This section also contained an evaluation of each paper in term of its overall 'impacts' on the future of fisheries and their contributions to reconciling fisheries with conservation. This evaluation was based on the following criteria: inclusion of explicit policy recommendations, interdisciplinarity, implication for sustainability, potential for reconciling fisheries with conservation, and contribution to the future of fisheries. The impact scores were aggregated and normalised to 100.

The evaluation exercise was conducted by 17 *AQUALINK* members and 15 other students and researchers who registered to participate. All papers presented at the plenary, concurrent, and special sessions were evaluated by 1-3 evaluators, who at the end of each session went through their notes, discussed the papers and recorded their consensual agreement about each paper. This process was particularly important for the 'rating' of the papers in terms of their overall impacts and contributions, considering the diverse disciplinary background and the different levels of experience (e.g., graduate students, post-doctoral fellows, early-career researchers) of the evaluators.

The data from the templates were transferred to a database, and quantitative and qualitative analyses of the data were performed. Preliminary results were summarised by *AQUALINK* members, and presented on the day after the Congress (May 7, 2004) to 45 workshop participants, including a few who did not take part in the evaluation exercise and a group of ten international invited 'experts' from a range of disciplines (see list of participants in Appendix 2). These experts were asked to respond to the summary presented, and to suggest aspects of research and initiatives critical for reconciling fisheries with conservation (see Ainsworth and Dingerson, 2005). Workshop participants also worked in small discussion groups in the afternoon to identify key issues leading to fisheries problems and propose innovative solutions (see summary in Bundy *et al.*, 2005b).

RESULTS

Geographic distribution and coverage of current fisheries research

About half of the research presented in the 223 papers was conducted in developed countries (Figure 1), about 59% of these studies were located in North America, 22% in Europe and the rest in developed countries in other areas. Of the 17% of the research conducted in developing countries, around 45% of the studies were in Latin America and Caribbean and Asia, with the rest in Africa. Only 7% of the total 223 papers were global in nature, and the other 25% were not specific to any geographical area.

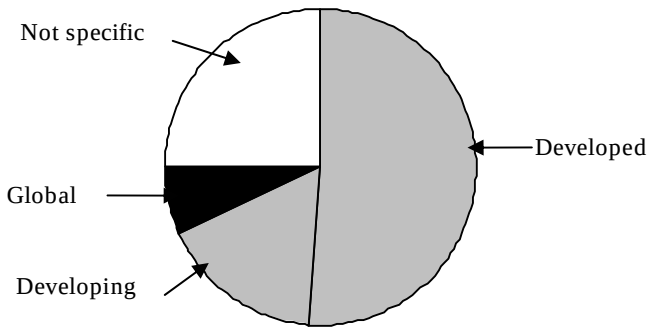

Figure 1. Geographical coverage of the papers categorised based on level of development.

Four aspects of research, i.e., natural systems, social, economic, and policy and management were used to categorise the focus of the papers. About 44% of the papers had a single focus, while 35% focused on two aspects, 13% on three, and 8% (or 18 out of 223) on all four. Of the papers with a single focus, 64 of them were related to natural systems, 23 to policy, 9 to economics and only one paper dealt solely with social aspects (Table 1). There were more papers addressing the combination of natural system and policy aspects (43 papers) than in other combinations. Social issues were frequently addressed in conjunction with policy. Overall, economics had the poorest coverage among all four aspects (Table 1).

Table 1 Distribution of papers based on their focus

	NS	Policy	Social	Economics
Natural systems (NS)	64	-	-	-
Policy	43	23	-	-
Social	6	19	1	-
Economics	6	3	2	9

	NS	Policy	NS/Policy
Policy/Social	21	-	-
Policy/Economics	3	-	-
Social/Economics	3	2	18

Countries were categorised into developed and developing based on UNEP 'Human Development Index', which measures a country's status in terms of life expectancy, educational attainment of its citisen and adjusted real income (UNEP, 2000). The distribution of research topics varied between developing, developed and global locations (Figure 2). In developed and developing countries, more papers focused on natural systems than the other topics, whereas for papers addressing global fisheries, natural systems and policy issues were equally covered. Economic aspects received similar coverage to social aspects in the global studies, while in developed and developing countries, social issues were addressed more frequently than economics.

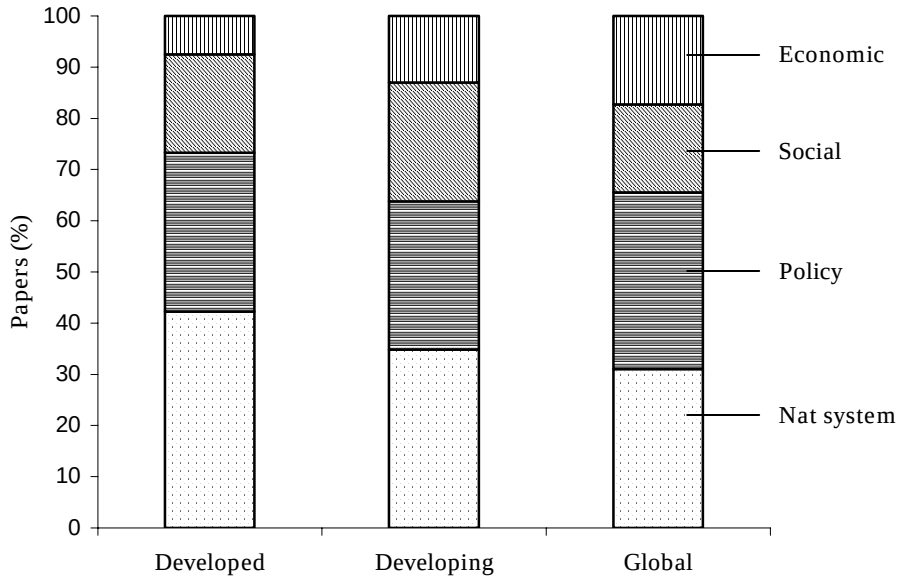

Figure 2 Distribution of papers (%) by research aspects by location.

Overall, 192 papers addressed marine and brackish systems and 85 addressed freshwater systems. Of all the marine and brackish papers, 33% were related to coastal systems, 14% to continental shelf systems and 11% to estuarine systems. The remainder was split at 8% each for coral reefs, deep sea and ocean, while about 2% each were concerned with enclosed and polar seas. The freshwater systems that were well covered in the papers were rivers and watersheds; lakes and streams were less well covered. Almost half of the papers dealt with industrial fisheries, followed by small-scale fisheries (about 32%), and recreational fisheries (16%). The other 17% of the papers were divided evenly into subsistence and aboriginal fisheries. Figure 3 shows the distribution of the papers by type of fisheries and research location. Small-scale fisheries were the only fisheries covered mostly in developing countries (not shown). Studies about other fisheries were conducted more in developed countries than in developing countries. Interestingly, at the global level, small-scale fisheries and industrial fisheries were equally addressed.

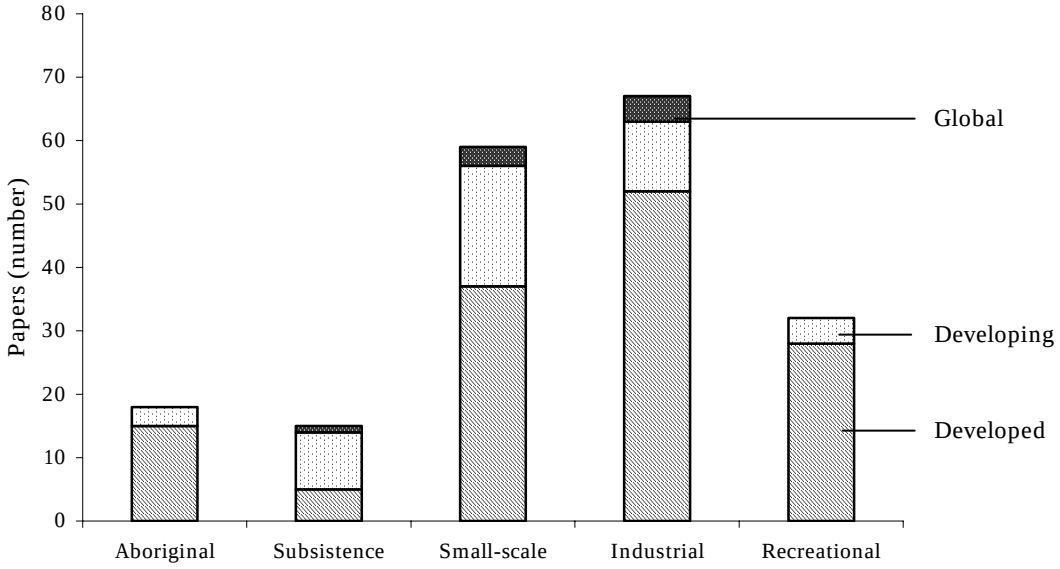

Figure 3 Distribution of papers (number) by fisheries type and location

In a period where multi-species approaches and ecosystem management are gaining importance, it is worth examining whether this is reflected in the papers presented at the 4WFC. The results are encouraging: 35% of papers used single-species approaches, 35% multi-species approaches and 24% took an ecosystem approach to fisheries. While it is not surprising that the majority of the papers dealt with present time period, it is interesting to see that 36% looked at past history and 18% at the future. The analysis also showed that 38% of the papers were related to local fisheries issues, 23% to national, 25% to international, and 15% to global fisheries issues.

Overall importance and contributions to future of fisheries

The aim of Section 3 of the evaluation template was to assess the likely impacts of the papers in reconciling fisheries with conservation and in contributing towards a positive future for fisheries, based on several criteria (Appendix 1). First, it was considered important that papers should have explicit policy recommendations or implications, particularly with respect to sustainable fisheries. Further, to acknowledge the interactions and dynamics between natural, social, and economic systems, papers attempting to integrate these various aspects were considered highly likely to contribute to addressing current fisheries problems. We also considered dissemination of research results an important criterion for paper impact; thus any effort to communicate results to the general public and indications of success were noted.

Starting with the papers' contributions to education, the analysis showed that an overwhelming number of papers did not make any special effort to communicate the research results to general public. However, the evaluators considered that about 65% of the topics addressed in the paper should be included in an

undergraduate curriculum for fisheries and marine conservation. Further, about 82% of the research topics were considered worthy of support and should be promoted for future development.
Table 2 summarises the evaluation of the papers based on the criteria indicated above. The majority of the papers provided explicit policy recommendations and implications, had implications for sustainable fisheries and would potentially contribute to reconciling fisheries with conservation. However, the evaluators considered only 44% of the papers to be actively integrating natural, social or economic aspects.

Table 2 Distribution of papers (%) based on impact criteria.

Criteria	Yes	No	Not clear
Explicit policy recommendation/implication	65	35	0
Integrated consideration (natural, social and economics)	44	42	14
Implications for sustainable fisheries	85	15	0
Contributions to reconciling fisheries with conservation	75	11	14

Another criterion used to evaluate the papers was the importance of the paper for future of fisheries. Only about 15% of the papers were considered to be of a very high importance, while about 5% of the papers were considered to be of low importance. Based on all five criteria, impact scores were aggregated and normalised to obtain an overall impact. Only 17% of the papers were considered to have high overall impact (normalised score of greater than 80), and another 15% were of low impact (normalised score of less than 40). The majority of the papers (about 70%) had medium to medium-high impact (Table 3). The high impact research was conducted globally, in developed countries (31%) in developing countries (16%) and in global studies (16%), while the rest was in unspecified region. Further, these papers were of integrated nature and dealt equally with small-scale and industrial fisheries, although they were related more to natural system principles, such as precautionary, ecosystem-based and adaptive management, than social principles, such as transparency, accountability, inclusiveness and equity.

Table 3 Overall impact of papers for reconciling fisheries with conservation.

Overall impact	%
Low	15
Medium	22
Medium-High	46
High	17

DISCUSSION AND CONCLUSIONS

Since the WFC is the largest gathering of fisheries scientists and researchers, we considered it an appropriate venue to conduct the analysis of the approaches and methods currently employed to address global concerns in fisheries. The assessment framework used for the analysis provided an opportunity for a summary of a broad overview of research focus, as well as in-depth discussion (see other contributions in this volume). More importantly, it offered a good starting point for the discussion about the types of research needed to reconcile fisheries with conservation, as well as to fulfill other management goals.

Our analysis revealed that at least half of the research presented at the 4WFC was conducted in developed countries and the majority of the papers were related to natural systems. The former could be because the meeting took place in North America, which made it prohibitively expensive for many people from developing countries to attend. The latter could be due to the congress theme, 'conservation', which suggested an emphasis on natural systems. We found two encouraging trends, i.e., the high percentage of the papers on multi-species and ecosystem, and the substantial consideration of policy aspects in the discussion about the natural systems. The fact that a small number of papers focused solely on economics

(9 out of 223) and only one paper, a traditional ethnographic study, directly addressed people and society, suggests that participation by economists and social scientists was low at the congress. This could be the result, however, of the existence of other more specialised international fisheries conferences such as the International Institute of Fisheries, Economics and Trade and 'People and the Sea' conference series held at the University of Amsterdam, and mainly attended by social scientists and anthropologists. Addressing multiple issues related to fisheries from various disciplines serves to enhance our understanding of the interconnectivity between natural and human systems and the consequence on resource uses and conservation (Liguori *et al*., 2005).

The majority of papers included explicit policy recommendations and management implications for sustainable fisheries (see Table 2). This finding indicates an important step towards the formulation and implementation of effective fisheries policies despite the wide range of issues that need careful examination (Dingerson *et al*., 2005). Various tools and approaches are currently available and used in reconciling fisheries and conservation and in promoting fisheries management goals such as marine protected areas, habitat improvement and sustainable aquaculture (see Cheung *et al*., 2005). However, the success and effectiveness of these tools and approaches requires further examination.

Although the emphasis of the 4WFC was on research and management, two special sessions on the roles and involvement of the general public and other stakeholders and fish and seafood consumers brought different perspectives to the discussion (Turnipseed and Liguori, 2005). As shown in our analysis, social issues such as quality of life, justice and food security were hardly addressed in the research presented. More effort is required to disseminate information to the general public and to encourage their participation in the discussion about fisheries and conservation.

This evaluation of the overall impact of current research on reconciling fisheries with conservation suggests that the majority of the research has a significant contribution. However, on the whole, this research dealt largely with issues related to natural systems. We therefore conclude that for fisheries research to contribute to the balance between conservation and use, the following characteristics are necessary: integration of social and economic considerations and principles in research and discussion about policy and an innovation in the communication of research results to the general public.

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AN ANALYSIS OF HOW NATURAL SCIENCES ARE ADDRESSING FISHERIES WITHIN THE CONTEXT OF CONSERVATION

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ABSTRACT

We evaluated 164 papers presented at the Fourth World Fisheries Congress, which addressed various aspects of natural systems and their contribution to reconciling fisheries with conservation. These aspects included data analysis and methodological approaches, ecosystem modeling, ecosystem indicators, ecosystem properties, biodiversity, species at risk and anthropogenic impacts to aquatic ecosystems. Ecosystem approaches to fisheries management were addressed by many papers. Of the ecosystem modeling papers, over 50% used Ecopath with Ecosim. However, among all these papers there was a consensus that ecosystem-based fisheries management requires a multiplicity of methods including single species, multispecies and ecosystem approaches. Alternative non-market accounting is also an essential component of ecosystem-based fisheries management as the alteration of food web structure can lead to ecosystem shifts and alternative states. Methods to resolve conflicting objectives include multi-criterion analysis, a suite of quantitative and qualitative methods for environmental risk assessment, and the Management Strategy Evaluation method. Important to all of these approaches are transparency in process, explicit objectives, and wide stakeholder involvement. The high quality and innovative in the research presented suggests that when it comes to reconciling fisheries with conservation science is not the constraint. However, scientists and managers do need to include stakeholders in data collection and interpretation as well as decision-making. Equally critical to the success of scientific approaches to fisheries is communication and outreach: 51% of the natural systems papers indicated the success of the research, but only 9% made an attempt to communicate their results to the general public.

INTRODUCTION

Out of the 223 papers evaluated at the 4th World Fisheries Congress (4WFC), 164 papers addressed various aspects of natural systems. As might be expected from a world congress, many papers highlighted exceptional scientific research. Yet, their unifying message was that ample scientific expertise exists to address the meeting's main theme of reconciling fisheries with conservation. Although further advances can always be made, science is not the issue – we have plenty of it. The global loss of fish catch and biomass throughout the last century, Pauly (2004) reveals a sad picture and a worrisome future. It clearly demonstrates the serious consequences of maintaining the status quo in fisheries management and the need for a radical shift in the way that fisheries and oceans are managed globally.

We evaluated the 164 natural systems papers on the basis of their contribution to: data and methodological approaches, ecosystem modeling, ecosystem indicators, ecosystem properties, biodiversity, species at risk and anthropogenic impacts of aquatic ecosystems. Few papers dealt with any one issue alone, underlining the fact that fisheries issues are being approached from a variety of perspectives.

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DATA AND METHODOLOGICAL APPROACHES

Bayesian approaches to data analysis and global databases

Issues regarding data, stock assessment and ecosystem modeling were the key focus of fifty five papers. Sufficiency of data is always a concern in fisheries science and several papers focused on this. Specifically, they advocated better analysis of data sets with missing values and the compilation of different types of data to elucidate important trends. McAllister *et al.* (2004) considered the impact of missing data on parameter precision. They took a Bayesian approach to deal with missing data by estimating their probability distribution. Traditional methods for data filling may result in biases and do not give estimates of uncertainty, whereas Bayesian data imputation estimates are more precise, non-deterministic and can help avoid mis-estimation of stock status.

Chuenpagdee and Pauly (2004) created a global database of small-scale fisheries in order to analyze and compile major similarities and features of small-scale fisheries. This kind of database did not exist previously and provides the means to compare ecosystem impacts by small-scale fisheries on a global scale with large-scale fisheries. The database includes data from FAO country profiles, field data from regional and national sources, and values extrapolated for missing data. The results imply a major shift in the way we think about and manage small-scale fisheries: we must recreate the mental map and move small-scale fishers from the margins of policy to the center.

Tyedmers *et al.* (2004) also took a global look at fisheries, in this case from an energy perspective and estimated the global use of fuel by the fishing industry using a meta-analysis approach and the UBC Fisheries Centre “Sea Around Us” project database. They evaluated changes in energy performance of fisheries on a global scale using time series from 1970s to 2000 for over 250 fisheries. The use of fossils fuels has continued to rise in the face of stagnating catches, and can exceed the energetic value of the fish produces. The authors argue for a new approach to overcapacity in fisheries using fuel quotas.

Integrating stakeholders in data collection and interpretation

The need for stakeholder involvement was underlined in a conventional approach to stock assessment. Plaganyi *et al.* (2004) evaluated the effectiveness of classic assessment in the management of a resource in view of different stakeholders’ needs. They used the inconsistency between prediction from spatial age structure population dynamic model and observed trends to estimate the magnitude of poaching. They concluded that more stakeholder consultation and gradual changes in policy would be more effective at conserving resources then simply trying to strength fishery policy. Schweigert and Fu (2004) consulted with stakeholders to develop performance indicators for risk analyses that used a catch age stock reconstruction model in a Bayesian framework, modeling alternative recruitment functions identified during hot and cold climatic regimes. These authors hoped to overcome the challenges outlined in the previous study.

To develop alternative ways to collect data, Ianelli *et al.* (2004) focused on industry cooperation in data collection, with an opportunistic acoustic data collection program (low cost, high coverage). An added benefit was that the cooperation program built better relationships between scientists, managers, and community. McConney *et al.* (2004) also looked outside the standard scientific data collection routine to add information for management decisions. In order to turn data into information for decision making, a "people-centred approach" was used, which included participatory planning, ethnography, folk taxonomies, and all types of experts. Neiss *et al.* (2004) used conventional fisheries science approaches (to a macro level) and filled spatial and temporal gaps using local ecological knowledge (to a micro level) from archival records, oral histories, landing data, and log-book data. They explored long-term trends in spatial and temporal distribution of commercial species and ways that societal changes interact with environmental changes off the Newfoundland-Labrador coast.

Incorporating environmental data

Incorporating climactic regime data was a feature in 18 papers that dealt with data, stock assessment and ecosystem modeling. Several authors, including Schweigert and Fu (2004), incorporated environmental data into stock assessment and other predictive models in order to account for the effects of the environment on predictions. Peterman *et al.* (2004) used a Bayesian framework to improve estimates of stock recruitment parameters. They successfully used a multi-stock, spatial hierarchical Bayesian method to improve a stock recruitment model by incorporating environmental factors. Wise *et al* (2004) examined the relative influence of environmental factors and fishing effort related factors in modelling fish presence and abundance, based on General Linear Model and General Additive Model regression techniques. To develop more realistic and conservation based approaches to fisheries management, Rose (2004) explored the effect of climate variation on fish productivity in the Northwest Atlantic, tuning model parameters to period-specific situations (productivities) using past climate variability. He concluded that it is difficult to manage fish when you don't know what the productivity state is or how it affects growth, recruitment, mortality or distribution. Climate change cannot be ignored; we need to learn how to deal with ecosystem changes resulting from natural forcing functions.

Meta analyses

There has been interest in large-scale studies and meta analyses of fisheries data in recent years. In their large scale study of global fisheries, Kaschner *et al.* (2004) made several interesting points about the benefits and limitations of large-scale studies, based on the experiences of graduate students who work on models with a range of spatial and temporal scales around the world. They suggested that we need to deal with different scales in order to get ecosystem management right. Interestingly they noted that there are very few statistical approaches available to deal with uncertainty in large-scale models. They advised trying a range of model parameters and that model complexity need not increase in proportion to geographic scale. In another large scale study, Steel *et al.* (2004) emphasised the power of large-scale landscape analysis for understanding and managing freshwater ecosystems. In particular they wanted to detect linkages between geology, climate, land-use and indices of fish population performance in freshwater systems, in order to provide better management decisions. For example, in the Pacific Northwest, they identified associations between landscape conditions and salmonid spawner abundance in many watersheds that can explain up to 72% of the spatial variation in the year to year distribution of salmonids.

ECOSYSTEM APPROACHES TO FISHERIES MANAGEMENT

Ecosystem modelling and fisheries management

In recent years there has been a large increase in awareness and interest in ecosystem approaches to fisheries management. One methodological approach supporting this endeavor is ecosystem modeling, and 18 out of the 164 natural system papers evaluated employed this tool. Ecosystem models have been applied to a wide variety of ecosystems (there are around 20 primary publications per year on ecosystem models), and there is now a need to focus on testing these various modeling approaches (Christensen 2004). Although they have been advocated for long-term (strategic) management, ecosystem models are not currently used much in management because we have little experience applying them (but see Aydin and Livingston, 2004). However, ecosystem modelling is a very active field and progress is being made. Christensen (2004) called for institutional change which would incorporate ecosystem models and ecosystem experimentation. Furthermore, he suggested that managers need to consider the interaction between fisheries and climate in future models, use single species assessments to provide data for ecosystem models, and consider why primary production anomalies seem to be amplified up food webs, rather than dampened.

Of the ecosystem modelling papers, over 50% used Ecopath with Ecosim (EwE)[1], the ecosystem simulation package developed by Carl Walters, Villy Christensen and Daniel Pauly at the UBC Fisheries Centre. EwE has been widely used, and the interest lies now in the rigor of its predictions, its application abilities and the lessons that can be learned from it.

One interesting approach is to model the ecosystem of a previous time in order to inform future management decisions. Three papers focused on the idea of ecosystem restoration, using EwE, two of which used cost-benefit analyses in the development of restoration strategies for ecosystems and fish populations. In his introductory paper to the session "RFC and lessons from history", Pitcher (2004) explored his "Back to the Future" model (Pitcher *et. al.*, 1998b), which uses ecological, economic and social criteria to explore optimal policy goals, given exploratory modeling of earlier systems. The modeling of earlier systems is based on biological data, literature review, archaeological evidence, and qualitative approaches such as local ecological knowledge and workshop environments. Ainsworth and Pitcher (2004) also explored this approach with an application to northern British Columbia, Canada using Ecospace (Walters et. al., 1999). They first identified recovery targets by modeled four discrete time periods (c. 1750, 1900, 1950 and 2000) and then used a new spatial optimization routine to explore optimal fleet configuration under a range of policy options that trade off conservation and exploitation. The authors suggested that this is a way to incorporate "realism" into restoring or rebuilding ecosystem where realism is defined as the social/economic factors that are inherent to establishing viable management goals. The proposed analysis examined the total benefits and costs that could derive from each historical ecosystem, along with the costs associated with restoration efforts and sustainable fisheries. This ecosystem-based set of tools so far suggests that acceptable options at this time include only modest (realistic) economic and social goals to allow for ecosystem restoration in the future and improved benefits in the long term. However, their results suggest that restoration can be made cost effective.

Several papers explored the impact of fishing on foodweb dynamics using EwE. In a paper that has potential to have far reaching benefits to reconciling fisheries with conservation, Gaichas *et al.* (2004) took a comparative approach to explore the impact of fisheries on different foodweb structures. They classified three ecosystems as scale free or randomly connected neural networks. In scale free networks, there are a few highly connected nodes, while most nodes have few connections. Therefore, the selective removal of species (or nodes) by fisheries could have a large impact on scale free systems, if highly connected nodes are removed. The authors concluded that we should focus on protecting highly connected species to avoid structural impacts of fishing on the food web, and that food web dynamics are important to consider for sustainable fisheries management. Link (2002) also explored the idea of connectivity in foodwebs who showed that the Georges Bank ecosystem is loosely connected and that fisheries are unlikely to have serious trophic impacts.

The importance of accounting for food web dynamics and natural mortality in fisheries management was emphasised by Zetina-Rejon *et al.* (2004) and Powers *et al.* (2004) who highlighted the need to consider the role of upper predators while managing lower trophic level fisheries. At the same time, Ramor *et al.* (2004) asked that we consider the functional value, market value and ecological value of non-target lower trophic level benthic species that form the basis of marine food webs that support upper trophic level commercially fished species. This kind of accounting is an essential component to ecosystem-based management as the alteration of food web structure can lead to ecosystem shifts and alternative stable states.

Fulton *et al.* (2004) described the success of multisector management on the Northwest Continental Shelf of Australia, including implementation of successive generations of ecosystem models. There are many, potentially conflicting uses of this area that require reconciliation. The authors applied management strategy evaluation (MSE), a technique that uses computer simulations to evaluation management options given various uncertainties in the fisheries system to resolve conflicting objectives (see section "Putting it all together using multi-criteria analysis, management strategy evaluation, and RAPFISH" below). The MSE and the models on which it is based have evolved through time and it is currently being used to manage the entire regional ecosystem of the Northwest Shelf, including transport by boats, pipelines and human impact in addition to fisheries. It considers multiple users of ecosystem and includes wide

[1] www.ecopath.org

consultation with stakeholders. The model is spatially explicit, based on a bio-physical simulation model, which uses a combination of classic dynamic and individual-based models. In addition it takes into account links between ecosystem function and the cumulative impacts of human activities. It summarises pressures on the ecosystem, and tries to reach compromise with resource users. This could be a role model for future ecosystem based management.

A scientific framework for providing ecosystem-based advice is also being developed for the Gulf of Alaska (Aydin and Livingston, 2004). The framework assesses the impacts of fisheries on target and non-target species and ecosystem factors impacting target and non-target species. It includes a suite of modeling approaches (single species models with bycatch, MSVPA, EwE and statistical models). The authors noted that there is growing pressure to develop fisheries ecosystem plans to provide some advice and warnings, though the value of such ecosystem plans for management depends on the time-scale under consideration. Single species approaches are appropriate for short time scales while longer time scales require ecosystem models to guide and evaluate management options. Aydin and Livingston (2004) pointed out that 1) relative results are more useful than absolute results, 2) ideal points don't exist and 3) management strategies should not be changed every year. The main challenges in this type of work are: how to specify and deal with model assumptions; how to include influences of climate and correlations with natural resource dynamics and how can we reach and maintain a desired ecosystem state?

Pikitch (2004) suggested that lots of data are not necessary for ecosystem based fisheries management. This author reviewed Bayesian decision analysis and alternative ecosystem-based fishery management (EBFM) as frameworks for maintaining the health of an ecosystem and incorporating alternative values of fish, which do not have large data requirements.

Ecosystem Indicators and Fisheries Management

Cury (2004) made the point that “you can't manage what you can't measure". In order for Ecosystem Approaches to Fisheries Management (EAF) or Ecosystem-Based Management (EBM) to be feasible, we need indicators with which to measure the success of that management. Cury (2004) proposed ecosystem indicators as a means of achieving the management objectives that will reconcile fisheries and conservation, and presented the results from an International Council for the Exploration of the Seas (ICES) working group addressing “Quantitative Ecosystem Indicators for Fisheries Management” and an ICES conference of the same name[2]. The development of ecosystem indicators is critical and there are a wide range of potential ecosystem indicators, including environmental, species-based, size-based, and tropho-dynamic indicators. Key to the success of a good indicator is that it can be translated into decision criteria. He concluded that a suite of indicators must be used to identify trends in fisheries affects. Forty six papers, including two keynote speakers (Pauly, 2004 and Sainsbury, 2004) proposed ecosystem indicators as a means to improve fisheries management. There is no shortage of proposed ecosystem indicators. Of these 46 papers, 29 described indicators for marine systems, eleven for freshwater systems and two included both marine and freshwater systems

Environmental indicators

Six papers focused on environmental indicators and the influence of the environment on ecosystems. Sharp *et al.* (2004) attempted to show how we can move from the usual hindcast methods for fisheries management (crisis-driven) to a more proactive process (forecasting). They made the point that stationary systems cannot be assumed and that we have to manage for change. Thus, equilibrium conceptual approaches cannot provide necessary insights. Environmental indicators included temperature, wind, rotation of Earth, and various periodic indices. They proposed to use a series of environmental indicators (decadal and regime shifts) to predict the effect of the environment on fisheries in the future. Barange *et al.* (2004) reviewed the use of environmental indicators in fisheries management. They pointed out that the usefulness of an environmental indicator depends on their explanatory power, their predictability and the time frame over which predictions can be made.

[2] www.ecosystemindicators.org

Species and other proxies used as indicators of ecosystem health

Molls and Nemtiz (2004) used Atlantic Salmon to indicate whether and how the Rhine River is improving from an ecological standpoint. The Atlantic salmon is a good indicator because different phases of its life cycle are dependent on different aspects of the river ecosystem, for example, spawning beds; nursery habitats, fish passages in the river and delta, and water quality. In a comparison of estuaries in south-eastern Africa and south-western Australia, Beckley *et al.* (2004) used catch per unit of estuarine dependent fish as a measure of estuarine health. They reasoned that fish abundance can be an indicator of estuarine health because their life cycle is completed within the estuary.

Physical characteristics have also been used as ecosystem indicators. In an historical study, Selbie *et al.* (2004) used palaeolimnological proxies (diatoms, stable Nitrogen isotopes, and zooplankton) from sediment core analysis to infer long-term sockeye salmon population dynamics. Sullivan *et al.* (2004) studied associations between geomorphic conditions and characteristics of fish communities and fish abundance, and found that geomorphic conditions could be used as an indicator for species richness and diversity in streams.

Challenges to identify and implement ecosystem indicators

Despite the various examples described above, using ecosystem indicators for fisheries management is not a straightforward task. Ecosystem indicators are only useful if they actually can measure what they propose to measure. Only seven papers discussed the performance or effectiveness of the indicator(s) used. Two papers used modeling to test indicators, while four papers used a comparative approach. For example, Rose (2004) compared results with and without the influence of decadal variation and with historical data. Piet and Jennings (2004) tested the response of a set of indicators (measuring size structure, species composition and life history traits) to different fishing methods in the North Sea. They studied the trend of the indicators rather than the absolute value and found that there was no straight forward response of the indicators to management and that they were not suitable for short-term management purposes. One problem was that recruitment variability causes indicator variation. Fulton *et al* (2004) found that simple indicators worked better than more complex indicators. Paramor *et al.* (2004) studied historical trends in benthic communities in the North Sea in order to explore their functional role in the ecosystem but concluded that attempting to translate theory into management plans was problematic. The testing and validation of ecosystem indicators is an important area for further research. Sainsbury (2004) pointed out that indicators need to be linked to high level operational objectives, and recommended the use of feedback loop simulation modeling to test the robustness of different policies and indicators.

Several papers considered the use of a suite of indicators and their integration into operation objectives. In his paper "Top 10 ingredients for implementing ecosystem-based fisheries management", Link (2004) discussed ways to practically incorporate ecosystem indicators into fisheries management. The ten factors that he proposed were: admit the problem, include more stakeholders, set flexible goals, use single species approaches more wisely, broaden our tools, establish long-term plans, establish equitable allocation process, implement and enforce precaution, more formalised performance measures, and monitoring and ground-truthing. Issac *et al.* (2004) reported on attempts to build a new management model for fisheries in Brazil which include gleaners, artisanal and industrial fisheries, operating at different scales with different magnitudes of impacts on ecosystem dynamics. Their approach was first to identify the degree of current sustainability, or lack there of, for each fishery along a gradient of sustainability. They classified fisheries based on 15 ecological and socioeconomic indicators using MDS ordination and canonical correlation analysis, ranking the 15 indicators for each fishery and estimating their sustainability. This approach is similar to the work of Link *et al.* (2002).

Sainsbury (2004) stressed that EBM requires a major change in philosophy. Such changes include the need to engage stakeholders into the management process, and the use of adaptive management, holistic approaches and ecosystem indicators. Despite this growing recognition that fisheries management will be more successful if stakeholders are more fully engaged in the evaluation and decision making process, of the 19 papers that gave information on who was involved in the development of ecosystem indicators, only three explicitly mentioned stakeholders.

Ecosystem Properties

We evaluated whether the 164 natural system papers addressed several key ecosystem properties: ecosystem resilience (the ability of an ecosystem to recover given a perturbation), ecosystem resistance (the extent to which an ecosystem is altered given a perturbation), ecosystem variability (the variance of population densities over time), and the ecosystem thresholds (the occurrence of alternative ecosystem states) (May, 1977). Despite the increasing recognition of the ecosystem-level effects of fishing and the prevailing call for ecosystem-based management (Chuenpagdee *et al.*, 2005), only 13% of the evaluated papers addressed the ecosystem properties described above. Nonetheless, these 22 papers shared many commonalities.

Assessment methods

A suite of both physical and biological indicators is used to assess anthropogenic affects on system resilience. For example, abiotic measurements such as nutrient concentrations, sediment budgets, and temperature profiles, in addition to biotic measurements such as species assemblages, energy transfer and trophodynamics, productivity, population size structure, species richness, habitat fragmentation, and spawning habitat were all used in some combination to assess ecosystem resilience. Many papers used alternative management policies as experimental manipulations of anthropogenic impact, whether that impact was bottom trawling, hook and line fishing, logging, dam construction, agricultural diversion or coastal development. Other methods included the experimental manipulation of natural predators, meta-analysis, literature reviews, analyses of historical data, ecosystem modeling, large-scale landscape analyses, and public interviews.

One of the most convincing experimental design and data analysis techniques used to quantify ecosystem resilience was that of the BACI approach (Before After Control Impact) which used management policies as experimental treatments. Here, empirical field data collected before and after various management policies were used to quantify the magnitude of ecosystem resiliency given specific biological and physical parameters. For example, Richardson *et al.* (2004) investigated the effects of logging on stream system resiliency by quantifying the change in both biotic and abiotic ecosystem characteristics such as fish assemblages, invertebrate communities, productivity, sediment budgets and stream temperatures, across various management policies. In this experiment, the policy implications of riparian reserve size on system resiliency could be directly applied to future management decisions with a holistic understanding of the ecosystem-level effects. In essence, this is an application of adaptive management (Walters 1986), where the resource and the ecosystem services that support this resource were carefully monitored before and after a well replicated controlled experiment.

Disturbance and system resiliency

Although all 22 papers that touched on ecosystem properties suggested that the anthropogenic disturbance of sustained fishing pressure can have dramatic impacts on system resilience, Junk *et al.* (2004) pointed out that natural disturbance regimes are in fact a vital component to maintaining the ecosystem's ability to recover after perturbation. Other research suggests that natural disturbance can promote diversity and renewal processes (Scheffer *et al.*, 2001). Yet, Daskalov *et al.* (2004) reminded us that it is often difficult to discriminate between natural variability and human related effects. The positive relationship between natural disturbance and system resilience discussed by Junk *et al.* (2004) is of particular interest given that many salmon stocks in North America are managed for constant escapement thus the potential for eroding natural variability exists.

None of the natural system papers presented addressed thresholds and alternative states per se. However, state shifts in marine ecosystems are critical issues to tackle. They have been documented to occur as a result of both anthropogenic press perturbations such as intense fishing pressure (Fogarty and Murawski, 1998) and natural press perturbations such as the Pacific Decadal Oscillation (Mantua *et al.*, 1997). The implications are such that attempts to reduce the risk of unwanted state shifts should address the gradual changes that affect resilience rather than simply the fluctuations (Scheffer *et al.*, 2001).

Common constraints on applying the resilience concept

The primary challenge that was repeatedly presented in these papers was the reality that ecological processes are often poorly understood at large spatial scales, particularly the scale at which most management is conducted. Furthermore, unexpected ecosystem-level effects compound this uncertainty (Richardson *et al.,* 2004). Consequently, many authors found it difficult to integrate the concept of ecosystem resilience into management plans. The solution proposed by Steel *et al.* (2004) was the use of large-scale landscape analyses of management practices. This tightly parallels the much touted concept of adaptive management, originally proposed by Walters (1984), and echoed 20 years later at the WFC. To account for ecosystem resiliency, Sainsbury *et al.* (2004) advocated a combination of simulation modeling, adaptive management, and the use of marine reserves. Despite its popularity among scientists, many authors at the congress noted that adaptive management, the ultimate way to integrate the concept of system resilience into management, is rarely put into practice in North America.

Biodiversity

Biodiversity is considered to be composed of three main categories: (1) genetic diversity, (2) species diversity and (3) ecosystem diversity. These different components portray how biodiversity encompasses a number of different scales ranging from the gene to the ecosystem. Twenty six (16%) of 164 natural system papers made reference to biodiversity, but Sadovy (2004) presented the only paper that discussed biodiversity at all three levels. She made a strong case for the application of a broad battery of tools (such as stock assessments, enforcement of regulations and international legal instruments, removal of negative subsidies, etc.) to try to maintain historical levels of biodiversity. Some papers focused exclusively on the relevance of biodiversity as a metric or indicator of the state of aquatic ecosystems, while others described different biodiversity enhancing methodologies without dwelling much on the importance of biodiversity from either the ecological or the human perspective. Almost 15% (4) of the studies considered freshwater systems, 8% (2) estuaries, and the rest involved marine systems (coastal zones for the most part).

Biodiversity was given a central stage at the session titled “how to reconcile fisheries with conservation and maintaining biodiversity”. However, only Wilcock *et al.* (2004), considered biodiversity exclusively at the level of genetic variability within a species. The species was mackerel icefish (*Champsocephalus gunnari*), which despite its high dispersal capacity, shows population substructures that indicate low levels of gene flow among stocks both around large areas of the Southern Ocean (Scotia Sea and Heard Island), and at smaller scales within local areas. This study shows that the limited exchange of genetic material among stocks of a species with high ocean dispersal capacity is not what had been traditionally assumed, and this has very important implications for the future management of this and other pelagic fisheries.

Keystone species and biodiversity

Protection of key species, as a means of maintaining community structure, was emphasized by several authors. Gaichas *et al.* (2004) stressed the importance of certain essential species in maintaining the viability of entire aquatic communities or ecosystems through the analysis of food web structures. Fowler (2004) considered that sharks represent a good example of the new challenges and opportunities faced by fisheries managers to protect commercially exploited species that either lack traditional fisheries management or the management they have is failing. Fowler made the case that it is important to consider the use of wildlife conservation instruments for marine species, like sharks, which require careful management due to their unique biology as well as their economic and ecological relevance.

Using ecological and life history information from terrestrial fish taxa, Reynolds *et al.* (2004) presented a study of biological correlates that they consider may be used to assess the extinction threat to fish species for which there is limited information. In the case of marine fishes, their paper indicates that there are sufficient demographic similarities with large-bodied terrestrial organisms (i.e., delayed reproductive maturity, great susceptibility to intense exploitation, etc.) to provide shortcuts to preliminary assessment of threat status in data-poor fisheries. However, the same terrestrial-aquatic analogies do not work with freshwater fish species because for many of them habitat loss, rather than fishing pressure, is the main cause of extinction. The susceptibility of marine fishes to intense harvesting was further discussed by Hudson (2004). In her presentation, she took apart common myths about the high resilience of marine organisms to intense exploitation. These myths are based on presumed or real high fecundities of marine

organisms, wide distributions and fast rates of population growth. All these misperceptions are being challenged, according to Hudson (2004), by the Species Survival Commission of the IUCN (The World Conservation Union) in a bold attempt to reconcile fisheries with biodiversity conservation on a worldwide scale.

Remedial action to increase biodiversity

Remedial recommendations provided in 12 papers were quite diverse. Construction of artificial reefs was the most common approach presented to deal with declining reef biodiversity.
Most artificial reefs are made of piles of concrete cubic modules (Relini *et al.*, 2004) or heavy large structures such as decommissioned oil and gas platforms (Bull, 2004), which provide substrate, nursery habitats, refuge, and/or prey species for several kinds of aquatic organisms. Several southern European countries have been establishing artificial reefs in their coastal waters for the last 40 years with, generally, positive outcomes. For example, Relini *et al.* (2004) reported that in the Algarve coastal waters (southern Portugal) artificial reefs have increased and diversified fishing yields by providing shelter for juvenile fish emigrating from the estuaries to coastal waters, increasing biodiversity and epibenthic biomass and preventing the use of habitat-disruptive fishing gear. The best results were reported for the middle Adriatic Sea, where within four years of reef placement the income of small-scale fisheries were more than three fold the initial investment. The potential "recycling" of old oil and gas rigs as artificial reefs seems highly feasible according to Bull's (2004) data for the Gulf of Mexico and California's coast, where platforms have become refugia for increasingly rare and overexploited aquatic species. At least in California's case, where many of the oil and gas platforms are near the end of their productive life spans, the recycling of these large structures as reefs, or foundation for reefs, opens the door to what promises to be a cost effective way of creating or enhancing coastal habitats. Rather than just "throwing around" structures in the hope that the newly created habitats end up increasing fishing yields, Bortone (2004) proposed to focus artificial reef deployment in such a manner that enhanced the life history attributes of target fish species. The examples he provided are for the eastern coast of North America and include reef placements that facilitate offshore migration of juvenile fish (e.g., groupers), that offer shelter from predation (e.g., spiny lobster), or that provide species-specific structural features (e.g., red groupers). Finally, Seaman and Miller (2004) assessed a broad variety of habitat improvement techniques that included, among others, artificial reef construction, coastal runoff control, and fishing exclusion zones enforcement. In the case of artificial reefs, their paper underlined the fact that unless they are designed in such a manner that enhance productivity by providing novel habitats or by restoring damaged habitats, they may only serve as attraction devices and function as fishing gear and not as habitat improvements. The paper also evaluates the level of acceptance and adoption of various habitat improvement technologies among fisheries managers and researchers.

Other recommendations for remedial actions were creation of protected areas, modification of recreational fisheries management to improve biodiversity and sustainable fisheries, application of biodiversity laws and international conventions, and control human land use activities, fisheries and aquaculture practices.

Aquaculture and biodiversity

Only two papers discussed the potentially negative effects of aquaculture on biodiversity and fisheries. Dahl *et al.* (2004) addressed the need to better manage human activities and resource exploitation to protect biodiversity, natural productivity and water quality in Norwegian coastal waters. The authors of this paper considered this a means of providing adequate conditions for the sustainability of both the fisheries and the fish farming industries of that country. They referred to a series of human induced threats to the coastal ecosystem such as habitat alteration, pollution, eutrophication, over-fishing and aquaculture. Despite the list of negative environmental impacts they identified in relation to salmon farming in coastal waters, Dahl *et al.* (2004) suggested that this industry can be sustainable. Such a position overlooks the environmental impacts this industry has beyond the location of the net-pens, and relates to the low (approximately 20%) trophic level transfer efficiency associated with the conversion of feed-stock fish (used to produced feed pellets) to salmon (Tyedmers, 2000). This is a very critical problem, because as Rees (2003) maintains, salmon farming cannot be sustainable as long as it reduces (by diverting high-quality animal protein to feed pellet production) the global amount of food that could be available to humans. Bert *et al.* (2004) dealt with biodiversity in an indirect manner, by reviewing the

ecological impacts of aquaculture around the world. The presentation constitutes a summary of larger report, currently in press, by the same authors.

Biodiversity in freshwater environments

Four papers addressed biodiversity in freshwater environments. Two examined the importance of flooding events in maintaining diverse riverine habitats and supporting fish diversity. Combining literature review results with recent field work, Junk and Bayley (2004) assessed the flood pulse concept relevance and predictions with regard to fish populations and fisheries in tropical and temperate regions of the world. In general, they reported that the diversity of life history types is reduced and community structure altered in systems with strongly modified flood pulses. This causes both biological production and fishery yields to drop. Hence, as a management objective they recommend (in regulated systems) the periodic coupling of river channel with floodplain by a flood pulse similar to historical natural events to maintain productive fish communities and viable inland fisheries. Their conclusions were supported by Ondrackova *et al.* (2004) who evaluated the role of managed flooding in increasing biodiversity and fish densities in channelised rivers of the Czech Republic. Sullivan *et al.* (2004) explored the factors that control fish diversity in streams. Geomorphic conditions were revealed as important for controlling habitat and explaining a significant percentage of both species richness and diversity. This work highlights the strong influence that geomorphology may have on biotic factors and has important implications in the conservation of biodiversity in lotic systems. Chao (2004) investigated the ecological and social benefits of a sustainable ornamental fishery in the Rio Negro, Amazon Basin, Brazil. This study concluded that preserving fish diversity and abundance, as well as the ecosystems that ornamental fish depend on, can provide sustainable social and economic benefits for small communities in the interior of the Amazon Basin. However, deforestation threatens the viability of the ornamental fishery in the region.

Quantifying biodiversity

A large variety of methods were used to estimate biodiversity, but counting species numbers or relying on some index of species richness were the most common approaches to come up with a metric that could be useful to monitor either temporal or spatial changes in biodiversity. Other methods include genetic analyses to measure biodiversity, while food web analysis, and habitat area. The spatial scales over which biodiversity was investigated varied widely from approximately 10 km to over 1000 km, and from a geopolitical perspective range from the local level within nations to the international scale.

Nine papers used a comparative approach in their study of how to reconcile fisheries with conservation and the maintenance of biodiversity. Again, the approaches were very diverse, such as comparison between natural with artificial reefs, marine and freshwater fish, different geographic areas, among species with different life histories, and trawled and untrawled areas. Exotic species were considered in only three papers. In all cases the exotic species had been purposely introduced either to create a new fishery or for use in aquaculture.

SPECIES AT RISK

Forty-three papers addressed species at risk issues. Of these papers, 53% identified overexploitation as the primary threat contributing to risk. Out of four remaining broad categories of threat, 21% of papers identified habitat degradation as a causal factor, 9% identified climate change, 5% pollution and 5% exotic species introductions as primary threats leading to risk. Bycatch and food web interactions with other fisheries were specific threats that were identified as factors contributing to risk. This is contrary to terrestrial systems where habitat degradation and exotic species introductions have been pinpointed as the primary threats contributing to species declines (Soulé and Orians, 2001).

Only six papers offered estimates on the probability of recovery although 26 papers offered management policy recommendations to aid in the recovery of the species at risk. Area closures (no-take marine reserves, marine protected areas) and gear restrictions or modifications were the two most common policies suggested to reduce risk. Listing the species to regulate trade (e.g., CITES) or protect its critical habitat (e.g., SARA and ESA) was the third most common suggestion. Other management policy suggestions included habitat protection and restoration, community-based management and stakeholder

involvement, enforcement of a minimum sustainable length and stock enhancement. Only two papers suggested complete fishing moratoriums.

ANTHROPOGENIC IMPACTS

Anthropogenic impacts were considered in 55 papers. The degree of attention given to this topic ranged from simple references to some human impacts to detailed analysis of the effects of by-catch, overfishing or habitat alteration. Several papers discussed other human-induced impacts on fisheries resources. These included habitat destruction by dynamite fishing, coral mining for lime, water pollution, introduction of exotic species, fish passage barriers in rivers and streams, freshwater withdrawal for agriculture, industry and urban use, and drastic alteration and simplification of lotic systems by diverse land use activities.

Bycatch

Almost 44% (24) of these papers focused on the effects of by-catch on a range of species, including sea turtles, dolphins, birds, and juvenile fish not targeted by the fishery. The measures proposed to address bycatch related problems included mesh size selection, gear modification, turtle exclusion devices and dolphin mortality reduction devices, discriminatory fishing practices, reduction in overall fishing effort, and the use of bird scaring devices.

Watson (2004) reviewed gear modification programs that were successful, such as the development of shrimp trawl design modifications (e.g., use of an extended funnel in the cod end of nets) that reduce the mortality of turtles and finfish in the penaeid shrimp trawl fisheries, and gear modifications that reduce turtle by-catch in pelagic longline fisheries. Turtle by-catch in longlines can be significantly reduced through changes in hook styles, according to Allen's (2004) findings. Chubb *et al.* (2004) reported that the installation of a bar in the opening of lobster traps can prevent Australian sealion by-catch in Australia. Jones *et al.* (2004) presented a comprehensive review of studies that either examined the effectiveness of visual stimuli on changing fish response to trawl gear or quantified the effects of varying light levels on fish catchability. Some of the gear modifications they referred to, which allow undersised fish and non-target species to escape, involved the use of square-mesh panels and twine color, specifically white-colored escape panels and a large orange escape patch in bellies of nets.

Some of the more realistic recommendations to significantly reduce by-catch involved changes in fishing gear, fishing practices and to the way we think about fishing gear and by-catch. For example, Zhou's (2004) paper provided a very comprehensive list of gear and technique modifications that should be applied, and include changes in discriminatory fishing practices, selection grid, angle of trawling cables, towing speeds, hook shapes and types, visibility of netting, TEDs, and multi-panel trawls. Broadhurst *et al.* (2004) took an additional step and proposed some "outside the box" (or in their case, "lateral") thinking. They argued that while modifications to existing gear have caused important reductions in by-catches, very few, if any, of the alterations are 100% effective. Hence, after examining what is realistically achievable through endless modifications of poorly selective fishing gear, Broadhurst *et al.* (2004) suggested the consideration of entirely alternative gears that are inherently more selective either due to their design and/or operation.

The environmental impacts of fishing gear received relatively little attention in this congress. Zhou's (2004) paper made brief reference to this type of problems in a general call for more sustainable fishing technologies and harvests. The negative effects of trawling on benthic communities were touched upon briefly. Valdemarsen (2004)'s paper was unique, however, in the sense that it presented a series of detailed gear modifications to reduce the negative effects of trawling.

Evolutionary consequences of sports fisheries

Cooke *et al.* (2004) argued that fishing can lead to evolutionary selection and thus genetic changes in fish stocks. This has been studied to some extent in marine fishes, but rarely done for a freshwater species. They argue that selection pressure may be higher in freshwater than marine environments because fishing pressure can be more intense and more targeted on certain individuals. The aim of their paper was to determine if there is evolutionary selection on largemouth bass related to angling pressure and if angling

vulnerability is heritable. The authors reported on a long-term experiment (25 years) where a lake was first drained, then a long-term artificial selection experiment conducted to determine whether largemouth bass have a low or high vulnerability to angling (over four fish populations). They measured cardiovascular performance using doppler flow probes (heart rate), and conducted behavioral work, captured with underwater video. They concluded that vulnerability to fishing was a heritable trait, and that those fish more vulnerable to fishing had higher metabolic rates, higher consumption rates and showed more parental care. This research links evolutionary change to human influences, and since there is a potential for this to happen in the wild, should be considered in management.

Pollution

The impacts of water pollution on aquatic ecosystems were illustrated in various water systems, such as closed salt water bodies (e.g., the Black Sea, Daskalov 2004), lentic systems, like the Laurentian Great Lakes (Stein and Goddard, 2004), and rivers (e.g., the Rhine River, Molls and Nemitz 2004). These impacts, including water contamination through both point and non-point sources of nutrients, agrochemicals, heavy metals, and other contaminants, generally resulted in significant losses of fisheries resources. Only one paper by Thorne's and Thomas' (2004) looked at the effects of accidental oil spills on fisheries resources. They studied the devastating effects that the combination of the Exxon Valdez oil spill and overfishing had on the Pacific herring population of Prince William Sound, Alaska. The results of their food web analysis showed that the decline of both marine mammal and bird populations followed the collapse of herring. Steller sea lions, which rely very heavily on herring schools during winter, were particularly hard hit. The authors of this paper anticipate a major conflict between fishing interests and marine mammal conservation advocates once the herring population, which is rebounding after the 1998 fishing moratorium, approximates its historical fishing threshold.

Freshwater habitat alteration

The alteration of lotic systems by dams, weirs, and dikes, water withdrawal, and various land use activities was addressed in nine papers. Comoglio *et al.* (2004) referred to most of these human alterations to fluvial ecosystems in their presentation about the current scenario, new trends and policies in the Piedmont Region of Italy with regards to water use and fish habitat protection. This paper presented an interesting European version of the type of multi-stakeholder process that has shaped the management of many North American watersheds. Because Alpine stream fish populations do not have a significant economic value in the region, except to a relatively small stakeholder group (e.g., sport fishers, lodge owners, equipment retailers), until recently, the Italian legislature was able to ignore the regulations necessary for the protection of minimum in-stream flows.

Freshwater management is critical in many areas of this world. Improved freshwater productivity in the developing world has been equated by international development agencies with increased agricultural output, though not with healthy ecosystems and fisheries resources, which could provide sustainable food production and generate employment. Dugan (2004) maintains that the result of such perspective has been the degradation and loss of freshwater fisheries at a high cost to the communities that traditionally depended upon them. His paper contributes to the identification of the issues that need to be considered if future investments in water management are to help sustain (or increase) river fisheries.

Wissmar (2004) and Gregory (2004) reviewed historical changes in watersheds and fish habitat brought about by human settlement and a broad number of land use activities that have re-shaped the Pacific coast of the USA during the last 200 years, using the Cedar River, near Seattle, Washington and the Willamette River (in the Lower Columbia Basin) as examples respectively. Gregory's simulation of aerial views of the Willamette River Valley at approximately 50 year-intervals should prove particularly useful in the development of alternative future landscape conditions with stakeholder and public input.

PUTTING IT ALL TOGETHER USING BAYESIAN, MULTI-CRITERIA, AND RAPFISH APPROACHES

Conflicting objectives seem to characterise the management of most fisheries around the planet. Such conflicts are the result of many interacting social, economic, and ecological processes, and some

potentially useful approaches to reconcile conflicting objectives were presented in several different papers. Sainsbury *et al.* (2004) discussed three methods, 1) multi-criterion analysis, 2) a suite of quantitative and qualitative methods for environmental risk assessment, and 3) the Management Strategy Evaluation methodology, and described their practical applications in diverse fisheries and management contexts. The common features of these methods include: transparency in process, explicit objectives, and wide stakeholder involvement. They can be applied in data-rich and data-poor scenarios, to clarify the trade-offs and risks associated with proposed management actions, and evaluate data adequacy against a standard (e.g., Marine Stewardship Council).

The third approach, Management Strategy Evaluation (MSE) has the advantage of identifying management strategies that are robust to uncertainties in both the management and natural systems, and has been applied to several fisheries discussed at the WFC. Specifically, the MSE methodology uses simulation modelling to examine the performance of management strategies and trade-offs among objectives. One example is the management strategy for Antarctic krill chosen by the Commission for the Conservation of Antarctic Marine Living Resources, which accounted for uncertainty in population parameters and stock assessment as well as the ecological role of krill as prey for whales, seals, fish, and bird species (Hewitt *et al.*, 2004). Cass *et al.* (2004) incorporated different stakeholder priorities and structural uncertainty into the MSE for sockeye salmon in the Fraser River, British Columbia. Specifically, they considered structural uncertainties through the use of both Bayesian analysis and simulation models, and incorporated conflicting stakeholder views in a "multiattribute value function". Stakeholder meetings were held to examine trade-offs in objectives and to establish long-term management plans given various uncertainties. The authors concluded that the incorporation of uncertainties into the decision making process would generate robust strategies and that participation in model building would facilitate the acceptance of a chosen management strategy.

On the same theme, Jones (2004) concluded that the biggest challenge to successful decision analysis approaches was the ability of researchers to communicate results to stakeholders. If ineffective, then decision analysis will not facilitate the decision making process. The multicriteria evaluation can be done using a GIS-based decision support model, as presented by Lane *et al.* (2004). In order to select coastal sites suitable for aquaculture, fisheries, and marine reserves depending on the objectives of various stakeholders, the application to coastal area zoning overlays a number of variables of interest and decision criteria.

A different integrative approach to fisheries management is RAPFISH (Rapid Assessment of Fisheries), a multidisciplinary comparative evaluation of "health" of fisheries, originally developed by Pitcher *et al.* (1998a), and further elaborated by Pitcher (1999) and Pitcher and Preikshot (2001). Tesfamichael *et al.* (2004) presented a case study from the Red Sea where they evaluated 26 fisheries operating in the red sea. Fisheries were evaluated across five dimensions (ecological, economic, social, technological and ethical) and scored on 45 attributes using multi-dimensional scaling technique. The 26 fisheries were compared to “good” and “bad” reference points. There was some discussion as to how such reference points are defined, a subject of general debate in fisheries science.

DISCUSSION

Fisheries science and management require an interdisciplinary approach that integrates biology, ecology, economics, social, policy and governance to be successful. Many of the natural systems papers reflected this need, at least in passing: 52% of the papers included references to policy or management consideration, 29% to social and 18% to economic considerations.

A strong theme throughout the conference was the need to include stakeholders in the fisheries management process. It has become glaringly clear that one can not evaluate ecosystem dynamics without considering humans as primary predators. As such, human dynamics, manifested through social and economic drivers, are important components leading to ecosystem change (Walker *et al.*, 2002). However, only 13% of the 164 natural systems papers evaluated attempted to integrate ecology, economics and social issues.

Vincent (2004), for example, presented a comprehensive analysis of how tourism, ornamental fisheries, recreational fisheries, and nearby trawling damage coral reefs. She made a strong case for reducing such pressures while changing the entire socio-economic context of the fishing communities that exploit coral reef resources. The change requires the development of alternative livelihoods for fishers and, in particular, directing opportunities towards women, who play a very important role in the decision making process even when they do not go out fishing on the boats. She also argued for serious engagement from local government, as well as from multilateral agencies and international NGOs.

Community- and industry-driven research and management is a relatively new direction for fisheries science and management. On this new tack, people need to be involved from the onset of research design, from developing the lines of inquiry, to data collection and interpretation through to management implementation. Building partnerships with fishermen, communicating research findings, instigating learning feedbacks, communicating past lessons learned and engaging coastal communities are critical aspects of maintaining resilient social-ecological systems and reconciling fisheries with conservation. Public comment is not enough.

There was little discussion of natural systems in the context of economics, despite the fact that fish and the ecosystem properties that sustain them can be regarded as natural capital. The paper by Wood (2004) was an exception. It examined the effects of economic development on biodiversity, and concluded that such development and the policies that promote it fail to recognise the full value of biodiversity as an essential environmental condition. According to Wood, a new conception of "biodiversity value" is urgently needed and can be applied to justify policies that would pre-empt economic development whenever it threatens species survival. Cabanban (2004) compared the estimated value of coral reef fisheries and coral reef related tourism in Semporna, Sabah, Malaysia, and concluded that the eco-tourism potential of these reefs outweighs by far the value of the reef fishery. In light of such results, the author of this study recommends investment of capital for the conservation of biodiversity in these Malaysian ecosystems. These examples indicate the need to consider feedbacks between economic incentives and ecosystem impacts.

The hidden cost of declining ecosystem resiliency is rarely recognised. For example, the collapse of Atlantic cod stocks in the northwest Atlantic in the early 1990s resulted in a huge economic loss to coastal communities and continues to have profound economic repercussions for many people. Yet the cod dollars were not lost solely due to there being fewer cod. Larger, longer-lived cod may be more resilient. Longhurst (1998) suggested that the long-lived age structure and delayed age of maturity of northern species such as cod are an adaptation to recruitment variability that is best-fitted to their long term survival. Removal of that age structure endangers their ability to survive poor recruitment. Cod has lost the older age groups, and thus a large part of their spawning potential. Not only would this cause collapse, it would seriously retard, if not prevent, recovery (Longhurst, 1998). Furthermore, it is possible that adult cod play an important role in the ecosystem by cultivating the success of their larvae and juveniles by preying on the predators and competitors of those juveniles (Swain and Sinclair, 2000, Walters and Kitchell, 2001, Bundy and Fanning, in press). In the virtual absence of cod, other, smaller species such as sand lance (*Ammodytes dubius*), shrimp and crab have increased in abundance. Management of ecosystem resilience in the northwest Atlantic failed. However, the ecosystem is still functioning, albeit in a different configuration, and now supports lucrative shellfish fisheries, benefiting the lucky few.

Of the 164 papers presented here, only 76% were considered to have implications for sustainable fisheries, and 77% contributed to the discussion of reconciling fisheries with conservation, meaning that over 20% of the papers presented at the 4WFC were effectively side issues. Only 5% of papers were considered to be very highly important for the future of fisheries, 31% highly important, 41% of medium important and over 20% of little or no importance.

Scientifically, we are adding increments to our knowledge. There are still large unknowns, such as ecosystem structure and functioning in the face of stochastic processes, but a full understanding of these processes is not necessary to manage fisheries for a positive future. The answers to this challenge lie in the other arenas of fisheries science discussed in other parts of this report. Critical to the success of scientific approaches to fisheries are communication and outreach: 51% of the natural systems papers indicated the success of the research, but only 9% made an attempt to communicate their results to the general public.

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HOW ARE WE PERFORMING IN THE SOCIAL ASPECTS OF FISHERIES SCIENCE?

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ABSTRACT

Oral presentations at the 4th World Fisheries Congress were analyzed to identify research trends in papers considering social issues. This paper describes the social issues addressed at the Congress, assesses the integration of social issues into current fisheries management, and provides examples of innovative approaches in research and resource management. Commercial fishing industries, decision makers, small-scale fisheries, and scientists were the most commonly addressed stakeholder groups. While many presentations focused on resource allocation and stakeholder conflict, few addressed poverty, food security, or quality of life. Presentations addressing social issues often stressed the importance of communication between scientists, stakeholders, and managers during the research process, however relatively few researchers discussed actual efforts to communicate research results to a broader audience. In general, presentations that addressed social aspects were considered to have a medium to high overall positive impact on reconciling fisheries with conservation.

INTRODUCTION

We now find ourselves at a stage in which management is becoming more focused on the human aspects of both fisheries and conservation (Lackey, in press). The present management era is marked by the emergence of approaches involving multiple stakeholder groups, co-management, and the precautionary principle. In this new millennium, the crisis in global fisheries has demanded creative and interdisciplinary adaptations in fisheries research and management. The theme chosen for this 4th World Fisheries Congress (4WFC), "Reconciling Fisheries with Conservation" reflects this significant trend. Of the 223 papers presented at this Congress, 71 addressed the social aspects of reconciling fisheries with conservation. Of these papers, which issues did they address and what innovative objectives, approaches, and results did they contribute? It is the objective of this paper to describe the social issues that were addressed in the oral presentations presented at the 4WFC, to assess the integration of social issues into current fisheries management, and provide examples of innovative approaches in research and resource management.

STAKEHOLDERS ADDRESSED

Commercial fishing industries (large-scale fisheries) and decision makers, followed by small-scale fisheries and scientists, were the most commonly addressed stakeholders in the 223 oral presentations (Figure 1). The inclusion of the category 'small-scale fisheries' indicates an important research trend, especially

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considering estimates indicating that 95% of all fishers are small-scale fishers (Lopuch, 2004). It is expected that by 2020 about 71% of the global catches will come from developing countries (Delgado *et al.*, 2003), where most of the small-scale fisheries are concentrated.

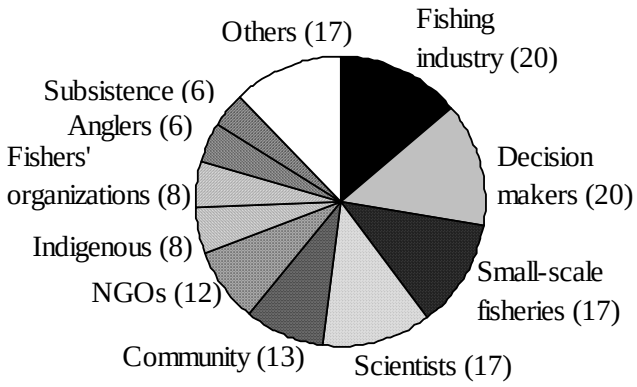

Figure 1. Stakeholders addressed in 223 papers presented orally during the 4WFC (%). "Others" include: politicians, farmers, tourism operators, marketing sector, children, tourists, seafood processors, women, divers, enforcers, and inventors of bycatch reduction devices. Because many papers addressed more than one stakeholder group, combined percentages equal over 100%.

Daniel Pauly described a historical data imbalance in which quantitative research methods have been commonly applied to large-scale fisheries and qualitative methods to small-scale fisheries (Small-Scale Fisheries Roundtable discussion: "Small is Beautiful?" May 4, 2004). Because of this pattern, presentations dealing with social aspects may more likely focus on case studies of small-scale fisheries than industrial fisheries. When only the 71 presentations that addressed the social aspects were considered, we found that 37% dealt with commercial industrial fisheries and 78% addressed small-scale community fisheries (including subsistence and aboriginal fisheries) (Figure 2). Chuenpagdee and Pauly (2004) provided an analysis of major features and similarities between small-scale fisheries worldwide and a comparison of the ecosystem impacts of these fisheries in relation to large-scale fisheries on a global scale.

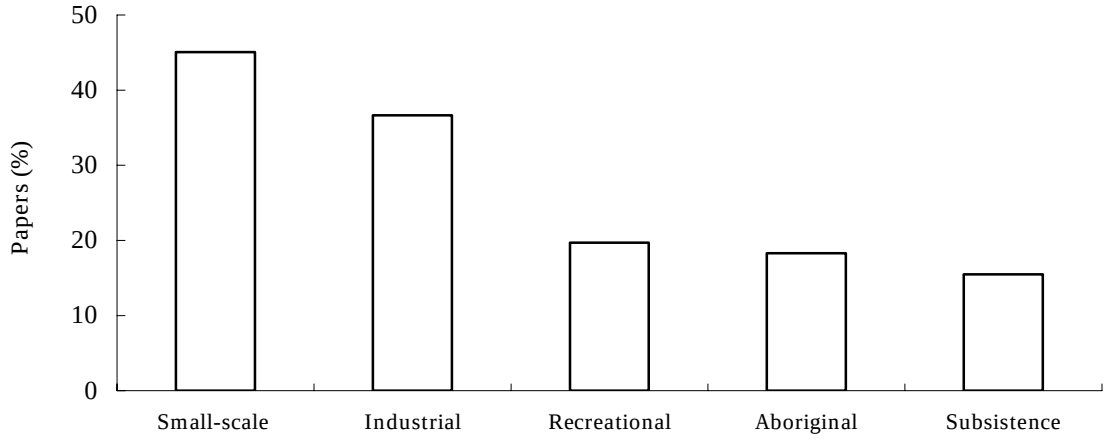

Figure 2. Fisheries considered in 71 papers specifically addressing social factors. Because many papers addressed more than one type of fishery, combined percentages equal over 100%.

On the other hand, the low representation of recreational fishers (anglers), fishers' organizations, indigenous communities, subsistence fishers, women, and children show how far we are from a complete

understanding of how fisheries operate worldwide, at least from the perspective presented at the 4WFC. Recreational fishers were addressed in only 6% of all oral presentations; this group is increasing in number and impact, in some cases harvesting more fish than commercial fisheries (Gentner and Lowther, 2002; McPhee *et al.*, 2002). Subsistence fishers were also addressed in only 6% of all oral presentations at the Congress. Due to population growth and health concerns (Choo and Williams, 2003), a closer look at subsistence fisheries is urgently needed. According to the templates, only one oral paper explicitly addressed women in fisheries, despite the direct and indirect importance of women as fishers, workers in the fish marketing and processing sectors (Yater, 1982), and more recently, as leaders in fisheries management (Sultana *et al.*, 2002). The absence of research involving women in fisheries at this Congress does not reflect the current movement towards understanding gender issues and the roles of women in global fisheries, as illustrated by the events listed by Williams *et al.* (2002):

1994 – National Symposium on Women in Fisheries in Cambodia;
1996 – Regional Seminar on Women in Fisheries in Indo-China Countries;
1998 – International Symposium on Women in Asian Fisheries;
2001 – Global Symposium on Women in Fisheries.

Eight percent (18 papers) of the oral presentations explicitly addressed future generations and only 3 considered children as stakeholders in fisheries. Reconciling intergenerational equity with the need to exploit fisheries resources right now remains a formidable challenge, particularly for developing countries where food security is one of the most important issues. Sumaila and Walters (2004) suggest that the way we discount the future should be changed to give more weight to future generations through the use of an intergenerational discount clock, a concept to be considered in more detail in Liu *et al.* (2005). While a large number of presentations did not focus their objectives on future generations, some are to be commended for their innovative results, which recognise that future generations will need more than healthy fish stocks. In Brazil, for example, research resulted in the development of a fishers' school, specifically designed around fishing seasons and schedules for the children/young adults of fishing families (Schärer, 2004). Although not a new concept, as a similar initiative took place in 1930 (Paiva, 2004), it represents an important example of the creative arrangements that must be made in order to ensure that earning a living and gaining a formal education are not mutually exclusive for young people in fishing families.

While much of the research presented at the Congress was interdisciplinary, only 9% of the oral presenters integrated considerations from stakeholders across economic sectors (tourism, forestry, fisheries, etc.) into their research. Although our templates separated stakeholders into categories for analysis, a few presentations stressed that stakeholder groups are often fluid and integrated categories. In Argentina, for example, conservation NGOs seek to protect native fishes and may disregard the importance of the exotic salmonid recreational fishery (Vigliano, 2004). In this case, stakeholder groups, identities, and interests overlap when members of conservation organizations also make their livings as fishing guides.

SOCIAL ISSUES ADDRESSED

The analysis of the templates showed clear trends in the issues addressed at the 4WFC. Resource allocation was the most frequently tackled social issue (Table 1). In addition, 12% of oral presentations focused on stakeholder conflict. At the other end of the scale, issues such as quality of life, capacity building, and food security each received attention in only 3% of all oral presentations. Poverty was discussed in only 4% of all oral presentations, demonstrating that research on this important human dimension of reconciling fisheries with conservation was not well represented at this Congress. Other social issues addressed were varied and included maintaining livelihoods, animal rights, psychological effects of privatization, institutional performance, and cooperative research.

Table 1 Social issues addressed in oral presentations at the Congress. Percentage indicates proportion of all oral presentations (223) addressing each issue. The combined percentages equal over 100% because the majority of presentations addressed more than one issue.

ISSUE	%
Resource allocation	17
Stakeholders conflicts	12
Social consequences from management decisions	10
Justice/Equity	10
Property rights	9
Local Ecological Knowledge	9
Stakeholders values	9
Social organization	6
Alternative livelihoods	4
Ethical issues	4
Poverty	4
Historical use/rights	4
Quality of life	3
Capacity building	3
Food security	3

Many scientists emphasised the need to empower fishing communities to conserve their traditional livelihoods, thus placing less stress on resources impacted by advanced fishing gears. However, others debated the intentions behind supporting a certain kind of fishing, criticizing the temptation to naively romanticise life in poor communities with over-exploited resources. During the Small-Scale Fisheries Roundtable held at the 4WFC, the discussion theme of "reconciling fisheries with conservation" consistently turned to reconciling development with fishing and conservation (Chuenpagdee and Liguori, in press). Family or community fisheries ensure food security, provide jobs, and typically cause less environmental degradation than large-scale fisheries. However, as Nandakumar D. reminded roundtable participants, while these characteristics appeal to scientists, around 90% of the small-scale fishers he interviewed in India would like to own larger boats and earn more money to support their families. Illustrating the complex socio-political history behind the development/conservation debate, one scientist warned: "we could be accused of 'keeping fishermen backwards'..." (Small-Scale Fisheries Roundtable, May 3, 2004).

STAKEHOLDER INVOLVEMENT AND COLLABORATIVE RESEARCH

Stakeholders were involved in approximately 24% of all the studies presented at the 4WFC. Analysis of the question: "How are the stakeholders involved in the research?" identified three categories of stakeholder involvement: research subjects, involvement in the decision-making process, and active involvement in the research process. Of the studies involving stakeholders, 72% involved stakeholders as research subjects. "Research subjects" defines a category of stakeholders who provide information to researchers but are not active participants in the research process. They participate through interviews, surveys, meetings, questionnaires, or consultations, providing demographic information, sharing local ecological knowledge, or supplying historical and present fisheries catch statistics. The next category defines stakeholders that are involved in decision-making, policy evaluation, or management. This category comprised 17% of the studies that involved stakeholders. In most cases, stakeholder views were incorporated into policy evaluation. Finally, active involvement in the research process was limited to very few studies (11% of the presentations addressed stakeholder involvement). Active involvement is defined

as stakeholder involvement in the research process, ranging from keeping logs of fishing activities to developing research questions.

Traditionally, government staffed research programs conducted fisheries research. Over the past decades, however, there has been an increase in cooperative research that involves other parties, such as commercial and recreational fishers, in the research process. The National Marine Fisheries Service (NMFS), for example, now has policies in place to support this kind of research (National Research Council, 2004). Some of the benefits of cooperative research include improved relationships with industry and increased credibility of fisheries data.

One of the studies presented at the Congress that incorporated active involvement of stakeholders included cooperative research between the commercial groundfish fisheries in the North Pacific and federal scientists (Ianelli, 2004). In this study, fishers supplemented conventional data collection by providing temperature and acoustic data. In the Scotia-Fundy Region of Atlantic Canada, fishers' organizations are developing research projects addressing social science issues. Both researchers and fishers are engaged in a participatory approach to identify research needs (Charles, 2004a). This project allows fishers to be researchers; an academic team is available for assistance only if requested.

LOCAL KNOWLEDGE

Local knowledge was explicitly addressed in 19 out of 223 total oral presentations at the 4WFC (9%). Research regarding local, traditional, and indigenous knowledge has been controversial in recent years due to the problems that emerge when dynamic local knowledge, embedded in experiences of a certain place, is fragmented, codified, decontextualised, compartmentalised, and distilled in order to fill certain slots in a research project or management plan (Ellen *et al.*, 2000). When managers and scientists attempt to organise local knowledge into "bite-sized chunks" or blueprints for general use, the result is problematic. As Pinkerton (2004) reminds us, "the success of community-based institutions in particular situations has led some to imagine that such arrangements are simple and easily replicable everywhere". However, the case of the culturally and commercially important pirarucu (*Arapaima gigas*) in the Amazon Varzea floodplain is one innovative example of how detailed local knowledge has allowed replicable success in decentralised, community-based management. Local fishers' intimate knowledge of this obligate air-breathing fish allows them to perform stock assessments by recording accurate counts as each fish surfaces. Castello (2004) presents this case as a "keystone social process" in that it builds a politically organised structure at the community level that is replicable on the larger scale.

The dynamic, experiential knowledge of local people is invaluable for fisheries management claiming any degree of sustainability (Ellen *et al.*, 2000). Research has moved beyond the early notions of idealised traditional knowledge and many practical approaches have emerged. Concepts like 'participation', 'empowerment', and 'bottom-up' (Ellen *et al.*, 2000) have become common words in fisheries. Charles (2004b) provides an example of initiatives in Canada to create partnerships between aboriginal fishers, non-aboriginal fishers, NGOs, and scientists to establish community-based management using the knowledge of both local aboriginal and non-aboriginal peoples.

'People-centered' and 'pro-poor' approaches mentioned at the 4WFC describe new strategies to use the expertise and experience of local people as well as to ensure that the people benefiting from conservation projects are the people in local communities. Some presenters stressed the need to involve people not only in the research but also in participatory planning of projects, implementation, and evaluation. Knowledge is not something that can simply be extracted from a community (Nadasdy, 1999). McConney (2004) warned that contortions of co-management in over-exploited small-scale fisheries may be more reflective of coercion than cooperation. Nadasdy's (1999) question, "Who is going to use, interpret and/or manipulate this kind of local research?" becomes essential. According to this author, "If the answer is not 'local community members' then the research will probably do more harm than good."

COLLABORATION IN MANAGEMENT

In 18% of the oral presentations at the 4WFC, researchers described community involvement in management/decision-making processes through consultations, providing local knowledge, promoting community-based management, and conducting research. Eleven percent of the studies reported collaborations or partnerships between communities and managers. These collaborations were in the form of co-management, sharing of knowledge or negotiations concerning management options. At the 'Innovation and Outlook in Fisheries Workshop' panel discussion (Ainsworth and Dingerson, 2005), participants suggested that much of the co-management literature romanticises empowerment; community members are often offered workshops and focus groups, conflicting with the time they need to spend earning a living, when this is not the kind of empowerment they seek. One of the panelists, Patrick Christie, emphasised that people's aspirations and values must be taken into consideration in our attempts to form partnerships with members of fishing communities; other workshop participants observed the trend towards autocratic line drawing, i.e., policy-making without thorough consideration of socio-economic implications for local people. This trend, driven by the urgency of the situation for global fisheries, has even led some to refer to conservation, particularly in the southern hemisphere, as a form of "new colonialism" (Patrick Christie, Innovation and Outlook in Fisheries Workshop, 2004). Pinkerton (2004) shares this concern: "It is often difficult for natural scientists focused on the alarming status of the world's fish stocks to appreciate that simply tightening regulations or setting aside large protected areas will not by themselves achieve the goal of conservation." Of the 71 oral presentations that addressed social aspects, only 17% explicitly explored the social and economic impacts of different management options. Workshop participants discussed the importance of local participation and planning throughout all stages of the research process.

COMMUNICATION

Despite the rhetoric extolling the benefits of participation and communication when incorporating social factors into fisheries research, studies considering social aspects made no greater effort to find innovative ways of communicating research results to the public (only 8%) than did all other studies (only 9%). One example of effective communication of research includes a video of a North Pacific watershed produced to share future scenarios with members of the public (Gregory, 2004).

CONCLUSION

Much of the research presented at the 4WFC suggests that projects and policies aimed at reconciling fisheries with conservation will be successful only when they are socially sustainable. In general, presentations that addressed social aspects were considered to have a medium to high overall positive impact on reconciling fisheries with conservation and hence on the future of fisheries. The majority of the research presented was both innovative and interdisciplinary; cutting-edge approaches are being developed to adapt social science methods for use in resource management. However, it seems we still have a long way to go in terms of involving stakeholders from the inception of research programs and new policy options, as well as in the evaluation and improvement of management plans that are already in place. Moreover, we seem to continue failing in what is considered one of the most important products of our research: communication.

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ECONOMICS DISCUSSION AT THE 4TH WORLD FISHERIES CONGRESS

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ABSTRACT

While the importance of economics to fisheries management has widely been recognised, it has not been adequately addressed in practice. The aim of this paper is to assess how economic research on fisheries contributes to reconciling fisheries with conservation at the 4WFC. In summary, 2 of 39 sessions specifically addressed economic aspects of fisheries issues. One session involved issues on fisheries trade and marketing, while the other focused on valuation of fisheries resources. A total of 46 out of 223 papers assessed addressed different economic aspects. Specially, economic values of fisheries resources were discussed by almost all the papers, followed by different fish products, future generations and externalities. About 72% of these papers were considered to have an overall medium to high impacts on the future fisheries. Most of these studies should be supported and promoted in the future because of their pioneering nature, and effort they made in the extension of empirical research and its scope.

INTRODUCTION

In discourses about fisheries management, it has become a common practice to underscore the importance of economics. While it is recognised that fisheries, especially small-scale, contribute to food security and livelihood, more attention has been placed on income generation, employment and export earnings, and how they serve as incentives to increase fishing pressure on the resources. The current status of fisheries resources requires changes and improvement in fisheries management, to avoid further declines in catches, and to minimise the ecosystem impacts of fishing, as well as to ensure the social and economic viability of fishing communities. In general, economic principles and approaches, including capital theory, game theory and economic analysis, have been used to test alternative management schemes through measures such as allocation, licensing systems, and property rights regimes while searching for better options to sustain fishing resources and reduce conflicts among users. Behavioral models have explored how different types of economic incentives motivate fishing practices and rapid development, leading eventually to over-fishing, over-capitalization, and over-subsidies problems faced in the world fisheries today. A survey of the development of fisheries economics and fisheries policies since the 1950s (Wilen, 2000) offered several insights about the relationship between economics and the world fisheries problems. With the increasing pressure on fisheries resources and after the extension of national jurisdiction under the exclusive economics zone (EEZ), issues such as overcapitalisation, both existing and emerging, rose to the attention of economists. Since the first widely employed solution, the limited entry system, did not prevent dissipation of economic rents, rights-based system, i.e., individual quotas, and individual transferable quotas (ITQ), were introduced, and soon gained popularity, with currently over 55 fisheries around the world being managed under this system (Wilen, 2000).

While the importance and success of ITQs in addressing fisheries problems is arguable (see Bromley and Macinko, 2003, Pauly and Maclean, 2003, Copes and Charles, 2004), we agree that there are pressing practical issues and a large set of questions that can be addressed through empirical analyses and real-world understanding of policy implications. On the whole, it seems appropriate that economic analyses

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and tools should be used to contribute to the sustainable management of fisheries, especially if they are part of an integrated, systemic perspective (Charles 2001, Hall *et al.*, 2001, Seijo and Caddy, 2000).

The aim of this paper is to assess how research on the economics aspects of fisheries, as presented at the 4WFC, contributes to reconciling fisheries with conservation. In the next section, we summarise issues discussed at the two sessions designated for economics, but within the broad context of fisheries economics. Issues discussed in other sessions and the overall assessment of economic considerations at the congress was presented at the end of the paper.

ECONOMICS CONSIDERATIONS IN FISHERIES AT THE 4WFC

The roles of economics in reconciling fisheries with conservation were given some recognition at the 4WFC. Two of the 39 sessions specifically addressed economic aspects of fisheries issues. One session involved issues related to fisheries trade including current and historical trade statistics, trade measures, eco-labelling, CITES, common markets, capitalization, market and ecosystem interactions. The other session focused on valuation of fisheries resources, including forms of economic values, impact of subsidies, costs of management, costs of management in relation to value of fish to society and costs of lack of management. The following summarises and discusses the nine papers (about 4% of the total) that dealt directly and solely on economic issues in fisheries. Overall, five papers were related to economic valuation, while three dealt with trade and one with instruments.

Trade and marketing

The focus on trade and marketing reflects the concern that, while several types of economic tools and approaches have been rigorously employed to improve fisheries management, a broad economic analysis to evaluate changes in fisheries as a response to the rise and fall of global supply and demand is still lacking (Delgado *et al.*, 2003). This is particularly important in this era of globalisation, where supply from capture fisheries is decreasing while demand continues to increase. Technological improvements in the fish processing sector mean that the variety of fish and seafood products has increased. Further, development in freezing and packaging technology, as well as modern means of transportation, makes it possible for products to reach a wider geographic range of consumers. However, discussion of market and trade is not limited to food fish and fisheries, as about 30% of fish catches is utilised for non-food purposes, mainly for reduction to fishmeal and fish oil (FAO, 2002). Utilization of fisheries catches for fish reduction is a contentious issue with the current debate about environmental impacts (e.g., shrimp farming and mangrove forests in Thailand; Csavas, 1993; aquaculture of carnivorous species; Tuominen, 2003), and health issues of aquacultured species (e.g., toxin in salmon; Hites *et al.*, 2004). There is also the question of using these 'low value fish' for fish reduction, when in many developing countries and poor fishing communities, these fish are 'choice fish' and are directly consumed by humans.

Understanding the marketing and trading system of fisheries products, at local, national and global scales, can develop an overall appreciation of the root-causes of world fisheries problems related to human consumption and utilization of fish and fisheries products. In our assessment of research presented at the 4WFC, we attempted to capture the range of products that were traded, the marketing systems employed, the national and international regulations and requirements, as well as to document whether a product certification system was used and to gauge the effects of globalisation on fish trade.

Most of the papers on trade and marketing were related to fish supply and demand, and the structure of trade, with an emphasis in developing countries. The increase in total fish production was reported to come from developing countries and aquaculture. Fish export has become a significant source of foreign exchange earnings in these countries, although some barriers (e.g., high cost of food safety compliance) limit their ability to export fish products in the global market. Further, the rising fish trade has accelerated concerns for food security of the poor and the environmental impacts of resource uses. On the one hand, the poor depend on low-value fish species as a main source of protein, but the prices of these low-value fish are increasing; on the other, most wild fish stocks are fully or overexploited and aquaculture will continue playing an important role in fish trade and its practice needs to be sustainable (Ahmed *et al.*, 2004). Based on this background, an AsiaFish model was constructed in an attempt to project supply,

demand and trade of special fish groups and key species in the nine major fish producing countries in Asia. This model is a significant improvement on earlier aggregated FAO and IMPACT models because it is a disaggregated multi-market equilibrium model that allows targeting of special fish groups and key species (Dey *et al.*, 2004).

Another interesting aspect of fish trade and marketing was the use of fish trade data to benchmark and estimate sustainable fisheries exploitation rates when fisheries data is poor. For example, (Clarke *et al.*, 2004) estimated sustainable yield and exploitation rate for blue shark using fish trade data. Their results showed that the shark fishery is close to the upper limit of sustainable exploitation. This method provides a very creative and innovative framework for managing fish species, such as sharks and those that are highly traded in the market, while biological data are inadequate for stock assessment.

Subsidies and overcapacity

Subsidies and overcapacity are among the factors identified by FAO as those leading to unsustainability in fisheries (Swan and Gréboval, 2004), although they were not well covered at the 4WFC. When fisheries became a priority sector to boost economic growth in many parts of the world, several governments provided subsidies to promote the fishing industry, which led to over-capitalization, and over-capacity. And this is considered now as one of the most pressing problems of the world fisheries (Kirkley and Squires, 2003, Clark *et al.*, 2004). The fishing industry continues to enjoy this privilege despite the crisis in fisheries, as governments struggle to find ways to remove subsidies. Buy-back programs, initiated to reduce overcapacity, have not only failed to reduce capacity and prevent overfishing (Holland *et al.*, 1999), but gave fishers incentives to over-capitalise. The presentation by Clark *et al.* (2004) demonstrated that these instruments can have "decidedly" negative impacts on fisheries management and conservation if the vessel owners anticipate the changes. In other words, the schemes will exacerbate the vessel capacity problem because the vessel owners consider a subsidy for current investment in vessel capacity and will be paid back in the future. In this case, it is conflicting from conventional perception that decommissioning subsidies can be beneficial to fisheries conservation. Further, buy-back programs often remove less efficient vessels from fishing fleets, which may then proceed to fishing under new ownership (Pauly and Maclean, 2003).

The global study conducted in the early 1990s showed that the costs of operating the world fishing fleet exceeded income from fishing by substantial amounts in consideration of the world's fishing vessels as one fleet, while another global study conducted in the late 1990s suggested that fishing was economically viable based on the world's active fishing vessels (FAO, 2000). The discrepancy between these two global studies is partly due to how subsidies were incorporated in the economic and financial analyses (FAO, 2000). A report by Milazzo (1998) indicated that fisheries subsidies contributed to excessive investment in boats and gears, and overcapacity in developed countries. The same trend is observed in developing countries, and often with drastic effects in terms of resource over-exploitation by the industrial fishing sector which contributes to the marginalization of small-scale fisheries, as seen for example in Thailand (Chuenpagdee and Pauly, 2004). Marginalisation occurs because subsidies add barriers to the participation of the small-scale sector in fishing activities and management decisions (Delgado *et al.*, 2003). To address issues related to subsidies and overcapacity, we focus on assessing, based on presentations at the 4WFC, the extent to which economic instruments and other mechanisms are employed to address subsidies and overcapitalisation problems.

Economic valuation

Resource valuation and economic analysis are tools developed to assist policy makers in their decisions about resource use allocation and in the appraisal of development and implementation of alternative projects. Such topics have attracted the attention of a large group of economists. Costs and benefits related to fishing are generally incorporated in fisheries economic analysis, and economic values are provided (Talbot, 1991). Unfortunately, conventional approaches relying mainly on the market value of fisheries resources and are more commonly used than alternative approaches to account for total values of fisheries resources. Even when the latter is attempted, it is often through constructed-market approaches, such as contingent valuation, even though their problems are recognised (see discussion in Knetsch, 1994; Kahneman *et al.*, 1999, for examples). Fewer approaches have considered 'non-monetary' methods, e.g., multi-attribute choice approaches (Gregory, 1987, Días DeLeón and Seijo, 1992) and the damage schedule which measures the relative importance of resource (Chuenpagdee *et al.*, 2001). Finally, an improvement

to the conventional cost-benefit analysis includes discussion about issues such as lower discount rates for future events (Weitzman, 1998) and intergenerational discounting (Sumaila, 2001) to mitigate long-term environmental projects and to account for the interests of future generations, respectively.

Economic valuation covered more than half of the economic topics presented in the congress. Three aspects were emphasised: the role of discounting, economic values in large vs. small-scale fishing sectors, and within the community at large, and economic loss caused by pollution. Discounting, a process where future values are converted to present values, can be related to the current generation as in conventional methods or to future generations. Sumaila (2004) argued that future generations should have the same opportunity to exploit fisheries resources as the current generation; thus they should decide on how to discount their benefits from fisheries resources by themselves. In other words, the proposed 'intergenerational discounting' puts more weight on future generations than conventional discounting does. An application of this discounting method to Atlantic cod fisheries illustrated that conventional discounting promoted an "aggressive harvest policy", while intergenerational discounting showed "historic gross over-fishing of Atlantic cod to be economically unappealing" (Ainsworth and Sumaila, 2004). This suggests that intergenerational discounting may be a more appropriate method than conventional discounting for reconciling fisheries with conservation, particularly for long-term considerations.

Economic values are very important criteria when making tradeoffs in allocating resources between individuals and society and for present and future uses. Alcock (2004) investigated different valuations within the fishing industry based on the assumptions that different fishing sectors had different characteristics and economic values. The large-scale fishing sector was characterised as capital intensive, vertically integrated, commodity-value based (e.g., more responsive to global markets, weak sensitivity to externality and high discount rate). In contrast, the small-scale fishing sector was labour intensive, subsistent, nutrition-value and commodity-value based (e.g., more responsive to local markets, strong sensitivity to externality and low discount rate). The comparative study revealed that the objectives of the state policy were in accord with values of large-scale fishing sector for global seafood markets and failed to reflect social and ecological values in the regional and local levels. Another presentation by Scholz *et al.* (2004) illustrated the use of an integrated, spatially explicit assessment framework. A regional (West Coast) geographic information system was built to links areas of ocean to coastal communities. This database contains oceanographic, ecological, fishery-dependent, and socio-economic information. The analytical framework was used to derive values of different areas of ocean to different fishing fleets, including use (e.g., fisheries) and ecological values. The study showed that it was possible to jointly consider socio-economic and conservation concerns and to use the results for discussion about regulatory requirements, such as economic impacts of fishery management and marine conservation measures.

Finally, pollution was considered another pressure that intensified economic loss of fisheries resources, in addition to fishing exploitation. Anna and Fauzi (2004) constructed a bioeconomic model of Jakarta Bay that embedded pollution variables to estimate economic loss due to pollution. The results indicated that pollution reduced sustainable yields and resource rents to about 60%, which, it was suggested, was higher than the reduction due to fishing pressure.

IMPORTANCE OF ECONOMICS IN THE WORLD FISHERIES

Although only nine papers in two sessions dealt directly with economics issues, a total of 46 (out of 223) papers addressed different economic aspects using studies conducted mainly in Asian developing countries and in North America. In sessions other than the two designated ones for economics, topics such as values of biodiversity, recreational benefits, fuel costs of fishing, and benefits of aquaculture were discussed. Sadovy (2004), for example, suggested a need to recognise not only ecological values, but economic values of biodiversity and conservation of certain species. The plea for the recognition of the economic importance of recreational fisheries was prominent in the session on "Role of sport fisheries in reconciling fisheries with conservation". Cowx (2004), acknowledging the difficulty in the quantification of recreational fisheries values, called for more involvement in planning and management by anglers and their associations. Incorporating recreational fisheries values into the allocation of harvest quotas may affect the commercial fishing sector, using the case of sea bass in Wales, Richardson *et al.* (2004) argued, however, that economic gains from recreational fisheries could compensate for the losses in commercial landings. Another important economic consideration is the cost of fishing, particular fuel cost which is considerable in industrial fishing. Addressing over-capacity problem using a new approach that involves

use of fuel quotas holds high promises, according to Tyedmers *et al.* (2004). Finally, Volpe (2004) pointed out that conservation and benefits were already reconciled in aquaculture and thus attention should be focused on addressing existing social, cultural or economic inequalities related to aquaculture development.

As shown in Figure 1, almost all papers dealing with economics discussed economic values, such as market (61%), non-market (20%), intrinsic (14%) and option values (5%). Discussions about fishery products (e.g., live, fresh, frozen, processed, dried/salted and trash fish) were also prominent in 24 papers. The Discussion dealing with future generation and externality were presented in 8 and 6 papers, respectively. About 72% of these papers were considered to have an overall medium-high to high impact on the future of fisheries.

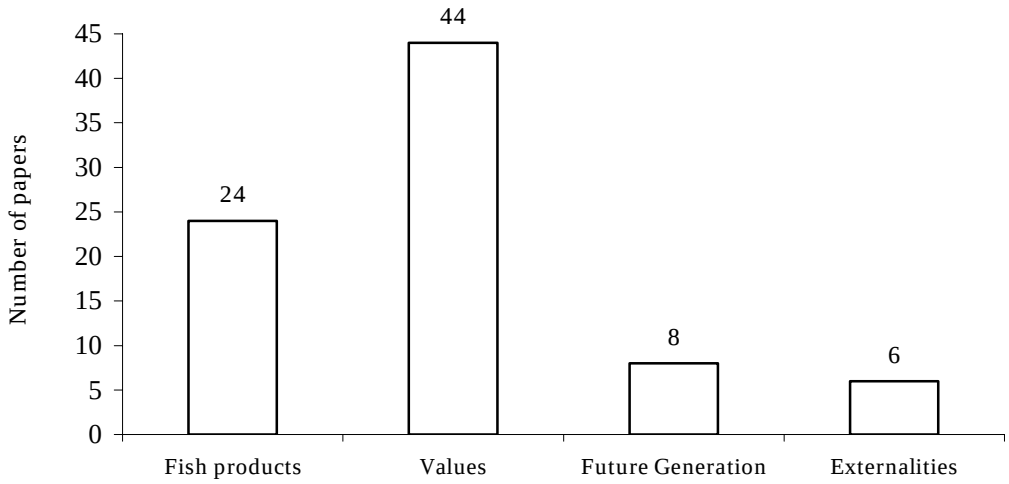

Figure 1 Number of papers covering different economic topics.

Although most economic papers did not provide explicit management or policy recommendations, they were considered to have implications for fisheries management and contributions to sustainable fisheries. For instance, Sumaila's intergenerational discounting called for different management measures that acknowledge the importance of future generations and long-term considerations (Sumaila, 2004). Anna and Fauzi's study suggested that other non-fisheries issues, such as pollution, needed to be considered in fisheries management (Anna and Fauzi, 2004). Moreover, since many papers showed the importance of considering market and non-market values and social and ecological values in an overall assessment of fisheries, their contributions to the discussion about reconciling with conservation were considered relatively high. In terms of the overall importance of these papers for the future of fisheries, most papers were considered to have medium or high importance. We concluded that many of these economic studies should be supported and promoted because of their pioneering nature (e.g., intergenerational discounting, AsiaFish model), their effort in the extension of empirical research (e.g., pollution, GIS), and the scope of the study (e.g., large-scale structural changes of fish supply, demand and trade).

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TOOLS TO RECONCILE FISHERIES WITH CONSERVATION: INSIGHTS FROM THE 4TH WORLD FISHERIES CONGRESS

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ABSTRACT

This paper summarises the various tools to reconcile fisheries with conservation that had been mentioned or discussed in the oral presentations of the 4th World Fisheries Congress. We evaluated papers related to protected areas, aquaculture and habitat improvement and stock enhancement. Out of the 223 presentations, 62 addressed these tools. Among these areas, protected areas received the most attention while less attention was given to the latter two. This may reflect the large potential of protected areas and the problems associated with aquaculture and habitat improvement and stock enhancement as conservation tools, or may be due to biases in the congress participants' areas of study.

INTRODUCTION

The decline of the world's capture fisheries was repeated like a refrain throughout many of the presentations at the 4th World Fisheries Congress (4WFC). Scientific, industrial and political bodies worldwide have come to recognise the trend, and it is now widely believed that strict conservation will be necessary to sustain capture fisheries into the future. The question therefore becomes how we may best reconcile the need for fisheries with conservation. Various tools have been suggested to provide the answer to this question. Here, we selected some of the widely advocated tools which include protected areas, aquaculture, habitat improvement and stock enhancement. We summarised their approaches and applications mentioned in the oral presentations of the 4WFC. We then compared them with the current situation in this area of study as revealed from the literature.

Protected areas

The potential of protected areas to reconcile fisheries and conservation has become a hot topic of discussion over the last several years. Most of the attention has focused on the establishment of marine protected areas (MPAs). A commonly cited definition of a MPAs is "*any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment*" (Kelleher and Kenchington, 1992). MPAs can potentially offer multiple benefits such as conservation of biodiversity and habitats, protection of threatened species or populations, protection and restoration of habitats and ecosystems, control fishery exploitation rates, protect critical stages of species life history, reduce secondary impacts, provide insurance against management failures and conserve life history traits and genetic diversity (National Research Council, 2001). As a tool, MPAs vary slightly in terms of level of protection, ranging from small no-take reserves to multi-use areas (Gell and Roberts, 2003). As a result of global declines in fish catch, there has been a call for the establishment of large scale marine reserves which would prohibit fishing (Pauly, 2004, Gell and Roberts, 2003).

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Aquaculture

Among the potential tools identified and examined at this year's Congress, aquaculture was mentioned as one possible alternative to capture fisheries. It has the potential to supplement wild fisheries harvests and increase food security, to provide livelihood alternatives to traditional fishing practices - and importantly, to ease the fishing pressure on dwindling stocks of wild fish. Industry seems to have recognised the niche left vacant by declining capture fisheries. Where global statistics indicate that the catches of capture fisheries has leveled off or decreased in recent years (Watson and Pauly, 2001), despite unprecedented levels of fishing effort, the world's aquaculture production has steadily increased for more than 30 years at a compounded rate of 9.2% per year (FAO, 2002). Today, world aquaculture production accounts for almost one third of total fish production, about 37.5 million tonnes per year. China accounts for approximately 70% of that production; currently more than 7 million people are employed by their booming aquaculture industry (FAO, 2002).

However, few scientists suppose that aquaculture offers a magic solution to our efforts to reduce the burden on the oceans. To the contrary, researchers have cautioned that farming carnivorous species could result in a net loss of total available food production, as otherwise edible fish are captured from the wild and converted to aquaculture feed (Naylor *et al.*, 2000, Pauly, 2004). This is of particular concern in places like British Columbia, where more than 90% of aquaculture products are (carnivorous) salmon species (MAFF, 2004). Additional concerns centre on problems of habitat modification, waste disposal, introduction of exotic species and pathogens. Nevertheless, current research is aimed to address these concerns and identify long-term sustainable aquaculture practices.

Habitat improvement and stock enhancement

Habitat improvement and stock enhancement have long been suggested as a means to restore, conserve and increase the productivity of exploited populations. As there are various published definitions for habitat improvement and stock enhancement, here we provided operational definitions for the terms based on selected literature. We defined habitat improvement as the increase in available habitat and/or access to key habitat for at least some stages of a target species' life history (Seaman and Sprague, 1991). Such objectives may be attained by artificial habitats (e.g. artificial reefs), modification (e.g. dredging sand-banks at the mouths of estuaries), protection or restoration of existing habitats. For stock enhancement, we used the definition noted in Molony *et al.* (2003): "the hatchery production of a particular species of fish to a particular size or stage, for release into an area or stock, to increase some aspect of fishing quality in the future (e.g. catch rates, total catch, biomass, abundance, etc)." Currently, definitive evidence on the success of habitat improvement and stock enhancement projects for restoring and conserving exploited stocks is not available. On the other hand, these approaches are suggested to be associated with various ecological risks and cautions on their applications have been raised.

PRESENTATIONS AT THE 4WFC

Protected areas

Of the 223 oral presentations, 34 addressed protected areas. The congress dedicated one session to this topic with six oral presentations and one additional MPA presentation in the Conservation in the Open Ocean session. Although not addressed in this paper, it is important to note that 44 posters had direct reference to protected areas and only one of the posters referenced freshwater protected areas. Evaluators also recorded the goals addressed by the protected areas. In summary, 17 papers addressed protection of ecosystems, followed by biodiversity conservation and the reduction of fishing mortality. The enhancement of productivity and habitat protection were noted in ten papers, followed by five papers on reduction of bycatch, and four on protection against stock collapse. These results are not surprising given the numerous benefits attributed to MPAs in reconciling fisheries with conservation (National Research Council, 2000, Roberts and Hawkins, 2000). Geographically, every region of the world was represented (Table 1).

Table 1. Summary of all presentations that addressed the "tool" issues. The presentations were broken down by their geographical focuses and types of tools addressed.

	No. of presentations on the topic		
Locations	**MPA**	**Aquaculture**	**Habitat improvement and stock enhancement**
North America	10	1	12
South America	1	0	1
Asia (South east)	4	1	1
Asia (others)	0	2	3
Oceania	6	0	1
Europe	3	1	3
Africa	2	0	0
Others	2	0	0

The introductory paper in the MPA session attempted to review the role of MPAs as a tool for fisheries conservation (Kalikoski and Vasconcellos, 2004). The presentation defined MPAs and their multiple benefits. However, evaluators noted that the presenter focused primarily on common property resources issues using a Brazilian case study. The next four papers addressed the design of MPAs based on various modeling techniques. The final paper in the session dealt with the role of MPAs in reconciling fisheries with conservation in Mexico. Unlike the other papers, it focused on the management issues, conflict resolution and fisheries management crisis (Bourillon *et al*., 2004).

In general, the evaluators' comments suggested that the presentations concerning protected areas contributed positively to the discussion of the Congress's theme. All the protected areas presentations recorded had implications for sustainable fisheries. The evaluators judged that 32 (out of 34) papers contributed to the discussion about reconciling fisheries with conservation. The majority, however, did not communicate their results to the general public, which is an area of concern. In general, the presentations relating to this topic had a high to medium rating in both their overall positive impact for reconciling fisheries with conservation, and their importance for the future of fisheries.

Aquaculture

Despite its increasing importance in global food production, issues regarding aquaculture seemed underrepresented. Out of 223 presentations recorded and analyzed, only eight were primarily concerned with aquaculture (although eleven more mentioned aquaculture in minimal detail). In addition to the six presentations made in a session on 'Reconciliation of Fisheries with Conservation and the Ecological Footprint of Aquaculture', two more papers focused on aquaculture, both were with regard to rearing animals for restocking of wild populations. Of these eight papers, three gave generic global overviews and five gave specific case examples (3 freshwater, 2 marine). Tropical case studies mentioned were in India and Malaysia, temperate cases studies were in Russia, Korea and Canada. Most presenters concerned themselves with the ecological impacts of farming, particularly its negative effects on water quality (although one researcher suggested bivalve culture as a possible means to improve water quality).

Of these papers concerning aquaculture, evaluators provided a below-average score in both fields, indicating that the papers contributed only marginally towards the goals of the conference. However, one exceptional paper, which was well-received by evaluators, focused on how aquaculture may co-exist with marine capture fisheries into the future through careful regulation of output, and design of common metrics to measure ecological impact (Volpe, 2004). Another noteworthy paper described an innovative mariculture technique, where herbivorous prawns could be cultured in fallow rice fields without the need for pesticides, or even feed. This last case example, incidentally from a developing nation, offers insights for sustainable practices from an ecological and socioeconomic viewpoint (Paimpillil, 2004). These highlights underpin the conclusion that there is significant room for growth in the vein of aquaculture research, and that such research should be promoted where possible.

Habitat improvement and stock enhancement

Habitat improvement and stock enhancement was addressed in 20 oral presentations, 17 of which addressed habitat improvement only, while the remaining 3 presentations also concerned stock enhancement. An equal number of presentations concerned marine and freshwater systems. The majority of the 20 presentations focused on North America (n=12), while the remaining focused on Asia, Europe and Australia. Most North American studies focused on freshwater systems (80%) (Table 1).

We found that "artificial reefs", "in-stream structure placement", "water pollution control" and "ban on fisheries" were the four most frequently mentioned techniques for habitat improvement. Among these four techniques, artificial reefs were addressed by most papers (n=7), followed by in-stream structure placement (e.g. logs, boulders), water pollution control and ban on fisheries (n=4 for each approach) (Figure 2).

Restoration was the most frequently used approach to habitat improvement in the presentations, and the targeted scale of the studies was the ecosystem. A large proportion of the presentations considered restoration (improvement with self-sustaining long term, large-scale, multi-species goals, n=13) as their approach to habitat improvement. Other approaches include habitat protection (protect ecosystem function, n=7) and enhancement (improvement with short term, localised, single species goals, n=6). The majority of the presentations were focussed at large ecosystem scales (n=13), which included watersheds, reefs, gulfs and straits etc, as opposed to sub-systems (stream reach, estuarine marsh, specific habitat type).

All papers that addressed stock enhancement also considered habitat improvement. Risks associated with habitat improvement and stock enhancement were addressed in only one presentation, which was concerned with the risk of disease associated with the use of artificial reefs and underwater electrical current to restore coral reefs.

The evaluators' comments suggested that the presentations concerning habitat improvement and stock enhancement generally contributed positively to the discussion of the Congress's theme. The evaluators judged that the contents of 12 presentations on habitat improvement and stock enhancement had contributed to the discussion on reconciling fisheries with conservation, while the types of research in 14 of them should be supported or promoted. In general, the presentations relating to this topic had a medium rating in both their overall positive impact for reconciling fisheries with conservation, and their importance for the future of fisheries.

DISCUSSION

The relatively small number of papers concerning protected areas in the Congress (n=34, out of 223) is surprising, considering the potential benefits of MPAs for reconciling fisheries with conservation. One of the drawbacks of MPAs is there limited impact on global fisheries due to their small size (Roberts and Hawkins, 2000). Recent estimates state that less than half a percent of the oceans lie within MPAs, and most of these have little or no effective management (Roberts and Hawkins, 2000). Moreover, the establishment of MPAs tends to be politically challenging to stakeholders, such as the fishing industry and is often a result of a political decision.

There was little attention focused on community-based protected areas, where a lot of action currently occurs. Social science research and economic modeling were given very limited attention at the congress considering both fields have been recently prominent in the literature (Christie *et al*., 2003, Sumalia and Charles, 2002). Evaluators also recommended that MPAs on the high seas require further investigation (Mossop, 2004).

One complaint made of the Congress, both in the closing dialogue session and in *AQUALINK's* subsequent panel discussions (Ainsworth and Dingerson, 2005), was that the private sector was underrepresented in the presentations. The discussion on aquaculture may have suffered because of this. However, several papers did espouse aquaculture as a tool to help reconcile fisheries with conservation. One paper mentioned aquaculture as a means to increase global food production (Tyedmers *et al.*, 2004), although it

did make due reference to the inefficiency of rearing predatory species. Some practical advice was also provided to managers in one paper that discussed methods to maximise genetic diversity in hatchery operations (Chebanov, 2004), and another that considered ecological and social citing criteria for net pen operations (Lane *et al.*, 2004). Bert *et al.* (2004) provided an effective world overview of solutions currently in use to mitigate environmental damage.

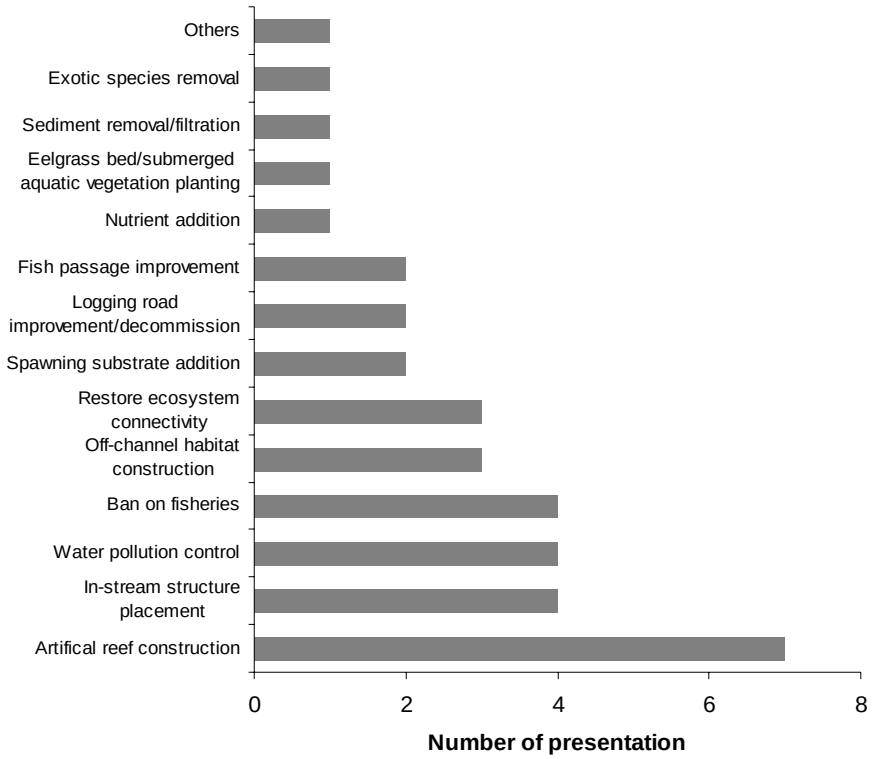

Figure 1. Summary of the types of habitat improvement technique that were mentioned in the oral presentations.

The relatively small number of papers concerning habitat improvement and stock enhancement in the Congress might imply that they were currently not considered as major approaches to reconcile fisheries with conservation. So far, the cost-effectiveness of these two approaches over the more conventional fishery management tactics is uncertain (Baine, 2001; Baine and Side, 2003; Molony *et al.*, 2003). On the other hand, their application is associated with certain ecological risks. It is generally believed that habitat improvement or stock enhancement alone is unlikely to be effective fishery management tools, unless the root causes of the ecological threats, such as over-capacity, pollution etc., are mitigated.

In the marine realm, constructing artificial reefs is the major technique used to improve habitat. Artificial reefs can be defined as a submerged structure placed on the substratum deliberately to mimic some characteristics of a natural reef (Jensen, 1998). Controversy over the cost-effectiveness of artificial reefs to meet fishery management and conservation goals is high (Bortone, 1998). A major rationale for use of artificial reefs to meet fishery management objectives (enhance and conserve stocks) is that they provide additional habitats for the living communities. These communities can eventually enhance recruitment to the surrounding areas. Also, some argued that artificial reefs merely attract stocks from surrounding habitats. Attraction would then increase the catchability of the stocks, and lead to further depletion of the stocks when the reefs are fished (Santos *et al.*, 1997). Reviews on the effectiveness of artificial reef projects in meeting fishery and conservation objectives also do not provide definitive conclusions (Baine, 2001). Further efforts to understand the effectiveness of artificial reefs in meeting various fisheries and conservation objectives may be required (Christian *et al.*, 1998)

In the freshwater realm, stream rehabilitation appears to be the focus of the presentations concerning conservation at the 4WFC. As natural freshwater habitats are increasingly disturbed by human activities, for instance, through construction of dams, logging, channelization etc., rehabilitation projects are suggested to be a means to restore the disturbed habitats and thus help to conservation the species inhabiting them. However, ecological data were lacking in many rehabilitation projects to assess this. Such data are important in evaluating the effectiveness of rehabilitation projects and improving management (Taniguchi *et al*., 2001).

Stock enhancement was addressed by even fewer presenters than habitat improvement. So far, cost-effectiveness of stock enhancement programs have been doubted (Molony *et al*., 2003, Walters and Martell, in press). Generally, effective stock enhancement does not only involve addition of hatchery produced fishes to the natural stocks, but also requires substantive a *priori* scientific understanding of the system, cost-benefit analysis, trial experiments and carefully designed monitoring programs. Moreover, considerable ecological risks are associated with stock enhancement programs, such as competition with natural stocks, transfer of disease etc. Molony *et al*. (2003) provided an example of a detailed framework illustrating how to carefully consider and conduct stock enhancement as a fisheries management tool. Based on their framework, we concluded that stock enhancement may be effective only in limited number of cases.

The focus on the ecosystem scale in the application of habitat improvement and stock enhancement may suggest an increasing recognition of the need for an ecosystem-based management approach. However, it is worrying that the presentations failed to address the ecological risks associated with habitat improvement and stock enhancement. It seems contradictory to their focus on ecosystem scale, as ecosystem approach highlights the need to address the impacts to both the targeted groups and the others that are associated with the system.

All in all, based on evaluator's comments, protected areas are "IN" approaches (as in 'innovation') to reconcile fisheries with conservation, while habitat improvement and stock enhancement are not. Aquaculture received only modest attention, and according to evaluators, presentations contributed little to the goals of the conference. It is not an "IN" approach. The establishment of a global network of large, no-take MPAs could have enormous benefits to conservation and fisheries. The uncertainty of the cost-effectiveness of habitat improvement and stock enhancement as tools to conservation and fishery management has also been highlighted. We agree that careful considerations should be made before applying these approaches.

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TALKING MANAGEMENT AND POLICY AT A SCIENTIFIC MEETING

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ABSTRACT

Use of scientific information when formulating fisheries policy and management strategies is essential to effectively managing the resource. In recent years there has been an increase in integration of disciplines, and, in this case, the integration of fisheries science with management and policy is examined. Information was collected on the treatment of policy in each scientific presentation, and this data was used to analyze trends. This paper, based on an analysis of contributions at the 4th World Fisheries Congress, provides information including what types of issues were addressed, how science was used, difficulties with policy implementation, and scientific uncertainty in decision-making. Sixty-six percent of the presentations addressed policy and management issues and, of these, 75% were considered to have a strong influence on the overall future of fisheries management. This degree of integration is encouraging, but additional consideration of resource management in fisheries science will enhance the effectiveness of management strategies.

INTRODUCTION

Fisheries scientists, managers and policy makers make different contributions to the development of policy and management strategies. Traditionally fisheries scientists conduct research purely to advance scientific understanding, while the managers and policy makers use this and other information to make decisions. The degree to which scientific information influences the final decision process is variable, and, depending on the socio-politico-environmental context, its influence may range from zero to high. Most recently, and given the current state of fisheries resources, science is more concerned with providing applied research that is useful for management and policy discussion. For sensitive and/or political issues, such as those concerning allocation of quotas, granting of access and reduction of fishing effort, decisions may be deferred on the basis of insufficient information or uncertainty in scientific findings. Such decisions have led to eventual collapse of fisheries stocks as in the case of the Antarctic whaling fishery. Interestingly, the reason for continued whaling in the Antarctic, which was scientifically uncertainty, was later used as a reason to stop commercial whaling (Heazle, 2004). Heazle argued, however, that science was not 'value-neutral' and decisions were often made based on the priorities and interests of policy makers at certain times.

In other cases, however, the use of preliminary science to craft effective fisheries policy has been successful. In a meeting of the International Commission for the Conservation of Atlantic Tuna (ICCAT) in 2000, the Commission put forth a recommendation that "All blue and white marlin brought to pelagic longline and purse seine vessels alive shall be released in a manner that maximises their survival" (ICCAT, 2000). Prevailing thought prior to this meeting was that marlin species released alive did not survive, but preliminary marlin bycatch survival data showed that marlin species are likely to survive if released appropriately (Kerstetter and Graves, unpublished). This recommendation is still in effect to help rebuild the population of blue and white marlin (ICCAT, 2000).

Fisheries management varies widely in strategy and scale. Traditional fishery management, such as that based on customary and territorial use rights, exists mainly in small-scale settings where traditional gear is used. Since the post-war years, fisheries increased in scale, fishing power and industrialisation,

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necessitating different state-based management schemes, such as limited-entry schemes, quota management, and rights and access allocation. The two main management objectives had been to maximise production for national consumption and international exchange, while maintaining resource sustainability. It became evident in the late 1980s and early 1990s, however, that state-supported fisheries development programmes had resulted in negative consequences for fisheries, the ecosystems (Pauly *et al.*, 2000, 2002) and the social systems (Bailey and Jentoft, 1990, Apostle *et al.*, 1998). Management approaches were modified accordingly with principles such as responsible fishing, precautionary and adaptive management. Also, policy objectives have, at least rhetorically, new foci on ecosystem health, resource conservation, social justice, and sustainable livelihoods.

The shift in the management focus and the principles underlying present management approaches require an integration of sciences, policy and management, such that scientific inputs contributing to improving policy and decision-making (Anon., 1995). We examine the existence of this trend at the 4th World Fisheries Congress (4WFC) by documenting the extent to which policy and management issues were discussed. Next, using the policy evaluation template (Appendix 1) as a framework, we summarise the findings in three sections: policy and management issues addressed, roles of international conventions and agreements, and principles and roles of sciences. Based on this evaluation, we provide recommendations for the effective integration of science and policy in the last section.

POLICY AND MANAGEMENT ISSUES ADDRESSED

Of the 223 papers presented at the 4WFC, 66% addressed policy and management issues. These percentages are encouraging, and we can state at the onset that scientists are increasingly linking their research to policy issues. Further examination is required to find out the context in which management and policy issues were discussed. As shown in Table 1, policy and management issues were discussed in research related to a wide range of topics. Over half of the papers that addressed policy and management issues (about 56%) did so when concerning topics such as allocation, equity, ownership and overcapacity, but less so in relation to the ethical, human and ecological dimensions of fisheries. Interestingly, policy and management were more often discussed in the context of aboriginal and recreational fisheries than in small-scale fisheries. This may be due to the fact that the majority of the research presented at the 4WFC was conducted in developed countries (Chuenpagdee *et al.*, 2005), where interests in aboriginal and recreational fisheries are prominent.

Table 1 also shows that policy and management discussion was more prominent in studies related to coral reefs and deep-sea ecosystems than in others such as coastal zones, watersheds, enclosed sea and streams. The policy and management interest in coral reefs system was mainly related to conservation effort at the global level (Vincent, 2004) or at community level (Mahon *et al.*, 2004, Satria *et al.*, 2004). Corresponding to the current interest in seamount conservation, a paper by Morato *et al.* (2004) addressed the management of seamount ecosystem in British Columbia. The other papers concerning deep-sea ecosystems focused more on impacts of fishing in national water, e.g., New Zealand (Clark, 2004) or in international water (Sharp-Brewer, 2004).

Table 1 List of research topics (as indicated by the name of the 4WFC session) categorised by the frequency by which policy and management issues were discussed. High means at least five papers in the session discussed policy and management issues; medium means 3-4 papers, and low means only 1 or 2 papers had policy and management discussion.

High	Medium	Low
Jurisdictional equity	Ethical approach	Maintaining biodiversity
Fair allocation	Human dimensions	Fisheries trade
Overcapacity and effort management	Ecological dimensions	Polar seas
Decision framework	Small-scale fisheries	Estuaries
Ownership across boundaries	Bycatch reduction	Floodplains
Aboriginal fisheries	Lessons from history	Enclosed seas
Roles of sport fisheries	Food web constraints	Streams
Protected areas	Stock assessment & adaptive management	
Marine fisheries habitat improvement	Ecological footprints of aquaculture	
Stock enhancement	Ecosystem indicators	
Lake and human-made lakes	Roles of data quality	
Coral reefs	Freshwater habitat improvement	
Deep sea	Climate change	
	Open ocean	
	Coastal zones	
	Watersheds	
	Large rivers	

In examining the level at which policy and management actions were discussed, we found that about half of the papers that addressed policy (72 out of 148) were related only to one institutional level (i.e. local, state/province, national, international or global), another 27% dealt with more than one level, and the rest did not specify which level their research addressed. Of the papers that only addressed one level of policy and management, 32% involved national, 25% international, and the rest was evenly distributed among local, state/provincial and global levels. Moreover, the analysis showed that 35 out of the total 223 papers concerned joint jurisdiction of fisheries or issues intrinsic to areas regulated by more than one jurisdictional, such as conflicting rules, laws and authority. Notably, many groups outside of government or jurisdictional entities, such as aboriginal fishers, recreational fishers, small-scale fishers, commercial fishers, tourists, and oil and gas companies, were also indicated as having influence over policy and management issues.

THE ROLE OF INTERNATIONAL CONVENTIONS OR AGREEMENTS

About 21% (31 out of 148) of papers addressing policy and management issues made direct reference to international conventions or agreements. The most often cited were the United Nations Convention on the Law of the Sea (UNCLOS), the FAO Code of Conduct for Responsible Fisheries, the Convention on International Trade of Endangered Species (CITES), the Convention on Conservation of Antarctic Living Marine Resources (CCMLR), and the EU Common Fisheries Policies. The issues related to these conventions or agreements were a combination of enforcement, compliance, and equity, while ethical issues were hardly considered. Twelve papers addressed issues related to IUU (illegal, unregulated, and unreported) fishing. Researchers mentioned measures such as trade sanctions and monitoring systems to promote compliance with fisheries regulations. Of the 31 papers addressing international conventions or agreements, six papers considered that these instruments were largely ineffective, two papers indicated

the contrary, and the rest did not specify. Difficulties in enforcement stemmed from problems with enforcement in a large area, high seas monitoring and difficulty in implementation. Interestingly, administrative costs were not specifically mentioned as being prohibitive. The two effective cases concerned the Alaskan sablefish and Patagonian toothfish fisheries (Lundsten, 2004) and the rehabilitation of the Laurentian Great Lakes (Stein and Goddard, 2004). Notably, both cases suggested that success was due to the collaboration among fishers and government agencies at different levels.

PRINCIPLES AND ROLES OF SCIENCE

The principles upon which management and policy decisions were made were assessed in 148 papers. Researchers documented that sciences are primarily used in conjunction with management actions based on principles such as ecosystem-based, precautionary, and equity/fairness (Figure 1). Again, ethical principles were mentioned by very few papers, as were legitimacy and accountability.

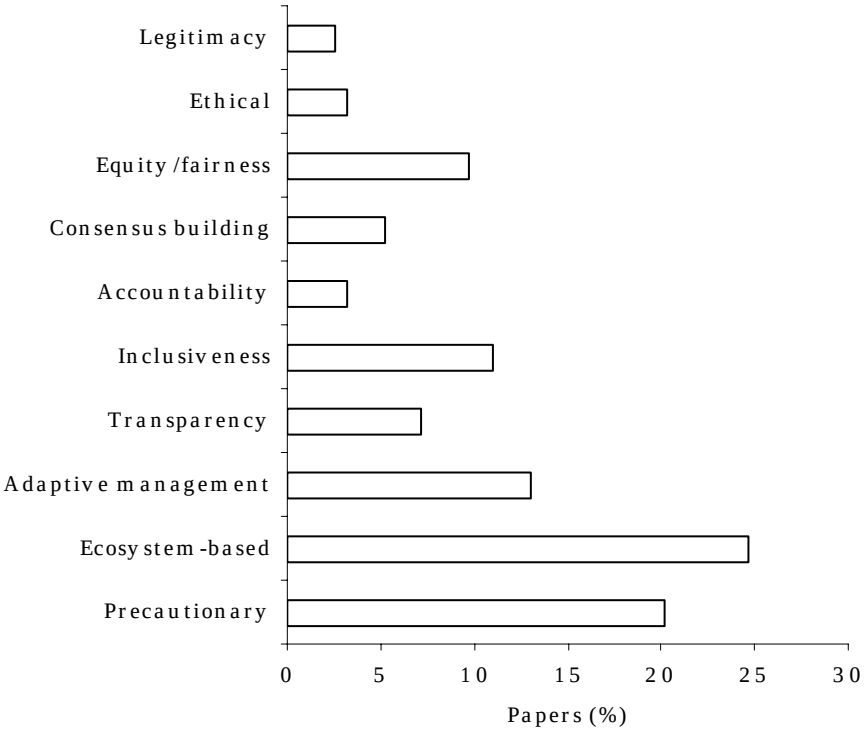

Figure 1. Principles used as basis for fisheries management and policies

Forty-eight papers (out of 148) were evaluated as basing policy and management on the "best available science" (Table 2). The role of sciences in management and policymaking were reported as not significant because the best science was not used (7), not available (5), overshadowed by politics (3) or lacked scientific credibility (2). The distribution of use of science by geographical distribution of papers based on level of development is shown in Table 2. It is worth noting that the one case where science not credible for use in management and policy occurred in a developed country, whereas the one case of strong politics prohibiting the use of science was recorded in a developing country (i.e., Argentina, see Vigliano, 2004).

Table 2. Distribution of papers (number) based on the use of science by level of development of countries where research was conducted.

Uses of science	Developed	Developing	Global	Not specified	Total
Best sciences used	19	11	3	15	48
Science not used	4	0	1	2	7
Science not available	2	1	0	2	5
Science not credible	1	0	0	2	3
Too much politics	0	1	0	3	4

INTEGRATION OF SCIENCES AND POLICY

It was encouraging to observe that researchers at an internationally important fisheries meeting such as the 4WFC discussed a wide range of policy and management issues. About 75% of the papers that addressed policy and management issues were considered to have medium-high to high-impact to the overall future of the fisheries. Indeed, our analysis showed that management and policy decisions in these medium-high to high impact papers were also based on the best available science. The results indicated that scientific information, to a large extent, was used in the policy and decision-making process, but researchers also reported that best science were not used universally and scientific uncertainties are prevalent in fisheries research. Scientific uncertainties will always exist, however, and should not preclude decision-making. Rather, decision-making should be attempted even if information is incomplete (Vincent, 2004). Inputs from stakeholders, including their views and beliefs (Cass *et al*., 2004) and their perception and judgments (Chuenpagdee *et al.*, 2001), can be used to complement scientific information. Also, as shown by several recent studies, local and traditional ecological knowledge is useful in informing science and management (e.g., Castello, 2004, Davis *et al*., 2004 and McConney *et al*., 2004).

Although "best science" may be available, its usefulness and timeliness to address fisheries problems remains questionable. As stated by Pauly (2004), science can be too passive and tends to respond mainly to crises. Both the precautionary principle and FAO Code of Conduct for Responsible Fisheries suggest the use of pro-active alternative management and decision frameworks to prevent future stock collapses. Finally, when science is not used in management and policy decisions, it may be due to the difficulty of translating technical scientific results, often presented as academic research, into management, or to the wider public. Only 11% of papers on policy and management tried to communicate their results to the general public. This supports the need for effective dissemination and communication of research results stated in Chuenpagdee *et al*. (2005).

Assuming that best sciences are available and well-communicated, a main problem concerning the integration of sciences and policy remains: the interest and willingness of policy and decision-makers to use scientific information. As our analysis showed, politics can prevent the full incorporation of good science into fisheries management decisions. This can be resolved partly through meaningful participation and involvement by resource users and other stakeholders. Using this strategy could help to provide a system of 'checks and balances' to the management implementation. Since only about 44% of all papers presented at the 4WFC demonstrated attempts to integrate natural, social, economic or policy aspects (Chuenpagdee *et al.*, 2005), more can be done to encourage integration. Some possible venues are through university interdisciplinary programmes, education and training, and through network activities, such as those represented in *AQUALINK*.

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ROLES OF COMMUNITIES AND STAKEHOLDERS IN RECONCILING FISHERIES WITH CONSERVATION

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ABSTRACT

Two forums at the 4th World Fisheries Congress provided space for stakeholder groups to air their concerns and conservation strategies. Representatives from fishing communities and consumers discussed rights and allocation, communication barriers, and the interconnectedness of diverse issues. Fostering effective communication among scientists, managers, policymakers, fishers, and the non-fishing public continues to be a critical challenge to reconciling fisheries with conservation. At both forums, panel participants reminded us that, while many fisheries scientists and conservationists may forget this, consumer demand determines what species fishers target. Thus, the application of market-based strategies to marine conservation may prove to be a critical component of global fisheries conservation strategies.

INTRODUCTION

In addition to the research-oriented presentation and discussion sessions at the 4th World Fisheries Congress (4WFC), two sessions were organised focusing on fishing communities and other stakeholders, particularly fish and seafood consumers. The first was the *'Forum on Reconciling Fisheries with Conservation within the Fishing Community'*, and the second was the *'Forum on Sustainable Seafood Movement'*. This paper provides an overview of the discussion at these sessions.

FORUM ON RECONCILING FISHERIES WITH CONSERVATION WITHIN THE FISHING COMMUNITY

The Forum on 'Reconciling Fisheries with Conservation within the Fishing Community' provided a unique opportunity during the 4WFC for two panels and several keynote speakers to address fisheries conservation as it specifically applies to varied stakeholders, many with longstanding connections to both fishing and conservation. Three overarching themes of the day's discussion included rights and allocation, communication, and the interconnectedness of ecosystems and environmental issues.

Rights and allocation

Much of the day's discussion centered on the idea that reconciliation between fisheries and conservation fundamentally concerns the allocation of rights. Allocation is a complex topic, as it relates to the division of access, rights, and privileges, not only between today's commercial and recreational fishers, but also between present and future generations. Panelists and forum participants discussed positive incentives for conservation and economic efficiency and questioned the associated costs and benefits. What cost does the overall community pay and how much benefit does it receive? A keynote speaker, George Kailis, of MG Kailis, a seafood corporation, stressed that the first step to evaluating costs to the community is to establish a "cost-recovery regime", in which fishers pay the full cost of management. Otherwise, fishing is subsidised by the community, which makes evaluating the true costs of fisheries difficult and makes managing fisheries into a welfare management decision.

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Speakers identified the commonly perceived split between individual rights and collective rights as inaccurate and counterproductive. Inherent to increasing the overall value of a fishery is the creation of new rights to protect the common right. One speaker stressed that if new rights are not created, a resource will have value to no one (i.e., it is not a zero-sum game). Kailis argued that management strategies such as limited-entry fisheries generate incentive for fishers to enhance the value of their rights with creativity and investment. Rights-based fisheries can empower fishers to conserve their resources, provided that problems concerning allocation are solved fairly.

Speakers repeatedly emphasised the fact that denying other people's rights ultimately undermines your own rights. Rights-holders should be the strongest advocates for the more equitable distribution of rights. In addition, participants urged the group to acknowledge government's actual capability and limitations for resource management in future discussions of rights and allocation. Andrew Rosenberg of the U.S. Commission on Ocean Policy reminded Forum participants that "the constituency for ocean resource issues must be broadened. If the public is not interested enough to create political pressure for conservation, it is unreasonable to expect government to take actions as strong as are needed."

Communication and commitment

Speakers and forum participants concurred that many important issues in fisheries conservation concern the use and interchange of technical information by policy, management, and public sectors. Fostering effective communication between scientists, managers, policymakers, and the public continues to be a critical challenge to reconciling fisheries with conservation. Understanding how diverse technical disciplines communicate with each other will be part of the ongoing challenge to work within our differences (e.g., language and technical capacity). One part of this is recognizing roles of different organizations and their communications strategies. For example, non-governmental organizations (NGOs) play a crucial role in creating political space to discuss controversial issues. NGOs are generally responsible for sounding the alarm during environmental crises, and try to do so in a fashion that avoids hysteria while still communicating their passion. They create what forum speakers called a "lighthouse effect," in which they illuminate important issues for the public to notice. This spotlight, however, has its disadvantages: it soon passes on to the next hot topic. Building ties with fishers and managers is difficult when NGOs' involvement is limited to sporadic times of crisis within their fisheries.

Many speakers highlighted the importance of relationships between individuals, and the theme of identifying barriers to collaboration and communication between scientists, fishers, and local communities was revisited often during the day's discussion. Participants spoke about the need to identify barriers and successes for collaboration. Unfortunately, while this forum should have provided the space to explicitly address these barriers, certain features of it prevented concrete discussion from developing. Because the forum was held in a large and elaborate ballroom, all participants faced forward and addressed panelists in formal commentary. Participants often had difficulty speaking to each other's comments as most questions were directed to the platform at front of the room. When one participant challenged the group to identify three barriers to communication between fishers and scientists as well as three solutions to these barriers, a brief response from panelists acknowledged the importance of this challenge, but no discussion materialised. In addition, the one-day forum conflicted with the day's scientific symposia and was held in a separate building. The segregation of this forum, as well as the 'Forum on the Sustainable Seafood Movement', conformed to historical tendencies to separate different forms of knowledge, thus reinforcing the perceived division between scientific knowledge and experiential knowledge and broader interests and applications. The logistical barriers to open communication at the forum mirrored epistemological barriers to developing innovative ideas and building trust, both of which are common challenges in collaborative projects involving diverse stakeholder groups.

Small places, big connections

The speakers also stressed the interconnectedness of environmental issues and of ecosystems. C.W. Nicol, International Conservation, described how often we forget the depth and breadth of our actions, especially the small ones. He used the analogy of a child wrapping a piece of elastic around her small finger. Left unattended, the hand will die, followed by the body. Nichols urged researchers and stakeholders to shift their attention back to the little places, the areas and issues that are inextricably connected to the larger systems that we struggle to understand and to protect. Following the theme of interconnectedness, a participant from France raised a concern, "How can children learn to recognise fish as a living resource if

the only time they see it is in their MacDonald's sandwich?" The need to foster the transformation of seafood consumers into discerning seafood customers was emphasised.

THE FORUM ON SUSTAINABLE SEAFOOD MOVEMENT

Environmental advocates, seafood suppliers, public relations experts, and a chef discussed the role of consumer choices in fisheries conservation at the Forum on the Sustainable Seafood Movement. Speakers and participants highlighted the conceptual framework and strategies underpinning the movement and the challenges it continues to face.

Making the ocean-plate connection

Harnessing the power of consumer choice to advance the conservation and restoration of marine ecosystems is not a new strategy. During the 1980's, public outrage in the United States over high dolphin mortality in the tuna fishery directly resulted in laws banning importation of tuna not caught in "dolphin-safe" fishing operations. In recent years, consumers have expanded their focus beyond dolphins, and the Sustainable Seafood Movement, driven by seafood pocket guides, eco-labeling, and partnerships with seafood purveyors and corporations, has gained momentum. Certification of ten major fisheries as sustainable by the Marine Stewardship Council and efforts by organizations like the Blue Ocean Institute, Environmental Defense, Monterey Bay Aquarium, and Seafood Choices Alliance to educate consumers, seafood suppliers, and chefs are hallmarks of a movement to accelerate the pace of positive change in the management of fisheries.

One of the most widely used strategies in market-based marine conservation is the publication of seafood guides, which enable consumers to make informed seafood choices at restaurants and seafood markets. The first guide to ocean-friendly seafood was published in 1998 in the Audubon Magazine. Also that year, SeaWeb and Natural Resources Defense Council initiated the first campaign to directly engage chefs. *Give Swordfish a Break* encouraged chefs to seek alternatives to Atlantic Swordfish, which at the time was severely overfished, on their menus. In 2000, Mércèdes Lee published the Seafood Lover's Almanac, which described the ecology and population status of common fish and shellfish species consumed in the United States and included sustainable seafood recipes contributed by well-known chefs. *Caviar Emptor* seeks to educate chefs and consumers about the severe declines of several species of sturgeon, especially Caspian Sturgeon, which provide Beluga caviar.

Speakers cited H.M. Johnson's 2004 Annual Report on the United States Seafood Industry indicating that more than seventy percent of the money spent on seafood in the United States is spent in restaurants. Rick Moonen, a founding member of the Seafood Choices Alliance and chef and restaurant owner in New York, described how the role of the chef has changed in recent years. The popularity of the Food Network and the many food magazines has bestowed celebrity and influence upon chefs. Participation of chefs in the Seafood Choices Alliance and species-specific campaigns has resulted in, for example, high-end seafood restaurants such as Le Bernardin in New York City not only refraining from serving Chilean Sea Bass but also displaying messages on the bottom of their menus declaring support for NRDC and SeaWeb's efforts to allow this species to recover.

Without suppliers of ocean-friendly fish, the Sustainable Seafood Movement can only go so far before losing steam. The Seafood Choices Alliance is now focused on addressing the disconnect between the fishing and retail sectors by distributing sustainable seafood supplier directories to chefs and retailers and hosting daytrips on fishing vessels for them.

Building business support

Representatives from major environment-business partnerships discussed their motivations for their partnerships and highlighted their successes and future goals during the day's forum. Perhaps the most famous partnership of this kind in marine conservation was between the World Wildlife Fund and Unilever, which formed the Marine Stewardship Council (MSC) in 1997. Since the council became independent of its founding organizations in 1999, Unilever has continued to support sustainable fisheries and, by 2003, was purchasing more than 50% of their fish from sustainable sources. The MSC certifies

sustainable fisheries that undergo a rigorous examination and public feedback period. Products that can be sourced to fisheries certified to MSC's standards can display the MSC logo.

The New England Aquarium formed a partnership with Ahold USA, a parent company of 1600 supermarkets in the United States with 20 million customers a week, to help the company research and choose fish from sustainable stocks. By making purchasing recommendations to the corporation, which is a major seafood purchaser, the aquarium creates incentive for fishers and fish farmers to develop sustainable harvesting practices to meet Ahold USA's requirements. Heather Tausig of the aquarium reported that Ahold USA is also seeking to train 1500 seafood managers in its stores to be knowledgeable about the fish they sell, the gears used during harvest, and the sustainability of fisheries.

What has compelled these businesses to pursue environmental over-compliance? Gwen Ruta, director of Environmental Defense's Alliance for Environmental Innovation, believes that corporations today are more aware of their roles as global players, and, as such, are more cognizant of their responsibilities to the environment. Dierk Peters of Unilever cited public spirit, enlightened self-interest (e.g., in securing a long-term source of whitefish for Unilever's large frozen fish supply business), and corporate social responsibility as motivating factors for Unilever to pursue an environmental as well as an economic bottom line.

Critical to developing effective partnerships is being upfront about the agendas of the partners involved. Ruta presented the example of the Alliance for Environmental Innovation's work with McDonald's, in which replicability was key to the alliance's agenda. In this case, the alliance explained upfront to McDonald's that if the partnership was successful in reducing McDonald's packaging wastes, it would seek out similar partnerships with McDonald's competitors. By being honest and demonstrating to corporations that generating real, quantitative results, not "green-washing" corporate policies, is their objective, environmental organizations have built and are building innovative partnerships with the business world to further conservation goals.

Marketing the sustainable seafood movement

In 2001, the Seafood Choices Alliance surveyed American seafood consumers, suppliers, and purveyors to ascertain their attitudes about seafood sustainability. Pinpointing Americans' views on issues ranging from seafood health to commercial fishing practices prepared the alliance to develop materials to effectively educate the spectrum of consumers and purveyors. Popularizing sustainable seafood choices also involves reversing messages that previous marketing campaigns have taught the public. Gerry Leape of the National Environmental Trust discussed how marketers re-named the Patagonian toothfish as "Chilean sea bass", and the consumption of the fish doubled from 1999-2002. Meanwhile, populations of the long-lived fish have plummeted as much as 60%, and commercial extinction of the species may occur within the decade. With the United States being the 2nd largest market for Chilean Sea Bass, campaigns, such as *Take a Pass on Chilean Sea Bass*, are necessary to reverse this trend and educate consumers, suppliers, and chefs about the status of this fish.

The visual message to consumers is one of bounty in today's seafood markets, which offer more variety than ever. Fostering an understanding of the "ocean-plate" connection in seafood purveyors and consumers, therefore, is a challenge that requires innovative approaches. Several strategies for effective communication of the Sustainable Seafood Movement among scientists, fishers, consumers, retailers, and corporations were discussed during the day's forum. A popular misconception within the scientific community has been that if scientists can publicise the facts about the exploitation of marine resources, via websites, documentaries, and print and television media, the public will understand how important the issue is and change their buying habits accordingly. Social marketing addresses the unlikelihood of this theory being effective on a large scale by acknowledging the inherent challenge in selling something to consumers that they do not know they need.

Mobilizing experts on behalf of the Sustainable Seafood Movement is a key strategy of the movement. Scientists, when communicating effectively, can lend credibility and a human connection to otherwise faceless laws and regulations. Six suggestions offered during the forum by public relations executive, Scott Widmeyer, are summarised below:

1. Do not say, "I don't know..." when you are talking with press or legislators. Scientists tend to dwell on the limits of their knowledge: grant proposals require that scientists characterise these limits and seek ways to push them back. As conservation advocates, however, scientists should not focus primarily on the limits of their knowledge but emphasise what they do know about the issue in consideration;
2. Be willing to engage with the public and media;
3. Share personal stories;
4. Do not assume that people understand science. Offering the context of the scientific process that led to an important finding lends much more credibility to the finding;
5. Do not talk only of crises: much of the public is experiencing "doom fatigue". Even the most enthusiastic of lay environmentalists tire of hearing warnings of imminent doom;
6. Establish long-term credibility by being honest about whom you are and what your agenda is when you speak to the public and media.

Challenges to the Sustainable Seafood Movement

1. "How do you encourage a company to source different seafood even when there are no other alternatives? How do you get a commitment for the development of a sustainable source when this alternative is not already available? That is, how do you get companies to affect change?" (Gwen Ruta, this forum)
2. How do we form lasting partnerships with businesses that can survive board changes, economic downturns, and the pressures of globalization?
3. How can we consistently reach people over time? The immense problem of dolphin bycatch in tuna fisheries captured the world's attention when many of today's consumers were children. Today, consumers are satisfied to know that dolphin meat is not in their tuna, but they have forgotten their past concerns about the detrimental effects of bycatch on marine ecosystems. Bycatch remains a major problem, but the issue is dead.
4. How do we ensure that the fish we buy is not derived from and contributing to the exploitation of workers and exacerbating starvation in some countries? How can we know that choosing to avoid certain types of seafood will not strip fishing communities of income that they depend on for their livelihoods? In the United States, 77% of all seafood eaten is imported, and the changes occurring in this market affect fisheries around the world (Michael Sutton, The David and Lucille Packard Foundation, this forum). Panelists did not discuss the possible implications that the Sustainable Seafood Movement may have when, for example, the public supports policies that make the importation of any non-dolphin-safe tuna illegal in the United States. As one participant in the forum reminded the group, "Angola's economy is teetering on collapse; the situation is desperate beyond your ability to imagine sitting in this room. If your fish is dolphin-safe, it must also be free from guilt, free from the exacerbation of starvation in Africa."

CONCLUSION

While many fishers and fisheries scientists may forget this, for many people, the food on their plate is their closest connection to aquatic ecosystems. The power of consumer choice to drive conservation may not be a new idea, but its application to marine conservation may prove to be a critical component of global fisheries conservation strategies. Popularizing the Ocean-Plate Connection among consumers, purveyors, and suppliers is the main objective of the movement, which seeks not to substitute itself for policy and management, but to serve as a tool to direct the motivation of concerned citizens and businesses towards making better choices. The Sustainable Seafood Movement is unique in that it seeks to inspire conservation rather than demand it: "[The movement] changed the tone of the marine conservation movement from one of a strictly combative sense to engaging the public in a positive atmosphere" (M. Lee, *pers. comm.*). By opening the discussion about seafood, the movement reaches people who do not yet realize how much they care.

RESULTS FROM PANEL DISCUSSIONS: PRIORITY AREAS FOR RESEARCH IDENTIFIED AT THE 4TH WORLD FISHERIES CONGRESS

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ABSTRACT

Following the 4th World Fisheries Congress in Vancouver, prominent researchers in fisheries and marine science volunteered their time to engage in a broad-view panel discussion with members of *AQUALINK* and other participants. In the first panel discussion, "Been there, done that", panelists identified important areas of current research in fisheries science, and evaluated the effectiveness of the Congress in addressing these concerns. Consensus suggested that representation was lacking from the presentations. In particular, there were too few participants present from developing nations. Conclusions reached by the first panel discussion indicate that there is a clear need to resolve long-standing issues of ownership and property rights in marine fisheries - in order to combat difficulties in managing the open pool resource. Participatory management, which takes advantage of local community knowledge and cooperation, has been overlooked as a means to achieve sustainable fisheries despite numerous success stories from the developing world. In the second panel discussion, "The new frontier", panelists considered emerging fields of study in fisheries science. They agreed that one priority for the future should be to encourage multidisciplinary research. We must especially consider how management decisions are likely to affect people and societies in diverse sociological terms. Finally, it is important to disseminate scientific findings to the public in a way that will engage them, and encourage grass-roots support for responsible and sustainable fisheries.

INTRODUCTION

The one-day workshop on 'Innovation and Outlook in Fisheries' was held on May 7, 2005, following the 4th World Fisheries Congress (4WFC). Members of *AQUALINK* presented a summary and analysis of presentations to a panel of fisheries experts (see Appendix 2). We challenged them to identify the most relevant and exciting areas of research presented at the Congress, and to suggest priority areas for future research in fisheries. The panel represented a broad cross-section of expertise: sociologists, economists, fisheries and natural scientists were present. More than 20 graduate students and other participants from Canadian and US marine science institutes attended. The dialogue was divided into two discussions: the first section "Been there, done that" considered the merits and applications of existing veins of research. The second panel discussion dealt with "The new frontier", and focused on emerging research in fisheries science. Panelists brought their collective knowledge and experience into focus to comment on important themes raised at the Congress, and determine whether the meeting had contributed towards the goal of reconciling fisheries with conservation. This article will summarise the main conclusions from each panel discussion.

To stimulate debate, four questions were put to the panelists:

1. What is your opinion about what we consider "hot" and "not so hot"? Have we (*AQUALINK*) missed anything? What other aspects should be considered?
2. Is there any merit in trying to continue with research that is considered "not-so-hot"?

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3. Based on your experience, is there any "new" research that needs to be done?
4. In your opinion, what is the most urgent action required to reconcile fisheries with conservation and how can it be achieved?

FIRST PANEL DISCUSSION: BEEN THERE, DONE THAT

Each panelist offered a brief statement in response to *AQUALINK's* questions, and highlighted what they believed were the most important topics to emerge from the Congress. The discussion that followed centred on a number of principle issues; this section summarises the main conclusions reached in the first panel discussion.

The need for representation

Following suggestions by Dr. G. Munro and Dr. K. Cochrane, there seemed to be consensus among panelists that economic issues in fisheries were underrepresented at the congress. The point was also noted in the day's presentations by *AQUALINK*. Dr T. Charles and Munro agreed that legal aspects were also underrepresented; they suggested that further work is needed to settle issues of ownership and property rights if conservation efforts are to be successful. However, to be fair to these concerns, Dr. D. Pauly pointed out that the direction of scientific research is not usually determined by scientists directly involved in the fisheries, but by governmental funding agencies. He suggested that funding and effort are not always directed to where they are needed, unfortunately, but to areas of immediate political advantage. The observation preceded Dr. J. Alder's comments in the second panel discussion - that government researchers are often unfairly restricted to work within the interests of industry.

Comments from several of the panelists reiterated a point that was originally brought up at the Congress during the end-session open dialogue. There was a generally uneven representation at the meeting – in particular, some panelists criticised that there were too few participants present from developing nations, and that industry was also poorly represented. It was noted also that students were underrepresented because of prohibitive conference fees.

Competition for a common pool resource

It was agreed upon by panelists that certain long-understood obstacles to effective marine management and conservation, although perhaps addressed at the congress, remain to be resolved in global fisheries.

Gordon Munro mentioned the widely stated problem of open access to common-pool fisheries resources, citing how resources are too often regarded as non-renewable by users - in practice if not in politics. That view contributes to unsustainable 'mining' of resources. He suggested that more research could help us to understand specific economic factors that encourage over-exploitation. Citing an example from the work of Vincent (KAMADA; community-based fishers alliance), he proposed that economic incentives have not been fully utilised throughout the world as a means to protect against resource depletion (e.g. eco-labelling). He went on to suggest that poachers and "free riders" pose a serious obstacle to the kind of 'passive' management in use today. If conservation is to work as a bottom-up approach, he suggests that communities need assurances that they will reap the benefits of conservation. Otherwise, uncertainty regarding the future of the resource will preclude the sort of long-term investment (monetary or otherwise) needed for effective conservation.

Remarks made by Daniel Pauly also relate to the common-pool resource problem. He believes that it is important to discriminate between "fishers", those who rely on the resource for long-term sustenance, and fisheries investors, whose intention is to provide a timely return for investors. Although investors are not necessarily greedy, he cautions, corporations view exploitation of marine resources as any other investment. To serve their bottom line, fishing companies will find exploitation acceptable to a degree far beyond what can be considered socially responsible.

Fishing communities are an understated resource

In contrast to big business, local communities have more interest in sustaining the resource. Dr P. Gallaugher presented an example where a local community member (with biological training) recognised a shortcoming in governmental research. The concerned citizen took it upon herself to "blow the whistle" on an ecological threat that was close to home – sea lice on coho salmon smolts. In another example, a private fisher led the initiative to develop a coho recovery box, to reduce bycatch mortality and thereby increase sustainable harvest rates. Dr. P. Gallaugher suggested that collaborative organizations like the Oceans Management Research Network (OMRN) can help harness the creative and industrious potential of fishing communities. She believes that partnerships between government, academic and community researchers can "take up the slack" left by governmental research deficiencies.

Communities are also a repository of ecological knowledge that has been widely ignored by scientists. Statements made by J. Charles, P. Gallaugher and K. Cochrane agree on the need to take a more participatory approach to fisheries management. In particular, there is a need to incorporate local ecological knowledge into science-based management, and to submit management plans for community approval. Not only will this improve management of stocks, it may also prompt a sense of ownership in the resource that will minimise the problems associated with common pool access.

Actions needed to reconcile fisheries with conservation

Kevern Cochrane suggested that the most urgent action needed to reconcile fisheries with conservation is to combat the increasing polarization between resource use and conservation. Nowhere is the polarization felt more strongly, he suggests, than in developed countries like Canada. Drawing an example from the process used by the African National Congress to abolish apartheid, he suggests that negotiations should focus on reconciliation between parties, in order to minimise conflict and stem the loss of resource potential. Although an objection raised during question period would advocate conflict as healthy human intercourse, K. Cochrane's point echoes the summation provided by Pauly in his plenary address. Given the advanced state of decline in most of the world's fisheries, the goal of fisheries and conservation should be the same – to return world fish stocks to some semblance of their former size and productivity.

SECOND PANEL DISCUSSION: THE NEW FRONTIER

This panel largely addressed where research in the field of conservation and fisheries should be headed. The suggestions ranged the continuum from science-based research to policy-based research to economic-based research. The main points from this discussion follow.

Scaling up adaptive management

Dr. J. Alder recognised that the role of the public servant is to serve the interest of the public, rather than an administrator whose interests may be elsewhere. She stated that many successful management systems have been small-scale adaptive management programs. The theory and science behind adaptive management is sound, but there are difficulties in implementing adaptive management at larger scales. Dr P. Christie added to this by addressing the marginalization of community-based natural resource management. He also raised the question as to how management can work at the larger scale when most management is being conducted at the local level. Difficulties arise with enforcement, implementation, buy in, and the role of NGOs in the management action. In these efforts, the developing world is way ahead of the developed world. Christie suggests that research be focused on action and the implications of those actions. Dr L. Morgan further discussed this issue by examining the human impact on ecosystems and questioning the standards by which ecosystem health goals are set.

Addressing the needs of underrepresented populations

Statements made by Dr P. McConney indicated that more research attention should be paid to underrepresented populations. Scientists and small-scale fishers working with management plans are not proactive in publishing the results of their trials; therefore, they tend not to get the scientific attention that may be warranted by the results. The women within small-scale fisheries are also a population where more

resources should be invested. These types of populations were underrepresented at the 4WFC. Scientists must work to involve more stakeholders in small-scale fisheries in the sharing of information.

Creation of incentives to protect resources

The need for non-market valuation of coastal resources was brought up by Dr R. Sumaila. Research in this area is lacking and adequate coverage of the topic could lend insight to the true value of our resources. It would also inform resource allocation efforts and work to create incentives to protect resources in the future. By using political means, the guidelines that currently do not restrain and may even encourage overfishing can be renovated to create incentive-based regulations that work to preserve more resources for the future. P. Christie added that some researchers have proposed a global system of Marine Protected Areas (MPAs). Difficulties would arise with a system of MPAs, such as social and political feasibilities, or motivation and placement of MPAs.

Working toward interdisciplinarity

Statements by P. McConney illustrate the interdisciplinarity necessary for successful management efforts. Compartmentalizing the variables (scientists, managers, stakeholders, etc.) associated with taking a management action will result in ineffective management. One must look at the interactive qualities among and between those groups that will be affected by the management plan. Communication among stakeholders and managers is the key to management success. Morgan recognised the importance of consideration of the human component of ecosystem management. The goals we set for the ecosystem should integrate information about needs of the human population in the area of the resource.

Dissemination of information

Another important area of research addressed by L. Morgan is the dissemination of information. As scientists, we are familiar with writing papers to be read by other scientists. Efforts need to be made to disseminate information to the public and design fact sheets and brochures to attract the interest of the public. Success and horror stories should be released to the general population, so people can learn from what has gone right/wrong in the past. This would lead to better understanding of why certain actions are taken rather than other actions.

CONCLUSIONS

Panelists acknowledged exceptional research presented during the 4WFC Congress, but warn that to successfully reconcile fisheries with conservation it will become necessary to take a broader view of science and management in the future. Recurring points raised in discussions called for a more holistic examination of the social and economic consequences of management decisions. In particular, scientists and managers must be amenable to a more bottom-up approach to management than has been traditionally applied, at least in the developed world. This will help us to capitalise on the industry of coastal communities, and it will facilitate the wide-scale support needed to ensure sustainable fisheries.

TO BOLDLY GO WHERE NO ONE HAS GONE BEFORE

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ABSTRACT

This paper reports on breakout group discussions that were part of a one-day workshop "Innovation and Outlook in Fisheries" held immediately after the 4th World Fisheries Congress (4WFC) by *AQUALINK*. The breakout groups offered participants the opportunity to flesh out ideas that they may have developed during the 4WFC and the workshop. Each group was asked to first derive a list of research issues and topics that need to be addressed in order to reconcile fisheries with conservation, then explore some of these in detail. Many issues were identified as important for reconciling fisheries with conservation, but perhaps the largest was communication. The identification of participatory, inclusive approaches to fisheries management with greater emphasis on bottom-up approaches to management was consistent among all groups. None of the groups focused on science issues alone and where ecosystem-based management or marine protected areas were discussed, it was mostly in relation to their social implications.

INTRODUCTION

After five days of listening to others espouse their ideas on reconciling fisheries with conservation at the 4th World Fisheries Congress (4WFC), participants at the *AQUALINK* "Innovation and Outlook in Fisheries" Workshop were given the opportunity to contribute to the discussion. After the presentation of the congress summary and responses from the panelists, workshop participants were divided into four groups, each comprising of a mixture of researchers and scientists in various disciplines and experiences (see Appendix 2 for the list of participants and their specialisation). Each group was asked to first derive a list of research issues and topics that need to be addressed in order to reconcile fisheries with conservation. These issues were then prioritised and participants were tasked to identify, for each prioritised issue, research objectives and questions, as well as to suggest methodologies that should be employed to accomplish the objectives. Participants were encouraged to think widely, debate freely and to be bold in their ideas for considering research topics and issues that need to be addressed in order to reconcile fisheries with conservation. At the end of the workshop, representatives from each group made a report back to the workshop for general discussion.

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Despite a wide range of issues listed from the first round of discussion, there was a degree of commonality such that most issues were identified by more than one group and some, for instance, "justice and equity issues" and "incentives and institutions" were identified by three groups. None of the issues listed were purely biological or ecological in nature and, as with the larger 4WFC, explicit recognition was made of the need for greater interdisciplinarity in research approaches and the management of resources. Other common methods to address the research issues included comparative and participatory approaches. While there was similarity in the direction of thought of the four groups, there were also differences in the details. This paper summarises some of the more involved group discussions based on the key issues identified.

KEY ISSUES, RESEARCH QUESTIONS AND WAYS TO ADDRESS THEM

Social justice, rights, access and equity

Discussion about social justice and equity evolved around the multiplicity of fisheries stakeholders and their relative access to the resource. Participants acknowledged the interactions among industrial, small-scale, artisanal and recreational fishers, and the implication of these interactions on allocation of access and rights. Profound examples of inequality and injustice were noted in the process of fisheries development, not only between developed and developing countries, but also between current and future generations. In particular they focused on the negative impacts of large-scale fishing on the small scale sector:

Issue	Loss of traditional livelihoods of small-scale fishers who have been disenfranchised from the fishery due to fisheries exploitation by the large-scale industrial sector.
Research questions	How can the small-scale fishers regain their traditional resources and how can we disengage the industrial sector from the resource?
Methods	International comparison of how small-scale sectors have lost their traditional resources using lessons from history from those who have lost access and those how have managed to retain or regain it.

Participants noted the difficulties in dealing with these issues. These include power remaining in the hands of industries because they control other aspects of the fishing process, such as processing or transportation. Furthermore, government has to support the idea of giving access back to small-scale fishers. Means to overcome these difficulties include communication of issues to resource consumers and resource users at the small scale level.

Values and intergenerational equity

The way we value our resources and equity between generations is a relevant approach to the question of reconciling fisheries with conservation. Three main research questions were presented to address the issues related to intergenerational equity:

Issue	Future generations should not be disadvantaged by the actions of the present generation. In terms of discounting, traditional discounting puts less weight on future generations because discounted net benefits of future generations are getting smaller and smaller; in other words, the current generation decides the needs of the future generations. However, future generations should have the right to decide what to do with fisheries by themselves, not the current generation. In order to ensure intergenerational equity, fisheries must be reconciled with conservation so that future generations have at least what we have currently.
Research question (1)	What is intergenerational equity?
Methods (1)	1. Case studies/working groups by region to define/determine intergenerational equity. 2. Identification of past wrongs and application in terms of future rights. 3. Review of difference perspectives from different disciplines.
Research question (2)	Why has intergenerational equity not been respected?
Methods (2)	1. Case studies/surveys/working groups to explore when intergenerational equity hasn't been respected and why not. 2. Identify how and when intervention in past situations could have ensured equitable outcomes. 3. Investigate role of population on intergenerational equity. 4. Investigate the role of increasing consumption per capita on intergenerational equity. 5. Investigate the role of trade on intergenerational equity. 6. Look at how intergenerational equity has varied relative to people's position on Maslow's hierarchy (demographic mapping).
Research question (3)	How do we quantify indicators to evaluate our progress in moving towards intergenerational equity?
Methods (3)	1. Counting ocean-based per capita protein consumption and extrapolation of need based on present use (no increase in use). 2. Decide on potential units for the quantification of intergenerational equity (how do we want to value efficiency?). 3. Identify incentives to promote intergenerational equity.

*Management schemes, institutions and issues of scal*e

Several groups discussed management structure of fisheries, incentives and institutions, including questions such as "Should the scale of management match the scale of the fishery?" What is appropriate structure and capacity of the management authority to manage the average small-scale fishery? These questions are related to the larger discussion held by one group on 'top-down vs. bottom-up management', as described below:

Issue	Top-down vs. bottom-up management is an issue of fairness and trade-offs. In top-down management, many people can feel disenfranchised, but even with bottom-up management not everyone can win. Integration of top-down efforts of government and bottom-up efforts of the people is required. Further, there is no one solution for balancing top-down and bottom-up approaches; there are temporal, power, capacity, and spatial components to be considered. Such effort must start at the community level and over time can result in people working together, acknowledging that everybody who is the part of a decision must be accountable for the decision.
Research questions	What are the points of paralysis, success, and challenges over time of the relative mix of top-down and bottom-up approaches, considering issues of transparency, accountability, disciplinary training, and power relations?
Methods	1. Meta-analysis of current literature 2. Cooperative analysis of issues at national level and how it actually happened at local level using indicators. Participatory research could be major indicator of success of different case studies' balance of top-down and bottom-up management strategies. 3. Trend analysis. 4. Education and capacity building.

Further, participants discussed some gaps in implementing ecosystem-based management (EBM) approach to fisheries, particularly the lack of social sciences. The issue is presented below with a suggestion on how to address it.

Issue	Ecosystem-based management (EBM) approaches to fisheries have not focused on the social sciences. Indeed, some funding agencies effectively exclude social considerations, such as the Packard Foundation, which defines EBM as "distinct from other management types, because it is determined solely by natural science, though it does have social implications". This implies that having social and ecological goals is a mistake. It may be difficult to include social considerations in EBM because the scale at which EBM is often described may be too large to address its social implications.
Research questions	1. Can the social implications of EBM be addressed in the given institutional framework? 2. What is the strategy to operationalise socially driven EBM within existing institutional frameworks? 3. Who has agency within EBM: fishers or scientists?
Methods	1. Comparative case studies: social and mandated-driven EBFM. 2. Education and capacity building.

Another group discussed the idea that management institutions should be modified to enable conservation considerations, through the process of incentives. They underscored the importance of involving stakeholders in the process (institution) and suggested using successful case studies to identify the scenarios and tools that work. Ensuring the long-term survival of new and potentially successful institutional arrangements is important because, in order for stakeholders to believe in the process, they have to believe that the institution will be there to serve the purpose in the future.

Local knowledge and participatory research

Related to the management issues discussed above, participants acknowledged that the roles of stakeholders could be improved, despite the increase implementation of co-management and community-based management. In particular, effective integration of local and traditional knowledge is required. The term local knowledge (LK) is used rather than traditional ecological knowledge (TEK) and is very rare now. LK is more appropriate and refers to knowledge that is not generated by the scientific method. Related to that is participatory research, which is considered a useful approach to encourage meaningful involvement of stakeholders. However, there is a lot of dogma in participatory research. Research shows that initially participatory projects are more expensive, but that over time, the goals of the research are realised with fewer resources, because there is greater compliance. The research questions and methods listed below are related to participatory research:

Issue	Discussion about local knowledge, participatory science/research and understanding stakeholders' roles can contribute to reconciling fisheries with conservation. The use of local knowledge is based on the assumption that locally based institutions have sets of knowledge. Although questions arise concerning the validation of local knowledge, its use can provide many more years of data than science can provide. In order to build LK sets into the management process, we have to incorporate it and the people that have accessed to it. Participatory science or research is a way to engage people who are not formal researchers in all stages of the research (i.e., consulting people, engaging people in data collection) to create true partnerships with the people. As participatory research is influenced by social and community situations, it is critical to look at the social aspects of community, and what comprises a community must be retained.
Research questions	1. Is participatory research feasible? 2. What is the appropriate role of participatory research towards capturing the generation of local knowledge? 3. What are the roles of local knowledge and participatory research in reconciling fisheries with conservation? 4. Participatory research has moved away from capturing indigenous knowledge. How do we then explore the role of local knowledge in the navigation of contemporary fisheries issues by fishers and coastal communities?
Methods	1. Mapping, diagramming, interviews. 2. Identify where and how communication with stakeholders is happening. 3. Comparison of different cases to see in what context local knowledge is useful to management. 4. Engage in participatory research to learn about it. 5. Incorporate tools that already exist in different countries, e.g., there are a number of them that are downloadable off of web. 7. Education and capacity building.

Effective communication and measures of success

Underscored throughout the 4WFC was the need for more effective communication between resources users, scientists, managers and decision makers, and this was raised in all the group discussions. Associated with this, participatory research was suggested as a research approach that enables communication.

Issue	Communication is required between all people involved in resource use, conservation and management. This includes an understanding of the way that different people think about issues.
Research questions	1. How to construct a broader understanding of the way people communicate, think about and approach different issues? 2. How can connection across disciplines be improved?
Methods	1. Look for ways to create network among stakeholders. 2. Work on bridging the gap between the stakeholders' perspectives by developing more effective communication tools. 3. Identify successful stories and tools of communication and present them to the fisheries community to encourage communication among themselves and with other groups. 4. Incorporate training on media communication and popular writing in university's scientific curriculum. 5. Educate the community, especially in less developed areas in order to make communication more likely. 6. Facilitate communication of results in various languages, for example by putting the results in the language of the listener. 7. Account for different cultural perspectives among fishers and work toward having granting agencies accept that a portion of the funding may be used for communication with the public rather than to other scientists. 8. Use participatory research to involve various scientists and resource users will help to take ideas and "translate" them to other disciplines and stakeholders.

In addition to these specific issues, two groups discussed the notion of success, that is, how do we know when fisheries are reconciled with conservation. Indeed what does the term "reconcile" mean? We need to

look at cultural construction of this term, for it is a value term, not an issue one. This also applies to the term “success”. The terms success, its feasibility and the consensus on what success means need to be identified. At some point, the definition should be explicit, for example using quantifiable targets to measure success.

CONCLUSION

As shown above, many issues were identified as important for reconciling fisheries with conservation, but perhaps the largest is communication. The identification of participatory, inclusive approaches to fisheries management with greater emphasis on bottom-up approaches to management was consistent among all groups. None of the groups focused on science issues alone, and where ecosystem-based management or marine protected areas were discussed, it was mostly in relation to their social implications. If the perspectives of the participants of this workshop are a measuring stick for the wider fisheries research world, then we can look forward to a more inclusive fisheries management process, with less focus on science and more focus on humans.

CREATING A POSITIVE FUTURE FOR FISHERIES AND COASTAL COMMUNITIES WORLDWIDE

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ABSTRACT

Fisheries research is gradually becoming more ecosystem-based and integrative, as indicated by an assessment of the science presented at the recently held 4th World Fisheries Congress. The standard approach to fisheries policy and management is to use research inputs from the natural sciences, while the paucity of research inputs from the social science is notable. At the same time, there is a broad range of concerns and challenges currently facing fisheries, including, ecosystem health, social justice, livelihood and employment and food security. Addressing these challenges requires that social and human dimensions be explicitly incorporated into fisheries research and management frameworks necessitating changes in the way fisheries problems are addressed and in the objectives and directions of research programs. As an extension to ecosystem-based fisheries research, we propose a people-centered research program that focuses on five key issues: social justice, total values, business and power, governance and ethics. We believe that promoting and implementing such a research program is required for its potential, despite challenges, to contribute to creating a positive future for fisheries and coastal communities worldwide.

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INTRODUCTION

The 4th World Fisheries Congress (4WFC), held in May 2004 in Vancouver Canada, had as its theme reconciling fisheries with conservation. An analysis of the over 200 papers presented at the conference indicates a strong consensus that the solution to contemporary fishery problems is not to be found in the natural sciences alone, but also within the realm of the social sciences (Chuenpagdee *et al.*, 2005). Two themes were identified as keystones for positive change: "management" and "communication". In brief, we need (1) different and better management of our fisheries and (2) improved communication between scientists, managers, resource users and other stakeholders. These are not new ideas, but they were given wide airing at the conference. While natural and social scientists are not managers, they are also not exonerated from the responsibility of working towards better management and communication. The identification of these goals indicates the direction future research efforts must take, and what sciences can contribute to creating a positive future for fisheries and coastal communities.

Many sciences play a role in providing information to support management and policy decisions. The challenge has always been to identify what key scientific inputs (e.g., anthropology, biology, ecology, economics, etc.) are required and what mechanisms are needed for management to effectively use the information provided by these disciplines. There has been much debate and discussion on the interaction between science, management and policy (see Dingerson *et al.*, 2005). Here, we limit our focus to addressing the first part of the challenge, which is to identify research areas that are currently under-investigated, but hold high promise for increasing our understanding and improving our management of the interaction between human and natural systems. In the following, we use the term "science" to include natural and social sciences.

Although the 4WFC focused on reconciling fisheries with conservation, the question we pose goes beyond that, i.e., "what research is required to create a positive future for fisheries and coastal communities?" We answer this question by first presenting the underlying concerns in fisheries and fishing communities and the main challenges faced in their management. Next, based on the assessment of current research presented at the 4WFC (Chuenpagdee *et al.*, 2005a), we evaluate the effectiveness and applicability of existing principles and tools employed to address fisheries problems. We then propose a people-centered research program that focuses on five key areas that have received relatively little attention in the past – social justice, comprehensive valuation, business and power, governance, and ethics – as a way to move towards a positive future for fisheries and fishing communities worldwide.

CONCERNS AND CHALLENGES IN WORLD FISHERIES

The concerns facing today's fisheries management can be grouped into four major areas (Chuenpagdee *et al.*, 2005b): ecosystem health, social justice, employment and livelihood, and food security. The emphasis at the 4WFC was on conservation, and the number of papers presented on natural systems (Bundy *et al.*, 2005a) suggests an overwhelming concern with ecosystem health.

It is commonly thought that when we take care of an ecosystem, we take care of the people who rely on it for food, livelihood and employment. However, this assumption may not always be valid, particularly if issues related to social justice and distribution of power are not addressed. Consider, for example, the case of industrial and small-scale fishing sectors. Conflicts arise not only due to these fisheries operating in the same areas or due to one activity having negative ecological and economic impacts on the other, but also because the two sectors usually receive differential treatment and support from governments, such as the industrial sector benefiting from more subsidies (Munro and Sumaila, 2002).

Small-scale fishers are often marginalised for reasons such as their remote physical location, lack of access to markets, and distance from or lack of interaction with political and management bodies (Pauly, 1997). In short, without consideration of social justice, healthy ecosystems alone do not guarantee fair distribution of food, equitable job opportunities, and increased quality of life for coastal peoples.

There are several challenges to addressing these four concerns. The main factors contributing to unsustainability and over-exploitation in fisheries include inappropriate incentives, high demand for limited resources, overcapacity, poverty and lack of livelihood alternatives, lack of good governance,

interactions with other sectors such as land-based and coastal activities, and inappropriate assessment and management tools (Swan and Gréboval, 2004). When external forces that influence fisheries management, such as globalised markets, power and politics are added to this list, we end up with complex problems. However, by setting clear priorities, and by engaging in innovative thinking outside the standard box of fisheries science, we can start to understand this complexity and be in a position to make progress toward creating a positive future for fisheries and coastal communities, as suggested in section 4. First, however, in the following section we examine current approaches, trends and needs in fisheries management.

ASSESSING CURRENT APPROACHES AND PRINCIPLES

Historically, a major focus of fisheries research has been to estimate maximum sustainable catch levels. Much effort has been placed on improving the methods used to do this, and although methods have changed over the decades, the essential question has remained the same. In recent years however, there has been a shift, at least at the rhetorical level, toward a broadened approach, with various international agreements such as UNCLOS (1982) and the Food and Agriculture Organization (FAO)'s Code of Conduct for Responsible Fisheries (FAO, 1995), aiming to set international principles such as the precautionary principle and international standards. Australia, Canada and the United States are examples of countries attempting ecosystem-based approaches to fisheries management (Juda, 2003), in contrast to single species approaches.

This shift is reflected in three cross-cutting and recurring topics mentioned in the majority of the papers presented at the 4WFC: stakeholders' participation in fisheries research and management, interdisciplinary approach to fisheries issues, and ecosystem-based management (Chuenpagdee *et al.*, 2005). These are representative of the human dimension, science, and management and are discussed further below.

Stakeholders' participation in fisheries research and management

Recent interest in meaningful involvement of stakeholders in fisheries management, through co-management, community-based management, and participatory research is widely appreciated, particularly as a route to more successful management of resources and better communication between resource users, scientists and managers. However, stakeholders' participation in research and management is not the norm, and is challenging at both large and small scales. The Eastern Scotian Shelf Integrated Management Initiative (Rutherford *et al.*, 2005) is an example of a large-scale governmental approach to the inclusion of all stakeholders (including the fishing industry, coastal communities, environmental interest groups, provincial and federal government, the shipping industry, the oil and gas industry, etc.,) in ocean management plans. This program is still evolving, but there have been challenges, such as maintaining stakeholder engagement in the collaborative planning process due to the time and resources required by, and the capacity of the stakeholders to participate, as well as questions of trust and sectoral protectionism. On a small scale, the case of community-based management of a marine reserve, Actam Chuleb, in Yucatan, Mexico (Chuenpagdee *et al.*, 2004) is one example among numerous others that exist worldwide. Local community members participated in this interdisciplinary research by engaging in survey of seagrass beds and mapping of lobster grounds, expressing preference judgments about resource importance through surveys and interviews, discussing management issues and options at stakeholders' workshops, and disseminating research results at conferences. The study showed that one community (San Felipe) was better equipped to participate in research and community-based management than the other (Dzilam de Bravo) because they were generally better organised and there were less migrants in the community.

Further research is thus required to better understand the conditions under which both large and small scale participatory approaches can be successfully undertaken. Stakeholder analysis is a tool that is initially conducted to gain understanding about the characteristics of stakeholders, their mobility, capability, and underlying values. Research on local knowledge and its contribution to informing sciences and management has increased, but more is needed (Liguori *et al.*, 2005). Essential questions about the legitimacy and validity of local knowledge and its uses and contributions to fisheries management remain (Davis and Wagner, 2003). Other research questions include what motivates people to fish for a living, in

the developed and developing worlds and in industrial and small-scale sectors, and how this is affected by the opportunity for alternative livelihoods. This type of research is on-going at the micro-level, but should be broadly incorporated into fisheries science (McGoodwin 1990, Charles 1995, Davis 1996, Neis *et al.*, 1999). Ultimately, more effort is required to change the role of stakeholders from one of research subjects and passive informants to one of active partners in research and management, or of leadership, or both.

Interdisciplinary approach to fisheries issues

An interdisciplinary approach to fisheries is essential since fisheries are complex, diverse and dynamic. While there will be an ongoing need for basic disciplinary research, the exciting advances are those that combine methods and use disciplinary knowledge to develop more holistic approaches to fisheries research. Addressing concerns related to ecosystem health, social justice, employment and livelihood, and food security in the same research framework is challenging. Interdisciplinary research requires exchange of knowledge and understanding in the way that sciences are conducted, data interpreted and results disseminated. This acknowledges the complementarities of the sciences. For example, natural sciences provide knowledge about ecosystems, while social sciences offer insights about institutions responsible for ecosystem-based management, as seen, for example, in capacity building for ocean and coastal management (Smith, 2002), and in the design and management of marine protected areas (Christie *et al.*, 2003, Rudd *et al.*, 2003). The strengths of different disciplines can be used to create a more robust and productive research framework. Since interaction and collaboration between scientists from different disciplines can result in a research protocol that draws upon knowledge from various disciplines (e.g., Decker *et al.*, 1992, Parker, 2003), this implies that there is a need within each discipline to explore creative approaches to interdisciplinary research. An interdisciplinary approach to assess ecosystem values, for example, can draw upon methods that involve assessing ecological functions and services of an ecosystem, accounting for both monetary and non-monetary values of an ecosystem (van Kooten and Bulte, 2000), as well as methods that elicit preferences and judgments of resource users and stakeholders of current and future generations (Chuenpagdee *et al.*, 2003, Sumaila and Walters, 2005, Liu *et al.*, 2005).

Ecosystem-based management

The last decade has witnessed the development of fisheries management principles that are precautionary and ecosystem-based. Management efforts are geared to address commonly stated concerns and challenges such as overfishing, fishing gear impacts, bycatch, illegal fishing, resource allocation, sustainability, restoration, co-management, and stakeholders' conflicts. Ecosystem-based management (EBM) addresses these issues in an integrated fashion, and is a response to calls from a growing number of scientists for protection and rebuilding of ecosystems (e.g., Pitcher and Pauly, 1998, NRC, 1999, Pauly and Maclean, 2003). Frameworks for EBM have been proposed and widely endorsed (EPAP, 1999, Ward 2002, Fletcher *et al.*, 2003, Hall and Mainprize, 2004, Livingston *et al.*, 2005, O'Boyle *et al.*, 2005, Pikitch *et al.*, 2005). However, in most cases they are not fully operationalised, and the development of useful ecosystem indicators and their translation into decision criteria is an on-going process (Bundy *et al.*, 2005a, Fulton *et al.*, 2005, Link, 2005, Rudd, 2004). Furthermore, the effectiveness of ecosystem-based management as practiced to date has yet to be evaluated, although tools such as the management strategy framework (Sainsbury *et al.*, 2000) are being developed for this purpose. A framework similar to EBM philosophically, but with a broader emphasis, is integrated coastal management (ICM). ICM focuses on ensuring that the various uses, activities and development in coastal areas are well-coordinated and incorporate environment, economic and social considerations (Cicin-Sain and Knecht, 1998). There are at least 700 ICM efforts throughout the world in over 145 coastal states, although only 45% are in operation, with varying levels of success and effectiveness (Sorensen, 2002). Interestingly, the degree of integration of fisheries within ICM, or of social dimensions within EBM is debatable (Bundy *et al.*, 2005b).

AN INTEGRATED ECOSYSTEM APPROACH FOR A POSITIVE FUTURE FOR FISHERIES AND COASTAL COMMUNITIES

Ecosystems are complex, non-linear systems composed of a multitude of interacting components. Similarly, anthropogenic activities in the marine environment occur within a complex set of interdependent components. There are many facets to these human activities, many of which have received little or no study in relation to the underlying ecosystems. Together, these components form a full

'fishery system' that includes the ecosystem and human dimensions (Charles 2001). The broad nature of these systems is reflected in statements like 'without fish and their ecosystems, there can be no fishery' and 'management of fisheries (and ecosystems) requires management of people'.

These simple truisms form the core of our approach, but not its entirety. To improve our ability to manage, and to create a positive future for fisheries, we need to increase our knowledge of both ecosystems and their response to perturbations, and the interactions between humans and aquatic ecosystems. Here we extend the idea of EBM to Integrated Ecosystem Approaches to Fisheries (IEAF), which explicitly includes natural and social sciences methodological approaches and understandings.

IEAF provides a framework for resolving conflicts and an opportunity to take a proactive approach for fostering and supporting sustainable communities and livelihoods in the fisheries sector and beyond. Overall, it uses the synergy between the health of ecosystems and of people as a key to creating a positive future for fisheries and coastal communities. This implies recognizing and exploring alternative strategies for ecosystem protection and community development.

In this paper, IEAF thinking is used to address the specific concerns in fisheries described earlier, i.e., ecosystem health, social justice, livelihood and employment, and food security. A greater emphasis is placed here on the human dimensions of IEAF, rather than the ecosystem aspects, since we know from the assessment of papers at the 4WFC that internationally, ecosystem science is already high on the research agenda of natural scientists and thus is receiving considerable attention (Bundy *et al.*, 2005b). While there are still many ecosystem-related research questions that remain open, such as identifying emergent properties of ecosystems and the resiliency of ecosystems to perturbations, progress is being made.

At the same time, there are human issues and areas of research that are critical to fostering a positive future for fisheries, but which are not being addressed. These human aspects all have ecosystem impacts, and by studying them with respect to their interaction with ecosystems, we may learn how to address key fisheries concerns. In the following, we describe our initial thoughts on research aspects focusing on the five human dimension issues outlined earlier – social justice, comprehensive valuation, business and power, governance, and ethics. These issues extend and complement sets of management and policy directions advocated for fisheries elsewhere (e.g., Pitcher *et al.*, 1998, Charles, 2001, 2004). They contribute both to the overall ecosystem-oriented and human-centric IEAF approach, and to the ongoing discussions on EBM.

Adjusting for social justice

Fisheries management decisions at the local, national and international level are often considered unfair to certain groups. For example, decisions favoring industrial, capital-intensive, large-scale fishing enterprises may harm small-scale fishers, as manifested in diminished, or lost, access to fishing, livelihoods, fish for food and decision making. One of the reasons for this is the failure of decision makers to fully comprehend or care about the value and contribution of the sector to the socioeconomic wellbeing of the communities involved.

Social justice has many definitions. To avoid philosophical discussions of the distinctions of these definitions, we use a simple description of five basic rights provided by Oxfam, an international aid and development agency[1] : (i) the right to a sustainable livelihood, (ii) the right to life and security, (iii) the right to basic social services, (iv) the right to an identity, and (v) the right to be heard. These principles may be useful in thinking about social justice. First, an analysis of power, its distribution and use, is required in order to understand how power influences management and policy decisions at all levels in fisheries exploitation and livelihood settings. More generally, research on social justice should address the following questions: What are the politics of decision making, the influence of corporate, business-oriented approaches, the integrity of management systems and their susceptibility to legal and illegal influence (i.e., lobbying and corruption), and the overall effectiveness of fisheries policies and agreements? How do these vary between local, national, and international levels? How can we effectively use the results of such analyses, i.e., how can we move from the study of power and decision making to the goals of affecting change?

[1] http://www.oxfam.org

Questions concerning social justice cover both inclusion and exclusion issues. The emphasis on inclusion issues is clear as seen in discussions of access rights for different stakeholders in communities (e.g., Davis and Jentoft, 2001). Social exclusion due to race, gender, and class, however, is not often discussed, although it is an important issue shaping management decisions (Sundberg, 2002). Recently, discussion about social justice was extended from a national perspective to an international perspective, relating to foreign industrial fishing fleets gaining agreements to fish in the waters of developing countries (Kaczynski and Fluharty, 2002). Questions about compensation and the trickle-down effects (positive and negative, and economic and ecological) to local fishing communities are at the forefront of the discussion.

Does social justice in fisheries distribution and access lead to more sustainable fisheries and healthy ecosystems? There may be no clear answer to this, as fisheries management and social justice necessarily interact within a broader policy environment. Management outcomes are context dependent and may not be directly related to whether the management style is top-down, open-access or community-based. Therefore, one approach to answering the above question would be to explore whether there is an empirical relationship between regimes that do afford a certain level of social justice and sustainable fisheries. A good place to start is an exploration across a broad range of fisheries and other common pool resource-type activities, and a comparative analysis of management regime, context and social justice (e.g., Pitcher and Power, 2000).

Accounting for comprehensive values

In practice, fishery decision making is based largely on monetary values of fisheries and aquatic ecosystems, despite the widespread recognition of other types of values such as non-use values and the inherent values for existence of ecosystems. These values do exist even though they may be more difficult to conceptualise, let alone measure. When they are measured, they are often discounted within the economically dominated sphere of fisheries management. Moreover, policy decisions are often made on the basis of the gross revenues that a fishery generates and the regional spin-off and employment benefits derived from those revenues, rather than the net benefits of revenues less true fishery costs. In a heavily subsidised fishery, this results in decisions favoring harvesting more fish than is ecologically sustainable as opposed to supporting a sustainable fishery operating at a lower level of activity with lower gross revenues.

Addressing how the range of values associated with ecosystems and our relationships to them are incorporated into decision-making requires both philosophical and technical discussion. The first set of questions are whether values experienced by people differ in scale and in kind, what difference would recognition of divergent value systems make to management decisions, and whether they are worth quantifying and incorporating in the decision-making process. If so, are there alternative approaches and tools, other than the standard valuation techniques, that help understand complex relationship between human and natural systems?

Research is also required to address the common disconnect between production and consumption systems. Consumers, particularly in the western industrialised countries, have abdicated their responsibility for food harvesting and production to fishers and aquaculturists (and farmers). Thus, they often have little or no knowledge of the true ecological or social costs of the seafood that they are eating and the broader range of environmental impacts associated with the provision of typical highly processed, consumer-ready products (Hospido and Tyedmers, in press). It is imperative that consumers are equipped with information about these costs in order to make their own value judgments concerning their choice of seafood consumption (see below).

Next are questions dealing with values and other factors that drive behavior and personal choices of fishers and other stakeholders (Charles, 1995, Salas and Gaertner, 2004).What are the forces that motivate different fishing sectors, e.g., industrialised or small-scale, to sacrifice conservation concerns, or the intrinsic value of a resource for more immediate monetary values? Do they recognise the values that they are implicitly giving to these resources? What mechanisms can be employed to ensure that these values are accounted for in their daily individual decision-making processes? What incentive or disincentive schemes can be used to influence individual and corporate behaviour? Can corporations have the same value systems as individuals?

Finally, there are many principles and approaches upon which the discussion of values can be based, such as the precautionary principle, ecosystem-based management, and intergenerational equity. A research

program could focus on how countries that adopt these approaches incorporate values into their fisheries management and policies.

Talking business

The presence of the 'human dimension' in fishery research has occurred mainly in the field of fishery economics, in particular production economics, bio-economics, socio-economics and trade and marketing (Whitmarsh and Charles, 2001). However, relatively little attention has been paid to the implications of treating fishing enterprises (particularly in large-scale and/or industrial fisheries) as businesses, comparable to other business sectors with an impact on the environment. Considering that the majority of fish landings are taken by corporations engaged in industrial fishing operations (Bundy and Davis, 2004), analysing fisheries and aquaculture from a business perspective may result in a better understanding of the incentives driving the operations and likely lead to better ecosystem-based management.

One aspect of this approach lies in seeking a better understanding of the 'aquatic food supply chain'. Globalisation has led to these supply chains stretching around the world, creating trade patterns with strong social and economic impacts on developing countries and small-scale fishing communities, particularly those with less buying power. It is important to understand the positive and negative impacts of the globalization of fish and seafood trade: the structure of the supply chain, the way it influences the distribution of products, the generation of profits for supply chain actors, as well as the provision of information that relays market demand signals to producers. The aquatic food supply chain can be complex, and research is required to identify corporate structure and linkages between companies. For example, who are the key actors in the marketplace, from fishing companies and aquaculture firms, through processors and distributors, to the end consumers? When products are sold in global markets, to what extent are individual corporations vertically integrated and control the entire supply chain? In some parts of the aquaculture industry, for example, corporations are involved not only in the production of juveniles and farm grow-out operations but also in feed production, reduction fishing operations for fish meal and oil along with downstream processing and the distribution of finished products. Thus, to what extent has this type of vertical integration and concentration of market power, generated externalities and can these externalities be internalised?

With the current structure, dominant corporations with concentrated market power may enjoy excessive profits in the face of reduced competition. For firms operating globally, there is also an issue of where profits are taken (known as transfer pricing) and whether profitability can be increased by arranging transactions between related companies such that the bulk of profits are taken in countries with low tax rates or where tax collection compliance is weak. Similarly, it may be possible to conduct certain aspects of business in regions with weak environmental regulations, basically permitting international firms to 'export' harmful production activities and impose externalities on those regions (that often tend to be the poorest and most vulnerable due to poverty).

As in other resource extraction activities, fishing results in a wide range of externalities impacting ecosystems, economy and society as a whole (Seijo *et al.*, 1998). These include the ecosystem effects of fishing (ICES, 2000, Bundy, 2004, Bundy and Fanning, 2005), damage to seafloor habitats by trawlers or dredgers (Steele *et al.*, 2002, Kaiser *et al.*, 1998), ecosystem effects of bycatch and discarding (Chuenpagdee *et al.*, 2003), ecosystem effects of illegal, misreported, and underreported catches (Sumaila *et al.*, 2004), the accumulated impacts on stocks being fished (Pauly *et al.*, 1998, Bianchi *et al.*, 2000, Zwanenburg 2000), substantial contributions to climate change (Tyedmers 2001, Tyedmers *et al.*, in press, Hospido and Tyedmers, in press), and loss of coastal community resilience through overfishing or through loss of community fishery access (Charles, 2001). Treating fishing enterprises as businesses introduces the idea of incorporating such externalities into decision making.

One approach would be to subject enterprises to remediation rules, such as the "Polluter Pays Principle", or to environmental impact assessments before licenses are granted. A similar argument for aquaculture firms suggests following the same principle if, for example, pollution from farms impairs juvenile fish production for wild fisheries in their vicinity or have some other deleterious effect on the environment. Incorporating externalities into the corporate cost function will affect their profitability, potentially driving improvements in fishing and farming technology that are environmental friendly. There is a need for research to assess the extent to which this would lead to positive substitutions among natural, manufactured, human, social and financial capital in the production process. Correcting market

distortions caused by externalities may improve inefficient resource allocation and should encourage investments in business activities and infrastructure that promote ecological and social sustainability.

Understanding fisheries governance

Fisheries governance encompasses all areas relevant to decision-making at all levels of management, and includes both formal and informal systems of management. The theme of governance provides a theoretical and practical framework within which to study societal problems occurring at various scales, e.g., individual, households, community, state, region and global (Kooiman, 2003). Governance studies must incorporate the diversity of values and ethical considerations that are taken into account in decision-making. Just as governance issues span multiple scales, so does implementation of measures to address them.

Several research questions arise from a discussion of good governance. At the theoretical level, it is important to examine how the governance concept came into use in fisheries and how its use has evolved and changed though time. This examination needs to occur within different disciplinary, cultural and contextual perspectives in order to eliminate confusion. The next set of questions relate to the underlying principles of good governance, what they are, how they can be achieved, and how they contribute to effective enforcement, compliance and dispute resolution. A comprehensive study on fisheries governance (Rudd, 2004, Kooiman *et al.,* 2005) provides a good place to start this kind of investigation.

An analysis of different governance models and the scale of their applicability would particularly help to understand the circumstances under which communities are empowered and how tension between different stakeholders is mediated. Identifying governance gaps and their effects on resources and ecosystems can help anticipate future problems for fisheries and coastal communities, particularly given emerging ocean and coastal uses such as offshore aquaculture and wind energy.

At the practical level, research questions concern who should be included in the discussion about governance, the appropriate criteria for decision-making under different scales and contexts, and the limitations of relying only on single disciplinary research or “sound science” in decision-making. This last point relates to the use of “lack of data” or uncertainty as reasons to maintain the status quo. Research is also required to operationalise the fisheries governance concept through, for example, identification of factors of governability (i.e., the capability of the governing system and the characteristics of the system to be governed) and examination of ways to strengthen existing governance systems.

Finally, a comparative analysis of national and regional approaches to governance, challenges and measures to address the challenges is encouraged. For instance, issues related to governance constraints and reforms in regional fisheries management organizations (Swan, 2004) and management of species at risk (VanderZwaag and Hutchings, in press) are increasingly important to national and regional fisheries management, and have direct implications to ecosystems. Further, an analysis of the effectiveness of various governing institutions, at local, national and international levels, in dealing with fisheries and aquatic ecosystems is required. Institutional reform may be needed to correspond with emerging and challenging goals related to EBM.

Emphazising ethics

Ethics are the mental constructs within which people make their day-to-day decisions. Ethics function and are expressed as values and choices in the entire aquatic food supply chain, with scientists playing an important role in informing the process. Ethical concerns are closely related to social justice and values, but are also reflected in individual and community behaviour. With few exceptions (e.g., Coward *et al.*, 2000; Safina, 2002), the importance of ethics in fisheries discussions is rarely emphasised. Fundamental questions that need to be examined include the value of including ethics in fisheries decision making, the extent to which ethical perspectives are already incorporated in different fisheries contexts, and how these views have changed through time.

Discussion about ethics starts from an understanding of what the societal goals are for a community or a country and the implications of a lack of societal goals. Can social pressure, which often enforces a sense of fairness and equity in some small groups, operate at larger scale? In a fisheries context, this question can

be directed at evaluating ethics and interactions at various levels, such as within the corporate industrial sector, within coastal fishing communities, and between the corporate sector and coastal fishing communities. There is growing ethical concern, for example, related to the use of ecologically sustainable fishing methods. One approach to address this concern uses market forces, including initiatives such as eco-labeling and product certification by Marine Stewardship Council and others, and a range of consumer seafood guides (e.g., Fish List[2] compiled by Blue Ocean Institute, Environmental Defense, Monterey Bay Aquarium's Seafood Watch Program and Seafood Choices Alliance). These provide incentives, for corporations and consumers alike, to consider sustainable practices (Peterman, 2002). Important research questions related to this issue include whether existing schemes in fisheries certification and labeling of fisheries products reflect ethical considerations. Further, what is the role of ethics in the certification and labeling of fisheries products and the establishment of the burden of proof such that large-scale fishing enterprises need to show, for example, that their activities do no harm (Dayton, 1988)? How do these certification processes become properly established and how effective are such schemes in influencing corporate and consumer behaviours?

Research on this issue can be extended to an analysis of the effectiveness of existing international mechanisms and regulations that aim to instil equity and fairness in corporate behavior (Glover and Earle, 2004). Similarly, there are research questions regarding the impact of ethics on the development and interpretation of principles such as sustainability goals, the precautionary approach, ecosystem-based management, and intergenerational equity (see Coward *et al*., 2000).

Ethical considerations are important at an individual level, and discussion can be encouraged through formal and informal education, and awareness-building programmes. One of the first questions is whether ethics can or should be taught to fishers, managers, and scientists. Currently, there is no liability for fishers, managers, or fisheries scientists whose actions result in loss or damage to natural resources or negative social or economic impacts for coastal communities. Would establishing a system of liabilities change or improve the performance of fisheries stakeholders, managers or scientists? These issues need to be captured in the research on ethical frameworks.

CONCLUSION

We have emphasised in this paper that humans are an integral part of marine ecosystems and that the behaviour and dynamics of both are complex and linked. In order to move through this complexity, and to address the problems faced by today's fisheries, ecosystem-based management approaches alone may not be sufficient. Here we propose a framework of 'Integrated Ecosystem Approaches to Fisheries' (IEAF) - one that explicitly focuses on interactions of humans and ecosystems, and that requires natural and social scientists to interact and collaborate in order to address global concerns in fisheries related to ecosystem health, social justice, livelihood, and food security.

The emphasis here has been on five key 'human dimension' issues – social justice, comprehensive valuation, business and power, governance, and ethics. Research on these key issues will help create the potential for a positive future for fisheries and coastal communities. The emphasis on the human dimensions of IEAF in this paper implies the setting of new priorities in related spheres – in research funding for theoretical, methodological and analytical development, in determining fisheries policy goals and management methods. These research issues require new thinking by all parties concerned with aquatic resource management, from governments and funding bodies to scientists and resource users, and new (or different) institutional arrangements and governance systems. They should be further explored and supported by existing theoretical frameworks, particularly to situate them in current ecosystem-based fisheries management. For example, an aspect of baseline research at this stage would involve exploring the possible consequences of incorporating consideration of these issues into future fisheries management plans, using approaches such as scenario analysis (Pauly *et al.*, 2003).

[2] www.thefishlist.org

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APPENDIX 1:

The evaluation template for assessing the contributions of papers presented at the 4WFC in reconciling fisheries with conservation

(Not actual size, reduced for formatting purpose)

SECTION 1: GENERAL INFORMATION

A. System description

1. Study location (e.g., name of country, sea, bay, etc.): _____

2. Type of system: ____ Coastal ____ Deep Sea ____ Polar Sea ____ Enclosed Sea
____ Coral Reefs ____ Continental Shelf ____ Estuary ____ River ____ Lake
____ Streams ____ Watersheds ____ Floodplains Others:_____

3. Type of fishery: ____ Aboriginal ____ Subsistence ____ Small-scale (commercial)
____ Industry ____ Recreational

4. Type of habitats: ____ Sandy ____ Mudflats ____ Seagrass ____ Reefs
____ Mangroves ____ Seamounts ____ Pelagic (water column) Others:_____

5. System level considered: ____ Single species ____ Multi-species ____ Ecosystem ____ N/A

6. Time period considered: ____ Historical _____ Present ____ Future ____ N/A

7. Geographic scale covered: ____ Local ____ National ____ International ____ Global ____N/A

8. Aspects addressed: ____ Natural systems ____ Policy / Management
(Choose all that apply) ____ People/ Society ____ Economics
Others:_____

B. Purposes / Issues (Describe what the paper is trying to do and/or issues that it tries to address):

C. Approaches / Methods (Describe what approaches/methods are used):

SECTION 2 A: NATURAL SYSTEMS (PART I)

A. Biodiversity

1. Does the paper address biodiversity? Y N
   What level? ____ Population/genetic biodiversity ____ Species ____ Ecosystem/community

2. What indices/methods are used to measure biodiversity? _____
_____

3. Over what spatial scale(s) is biodiversity measured? _____

4. What are the effects of fishing on within species genetic diversity/species diversity/ecosystem structure and function? _____
_____

5. Are there any remedial recommendations? Y N How? _____
_____

6. Is a comparative approach used? Y N How? _____

7. Are exotic species an issue? Y N How? _____

8. Are effects of aquaculture/artificial enhancement on the genetic biodiversity of wild stocks addressed?
   Y N How? _____

B. Ecosystem properties

1. Is ecosystem 'resilience' (the ability of the ecosystem to recover given a perturbation) studied?
   Y N How? _____

2. Is the response time (TR) of the ecosystem estimated?
   Y N How? _____

3. Is ecosystem 'resistance' (the degree / extent to which a system is altered given a perturbation) studied?
   Y N How? _____

4. What is the degree of perturbation required to shift the system to a new equilibrium?
   ____ High ____ Medium ____ Low

5. Is ecosystem 'variability' (the variance of population densities over time) studied?
   Y N How? _____
_____

C. Species at risk

1. What species are at risk? _____
   Why? _____

2. How is risk measured? _____

3. Does the paper indicate the probability of species/ecosystem recovery? Y N
   How is this recovery measured? _____

4. What management measures are in place to ensure recovery? _____

SECTION 2 A: NATURAL SYSTEMS (PART II)

D. Ecosystem indicators Indicator name: _____

1. Type of indicator: ____ Fishery ____ Physical ____ Ecological
   ____ Economic _ ____ Social ____ Integrated

2. What do they measure? _____

3. Who are involved in indicator development, and by what process? _____

4. Describe tests / applications: _____

5. Is the performance and/or effectiveness of the indicator evaluated? Y N
   If yes, with what criteria?

E. Anthropogenic impacts on the ecosystem (bycatch, habitat damage, pollutions, others)

1. Is bycatch addressed? Y N

2. What are the impacts of bycatch on the ecosystem? _____

3. What are the measures used to address bycatch?
   ____ Mesh size selection ____ Selection grid
   ____ Discriminatory fishing practices ____ Seabird scaring devices
   ____ Reduce overall fishing effort ____ Gear modifications (explain): _____
   Others: _____

4. Are gear impacts on habitats addressed? Y N How? _____

5. Are other impacts on ecosystem (e.g., pollution) addressed? Y N
   Source of impacts: _____
   Nature of impacts: _____
   Remedial measures: _____

6. Other impacts and remedial measures: _____

F. Data, stock assessment and ecosystem modeling

1. The paper deals with: ____ Stock assessment ____ Ecosystem modeling ____ Data ____ N/A

2. Approaches / techniques used: ____ VPA type ____ MSVPA type ____ Surplus production
   ____ Age structured ____ Mass Balance ____ Ecopath/Ecosim ____ Delay difference
   ____ Food web ____ Spatial Others: _____

4. Level of application: ____ Single-species ____ Multi-species _____ Ecosystem
   ____ Microbial ____ Lower trophic leve l Others: _____

5. Are environmental factors considered? Y N How? _____

6. How is 'uncertainty' addressed? ____ Bayesian ____ Monte Carlo ____ Jack-knife
   ____ Boot-strapping ____ Maximum likelihood ____ Not addressed Others: _____

7. Issues with data needs / requirements: ____ Data sufficiency ____ Data inconsistency
   ____ Data availability ____ Too much data
   Others: _____

SECTION 2 B: SOCIAL ASPECTS

A. Stakeholders / Communities

1. Who are the stakeholders that the paper addresses? (Choose all that apply)

____ Community in general	____ Indigenous community	____ Subsistence fishers
____ Small-scale fishers	____ Fishing industry	____ Recreational fishers
____ Fish / Shellfish farmers	____ Women	____ Children
____ Fishers organizations	____ Environmental NGOs	____ Processors
____ Marketing	____ Managers / Decision-makers	____ Politicians
____ Scientists	____ Tourism-related business	____ Tourists

____ Others: _____

2. How are they involved in the research / study? _____
_____

3. Which stakeholders benefit from this study?_____
How?_____

4. Briefly describe the community (number, members, etc.): _____
_____

B. Social issues addressed (Choose all that apply):

____ Resource allocation	____ Alternative livelihoods	____ Capacity building
____ Justice / Equity	____ Property rights / ownership	____ Historical use / rights
____ Food security	____ Quality of life	____ Stakeholders conflicts
____ Local knowledge	____ Stakeholders values	____ Social organization
____ Poverty	____ Social consequences from management decisions	
____ Ethical issues		

Others: _____

C. Roles of community / stakeholders in management:

1. Is community involved in management / decision making process? Y N N/A

If yes, how?_____

2. Are inputs from community incorporated in management decisions? Y N N/A

3. Is there collaboration / partnership between community and managers? Y N N/A

If yes, describe: _____

4. Does the research integrate considerations from stakeholders across economic sectors (e.g., fishers, tourism, forestry, etc.)? Y N N/A

5. Is there any explicit consideration for future generations? Y N N/A

6. Are management options explored (in terms of social and economic impacts to community)?

Y N How? _____

7. Is there any consideration or implication on new governance or new institutional arrangement?

Y N How? _____

SECTION 2 C: ECONOMIC ASPECTS

A. Trade and marketing of fisheries products

1. What type(s) of products are marketed? ____ Live ____ Fresh ____ Frozen
____ Dried / Salted ____ Processed ____ Low value fish (for reduction) Others:_____

2. Briefly describe the market system: _____
_____

3. Who sets prices for the products? _____

4. Is there a product certification involved? Y N N/A
If yes, which one? _____

5. Describe national / international regulations on products: _____
_____

6. Trade and marketing are affected by -
Trade agreement: Y N How? _____

Globalization: Y N How? _____

B. Economic instruments for fisheries management

B.1 Subsidies

1. What type(s) of subsidies exist in the fisheries? _____

_____

2. Who provides subsidies? _____

3. Issues with subsides (e.g., fairness, appropriateness, etc.): _____

_____

B.2 Capacity reduction: Describe efforts / mechanisms used for capacity reduction

_____

Is it considered effective? Y N Not clear

Why? _____

C. Economic valuation and analysis

1. Type of values considered in the study: (Choose all that apply)

____ Market value ____ Non-market value ____ Intrinsic value ____ Option value

2. Are future generations considered? Y N

3. Is 'externality' considered? Y N

4. Type of benefits considered and to whom: _____

_____

5. Type of costs considered and to whom: _____

SECTION 2 D: MANAGEMENT AND POLICY ASPECTS

A. Policy and management issues addressed

1. What are the issues? _____

2. What is the level of management involved? (Choose all that apply)

____ Local ____ State / Province ____ National ____ International ____ Global

3. Who has 'jurisdiction' over the issue area?

____ National government ____ State / Provincial government ____ Local government

____ Community ____ Joint jurisdiction (explain): _____

4. Are there groups or individuals with strong 'influence' over the issue? Y N N/A

Describe: _____

B. International conventions / agreements

1. Name of international conventions / agreements / initiatives apply / related to the fisheries: _____

2. Nature of conventions / agreements: ____ Legally binding ____ Not legally binding

3. System application: ____ Single species ____ Multi-species ____ Ecosystem

4. What are the issues related to these conventions / agreements? (Choose all that apply)
____ Enforcement ____ Compliance ____ Equity / Fairness / Justice ____ Ethical

5. What are some incentives and/or enforcement measures to promote compliance? (Choose all that apply)
____ Trade sanctions ____ Monitoring ____ Polluter pay principle Others: _____

6. Are enforcement measures / compliance incentives considered effective? Y N N/A
Why? _____

7. Is administrative cost / burden for compliance an issue? Y N N/A
How? _____

8. Is IUU (Illegal, Unreported, Unmandated) addressed? Y N N/A

C. Principles and roles of sciences

1. What 'principles' are used as a basis for management and policies? (Choose all that apply)

____ Precautionary ____ Ecosystem-based ____ Adaptive management

____ Transparency ____ Inclusiveness ____ Accountability

____ Consensus building ____ Equity / Fairness ____ Ethical

____ Legitimacy Others: _____

2. What are the roles of sciences in management and policies?

____ Policy is based on 'best available sciences.'
____ Best sciences are available, but not used.
____ Best sciences are not available.
____ Scientific credibility is not established.
____ Too much politics to allow good sciences.
Others: _____

SECTION 2 E: APPROACHES & TOOLS

A. Protected areas (PA)

1. What are the goals of PA? (Choose all that apply)
   - ____ Enhance productivity
   - ____ Conserve biodiversity
   - ____ Reduce fishing mortality
   - ____ Reduce bycatch
   - ____ Maintain cultural heritage
   - ____ Reserve against stock collapse
   - ____ Protect habitats
   - ____ Protect ecosystem

   Others: _____
2. PA is designed based on:
   - ____ Network design
   - ____ Representative system
   - ____ Temporal considerations
   - ____ Source / sink concept
   - ____ Sensitive habitats
   - ____ Impacts of fishing gears
   - ____ Multiple uses

   Others: _____
3. Special features: _____

B. Aquaculture

1. Species cultured: _____ Type: ____ Marine ___ Freshwater ___ Brackish
2. Origin: ____ Native ____ Exotic ____ Introduced ____ Genetically modified organisms
3. Food habit: ____ Carnivorous ____ Herbivorous ____ Omnivorous
4. What culture system is used? (Choose all that apply)
   - ____ Extensive
   - ____ Semi-intensive
   - ____ Intensive
   - ____ Closed-system
   - ____ Net pens
   - ____ Pond
   - ____ Cage
   - ____ Sea ranching
   - ____ Monoculture
   - ____ Polyculture
   - ____ Integrated system
5. Special techniques / features: _____

C. Habitat improvement and stock enhancement

1. What are the techniques used for habitat improvement? (Choose all that apply)
   - ____ In-stream structure placement (logs, boulders)
   - ____ Artificial reef construction
   - ____ Off-channel habitat construction
   - ____ Spawning substrate addition
   - ____ Logging road improvement/decommissioning
   - ____ Nutrient addition
   - ____ Fish passage improvement (e.g., tide gate removal)
   - ____ Restore ecosystem connectivity
   - ____ Riparian vegetation planting
   - ____ Water pollution control
   - ____ Eelgrass bed / submerged aquatic vegetation planting
   - ____ Sediment removal/filtration
   - ____ Exotic species removal
   - ____ Ban on fisheries

   Others: _____

2. What is the approach of the improvement work?
   - ____ Protection (protect functioning ecosystem)
   - ____ Enhancement (improvement with short term, localized, single species goals)
   - ____ Restoration (improvement with self-sustaining long term, large scale, multi-species goals)

3. What is the scale of the improvement work?
   - ____ Ecosystem (watershed, reef, gulf, straight, etc.)
   - ____ Sub-system (stream reach, estuarine marsh, specific habitat type)

4. Describe the method used for stock enhancement: _____

5. Does stock enhancement involve habitat restoration? Y N N/A
   If yes, what type of habitat? _____

6. What risks are considered?
   - ____ Genetic changes
   - ____ Competition with wild stock
   - ____ Disease transfer

   Others: _____

SECTION 3: SUMMARY AND EVALUATION

A. Special features about the paper

1. What is special about the objectives? _____
_____

2. What is special about the approaches / methodology? _____
_____

3. What is special about the results? _____
_____

B. Management / policy implications

1. Does the paper give explicit management / policy recommendations? Y N
Describe: _____

2. Does the paper attempt to integrate considerations for natural systems, social and economic?
Y N Not clear

3. Does the paper have any implications for sustainable fisheries? Y N
Describe: _____

C. Education and dissemination

1. Is there special effort and innovation to communicate the results to the general public? Y N
Describe: _____
_____

2. What are some evidences to indicate the 'success' of the research? _____
_____

3. Should the topics / issues discussed in the paper be included in an undergraduate program in fisheries and marine conservation? Y N Maybe

D. Overall impacts of the paper (based on your opinion)

1. Does the paper contribute to the discussion about reconciling fisheries with conservation?
Y N Not clear

2. Should this type of research be supported / promoted? Y N Maybe

3. What is the level of overall positive impact of the paper for reconciling fisheries with conservation?
____ None ____ Low ____ Medium ____ High ____ Very high

4. What is your overall rating of this paper in terms of its importance for the future of fisheries?
____ None ____ Low ____ Medium ____ High ____ Very high

APPENDIX 2

List of participants, Innovation and Outlook in Fisheries Workshop, Vancouver, 7 May 2004

Name	Institution	E-mail	Research interests
Ainsworth, Cameron	University of British Columbia, Fisheries Centre	c.ainsworth@fisheries.ubc.ca	Ecosystem modelling, restoration strategies for marine system of Northern BC
Alder, Jackie*	University of British Columbia, Fisheries Centre	j.alder@fisheries.ubc.ca	Coastal management and planning, coastal ecosystems, climate change
Anderson, Michelle	University of Montana	laperi@excite.com	Riverine fisheries and food webs, fish ecophysiology, remote sensing, Bayesian statistics
Bhole, A.G.	Institute for sustainable development and research, Mumbai	clkp123@yahoo.com; isdrklc@hotmail.com	Inland and ocean fisheries, ecology and environment
Bratty, Jessica	Fraser Basin Council	jbratty@fraserbasin.bc.ca	Conflict resolution, mediation, communication of technical information to stakeholders, policy and decision makers
Brunio, Erwin	Project Seahorse Foundation for Marine Conservation	eob_ps@mozcom.com	Marine Protected Areas, participatory research
Buchary, Eny	University of British Columbia, Fisheries Centre	e.buchary@fisheries.ubc.ca	Ecosystem-based modelling, marine biodiversity, marine policy and conservation, fisheries management, foodweb dynamics, restorative ecology, local and traditional ecological knowledge, long-term climatic impact, cognitive mapping, and perspectives of resources.
Bundy, Alida	Bedford Institute of Oceanography, Marine Fish Division	bundya@mar.dfo-mpo.gc.ca	Preservation of ocean biodiversity, impact of fishing on marine ecosystems, ecosystem-based management, development of assessment methods for data-poor fisheries, adaptive management of fisheries and interdisciplinary approaches to fisheries science
Charles, Tony*	Saint Mary's University, Management Science / Environmental Studies	tony.charles@smu.ca	Community based resource management, integrated fishery and marine indicators, and policy analysis

Name	Institution	E-mail	Research interests
Cheung, William	University of British Columbia, Fisheries Centre	w.cheung@fisheries.ubc.ca	Vulnerability of fishes, fisheries and ecosystem modelling, Chinese and Hong Kong fisheries, local knowledge
Christie, Patrick*	University of Washinton, School of Marine Affairs and Jackson School of International Studies	patrickc@u.washington.edu	Marine protected areas, integrated coastal management, community-based resource management, fisheries-tourism interactions, coral reefs, Southeast Asia
Chuenpagdee, Ratana	International Ocean Institute, Dalhousie University	ratana.chuenpagdee@dal.ca	Integrated coastal management, small-scale fisheries
Claudhari, K.K.	Institute for sustainable development and research, Mumbai	clkp123@yahoo.com; isdrklc@hotmail.com	Human dimensions / socio-economic issues, aboriginal issues
Claudhari, K.L.	Institute for sustainable development and research, Mumbai	clkp123@yahoo.com; isdrklc@hotmail.com	Data quality, IT applications, human dimensions
Cleofe, Jovelyn	Center for Empowerment and Resource Development, Inc. (CERD)	cerd@skyinet.net	Impacts of conservation and management of fisheries to small scale fisheries livelihood; mainstreaming women's issues and concerns in conservation and management efforts
Cochrane, Kevern*	Food and Agriculture Organization, Marine Resources Service	Kevern.Cochrane@fao.org	Fisheries assessment and management, ecosystem approach to fisheries, role of CITES in relation to commercially-exploited aquatic species
Curtis, Janelle	McGill University	janelle.curtis@mail.mcgill.ca	Population ecology, marine conservation, population genetics
Dingerson, Lindy	Virginia Institute of Marine Science	lynne@vims.edu	Management of coastal resources
Foster, Sarah	University of British Columbia, Project Seahorse, Fisheries Centre	s.foster@fisheries.ubc.ca	Involvement with the Convention on International Trade in Endangered Species (CITES) and aquatic species (particularly the listing of seahorses on Appendix II), the use of life history in informing management plans

Name	Institution	E-mail	Research interests
Gallaugher, Patricia*	Simon Fraser University, Continuing Studies in Science	pgallaug@sfu.ca	Bioscience, marine conservation, coastal studies, local knowledge
Freire, Katia	University of British Columbia, Fisheries Centre	k.mfreire@fisheries.ubc.ca	Commercial and recreational fisheries, modelling of ecosystems, common names of fish
Giannico, Guillermo	Department of Fisheries and Wildlife, Oregon State University	giannico@oregonstate.edu	Salmonid ecology, stream ecology, and watershed management. Also public education and outreach in watershed management and ecology
Holt, Carrie	Simon Fraser University	cholt@sfu.ca	Pacific salmon, international fisheries, stock assessment for data poor fisheries
Jenkins, Kiki	Duke University Marine Laboratory	ldj@duke.edu	Marine conservation, bycatch, conservation technology, sea turtles
Johnson, Derek	Centre for Maritime Research	djohnson@marecentre.nl	Globalisation, marine fisheries, fisheries management Gujarat State (India), Atlantic Canada
Lambert, Debra	Virginia Institute of Marine Science	dlambert@vims.edu	MPAs, stock assessment, tagging
Liguori, Lisa	University of British Columbia, Resource Management & Environmental Studies	liguori@interchange.ubc.ca	Resource management, small-scale coastal fishing communities
Liu, Yajie	University of British Columbia, Fisheries Economic Research Unit, Fisheries Centre	l.liu@fisheries.ubc.ca	Aquaculture technology and economics
Maxwell, Sara	Marine Conservation Biology Institute	sara@mcbi.org	Seamounts, deep sea corals
McConney, Patrick*	University of the West Indies, Barbados Centre for Resource Management and Environmental Studies (CERMES)	nrmoutreach@caribsurf.com	Marine resource management planning, governance and outreach
Morgan, Lance*	Marine Conservation Biology Institute	lance@mcbi.org	environmental impacts of fisheries, design of marine protected areas, marine biodiversity, conservation, metapopulations, deep sea corals

Name	Institution	E-mail	Research interests
Morgan, Sian	McGill University/ University of British Columbia	s.morgan@fisheries.ubc.ca	Dispersal of coral reef fishes, PVA, larval behaviour, tools for integrating stakeholders in decision-making processes
Munro, Gordon*	The University of British Columbia, Department of Economics	munro@econ.ubc.ca	Fisheries economics, fisheries management with a particular interest in fisheries management problems arising under the New Law of the Sea
Nandakumar, D.	University of Victoria, Department of Geography	nandan@uvic.ca	Sustainable livelihoods of artisanal fishing communities and Coastal Zone Management in developing countries
Pauly, Daniel*	University of British Columbia, Fisheries Centre	d.pauly@fisheries.ubc.ca	Global fisheries assessment, ecosystem-based approaches to fisheries, Darwin's fishes
Poon, Amy	University of British Columbia, Fisheries Centre	a.poon@fisheries.ubc.ca	Indirect sources of fishing mortality
Salas, Silvia	CINVESTAV Unidad Merida	ssalas@mda.cinvestav.mx	Fisheries economics and management, coastal management and decision analysis focused on small-scale fisheries
Salomon, Anne	University of Washington, Biology Department	salomon@u.washington.edu	Applied Marine Ecology, temperate nearshore rocky reef ecosystems, human alteration of coastal food webs, trophic effects of fishing and marine reserves
Serra, Rodolfo	Instituto de Fomento Pesquero	rserra@ifop.cl	Stock assessment/ population dynamics
Sharp, Ben	Ministry of Fisheries, New Zealand	ben.sharp@fish.govt.nz	New Zealand fisheries
Shannon, Lynne	Marine and Coastal Management, Department of Environmental Affairs and Tourism, South Africa	lshannon@deat.gov.za	Ecosystem modelling – trophodynamics/food webs. Regime shifts; small pelagic fish and their role in the marine food web
Simms, Jason	Department of Fisheries and Oceans	simmsja@dfo-mpo.gc.ca	Marine Protected Areas; integrated coastal management; species at risk
Sumaila, Rashid*	University of British Columbia, Fisheries Centre	r.sumaila@fisheries.ubc.ca	fisheries economics, game theory and modelling, natural resource valuation

Name	Institution	E-mail	Research interests
Teh, Louise	University of British Columbia, Fisheries Centre	l.teh@fisheries.ubc.ca	Effectiveness of MPA in conserving coral reef biodiversity and sustaining livelihoods.
Turnipseed, Mary	Blue Ocean Institute, New York	mturnips@hotmail.com	Marine ecology, ecosystem-based fisheries management, habitat conservation

* denotes the experts invited for the panel discussion

APPENDIX 3

List of participants, Creating a Positive Future for Fisheries and Fishing Communities Workshop, Halifax, 13-15 Jan 2005

Name	Institution	E-mail
Bundy, Alida	Bedford Institute of Oceanography, Dartmouth	bundya@mar.dfo-mpo.gc.ca
Charles, Tony	St. Mary's University, Halifax	tony.charles@smu.ca
Christie, Patrick	University of Washington, Seattle, Washington, USA	patrickc@u.washington.edu
Chuenpagdee, Ratana	International Ocean Institute - Canada, Halifax	ratana.chuenpagdee@dal.ca
Fanning, Lucia	Environment Canada, Dartmouth	fanningluciaec@dfo-mpo.gc.ca
Gonzales, Patricia	Bedford Institute of Oceanography, Dartmouth	gonzalezpatriciaec@dfo-mpo.gc.ca
Huston, Justin	Agriculture and Fisheries, Halifax	hustonje@gov.ns.ca
Liguori, Lisa	University of British Columbia, Vancouver	liguori@interchange.ubc.ca
Nandakumar, D.	University of Victoria, Victoria	nandan@uvic.ca
Pauly, Daniel	University of British Columbia, Vancouver	d.pauly@fisheries.ubc.ca
Ricard, Daniel	Dalhousie University/Bedford Institute of Oceanography, Dartmouth	ricardd@mathstat.dal.ca
Rudd, Murray	Fisheries and Oceans Canada Policy and Economics Branch - Maritimes Region	ruddm@mar.dfo-mpo.gc.ca

Name	Institution	E-mail
Salas, Silvia	CINVESTAV, Merida, Mexico	ssalas@kin.mda.cinvestav.mx
Smith, Jennifer	World Wildlife Fund Canada, Halifax	jsmith@wwfcanada.org
Sumaila, Rashid	University of British Columbia, Vancouver	r.sumaila@fisheries.ubc.ca
Turnipseed, Mary	Blue Ocean Institute, New York, USA	mturnips@hotmail.com
Tydmers, Peter	Dalhousie University, Halifax	peter.tyedmers@dal.ca
Vanderzwaag, David	International Ocean Institute - Canada & Marine and Environmental Law Program, Dalhousie University	david.vanderzwaag@dal.ca
Zwanenburg, Kees	Bedford Institute of Oceanography, Dartmouth	zwanenburgk@mar.dfo-mpo.gc.ca

APPENDIX 4

AQUALINK: FIVE-YEAR REVIEW (2000-2004)

http://fisheries.ubc.ca/aqualink/index.htm

Ratana Chuenpagdee[1] and Lisa Liguori[2]

[1]International Ocean Institute – Canada, Dalhousie University, Halifax, NS, Canada
[2]Institute of Resources and Environment and Sustainability, University of British Columbia, Vancouver, BC, Canada

FROM THE AMBITIOUS MISSION STATEMENT…

"To assess, maintain and improve the state of aquatic ecosystems through innovation in scientific research and integration of disciplines, perspectives and knowledge, and through facilitation of communication, education, training and practice"

…to measurable outcomes, but there is still a long way to go!

IN THE BEGINNING…

AQUALINK was created in 1999 by a group of graduate students, post-doctoral fellows, and research associates at the University of British Columbia. It serves as a supportive network to promote interdisciplinary, innovative and international research and activities related to aquatic ecosystems. It also aims at integrating knowledge from natural and social science disciplines to address issues concerning aquatic ecosystems. A review of *AQUALINK*'s accomplishments over the past five years reveals that the network has grown and expanded, both internationally and interdisciplinary. Annual highlights illustrate how *AQUALINK* has remained grounded by its original mandate, which challenges the group to continuously seek innovative methodologies and explore different perspectives.

2000

One of the first activities that the network conducted was to organise an internal annual workshop, aiming to set directions that the network should take. Two key research areas were identified. Firstly, we acknowledged the importance of new approaches in participatory research and avenues for integration of knowledge generated from different disciplines. We agreed that it was desirable and beneficial to include stakeholders in the management of natural resources, but noted concern that participatory research must be conducted with considerable planning and transparency and be responsive to the social, cultural, and regulatory context associated with each community. Two challenges to participatory research were also highlighted, i.e., the lack of tools to systematically assess the success of participatory research and the need to identify factors contributing to or inhibiting the process. The second priority was the understanding development in coastal areas within the larger economic and political context. We acknowledged the difficulties stemming from social and economic pressure associated with population growth, conflicting interests in resource utilisation, and emerging environmental problems. It was worth noting the importance of the exploration the institutional arrangements and infrastructure systems that allow local communities to benefit from globalisation rather than being subsumed by it.

2001

Maintaining the network with members who were largely busy with their academic work was proven to be a big challenge. The decision was made to hire one member on a part-time basis to serve as a coordinator of the network. *Atsuko Hasegawa*, a recent graduate from UBC, took the role and she was instrumental in organizing the bi-monthly web-based seminar series. The seminar provided a forum for members to communicate to each other about their work and to exchange research ideas. The second annual workshop was conducted mainly to develop strategies for working together, given the time and geographical constraints (with members spreading around the world). Year 2001 was devoted largely to the planning of the first major *AQUALINK* event, which was to design and facilitate discussions and workshops for the first Coastal Zone Asia Pacific (CZAP) Conference, held in Bangkok, Thailand the following year.

2002

Figure 1. (Standing from left): R. Chuenpagdee, E. Buchary, A. Bundy, P. Wongsnga*, C. Ware, L. Liguori (Sitting from left): J. Simms, V. Tsontos, D. Nandakumar, D. Fezzardi, G. Giannico. (* denotes non-members)

The first CZAP conference in Thailand brought together over 200 people from 23 countries to exchange knowledge and experiences about coastal resources issues and management. The conference was organised by *Ratana Chuenpagdee*, with support from *AQUALINK*, and major financial support from National Science Foundation, NOAA, OXFAM, and AusAID, among others. After a year of planning and developing facilitation protocol, eleven *AQUALINK* members represented the network at the conference (Figure 1). They performed a major role in the entire conference, facilitating workshops and discussion, and preparing the preliminary synthesis as inputs for the production of the conference proceedings (www.vims.edu/czap). In addition, some members participated in the '*Roles of Education in Sustaining Integrated Coastal Management*' workshop, organised by R. Chuenpagdee and *Guillermo Giannico*, together with two other colleagues.

At the conclusion of the web-based seminar series, *AQUALINK* initiated a quarterly newsletter, edited by *Lisa Liguori*, to keep members up-to-date on new opportunities and to stay connected as original and new members moved to new places and into new phases of their research careers. Back issues of *AQUALINK* newsletter can be found on the network website (http://fisheries.ubc.ca/aqualink/index.htm).

2003

The *AQUALINK's* successful role in CZAP inspired members to take on a new challenge in Vancouver, Canada where the network originally began. Planning for our role in the 4th World Fisheries Congress provided an opportunity to utilise the interdisciplinary strengths of members at this international conference challenging participants to "reconcile fisheries with conservation".

2004

Figure 2. (standing) A. Bundy (sitting from left) D. Pauly, K. Cochrane, P. Gallaugher*, G. Munro*, T. Charles. (* denotes non-members)

Continuing *AQUALINK's* pattern of ebbs and flows, 2004 was another monumental year. Organizing and facilitating the '*Innovation and Outlook in Fisheries*' workshop at the 4th World Fisheries Congress in Vancouver, British Columbia (Figure 2). Under the leadership of R. Chuenpagdee and *Alida Bundy* and sponsored by SSHRC, *AQUALINK* members and volunteer students and scholars conducted a systematic assessment of the papers presented at the Congress in terms of their contributions to address the congress theme (May, 2004). Using specially designed templates, we analysed research trends and quantified which ecological, social, political, and economic issues were commonly addressed. Our templates served to spark discussion not only about innovation and new outlooks, but also encouraged participants to take a critical look at which research paradigms are "in", and which are "out". In June, key findings were presented at the Coastal Zone Canada Conference in St. John's Newfoundland by R. Chuenpagdee and *Jason Simms*.

Another highlight in 2004 was the first international COASTFISH conference on small-scale fisheries in Latin America and the Caribbean, held in Merida, Mexico in October 2004 (Figure 3). The conference was organised by *Silvia Salas* and focused on tools and approaches employed in the assessment and management of coastal fisheries. In addition to paper and poster presentations, the conference uniquely included a panel discussion by fishermen and fisherwomen offering their perspectives about the status of fisheries in the region.

Figure 3. (from left) S. Salas, L. Liguori, R. Chuenpagdee

WHERE WE GO NEXT…

Besides sharing the results of collaborative research and activities and suggesting elements on which to base new research, one of *AQUALINK's* greatest strengths lies in the fact that our connections to people, places, and ideas outside our areas of expertise will continue to challenge us to question what we know.

At the COASTFISH Conference, one scientist asked a fisherman in the panel what it would take to abandon fishing. Revealing the complexity of one of *AQUALINK's* early goals stated in the annual workshop (2000), suggesting alternative activities to diversify the economic base of fishers, this man replied, "*I am a fisherman. You are a scientist. Can I ask you what it would take for you to abandon science?*" This kind of

statement demonstrates that many of *AQUALINK's* fundamental research questions may not be fully answered in conversations among scholars and more participatory research is needed.

As a follow-up from the 4th World Fisheries Congress, *AQUALINK* hosted a workshop called '*Creating Positive Future for Fisheries Worldwide*' in Halifax, Nova Scotia, January, 2005, to address the common assumption that when we take care of an ecosystem, we take care of the people who rely on it for food, livelihood and employment. It is important and impressive to note that areas suggested for new research call to mind discussions at *AQUALINK's* annual workshop five years ago. However, informed by both experience and data, these topics go beyond addressing initial research gaps to include areas of study not conventionally considered by scientists and managers of aquatic resources (e.g. social justice and power).

Clearly, there are many great challenges facing *AQUALINK* members in their pursuit. The outcomes of the five-year work suggest, however, that they are paving the way and in the right direction.

MEMBERS OF STEERING COMMITTEE

2000: Eny Buchary, Ratana Chuenpagdee, Guillermo Giannico, Sylvie Guénette, Melanie Power and Jim Vanderwal

2001: Shawn Booth, Eny Buchary, Ratana Chuenpagdee, Sylvie Guénette, Silvia Salas, Anne Salomon, and Miriam Wright

2002: Alida Bundy, Ratana Chuenpagdee, Bridget Ferriss, Guillermo Giannico, Amy Poon, and Vardis Tsontos

2003-2004: Eny Buchary, Alida Bundy, Ratana Chuenpagdee, Bridget Ferriss, Guillermo Giannico, Amy Poon, and Vardis Tsontos

ADVISORY MEMBERS (2000-2004):

Dr. Tony Charles, St Mary's University, Halifax, Canada
Dr. Kevern Cochrane, FAO, Rome, Italy
Dr. Rosemary Ommer, University of Victoria, Victoria, Canada
Dr. Daniel Pauly, University of British Columbia, Vancouver, Canada

List of *AQUALINK* members *

Members	Details
	*Name:* **Ainsworth, Cameron** *Origin:* Canada *Position:* PhD Candidate, Fisheries Centre, UBC *Email:* c.ainsworth@fisheries.ubc.ca *Specialization:* Ecosystem modelling, Restorative marine ecology "To reconcile fisheries with conservation we must reduce global fishing capacity through economic incentives: primarily, by reducing government subsidies and developing employment alternatives."
	*Name:* **Buchary, Eny Anggraini** *Origin:* Indonesia *Position:* PhD candidate, Fisheries Centre, UBC *Email:* e.buchary@fisheries.ubc.ca *Specialization:* Restorative ecology, the ecosystem effects of fishing, food web dynamics and modelling, fisheries management, policy and conservation, historical and cultural ecology, local and traditional ecological knowledge "Continue opening and facilitating honest and productive dialogues on sharing common resources amongst stakeholders"
	*Name:* **Bundy, Alida** *Origin:* British/Canadian *Position:* Research Scientist, Fisheries and Oceans, Canada, Bedford Institute of Oceanography *Email:* BundyA@mar.dfo-mpo.gc.ca *Specialization:* marine ecology, fisheries and ecosystem analysis "Reduce overcapacity, specifically the large-scale industrial trawling sector. Hold corporations responsible for their impacts on fisheries and ecosystems. Mine and move on should not be an option in fisheries of the C21st."
	*Name:* **Cheung, William W.L.** *Origin:* Hong Kong (China) *Position:* PhD candidate, Fisheries Centre, UBC *Email:* w.cheung@fisheries.ubc.ca *Specialization:* Ecosystem modeling, marine conservation biology "Controlling growth of human population and changing consumption patterns."

* Included the answers to the question "What is the MOST urgent thing that needs to be done to reconcile fisheries with conservation?"

Members	Details
	*Name:* **Chuenpagdee, Ratana** *Origin:* Thailand *Position:* Senior Research Fellow, International Ocean Institute, Canada *Email:* ratana.chuenpagdee@dal.ca *Specialization:* Small-scale fisheries, community-based management, integrated coastal management, valuation methods, fisheries governance "'Slow Fish', i.e., slow down fishing, scale down fisheries, support small-scale fishing communities."
	*Name:* **Dingerson, Lindy** *Origin:* USA *Position:* Graduate student, Center for Coastal Resources Management, Virginia Institute of Marine Science *Email:* lynne@vims.edu *Specialization:* Land use/shoreline resource planning "To take an ecosystem-based approach to management, with large consideration of humans, fishing needs, and conservation goals as a component of the plan."
	*Name:* **Divakarannair, Nandakumar** *Origin:* India *Position:* Ph.D. Candidate, Dept. of Geography,University of Victoria *Email:* nandan@office.geog.uvic.ca *Specialization:* Livelihood strategies, Sustainability issues among artisanal fishing communities. "Promoting sustainable practices of fisheries while asserting greater control over large scale industrial fisheries."***
	*Name:* **Freire, Kátia M.F.** *Origin:* Brazil *Position:* PhD Student, Fisheries Centre, UBC *Email:* k.mfreire@fisheries.ubc.ca *Specialization:* Fisheries (commercial and recreational), ecosystem modelling, common names of fishes, etnobiology "Education, communication, and consideration of future generations"
	*Name:* **Giannico, Guillermo Roberto** *Origin:* Argentina *Position:* Assistant Professor and Extension Fisheries Specialist, Department of Fisheries and Wildlife, Oregon State University, U.S.A. *Email:* giannico@oregonstate.edu *Specialization:* juvenile salmonid ecology, fish behaviour, watershed management, public education "There are many, but my priority would be to implement ecosystem based fisheries co-management in an economic context that is free of pernicious subsidies."

Members	Details
	*Name:* **Holt, Carrie** *Origin:* Canada *Position:* PhD candidate, the School of Resource and Environmental Management, SFU *Email:* cholt@sfu.ca *Specialization:* Fisheries simulation modelling, Pacific salmon, management strategy evaluations "In my opinion, the most urgent thing that needs to be done to reconcile fisheries with conservation is full recognition of scientific uncertainties in stock assessment, evaluating management strategies, and communication with other stakeholders."
	*Name:* **Lambert, Debra** *Origin:* USA *Position:* MS Student, Fisheries Department at the School of Marine Science/Virginia Institute of Marine Science, College of William and Mary *Email:* dlambert@vims.edu *Specialization:* Fisheries "Better cooperation and understanding amongst fishers, managers, and scientists."
	*Name:* **Liguori, Lisa** *Origin:* USA *Position:* MS Student, Resource Management and Environmental Studies, UBC *Email:* liguori@interchange.ubc.ca *Specialization:* Emerging and traditional fisheries in coastal communities; social impacts of conservation "Working with small-scale fishing communities should be a top priority when it comes to developing innovative and interdisciplinary partnerships for research and resource management; conservation projects should reflect the values and aspirations of local people."
	*Name:* **Liu, Yajie** *Origin:* China *Position:* PhD student, Fisheries Centre, UBC *Email:* l.liu@fisheries.ubc.ca *Specialization:* Aquaculture economics and management "Solving socio-economic problems."
	*Name:* **Poon, Amy** *Origin:* Canada *Position:* Web Writer, Vancouver Aquarium *Email:* Amy.Poon@vanaqua.org *Specialization:* Ghost Fishing "Education! Without a method to instill a sense of stewardship in people along the fishing chain, the focus is going to remain on commercial gain rather than ecological well-being."

Members	Details
	*Name:* **Salas, Silvia** *Origin:* Mexico *Position:* Associated professor, Cinvestav Merida *Email:* ssalas@mda.cinvestav.mx *Specialization:* Fisheries economics and fisheries management, focus on small-scale fisheries "To think globally and act locally, things are happening beyond our yard and beyond the context of fisheries. In order to achieve changes in the ocean and coastal governance I believe we need to star looking into a wider context and take small and big doable steps towards conservation and sustainable development."
	*Name:* **Salomon, Anne** *Origin:* Canada *Position:* Doctoral Student, Biology Department, University of Washington *Email:* salomon@u.washington.edu *Specialization:* Marine ecology, subsistence fisheries, marine reserve design, introduced species "Consider the social and ecological dynamics of the ecosystem, experiment with management policies and involve resource users in research, education and conservation actions from the design stages onwards."
	*Name:* **Simms, Jason** *Origin:* Canada *Position:* Oceans Biologist, Northwest Atlantic Fisheries Centre *Email:* simmsja@dfo-mpo.gc.ca *Specialization:* Marine protected areas, integrated ocean management "To effectively communicate the benefits of conservation to the fishing industry."
	*Name:* **Tsontos, Vardis M.** *Origin:* Greek, South African *Position:* Research Associate, Department of Biological Sciences, University of Southern California, Los Angeles *Email:* tsontos@usc.edu *Specialization:* Fisheries/population ecology, information systems "Curtail effort and prevent overcapitalization"
	*Name:* **Turnipseed, Mary** *Origin:* USA *Position:* Senior Researcher, Blue Ocean Institute *Email:* mturnips@hotmail.com *Specialization:* Fisheries conservation "Education and social marketing."

Members	Details
	*Name:* **Vidal-Hernandez, Laura Elena** *Origin:* Mexico *Position:* PhD student at CINVESTAV-MERIDA, Mexico Dpto. Recursos del Mar Carr *Email:* Levidal_mx@yahoo.com.mx levidal@kin.mda.cinvestav.mx *Specialization:* Fisheries, aquatic ecosystem modeling, environmental legislation "In my opinion, the most important issue to reconcile fisheries with conservation is to address fishing species assessment and management within their ecological context."