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Special Section Introduction

The Role of Economics in Mitigating Unsustainability of Fisheries: Dealing with Ecosystems, Governance, and Environmental Fluctuations

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The Fourth Biennial Conference of the North American Association of Fisheries Economics (NAAFE) was a forum for presenting papers dealing with the role of economics in mitigating unsustainability of fisheries and in contributing to responsible and sustainable development of aquaculture. Professional associations like NAAFE also contribute toward ensuring humanity's freedom from hunger, by advancing and communicating knowledge towards improving the efficiency of the production and distribution of fisheries and aquaculture products in a sustainable manner, and by raising the level of nutrition and standard of living in coastal communities.

In the Bangkok, Mauritius, and Cambodia meetings organized by FAO in this decade, unsustainability of fisheries was attributed to seven main factors: (*i*) lack of solid governance structures; (*ii*) incomplete knowledge of marine ecosystems; (*iii*) fishery complexities, and the associated uncertainties; (*iv*) inadequate incentives and subsidies that stimulate overcapacity; (*v*) stock fluctuations due to natural causes; (*vi*) growing demand of limited fish resources; and (*vii*) poverty and lack of alternatives for coastal development (Swan and Greboval 2006; Caddy and Seijo 2005).

To address some of these factors, the NAAFE 2007 forum was organized into 17 sessions dealing with ecosystem approaches to manage fisheries; spatial bioeconomic modeling and management of metapopulations; rights-based fisheries approaches of co-management; community-based management and individual transferable quotas (ITQs); valuation of ecosystem services and biodiversity; recreational fisheries; and trade, traceability, and marketing of fisheries and aquaculture products. The forum also offered five special sessions focusing on very important topics that included: application of harvest right-based concepts to the management of recreational fishing; future of aquaculture development in the region; fisheries subsidies: their scope and impacts; alternative approaches to discounting in the management of marine fisheries; and a plenary session on future policy challenges for sustainably managing fisheries in the region. Scientists from Brazil, Canada, Chile, India, México, New Zealand, Nigeria, Norway, Portugal, Spain, Trinidad and Tobago, and the United States of America participated in this conference. This special

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section of *Marine Resource Economics* presents four peer-reviewed papers that reflect the diversity of topics and research questions addressed during the conference. Articles included in this special section address issues such as the choice experiment developed by Wallmo and Edwards (2008) to estimate the existence value of protecting species and habitat diversity on the sea floor in areas that vary in size and allowable uses of the water column, and apply a latent class specification to accommodate taste parameter heterogeneity. Results of this article identify three latent classes in the sample and suggest that while protecting areas such as ecological reserves is utility increasing for most size/use combinations, smaller reserves with liberal use policies produce the largest increases. Wallmo and Edwards' research on spatial management of fisheries suggests diminishing marginal utility for marine protected area (MPA) sizes that are substantially smaller than ranges often cited.

Concerning fishermen behavior, Holland (2008) discusses a body of work by cognitive psychologists and behavioral economists, which suggests that decisions involving uncertainty often diverge substantially from what would be predicted by expected utility theory. Holland reviews relevant findings from the literature on decision making under uncertainty and previous empirical modeling of fishing decisions and explores the implications of a number of different behavioral theories on fishing decisions of various types.

Hutchinson (2008) used a generalized Leontief production function to examine the economic factors that influence output in the Trinidad and Tobago shrimp fishery. Factors such as output prices and the use of inputs in the fishery were assessed. The sequential artisanal-industrial fishery analyzed by Hutchinson operates seasonally in a mostly open-access, multi-species context. While shrimp is the main targeted species, various fish species are also targeted using gear modifications. It was found that for the artisanal shrimp trawl fleet in Trinidad and Tobago, effort, in terms of trip days, was estimated to have a significant effect on both shrimp and bycatch landings in almost similar levels.

To determine if management measures based on effort reductions, in particular days-at-sea (DAS) controls, can approach a harbor porpoise ITQ program in terms of efficiency, Bisack (2008) examined the New England sink gillnet fishery by using a numerical bioeconomic model. In this article, year-round and seasonal surcharges in combinations with overall DAS reductions were investigated. Results indicate that several programs for marine mammal protection can achieve the same conservation outcome with modest differences in industry profits.

During the keynote address by Prof. Jon Sutinen it was emphasized that coastal states are currently exploring stock recovery strategies and ecosystem approaches to improve fisheries management with the goal of achieving responsible, sustainable use of this renewable resource. Professor Sutinen also pointed out that these new approaches to fisheries management provide intellectual as well as practical challenges to the academic community of fisheries economists.

To expand in this subject area, the following are some considerations for the implications of establishing the ecosystem approach to fisheries.

Currently, there are international attempts by most fishing nations to implement an ecosystem approach in their domestic fisheries and in any international fishery in which they participate. The importance of the ecosystem approach to fisheries was recognized in 2001 by 47 countries participating in the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. The signing parties declared "…that in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, we will individually and collectively work in incorporating ecosystem considerations into that management…" (FAO 2001, p.106).

The utopia of an ecosystem approach to fisheries management is summarized by Chapter 17 of Agenda 21:

> The marine environment—including oceans and all seas and adjacent coastal areas—forms an integrated whole that is an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development. International law … sets forth rights and obligations of States and provides the international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources.

As pointed out by Cochrane *et al*. (2004) and Ward *et al*. (2002), a number of attempts have been made to translate this ideal into a practical and feasible approach, including those of the National Research Council (US) (1999), Convention of Biological Diversity, and the World Wide Fund for Nature.

FAO (2003) developed an interpretation of these and other efforts in the form of a rationale and a definition. The rationale: "The purpose of an ecosystem approach to fisheries is to plan, develop and manage fisheries in a manner that addresses the multiplicity of societal needs and desires, without jeopardizing the options of future generations to benefit from the full range of goods and services provided by the marine ecosystem." And the definition: "An ecosystem approach to fisheries to balance diverse societal objectives by taking account of the knowledge and uncertainties about biotic, abiotic and human components and applying an integrated approach to fisheries within ecological meaningful boundaries." As recognized by Cochrane *et al*. (2004), the implementation of the ecosystem approach to fisheries (EAF) is likely to be slow, and many countries, agencies, and individuals are still in the process of understanding and interpreting just what is intended by the term EAF. One aspect emerging in the discussion is the need to capture the human and ecological interdependencies relevant for spatial management of coastal ecosystems (Seijo and Caddy 2008).

Towards an EAF for Integrated Management of Coastal Ecosystems

Integrated management of marine ecosystems is an approach to manage multiple and competing uses of certain designated marine areas. It involves managing multiple stakeholders. Like EAF, it requires processes of participatory decision making and conflict resolution. Further, it requires estimation of externalities involved in using the ecosystem and valuation of the goods and services of the marine ecosystem. For the valuation of goods and services of coastal ecosystems, it is important to acknowledge that human welfare can be derived from them by direct use or consumption of fish products, recognition of the indirect value of a marine ecosystem ecological service to the production of other goods and services, use or consumption of goods and ecological services by future generations, and inherent existence of such goods and services (De Young *et al*. 2008).

The move towards EAF would, in many instances, be on an incremental and adaptive management basis in view of much greater uncertainties and risks. Two aspects that require attention are the time needed to learn and acquire knowledge and the need to carefully assess the distributional implications of EAF interventions. The EAF objectives and principles need to be revised and expanded to better reflect social, economic, and institutional implications. It is also recognized that understanding of EAF in the context co-management and community-based management is a priority (Seijo 2007).

It should also be recognized that because of the greater uncertainties involved in considering ecosystem dimensions than with the single-species approach, applica-

tion of decision theory to address situations of limited information seems to be the way to proceed, while building appropriate ecosystem information systems. These require more extensive coverage of capacity building and training mechanisms for applying EAF with appropriate parsimonia.

Some of the main issues that may need to be dealt with in the process of establishing ecosystem approaches for fisheries management are: (*i*) changes in management measures to implement an EAF are likely to lead to potential conflicts with stakeholders; this needs to be considered and allowed for in the process of developing an EAF for specific fisheries; (*ii*) data collection requirements are greater with the EAF than with single target species analysis of fisheries; (*iii*) in developing coastal states where it is already difficult to implement adequate data collection for single species, obtaining scientifically valid data in support of fisheries management following an ecosystem approach could pose major challenges; (*iv*) costs of building and maintaining data collection and analysis systems for entire marine ecosystems and their users (*i.e.*, artisanal and industrial fishers, eco-tourists, and non-consumptive users) are likely to be substantial; (*v*) information costs may need to be paid for by the multiple users of the ecosystem in order to meet the basic requirements for implementing an operational EAF; (*vi*) managing fisheries taking account of limited knowledge and uncertainties on biotic, abiotic, and human components will require the development adequate monitoring approaches; and (*vii*) the focus cannot be exclusively on biological monitoring, but should include the human dynamics involving institutional, economic, and social dimensions (Seijo 2007).

Ecosystem Dimension of Fishery Indicators: Some Recent Suggestions

In the parsimonious process of extending beyond the single-species approach to fisheries management, building an operational, useful system of indicators and corresponding reference points seems to be a fundamental step (Seijo and Caddy, 2000). In order for fishery indicators to become more meaningful, they should explicitly account for changes in the ecosystem in which they occur; either due to climate changes, overfishing, environmental degradation due to human activities, or the destruction of critical habitats.

In their contribution in *Science*, Pikitch *et al.* (2004) provided two major recommendations:

> …we need to develop community and system level standards, reference points and control rules similar to single species decision criteria. New analytical models and management tools will be needed as well. Multispecies and eco-trophic models must be refined and expanded to better account for system-level uncertainties, to derive system-level reference points, and to evaluate the ecosystem-level consequences of proposed management EAF actions.

It should be pointed out, however, that before specifying ecosystem indicators and reference points, as indicated by Sainsbury and Sumaila (2003), there are two basic questions to answer: (*i*) is there a need for explicit reference points for the ecosystem, such as food web dynamics, ecological community structure and biodiversity, or are species-based reference points sufficient, and (*ii*) if ecosystem reference points are needed, should they be based on properties of the undisturbed coastal ecosystem? There seems to be an additional question; that is, how do we proceed in the absence of baseline studies of early stages of coastal development? Again, the use of dynamic models and techniques for their parameter estimation in limited data situa-

tions seems to be a future research priority in this field. Because of the inherent uncertainty of the "original status" of ecosystem habitat and community structure, these modelling efforts should be stochastic in nature. The potential and associated complexities of conducting risk analysis for ecosystem based management are discussed by Butterworth and Punt (2003).

Final Remarks

NAAFE's ability to bring distinguished scientists and advanced graduate students together to address some the above-mentioned issues and research questions is one of the many reasons why NAAFE is essential for the region and why its member countries should find ways to strengthen and support it. NAAFE provides the countries of the region with an academic forum to communicate knowledge and advancement of science in fisheries and aquaculture economics. It also stimulates strengthening of existing human and institutional linkages and provides opportunities for future cooperation in teaching, research, and resource management.

I thank the NAAFE Board and Director, and express my gratitude and appreciation to the members of the organizing and scientific committees for their contributions to the academic quality of the forum. Special thanks to the scientists that participated as academic reviewers of the papers submitted to this special section.

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