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World Fisheries

A Social-Ecological Analysis

Edited by
Rosemary E. Ommer, R. Ian Perry,
Kevern Cochrane and Philippe Cury

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World Fisheries
A Social-Ecological Analysis

Fish and Aquatic Resources Series

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Series Foreword

Hari Seldon and the order of consilience

> *It is the custom of scholars when addressing behavior and culture to speak variously of anthropological explanations, psychological explanations, biological explanations, and other explanations appropriate to the perspective of individual disciplines. I have argued that there is intrinsically only one class of explanation. It traverses the scales of space, time and complexity to unite the disparate facts of the disciplines by consilience, the perception of a seamless web of cause and effect.*
> E.O. Wilson

It has long been known that, to manage fisheries, we have to manage people, a notoriously messy process, as well as deal with the natural world of ecology and all its uncertainties, another set of messy processes. Yet, reflecting Wilson's strictures, the understanding of fisheries systems has proceeded largely in the separate solitudes of social and natural sciences and this has meant a lack of integrative solutions to chronic fisheries problems. And until recently, practical ways of moving towards Wilson's consilience have been inept at best, and disastrous in the worst cases (Pitcher and Lam, 2010).

Many seeking consilience of the social and ecological aspects of humans look enviously at the *Foundation* series of books, classics of 1950s science fiction, in which Isaac Asimov's protagonist, Hari Seldon, spends his life developing psychohistory, a concept of mathematical sociology analogous to mathematical physics.[1] Using the law of mass action, Seldon's algorithm can predict the future, but only on a large scale. It works on the principle that the behaviour of a mass of people is predictable if the quantity of this mass is very large (quadrillions in Asimov's envisioned galaxy of humans, inhabiting millions of star systems throughout the Milky Way). The larger the number, the more predictable is the future. Using his algorithm, Seldon foresees the imminent fall of the Galactic Empire, and a dark age lasting 30,000 years before a second great empire arises. To shorten the period of barbarism, he creates two Foundations, small, secluded havens of all human knowledge, at "opposite ends of the galaxy" and the stories follow the fortunes of this venture.

If only we understood Seldon's math, all would be well in the world of fisheries ecosystems and their embedded fish and fishers. Barbasi (2005) suggests that something along the lines of the Seldon formula may emerge from interdisciplinary team research on a vibrant consumer society that has developed webs of myriad electronic tags. But while Asimov's fictional Seldon solved E.O.Wilson's unity of knowledge, unfortunately, in real life things

are not so easy and we are still waiting for the critical theory to be invented. In the meantime, the social-ecological approach fostered by this book points a hopeful way forward.

In Asimov's stories, Seldon's theory could not handle innovation. To make sure that the predictions worked, the Foundation tried to freeze technological development and was ultimately unsuccessful. In fisheries, technological innovation has changed the ground rules for traditional coastal fishing societies where a sustainability ethic may emerge (Trosper 2009). The process has led to massive serial depletion of most of the world's major fisheries resources (Pitcher 2001, and for example, deep water and seamount fisheries, Pitcher *et al*., 2010), This process has prejudiced ecological sustainability and the very existence of many linked human livelihoods. The principal sufferers have been small-scale coastal communities, largely the subjects of this book.

This pioneering book, bringing together social and natural science into a fresh social-ecological perspective, presents case studies and concepts that point the way forward. The 24 chapters derive originally from a conference held at the Rome headquarters of the Food and Agricultural Organization of the United Nations in 2008 that attracted over 200 of the world's leading researchers in this field.

While there are significant other challenges, for example in establishing safe operating limits for the major biogeochemical global systems (Rockstrom *et al*., 2009), social-ecological systems may be key to human survival of the coming eco-crisis. Although they are vulnerable to disruptions of the biogeochemical norms, social-ecological systems nevertheless have significant adaptive capacity and may be able to sustain human well-being through difficult changes (Chapin *et al*., 2009). On a 50-year time-scale, many forecast a dark age of mayhem and destruction, while the human population grapples with serious food shortages of all kinds caused by ignoring the mismatch between ecology and unfettered human behaviour. This includes the catastrophic loss of the productive capacity of the world's oceans and fisheries. We can hope that the insight provided by the social-ecological approach will be analogous to Asimov's Foundation in averting or at least mitigating this impending catastrophe.

Endnote

1. Asimov's publisher, John W. Campbell of Astounding magazine (where Foundation first appeared), reported that Asimov's inspiration came from the logical analysis of historical trends in Gibbon's 1776 *Decline and Fall of the Roman Empire*. Asimov said he used, "a little bit of cribbin' from the works of Edward Gibbon."

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1. explore conceptual issues relating to social-ecological re- sponses in marine systems to global changes;
2. analyse case studies of specific examples of social-ecological responses in marine systems to significant environmental changes manifested locally;
3. synthesise the work of natural and social scientists and build comparisons of social-ecological responses in marine ecosystems subjected to major environmental variability;
4. develop innovative approaches to the use of science and knowledge in management, policy and advice; and to
5. identify policy initiatives that would enhance marine govern- ance structures such that they would encourage the building of resilient social-ecological systems.

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Part I

Social-Ecological Systems in Fisheries

Chapter 1
Introduction

Rosemary E. Ommer and R. Ian Perry

The ocean is fundamental to life on this planet, covering 70% of its surface and playing a major role in regulating the Earth's climate and the biogeochemical cycling of key elements. Yet it remains comparatively little understood, while being hugely exploited in response to human food requirements, and the need for other resources such as oil and gas. Human beings are having a huge impact on our oceans, without understanding the long-term consequences of our actions; the oceans also impact on human beings. The relationship between human beings and the oceans is two-way: humanity and the sea are inter-dependent, and we will not manage marine matters wisely until we make that an everyday part of our thinking. It is important to look at the linkages between oceans and ourselves, and to start to understand these linkages as part of how we think about, and act as stewards of, our oceans.

Failure to recognize the full implications of this humans-in-nature concept (Berkes and Folke, 1998) has left oceans, and many fish-dependent communities in both the developed and the less-developed world, in trouble, since both industrial and artisanal or small-scale fisheries are stressed as more and more fish stocks shrink or even become endangered. Fishing nations are now becoming more concerned about "species at risk", but there has been insufficient analysis that ties people and fish together in ways that will alter management thinking about the ways in which non-industrial and "industrial" coastal communities are also at risk. In short, the management of the world's fish and fishers remains deeply problematic, not least because, by separating fish from fishers and by not recognizing the interdependence of these two, what are really interdependent problems have been thought of in separate spheres.

There are two distinct modes of management that exist in today's fisheries. The first concerns the technologically-sophisticated deepwater ocean fleets that may be nationally based, but operate internationally. They are managed, for the most part, through quotas and regulations aimed at servicing the needs of the multinational and commercially important business enterprises. They fish their own territorial waters but are also invited into the waters of some nations that are resource-rich but fiscally less well endowed, with access granted

World Fisheries: A Social-Ecological Analysis, First Edition. Edited by Ommer, Perry, Cochrane and Cury.

them for a sum of money that boosts national wealth over the short term, while depleting national resources over the longer term. The second concerns the management of small-scale and artisanal fisheries, usually thought of as commercially less important or important only in the less-developed world, although small-scale fisheries also exist in the developed world (e.g., Newfoundland and Norway). As a result, an analytical divide exists in the academic (natural and social scientific) and management policy literatures. All too often, analysis of "small coastal", "small boat", "inshore", or "artisanal" fisheries, and that of industrial high technology, large-scale fleets are not found in the same journals. The debate about management at the national level in the developed world, and to some degree globally, is found mostly in policy and management journals, national and international. They focus on regulatory concerns to do with the equitable access of large-scale fleets to the world's fish. By contrast, the literature on small-scale fisheries is to be found more often in the development, resilience, and ecological literatures. This reflects a perception that the big fleets are the important fisheries sector contributors to national wealth, and hence of primary concern to national and international regulators. By contrast, small-scale fisheries seem to be perceived to be primarily subsistent in purpose, and thus not of equal status, since the "wealth" they may generate is of a different scale and nature, frequently not going into national employment statistics and tax coffers or contributing to industrial profits, expenditures, and wages.

This "separate silos" approach to different scales of fishing activity ignores the fact that subsistent economies relieve the state of the need to provide other kinds of costly support, be that in welfare payments or the costs of crime that are so often the downstream result of unremitting poverty. In this book, therefore, we take a different view, dismissing neither the importance of industrial fleets nor that of local fisheries. Instead, while acknowledging the significant distinctions between them, we also recognize that both are part of the world's interdependent social-ecological systems (see Berkes, Chapter 2). This means that they must bear responsibilities as well as rights when prosecuting global marine resources on which they ultimately depend and on which they have significant impacts. By extension, then, not only are they subject to quota regulations and international agreements, but they also bear responsibility for impacts that are all too often seen as "externalities" – costs to the ecological part of the global social-ecological system that are frequently ignored or seen as impossible to regulate.

This book grew out of an international symposium on these topics, lead by the Global Ocean Ecosystems Dynamics (GLOBEC) program, by Eur-OCEANS Work Package 6 on the Ecosystem Approach to Marine Resources, and by the Food and Agriculture Organisation of the United Nations (FAO), and held at FAO Headquarters in Rome in July 2008. It is not just a collection of papers from that symposium, however. Rather, the central goal of the publication is to bring together work on social-ecological marine research that cuts across disciplines, identifies key common elements and approaches that promote resilience of marine social-ecological systems in the face of global changes, and points to next steps. The book comprises contributions on conceptual issues relating to social-ecological responses in marine systems to global changes; offers illustrative case studies of specific examples of social-ecological responses in marine systems to significant environmental changes manifested locally; develops a synthesis between natural and social scientists on the topic; and points the way forward with innovative approaches to the use of science and knowledge in management, policy, and advice.

The book has six parts. Part I introduces the concept of marine social-ecological systems with a chapter by Berkes. Part II presents examples of conceptual and numerical modeling approaches to marine social-ecological systems, including integrated models from climate to people, bio-economic models, and conceptual models for developing true inter-disciplinary studies of marine ecosystems and global change. Part III is about knowledge, and how knowledge relates to understanding, management, and the power which provides the basis for wise use of ocean systems in a world of social and environmental change. Part IV discusses values, the economic values of marine habitats and ecosystems but goes further to consider social and spiritual values. Part V addresses issues of governance, and includes case studies of how marine social-ecological systems have addressed (or not) global changes. Part VI provides a synthesis of the lessons learned and the next steps towards developing integrated and adaptive marine social-ecological systems for a changing world.

In Part I, Berkes describes how fisheries are not purely ecological systems isolated from human influence, nor are they purely social systems that function independently of the ecosystems that support them. Rather, fisheries are linked social-ecological systems in which human activities modify the ecological subsystem; the nature of resources and their availability in turn modifies the social subsystem. The necessity of considering natural and social systems together is a conceptual development that has implications for adapting to global change. Some of the key elements of these conceptual shifts include:

1. changing perspectives on the notions of resources and their management;
2. formulation of fishery objectives that consider ecological, economic, and social concerns, including livelihood needs, responding to the broader notion of sustainability;
3. expansion of the scope of management information to include fishers' knowledge and learning, and the use of deliberative methods and multiple epistemologies to deal with complexity; and
4. development of participatory governance with community-based institutions and attention to multi-scale linkages from local to global as a way of dealing with complexity and change.

Conceptual and numerical modeling approaches to marine social-ecological systems are presented in Part II. In the first chapter, Barange *et al*. describe a large-scale modeling approach in which results from global climate models are down-scaled to regional marine ecosystem models, which then simulate the implications of climate change for the productivity of these ecosystems. Barange *et al*. then extend these regional ecosystem models to include their impacts upon humans, by assessing the vulnerability of fisheries in national economies and fish-based global commodity markets to climate change. Their results provide a new framework and new insights into the complex interactions between nature and humans under climate change. Miller *et al*. provide a specific example of bio-economic modeling as applied to the management of tuna fisheries in the Pacific Ocean. This situation involves fish which migrate between the exclusive economic zones of coastal and small island nations and the high seas, and the allocation of fishing privileges and benefits between these coastal and island nations and distant-water fishing nations. The study illustrates well the interplay between climate variability, fish distributions, alternative

management strategies, and the division of benefits among distant-water fishing nations and small island and coastal nations. Thébaud and Blanchard provide an integrated biophysical and economic analysis of changes in fish production and fisheries, and the drivers of these changes, at multiple scales from the northeast Atlantic to the Bay of Biscay. They demonstrate how ecosystem modifications caused by both the direct and ecosystem effects of fishing can be reinforced by biophysical impacts of climate change (i.e., warming sea temperatures) and large-scale economic changes relating to declining prices for fish. The last two chapters of this part address the issues of how to do interdisciplinary modeling of these complex marine social-ecological systems. Starfield and Jarre describe the inherent difficulties, but also the opportunities, in developing such models, which cut across and involve many (often very different) scientific disciplines. They discuss six crucial considerations for interdisciplinary modeling, and propose frame-based modeling as one suitable approach. Gasalla and Diegues describe an approach to interdisciplinary modeling that goes further than Starfield and Jarre, to include interactions with fishers and to incorporate their environmental knowledge. Gasalla and Diegues call their approach "Ethno-oceanography". It represents an interdisciplinary feedback framework combining fishers ("bottom-up") and science ("top-down") systems of knowledge. It leads to Part III of this book, on knowledge.

Part III considers knowledge about marine social-ecological systems: who has it, and how it can be used to promote a better future. It begins with the chapter by Kildow, in which she draws a comparison between environmental "tipping points" or thresholds and those in human social systems. Perceptions of economic risk help to create societal "tipping points", and economic indicators can provide evidence of the pace and direction of these changes. What these economic indicators cannot get at, however, are issues of culture, education, and social cohesion, which underlie the shifts that these indicators measure. This is followed by Masumbuko *et al*., who describe the role that scientific knowledge plays in fisheries management in West Africa, in particular when faced with the uncertainties of climate change. They highlight important needs for improved scientific information, in particular as fisheries are impacted by global changes, needs for human resources in order to obtain scientific information, and for mechanisms to move scientific information from professionals to knowledge users such as decision-makers. Yanez *et al*. present a case study of the knowledge needs in Chile to ensure the sustainable use of fisheries resources. They find that research in Chile has focused on fish biology studies, with little work on oceanographic, economic, social, or governance factors. They conclude that work which integrates the social and governance aspects with oceanographic, biological, technical, and economic factors of Chilean fisheries is essential to ensure their sustainability. The final chapter in this part, by Neis, is an important reminder that all knowledge is context-dependent, patchy and partial, and derives in part from the social-ecology of those who produce it. She argues in particular for stronger institutional recognition and support for the value of collaborative knowledge production from a variety of different sources, that can cut across disciplinary and expert/local divides to allow knowledge to inform wise action and valued outcomes.

Part IV considers the values of marine social-ecological systems, in which "value" is defined to include much more than the purely economic. This part begins with a chapter by Buchary *et al*., who examine illegal, unreported, and unregulated (IUU) fishing in Indonesia in the context of fisheries management practices and poverty. They conclude that financial