Ecosystem-Based Management for Marine Fisheries

Showing how big-picture patterns can help overcome the failures of conventional management, this book is ideal for students, researchers, and professionals involved with marine fisheries. It explores not only the current practice of the "ecosystem approach" to fisheries management, but also its critical importance to even larger perspectives. The first section gives a valuable overview of how more and more of the complexity of real-world systems is being recognized and involved in the management of fisheries around the world. The second section then demonstrates how important aspects of real-world systems, involving population dynamics, evolution, and behavior, remain to be taken into account completely. This section also shows how we must change the way we think about our involvement in, and the complexity of, marine ecosystems. The final chapters consider how, with the use of carefully chosen macroecological patterns, we can take important steps towards more holistic management of marine fisheries.

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Ecosystem-Based Management for Marine Fisheries

An Evolving Perspective

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Foreword

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The necessity of an ecosystem approach (EA) to fishery management has been gaining worldwide recognition in recent years. This concept provides an attractive alternative to viewing fisheries mainly as a profit-oriented economic enterprise, especially given a growing dissatisfaction with a long, mixed, and in some cases dismal record of resource overfishing, depletion, and collapse. Though it is intuitively appealing, the EA concept has been rather difficult to define formally. Yet, something called "an ecosystem approach" is now being attempted in many different fisheries systems – collectively characterized with as much variety as common ground. There are yet more proposals for how to implement an EA waiting to be put into practice. The diverse collection of examples in this book provides an overview of EA both in current practice and future potential, and may contribute a subjective sense of what EA actually is, whether or not we attempt a definition.

Part of the difficulty in defining EA is that it reflects a set (or sets) of values, and human values notoriously elude formal definition. Such plausible concepts as "ecosystem health" are value-based, and it may be a false assumption that they can be measured and defined objectively. However, once the subjective terms of reference for EA have been established, some degree of conditional objectivity may become possible.

Man is the only creature that frequently takes action based on an abstract, imagined, and even probabilistic future. Our thinking capacity is specialized for this unique talent, and with modern scientific and technological advances, our capability to anticipate possible future realities has reached truly astounding levels, especially in the physical sciences. But the level of understanding and predictability in the physical world far exceeds what can be accomplished in the natural biological world. In the physical world we have the benefit of understanding "laws of nature" that always work the same and confer precise predictability, at least in simple systems. In contrast, biological systems are extraordinarily complex and difficult to predict. Part of the problem is that individuals, populations, and ecosystems do not so much follow "rules of nature" but rather play "games of nature." The basis for this sort of natural gamesmanship is evolution itself – the Darwinian law of biological nature (albeit probabilistic), that there are winners and losers at all levels of biological organization, and over time, the properties of the winners tend to propagate differentially.

As Cro-Magnon man emerged from the last ice age into a more temperate world, the species was one of the biggest evolutionary-ecological winners in the history of the planet, quite possibly due to traits such as abstract future planning that were strongly adaptive in the harsh ice-age environment, but that found unanticipated utility in a milder and productive post-glacial environment. A question now facing humanity is, where does the evolutionary-ecological game go next? Due to mankind's own evolutionarily tentative success, the global environment is again changing on a scale equivalent to the end of the last ice age. With deforestation and desertification, continental climate patterns have changed measurably just in the last few centuries. Marine ecosystems are being impacted by industrialized harvesting at unprecedented levels. Atmospheric changes are generating both a warming trend and ocean acidification, with drastic consequences. Within this environmental turmoil, the ecological-evolutionary game will continue, despite current human dominance – in fact, involving the effects of that dominance.

Mankind appears to be at the limit of its global ecological niche, given the rapidly declining ability of natural resources to sustain current human population growth rates. Technology is certainly a key factor in the ecological-evolutionary game – it is fair to say that the fate of all species (mankind included) now depends on what we do with it. More than generation of energy, extraction of raw materials, or improvement in agricultural yields, the science of ecology and its application to the management of human impact may ultimately be one of the most important aspects of mankind's strategy for the coming rounds of the game. Never before has a species had the potential to understand the ecological-evolutionary game itself, and to apply that understanding to evaluating present management choices with regard to future probabilities. This is the essence of an ecosystem approach.

Many fishermen and managers seem to consider EA to be a feel-good, annoying complication to the practical business of fishing. In the long run it is clearly more important than that, but its importance depends very much on the time frame or "planning horizon" for our management decisions. The great majority of people (including a significant fraction of fishery decision-makers) have such a short planning horizon that their main criterion is little more than maintenance of the status quo. The corresponding planning horizon is perhaps on the order of one year, and this time scale has been appropriate for most human decisions for thousands of years. Surviving through the next winter, or the next drought, has long been a primary concern. A modern equivalent may be "making the next boat payment." Maintaining the status quo has an additional political benefit in that it is easily understood and popular. But with modern technological fishing capacity it may have become a losing strategy in the game. For fisheries, status quo does not directly translate to "sustainable" except in the increasingly rare cases of very light exploitation.

In the middle of the last century, fishery science developed predictive models of single-species populations, partly in response to evidence that unmanaged fisheries tended toward severe depletion, and that higher levels of sustained productivity could often be accomplished by placing restraints on fishing activity. Initially, the new goal was "maximum sustainable yield" (MSY) which was equivalent to the largest constant yield that can be maintained as an ongoing status-quo policy. It wasn't long before the weakness of this concept became apparent – being the maximum, a constant harvest at this level renders the system unstable and will eventually fail because of natural fluctuations. Nonetheless, MSY is still a governing feature of many fishery management treaties and laws. Nowadays, the issue tends to be resolved by re-defining MSY. One method is to interpret it as the largest long-term average achievable under a more adaptive stabilizing catch policy.

In the last few decades, quantitative single-species fishery models have achieved a fair degree of success (and some notable failures) in predicting responses to changes in fishing intensity. Consequently, fisheries managers now often have planning horizons of five to ten years, and status quo is just one alternative in a dynamic range of management actions. But fishery science and management is now undergoing yet another transition. With longer observational histories, the effects of fishing on interacting stocks and ecosystems are becoming measurable. Mandated attempts at stock rebuilding are forcing consideration of longer planning horizons and fishery interactions. These management complications, together with the uncertain future of entire ecosystems have given rise to a more comprehensive approach. The trend toward that approach is the subject of this book.

But circumstances are overtaking us. There is general recognition of impending human-caused climate change, on a time scale that extends over centuries, and on a physical scale that is difficult to conceive, except for the perhaps ironic similarity to the end of the last glaciation that created our species. An "ecosystem approach" finally recognizes mankind as a powerful player in the natural game – a player potentially as powerful as all of the rest of the biological players combined.[1] It remains to be seen whether (or more accurately, for how long) man can sustain this status of ecological hegemony. There is no question that ecosystems will ultimately adjust and rearrange themselves in view of such a powerful influence. However when the intensity of human fishing pressure is combined with the scale and diversity of physical-biological changes associated with global climate change, massive ecosystem changes are likely to be seen sooner rather than later.

Now, just as an ecosystem approach is becoming a mandate for management, humanity is beginning to grapple with the final level of ecological consideration: management of our participation in the global system. For a single species that has now placed itself equivalent to all other species on the planet, a global perspective is an imperative if humanity expects to find any semblance of ecological sustainability through the next few centuries.

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[1] For example, this remarkable status is implied by the widespread rule-of-thumb that optimal fishing rates are similar to natural mortality rates (expressed as Fmsy = M), and this is equivalent to saying that at nominally optimal fishing intensities, human predation is equal to that of all other predators combined.

Cover artwork

The artwork on the cover is based on a photograph of a rock carving of a fish found along the Norwegian coastline, near Hjemmeluft (www.verdensarvenialta.no/english/container3.htm). Worldwide, fish were more than simply a commodity to indigenous peoples. The macroecological patterns found in ecosystems around the Earth also have a subjective quality we only superficially appreciate in the graphs we use to represent them. The infinite behind the origins of observed phenomena promotes holism in management when such patterns are embraced as guiding information. This book aims toward that holism in moving toward, through, and beyond ecosystem-based management in marine environments. We thank the World Heritage Rock Art Centre, Alta Museum, Alta, and Professor Knut Helskog of Tromsø University Museum, Norway, for making this photo available.