CONSERVATION BIOLOGY 22

Decision-Making in Conservation and Natural Resource Management

Models for interdisciplinary Approaches

Edited by Nils Bunnefeld, Emily Nicholson and E.J. Milner-Gulland

CAMBRIDGE

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This volume provides frameworks for improving the integration of natural resource management with conservation, and supporting stronger collaboration between researchers and practitioners in developed and developing countries. Novel approaches are required when ecological and social dynamics are highly interdependent. A structured, participatory, model-based approach to decision-making for biodiversity conservation has been proven to produce real-world change. There are surprisingly few successful case studies, some of the best are presented here. Researchers and practitioners need this interdisciplinary approach, focussed on quantitative tools that have been tested and applied.

Nils Bunnefeld is an Associate Professor at the University of Stirling. His research focuses on the interaction between people and nature with an emphasis on mathematical and statistical modelling. In 2016, he was awarded a 5-year European Research Council Starting Grant (ConFooBio) on resolving conflicts between food security and biodiversity conservation.

Emily Nicholson is a Senior Lecturer at Deakin University, Australia. Her research focuses on solving critical conservation problems and measuring change in biodiversity. Her work has helped to develop a new framework for assessing risks to ecosystems, the Red List of Ecosystems, adopted as the global standard by the International Union for the Conservation of Nature (IUCN).

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To the conservationists of the future

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This book is a collaboration between colleagues from very different fields that all intersect at the social-ecological systems concept, including fisheries, wildlife, invasive plants as well as human well-being. We are grateful for their insightful contributions and ideas and all the effort they have put in to shape their chapters to fit into the theme of the book and connect with other contributions.

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We thank our families for all the support for quite some years while we worked on this book, especially Lynsey, Rowan and Martin, and Sam, Manny, Sol and Isaac.

We dedicate this book to the conservationists of the future, who face the daunting task of reconciling the increasingly difficult and urgent needs of both humanity and the environment, so that we can continue to live well with nature. We hope that this book is helpful to their efforts.

Contents

1

Introduction

NILS BUNNEFELD, EMILY NICHOLSON AND
E.J. MILNER-GULLAND

1.1 THE NEED FOR THIS BOOK

Making decisions about the management and conservation of nature is complex and consequently difficult. The complexity stems from the many competing pressures on natural systems, with their opportunities and benefits for different groups of people, set within a constantly varying social and ecological environment. However, there are also opportunities for better decision-making, leading to better outcomes for all sides. This book showcases one such set of opportunities – the benefits of taking a structured, participatory, model-based approach to decision-making for biodiversity conservation.

The largely unrealised potential of using this approach to making decisions about wildlife management became very clear to N.B. and E.J.M.G. when we worked on an endangered antelope endemic to Ethiopia, the mountain nyala (*Tragelaphus buxtoni*). When we got involved in the project in 2010, the total population was estimated at just less than 4,000 individuals (Atickem et al. 2011; Bunnefeld et al. 2013). The pressures on this antelope are high because of a combination of hunting, habitat loss and poaching. The situation was complex due to high uncertainty about the population size because monitoring was limited and the impacts of habitat loss and poaching were unknown. The question to which the Ethiopian Wildlife Authority wanted an answer was how to set a sustainable quota that increases their income, while also providing benefits to local communities. The plan was to reinvest the funds into monitoring, habitat conservation and livelihood support for local people. We used a management strategy evaluation-type simulation model that incorporated the dynamics and uncertainties mentioned earlier (Bunnefeld et al. 2013) to find answers to this question. However,

funding stopped before we could start the process of implementing a decision-making process, and the situation is currently unchanged, despite a pathway to better management now being available thanks to our collaborative research project. This failure to translate research into impact sparked our interest in finding examples where such a translation had taken place, and understanding the factors enabling it to happen. There are surprisingly few successful case studies; some of the best are presented in this book.

There is currently no end in sight for the present biodiversity crisis, or even a road map for slowing down current rapid biodiversity loss (Venter et al. 2016). Biodiversity loss is important for society at large because of the complex relationships between biodiversity conservation, food security and human well-being, including both synergies and trade-offs (Mace et al. 2012). Given the occurrence of environmental and climate change, and a growing human population to feed, human well-being will rely on better decisions to turn potential synergies between biodiversity conservation and human advancement into real-world opportunities for a positive change. The UN's Sustainable Development Goals (SDGs) define the way governments and businesses should set development priorities over the next thirty years (Terama et al. 2015). However, the prospects for real change are limited, if the evidence to date is anything to go by. Tittensor et al. (2014) suggest how the UN Convention on Biological Diversity's (CBD) Aichi targets are not producing the desired outcomes. What is certain is that an approach that is narrowly focussed on either human development or environmental protection cannot deliver sustainable solutions to managing the complex and uncertain social-ecological interactions and feedbacks, which constitute people's relationships with nature (Larrosa et al. 2016). With this in mind, this book brings together authors from a range of disciplines to reflect on their experiences, successful and less so, in effecting real-world change on the ground. Their experiences point to a new way to make decisions for sustainable resource management and biodiversity conservation, which may improve outcomes for both humans and nature.

1.2 A SHORT HISTORY OF QUANTITATIVE APPROACHES TO BIODIVERSITY CONSERVATION

Humans have managed and manipulated ecosystems for their own benefit for millennia, typically using conceptual models as a basis for

decisions. There was an early realisation that resources are limited and that this has implications for the viability of humanity (Malthus 1798). In the 1970s, the tragedy of the commons was the prevailing theory explaining the inevitable overexploitation of natural resources (Hardin 1968), harming both the state of the natural resource and eventually people themselves through a shortage in the resource they depend upon or enjoy. The tragedy of the commons theory is based on an open access system where increased exploitation benefits a single person, whereas the costs are shared among all those using the resource (such as sheep grazing by different farmers on land over which they have no ownership). Later critiques highlighted that open access is only one of a number of potential land tenure situations; others, such as communal ownership, are more amenable to management (Ostrom 1990).

Conceptual models such as the tragedy of the commons were formalised as quantitative models to support decision-making about managing natural resources. Early examples in natural resource management (NRM) include the use of models to set sustainable fishing harvests (Gordon 1954; Beverton and Holt 1957). Such models stemmed from advances in ecology and mathematical modelling (and later economics), and predominantly found application in fisheries, forestry, agriculture and harvesting wildlife in the 1950s, based on the relationship between the rate of replenishment and growth of a resource (such as an animal or plant species) and the off-take of this resource. This was formalised into the maximum sustainable yield (MSY) – the point at which the maximum number of individuals can be taken from a population without causing a decline in numbers. Classical MSY is, however, based on strong assumptions, such as that the environment is deterministic, all individuals in a population can be represented in a single value for population size (rather than structured by e.g. age, sex or spatial location) and under the simplest formulation of density dependence (logistic growth), that density dependence operates symmetrically so that MSY is found at half of the carrying capacity (the maximum population size; Clark 1990).

In the 1990s, there was a realisation that stochastic events, such as year-on-year changes in weather and demographic variability, lead to fluctuations in population size and growth rate, increasing the chance of overexploitation and even extirpation of a local population if hunting is too heavy. Models accounting for this uncertainty led to recommended harvesting limits being related to the degree of variability in population dynamics (Lande et al. 2003). However, these models also