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# Introduction

Navjot S. Sodhi and Paul R. Ehrlich

Our actions have put humanity into a deep environmental crisis. We have destroyed, degraded, and polluted Earth's natural habitats – indeed, virtually all of them have felt the influence of the dominant species. As a result, the vast majority of populations and species of plants and animals – key working parts of human life support systems – are in decline, and many are already extinct. Increasing human population size and consumption per person (see Introduction Box 1) have precipitated an extinction crisis – the "sixth mass extinction", which is comparable to past extinction events such as the Cretaceous-Tertiary mass extinction 65 million years ago that wiped out all the dinosaurs except for the birds. Unlike the previous extinction events, which were attributed to natural catastrophes including volcanic eruptions, meteorite impact and global cooling, the current mass extinction is exclusively humanity's fault. Estimates indicate that numerous species and populations are currently likely being extinguished every year. But all is not lost – yet.

Being the dominant species on Earth, humans have a moral obligation (see Introduction Box 2) to ensure the long-term persistence of rainforests, coral reefs, and tidepools as well as saguaro cacti, baobab trees, tigers, rhinos, pandas, birds of paradise, morpho butterflies, and a plethora of other creatures. All these landmarks and life make this planet remarkable – our imagination will be bankrupt if wild nature is obliterated – even if civilization could survive the disaster. In addition to moral and aesthetic reasons, we have a selfish reason to preserve nature – it provides society with countless and invaluable goods and absolutely crucial services (e.g. food, medicines, pollination, pest control, and flood protection).

Habitat loss and pollution are particularly acute in developing countries, which are of special concern because these harbor the greatest species diversity and are the richest centers of endemism. Sadly, developing world conservation scientists have found it difficult to afford an authoritative textbook of conservation biology, which is particularly ironic, since it is these countries where the rates of habitat loss are highest and the potential benefits of superior information in the hands of scientists and managers are therefore greatest. There is also now a pressing need to educate the next generation of conservation biologists in developing countries, so that hopefully they are in a better position to protect their natural resources. With this book, we intend to provide cutting-edge but basic conservation science to developing as well as developed country inhabitants. The contents of this book are freely available on the web.

Since our main aim is to make up-to-date conservation knowledge widely available, we have invited many of the top names in conservation biology to write on specific topics. Overall, this book represents a project that the conservation community has deemed worthy of support by donations of time and effort. None of the authors, including ourselves, will gain financially from this project.

It is our hope that this book will be of relevance and use to both undergraduate and graduate students as well as scientists, managers, and personnel in non-governmental organizations. The book should have all the necessary topics to become a required reading for various undergraduate and graduate conservation-related courses. English is

## Introduction Box 1 Human population and conservation
**Paul R. Ehrlich**

The size of the human population is approaching 7 billion people, and its most fundamental connection with conservation is simple: people compete with other animals, which unlike green plants cannot make their own food. At present *Homo sapiens* uses, coopts, or destroys close to half of all the food available to the rest of the animal kingdom (see Introduction Box 1 Figure). That means that, in essence, every human being added to the population means fewer individuals can be supported in the remaining fauna.

But human population growth does much more than simply cause a proportional decline in animal biodiversity – since as you know, we degrade nature in many ways besides competing with animals for food. Each additional person will have a disproportionate negative impact on biodiversity in general. The first farmers started farming the richest soils they could find and utilized the richest and most accessible resources first (Ehrlich and Ehrlich 2005). Now much of the soil that people first farmed has been eroded away or paved over, and agriculturalists increasingly are forced to turn to marginal land to grow more food. Equally, deeper and poorer ore deposits must be mined and smelted today, water and petroleum must come from lower quality sources, deeper wells, or (for oil) from deep beneath the ocean and must be transported over longer distances, all at ever-greater environmental cost.

The tasks of conservation biologists are made more difficult by human population growth, as is readily seen in the I=PAT equation (Holdren and Ehrlich 1974; Ehrlich and Ehrlich 1981). Impact (I) on biodiversity is not only a result of population size (P), but of that size multiplied by affluence (A) measured as per capita consumption, and that product multiplied by another factor (T), which summarizes the technologies and socio-political-economic arrangements to service that consumption. More people surrounding a rainforest reserve in a poor nation often means more individuals invading the reserve to gather firewood or bush meat. More people in a rich country may mean more off-road vehicles (ORVs) assaulting the biota – especially if the ORV manufacturers are politically powerful and can successfully fight bans on their use. As poor countries' populations grow and segments of them become more affluent, demand rises for meat and automobiles, with domesticated animals


**Introduction Box 1 Figure** Human beings consuming resources. Photograph by Mary Rose Posa.

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**Introduction Box 1 (Continued)**

competing with or devouring native biota, cars causing all sorts of assaults on biodiversity, and both adding to climate disruption. Globally, as a growing population demands greater quantities of plastics, industrial chemicals, pesticides, fertilizers, cosmetics, and medicines, the toxification of the planet escalates, bringing frightening problems for organisms ranging from polar bears to frogs (to say nothing of people!) (see Box 13.1).

In sum, population growth (along with escalating consumption and the use of environmentally malign technologies) is a major driver of the ongoing destruction of populations, species, and communities that is a salient feature of the Anthropocene (Anonymous 2008). Humanity, as the dominant animal (Ehrlich and Ehrlich 2008), simply out competes other animals for the planet's productivity, and often both plants and animals for its freshwater. While dealing with more limited problems, it therefore behooves every conservation biologist to put part of her time into restraining those drivers, including working to humanely lower birth rates until population growth stops and begins a slow decline toward a sustainable size (Daily *et al.* 1994).

## REFERENCES

Anonymous. (2008). Welcome to the Anthropocene. *Chemical and Engineering News*, **86**, 3.

Daily, G. C. and Ehrlich, A. H. (1994). Optimum human population size. *Population and Environment*, **15**, 469–475.

Ehrlich, P. R. and Ehrlich, A. H. (1981). *Extinction: the causes and consequences of the disappearance of species*. Random House, New York, NY.

Ehrlich, P. R. and Ehrlich, A. H. (2005). *One with Nineveh: politics, consumption, and the human future*, (with new afterword). Island Press, Washington, DC.

Ehrlich, P. R. and Ehrlich, A. H. (2008). *The Dominant Animal: human evolution and the environment*. Island Press, Washington, DC.

Holdren J. P. and Ehrlich, P. R. (1974). Human population and the global environment. *American Scientist*, **62**, 282–292.

**Introduction Box 2 Ecoethics**
**Paul R. Ehrlich**

> The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land…. Aldo Leopold (1949)

As you read this book, you should keep in mind that the problem of conserving biodiversity is replete with issues of practical ethics – agreed-upon notions of the right or wrong of actual behaviors (Singer 1993; Jamieson 2008). If civilization is to maintain the ecosystem services (Chapter 3) that can support a sustainable society and provide virtually everyone with a reasonable quality of life, humanity will need to focus much more on issues with a significant conservation connection, "ecoethics".

Ultimately everything must be examined from common "small-scale" personal ecoethical decisions to the ethics of power wielded by large-scale institutions that try (and sometimes succeed) to control broad aspects of our global civilization. Those institutions include governments, religions, transnational corporations, and the like. To ignore these power relations is, in essence, to ignore the most important large-scale issues, such as conservation in the face of further human population growth and of rapid climate change – issues that demand global ethical discussion.

Small-scale ecoethical dilemmas are commonly faced by conservation biologists. Should we eat shrimp in a restaurant when we can't determine its provenance? Should we become more vegetarian? Is it legitimate to fly around the world in jet aircraft to try and persuade people to change a lifestyle that includes flying around the world in jet aircraft? How should we think about all the trees cut

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**Introduction Box 2 (Continued)**

down to produce the books and articles we've written? These sorts of decisions are poignantly discussed by Bearzi (2009), who calls for conservation biologists to think more carefully about their individual decisions and set a better example where possible. Some personal decisions are not so minor – such as how many children to have. But ironically Bearzi does not discuss child-bearing decisions, even though especially in rich countries these are often the most conservation-significant ethical decisions an individual makes.

Ecotourism is a hotbed of difficult ethical issues, some incredibly complex, as shown in Box 14.3. But perhaps the most vexing ethical questions in conservation concern conflicts between the needs and prerogatives of peoples and non-human organisms. This is seen in issues like protecting reserves from people, where in the extreme some conservation biologists plead for strict exclusion of human beings (e.g. Terborgh 2004), and by the debates over the preservation of endangered organisms and traditional rights to hunt them. The latter is exemplified by complex aboriginal "subsistence" whaling issues (Reeves 2002). While commercial whaling is largely responsible for the collapse of many stocks, aboriginal whaling may threaten some of the remnants. Does one then side with the whales or the people, to whom the hunts may be an important part of their tradition? Preserving the stocks by limiting aboriginal takes seems the ecoethical thing to do, since it allows for traditional hunting to persist, which will not happen if the whales go extinct. Tradition is a tricky thing –coal mining or land development may be family traditions, but ecoethically those occupations should end.

Perhaps most daunting of all is the task of getting broad agreement from diverse cultures on ecoethical issues. It has been suggested that a world-wide *Millennium Assessment of Human Behavior* (MAHB) be established to, among other things, facilitate discussion and debate (Ehrlich and Kennedy 2005). My own views of the basic ecoethical paths that should be pursued follow. Others may differ, but if we don't start debating ecoethics now, the current ethical stasis will likely persist.

- Work hard to humanely bring human population growth to a halt and start a slow decline.
- Reduce overconsumption by the already rich while increasing consumption by the needy poor, while striving to limit aggregate consumption by humanity.
- Start a global World War II type mobilization to shift to more benign energy technologies and thus reduce the chances of a world-wide conservation disaster caused by rapid climate change.
- Judge technologies not just on what they do *for* people but also *to* people and the organisms that are key parts of their life-support systems.
- Educate students, starting in kindergarten, about the crucial need to preserve biodiversity and expand peoples' empathy not just to all human beings but also to the living elements in the natural world.

Most conservation biologists view the task of preserving biodiversity as fundamentally one of ethics (Ehrlich and Ehrlich 1981). Nonetheless, long experience has shown that arguments based on a proposed ethical need to preserve our only known living relatives in the entire universe, the products of incredible evolutionary sequences billions of years in extent, have largely fallen on deaf ears. Most ecologists have therefore switched to admittedly risky instrumental arguments for conservation (Daily 1997). What proportion of conservation effort should be put into promoting instrumental approaches that might backfire or be effective in only the short or middle term is an ethical-tactical issue. One of the best arguments for emphasizing the instrumental is that they can at least buy time for the necessarily slow cultural evolutionary process of changing the norms that favor attention to reproducible capital and property rights to the near exclusion of natural capital. Some day Aldo Leopold's "Land Ethic" may become universal – until then conservation biologists will face many ethical challenges.

## REFERENCES

Bearzi, G. (2009). When swordfish conservation biologists eat swordfish. *Conservation Biology*, **23**, 1–2.

Daily, G. C., ed. (1997). *Nature's services: societal dependence on natural ecosystems*. Island Press, Washington, DC.

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**Introduction Box 2 (Continued)**

Ehrlich, P. R. and Ehrlich, A. H. (1981). Extinction: the causes and consequences of the disappearance of species. Random House, New York, NY.

Ehrlich, P. R. and Kennedy, D. (2005). Millennium assessment of human behavior: a challenge to scientists. *Science*, **309**, 562–563.

Jamieson, D. (2008). *Ethics and the environment: an introduction*. Cambridge University Press, Cambridge, UK.

Leopold, A. (1949). *Sand county almanac*. Oxford University Press, New York, NY.

Reeves, R. R. (2002). The origins and character of 'aboriginal subsistence' whaling: a global review. *Mammal Review*, **32**, 71–106.

Singer, P. (1993). Practical ethics. 2nd edn. University Press, Cambridge, UK.

Terborgh, J. (2004). *Requiem for nature*. Island Press, Washington, DC.

kept at a level comprehensible to readers for whom English is a second language.

The book contains 16 chapters, which are briefly introduced below:

**Chapter 1. Conservation biology: past and present**

In this chapter, Curt Meine introduces the discipline by tracing its history. He also highlights the interdisciplinary nature of conservation science.

**Chapter 2. Biodiversity**

Kevin J. Gaston defines biodiversity and lays out the obstacles to its better understanding in this chapter.

**Chapter 3. Ecosystem functioning and services**

In this chapter, Cagan H. Sekercioglu recapitulates natural ecosystem functions and services.

**Chapter 4. Habitat destruction: death by a thousand cuts**

William F. Laurance provides an overview of contemporary habitat loss in this chapter. He evaluates patterns of habitat destruction geographically and contrasts it in different biomes and ecosystems. He also reviews some of the ultimate and proximate factors causing habitat loss.

**Chapter 5. Habitat fragmentation and landscape change**

Conceptual approaches used to understand conservation in fragmented landscapes are summarized in this chapter by Andrew F. Bennett and Denis A. Saunders. They also examine biophysical aspects of landscape change, and how such change affects populations, species, and communities.

**Chapter 6. Overharvesting**

Biodiversity is under heavy threat from anthropogenic overexploitation (e.g. harvest for food or decoration or of live animals for the pet trade). For example, bushmeat or wild meat hunting is imperiling many tropical species as expanding human populations in these regions seek new sources of protein and create potentially profitable new avenues for trade at both local and international levels. In this Chapter, Carlos A. Peres highlights the effects of human exploitation of terrestrial and aquatic biomes on biodiversity.

**Chapter 7. Invasive species**

Daniel Simberloff presents an overview of invasive species, their impacts and management in this chapter.

**Chapter 8. Climate change**

Climate change is quickly emerging as a key issue in the battle to preserve biodiversity. In this chapter, Thomas E. Lovejoy reports on the documented impacts of climate change on biotas.

**Chapter 9. Fire and biodiversity**

Evolutionary and ecological principles related to conservation in landscapes subject to regular fires are presented in this chapter by David M. J. S. Bowman and Brett P. Murphy.

**Chapter 10. Extinctions and the practice of preventing them**

Stuart L. Pimm and Clinton N. Jenkins explore why extinctions are the critical issue for conservation science. They also list a number of conservation options.

**Chapter 11. Conservation planning and priorities**

In this chapter, Thomas Brooks charts the history, state, and prospects of conservation planning and prioritization in terrestrial and aquatic habitats. He focuses on successful conservation implementation planned through the discipline's conceptual framework of vulnerability and irreplaceability.

**Chapter 12. Endangered species management: the US experience**

In this chapter, David S. Wilcove focuses on endangered species management, emphasizing the United States of America (US) experience. Because the US has one of the oldest and possibly strongest laws to protect endangered species, it provides an illuminating case history.

**Chapter 13. Conservation in human-modified landscapes**

Lian Pin Koh and Toby A. Gardner discuss the challenges of conserving biodiversity in degraded and modified landscapes with a focus on the tropical terrestrial biome in this chapter. They highlight the extent to which human activities have modified natural ecosystems and outline opportunities for conserving biodiversity in human-modified landscapes.

**Chapter 14. The roles of people in conservation**

The effective and sustainable protection of biodiversity will require that the sustenance needs of native people are adequately considered. In this chapter, C. Anne Claus, Kai M. A. Chan, and Terre Satterfield highlight that understanding human activities and human roles in conservation is fundamental to effective conservation.

**Chapter 15. From conservation theory to practice: crossing the divide**

Madhu Rao and Joshua Ginsberg explore the implementation of conservation science in this chapter.

**Chapter 16. The conservation biologist's toolbox – principles for the design and analysis of conservation studies**

In this chapter, Corey J. A. Bradshaw and Barry W. Brook, discuss measures of biodiversity patterns followed by an overview of experimental design and associated statistical paradigms. They also present the analysis of abundance time series, assessments of species' endangerment, and a brief introduction to genetic tools to assess the conservation status of species.

Each chapter includes boxes written by various experts describing additional relevant material, case studies/success stories, or personal perspectives.