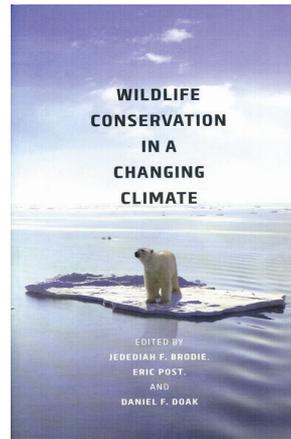


while working as a professor at Princeton University. Every summer, and the summers thankfully got longer after he formally retired from Princeton, Bonner drove to his Nova Scotia home with his typewriter (and later his computer) and looked for the big picture. He has been enormously successful not only in defining the big picture, but also in communicating it to a wide audience. The titles of his successive books, *Morphogenesis*, *Cells and Societies*, *The Evolution of Development*, *The Cellular Slime Molds*, *The Ideas of Biology*, *Size and Cycle*, *The Scale of Nature*, *The Evolution of Culture in Animals*, *The Evolution of Complexity*, *Life Cycles* (and more), tell a tale of relentless search for the big picture. But alas, Bonner tells a lie when he says that many biologists live two lives. Too few I would lament and much worse, we are bending over backwards to prove Bonner wrong. Today we put so much pressure on young biologists to publish far too many little papers in so-called high-impact journals, that they have no time to look for the big picture.

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Wildlife Conservation in a Changing Climate. Jedediah F. Brodie, Eric Post and Daniel F. Doak (eds). The University of Chicago Press, London. 2012. 416 pp. Price: US\$ 45.

Climate change has emerged as the environmental and ecological challenge of our times – our response to it will determine the fate of our species and that of many others on this planet. The field of wildlife conservation has in recent decades woken up to this specific challenge, with a slew of studies addressing the effects of climate change on wildlife populations. This book attempts to synthesize this body of work with the intent of focusing attention on the question ‘What can we actually do about it?’

Given the vast and rapidly moving literature that they are dealing with, the editors of this book are to be congratulated for their stellar effort in bringing together a volume that addresses the subject from local to global scales and from species to community-level effects. Despite the very complex issues that are being addressed and diversity of the studies themselves, the book makes a credible attempt at synthesizing across the science and practice of conservation in a changing climate.

In a brief but succinct introduction, Brodie *et al.* (chapter 1) summarize elegantly why climate change today poses a different challenge to the Earth’s species than it did in her deep history – the rates of climate change today are unprecedented compared to the past, and at the same time, these rapid changes are operating on wildlife populations that are already heavily impacted and constrained by human activities. The authors then highlight the limited use of popular niche modelling techniques as a predictive tool

for future species distributions, and stress the importance of detailed data on species demography and species interactions in assessing and predicting the potential impacts of climate change.

The main body of the book is divided into three sections. In the first section, studies focus on the current and potential impacts of climate change on wildlife with a dominant theme being the exploration of different types of modelling approaches to the same. While Matthews *et al.* (chapter 4) explicitly incorporate shifts in demographic parameters into matrix models to predict future changes in populations of pond-breeding frogs, Fordham *et al.* (chapter 5) discuss range shifts in populations of an invasive vertebrate species using spatially explicit meta-population models. Where these kinds of intensive and long-term data are available, these modelling approaches have excellent predictive power. In chapter 7, Young *et al.* propose a ‘climate change vulnerability index’ that combines the use of natural history, distribution and climate data to assess which species are most vulnerable to climate change in a given region, but beyond its ability to quantify a common-sense judgements about which species are vulnerable, the actual utility of this index in management terms remains somewhat obscure.

The second section of the book deals with various case studies of the impacts of climate change on wildlife populations, at both guild and species scales. Owen-Smith and Ogutu (chapter 8) address the impacts of changing rainfall patterns on movements of ungulate populations in African ecosystems, with an important message being that future solutions must involve conservation outside protected areas where animal populations will wander as they track changing resource patterns. A similar theme is echoed by Le Galliard *et al.* (chapter 9), who consider the future of squamate reptiles in Europe, and call for increasing connectivity across the landscape between protected areas. The final chapters in this section are species-level case studies, with Ray *et al.* (chapter 12) suggesting that the American pika might simply run out of its mountain habitat as temperatures rise, while Tews *et al.* (chapter 13) call attention to the massive mortality impacts of stochastic extreme winters on populations of Arctic caribou. With both studies suggesting that there are no clear

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management interventions that can ameliorate these effects, the sobering message is that in the face of climate change, the odds may simply not be in favour of some species, and conservation biologists will have to accept that some species, even charismatic and seemingly abundant ones, are in triage.

The third and final section of the book deals with how conservation practitioners can innovate their approaches to manage species populations for adaptation to climate change. Cross *et al.* (chapter 11) give us interesting insights on what efforts to increase habitat connectivity will actually entail on the ground. Popescu and Hunter (chapter 17) address the controversial issue of assisted migrations as an adaptive and direct response to climate change. Wilmers *et al.* (chapter 16) make a case for the 'rewilding' of predator populations for their functional roles in limiting herbivore populations and ultimately in limiting carbon dioxide levels – certainly a perspective on carnivores is explicit to the context of climate change.

The concluding remarks (chapter 19) leave us with four key take-home messages: gradual climate changes may often elicit sudden, nonlinear responses in species populations; effects of climate change on species populations will generally be non-additive to threats posed by other factors; the indirect effects of climate change on species through its effects on resource supply or available habitats may often be stronger than its direct effects, and changes in species interactions may be important modifiers of the direct impacts of climate change.

In all, the book is a good overview of the subject for students, researchers and practitioners alike. It does however raise some unresolved philosophical issues in how we might think about wildlife conservation in the context of climate change. For example, the theme of 'resilience' is emphasized by the authors in the introduction and does indeed appear in various chapters. However, this is somewhat problematic, not just because the theme itself is poorly defined, but because the relevance of resilience, which is widely defined in terms of the abilities of ecosystems or species to remain stable in the face of perturbations, may be restricted in the context of climate change. Climate change is expected to lead to novel climate spaces, novel community assemblages and ecosystem states and to require novel responses from species, i.e. it is now almost axiomatic with the idea that everything will change. A key challenge then is to predict the nature and directions of these novel responses and novel communities and ecosystem states and to redirect conservation efforts to be effective in these novel regimes. Also, whether this book directs us towards 'what to do to conserve wildlife in the face of climate change' remains an open question. While some chapters do address these questions specifically, such as where authors make the case for assisted migrations or the rewilding of carnivores, the reader does not come away with a common sense answer to this problem. At the heart of this lies a complex challenge: that of understanding when it is climate rather than multiple other immediate threats that imperils

species and what responses are needed to counter the impacts of climate change per se that are different from known conservation responses. In this regard, it would have been useful to draw some broad synthetic conclusions as to whether certain types of species and ecosystems are more affected by climate change than others, or which species and ecosystems are relatively more threatened by climate change per se rather than other immediate threats such as land-use change, hunting, habitat fragmentation, etc. However, apart from a few generalizations, such a synthesis is not quite addressed in this book, perhaps because it is simply too difficult. Such an effort will be an important conceptual contribution to this growing and urgent body of research.

Finally, with the exception of Owen-Smith and Ogutu (chapter 8), there is a noticeable lack of literature from the tropics and sub-tropics which harbour majority of the world's diversity. A quick literature search using the *Web of Science* suggests that this is in fact reflective of a genuine paucity of research on this theme from these regions of the world – a clarion call for more research that specifically addresses the current and potential future impacts of climate change on the diverse wildlife of the vulnerable and biodiverse tropics.

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