This book is a mixture of several stories that could be read enjoyably a chapter at a time, with each chapter telling its own unique piece of the story of migration in northwestern Ohio. Kenn Kaufman also narrates the audiobook, which is an enjoyable listen. I can see this book joining many others that challenge each of us to see each bird with wonder, and to embrace the human aspect of our work, even when it is challenging, for the betterment of our own communities and to help the birds that we all enjoy. *A Season on the Wind* is a book full of wonder at the spectacle and nuance of migration, something that Kaufman has clearly not lost, and he hopes we do not either.

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Effects of Climate Change on Birds

Peter O. Dunn and Anders Pape Møller (eds.), 2nd ed. 2019. Oxford University Press, Oxford, UK. 288 pages, 48 images (15 in color). ISBN 9780198824268. $100 (Hardcover). Also available as an e-book

More research on the effects of climate change has been dedicated to birds than to any other group of animals. It may, then, be surprising how few synthetic works exist that compile what we know so far. To be sure, excellent books are available on the subject—prominent examples include *Birds and Climate Change: Impacts and Conservation Responses* (Pearce-Higgins and Green 2014), *Winged Sentinels: Birds and Climate Change* (Wormworth and Sekercioglu 2011), and several works on specialized topics. The aforementioned books are syntheses by individual ornithologists; to my knowledge, the first edited volume to bring a large group of experts together was *Birds and Climate Change* (Møller et al. 2004), followed by *Effects of Climate Change on Birds* (Møller et al. 2010).

Now, the latter volume has been updated in an outstanding second edition under the same title, with a partial change in editors (Dunn and Møller). In the introductory pages, the editors state, "This new edition attempts to synthesize what is known about the effects of climate change on birds, as well as point out new methods and areas for future research." This is no easy task, given the sheer volume of research. The editors calculate that there are now more than 11,400 papers on birds and climate change, with more than 7500 published after their volume's first edition. To their credit, they have met this challenge with remarkable efficiency—this is a relatively small and digestible book.

The first edition of this work has been an important resource for research and education over the past decade, and given the need for integrative understandings of the multiple aspects of climate change biology, this new and improved edition is very timely. At the broadest level, its organization has not changed—it includes an introductory section with a chapter on climate change, that is, for the most part, without reference to birds, a section (five chapters) on methods for studying the effects of climate change on birds, and two large sections summarizing the current state of knowledge about the observed and predicted effects of climate change on birds at the population level (six chapters) and the interspecific level (five chapters).

In the first section, Chapter 2 provides a solid and up-to-date background on climate change science and, of course, how and why climate has changed and will change. Written by two authorities on the subject (Trenberth and Hurrell), it clearly and concisely reviews several topics many ornithologists may not be familiar with, and that impact birds, such as the multiple modes of global climate oscillation and observed changes thereof. However, connections between strictly climatological phenomena and animal populations are not pointed out in this chapter and, in fact, several topics discussed here are not mentioned again in the book. This disconnect was an early criticism of the first edition (Tingley 2011) and, although it may be a minor

concern, I am not sure much improvement has been made.

Arguably, making these linkages is not the job of a climatologist, and specific climate–bird connections are the subject of subsequent chapters. However, a middle ground that would be particularly useful for graduate students, other early-career scientists, and conservationists (part of the target audience identified by the editors in Chapter 1) still seems to be missing. One can imagine an early chapter devoted to general biological, ecological, and physical science principles justifying and framing research into particular areas of climate change effects on birds (and other organisms and ecosystems). This might do more than just link Chapter 2 to the rest of the book—it could generally help readers appreciate climate change biology from a more integrative perspective and provide a grounding for the entire volume.

The second section, concerning methods for studying the effects of climate change, has been substantially re-organized from the previous edition. Where chapters on capture–mark–recapture models and methods for studying evolutionary consequences of climate change are gone, a short chapter on long-term ornithological data sets remains, and there is a new chapter that surveys long-term climate data sets and their use. This latter addition should be helpful for graduate students and others seeking entry points into climate change biology analysis, although it is too brief to offer a full review of the ever-expanding range of available resources and techniques, and the choice of highlighted topics and data sets may appear selective to some readers.

Other changes, including the loss of a chapter dedicated to time-series analysis and the gain of one on quantifying climatic sensitivities, really amount to updates and re-organization rather than loss or gain of whole topics. Time-series analysis is necessarily given attention in the climatic sensitivity chapter as well as the chapter covering prediction of population dynamic effects, whereas these chapters also now provide expanded coverage of spatial and spatiotemporal approaches. The re-organization of the book's second section broadly mirrors developments in research over the past decade, and benefits from expanded surveys of available data sets as well as improved alignment of chapters around thematic areas rather than narrow methodological approaches.

The third and fourth sections are arguably the heart of the book and provide the content that will be of most interest to most readers. The primary areas of research into how climate change has impacted, and will further impact, birds are surveyed by experts in each area. Some topics are very familiar in climate change biology—migration and breeding phenology, population ecology, species distributions, and community composition—but other chapters deal with emerging topics or areas where less is known about modern climate change effects, e.g., evolutionary responses, host–parasite relationships, and predator–prey interactions. As in the preceding section, there is some re-organization of chapters since the first edition. Most major themes are retained and given thorough updates, and two new chapters expand the range of the book: one on physiological and morphological effects, and one exploring the relevance of bird studies to other taxa. Some readers may find the different voices in which these chapters are written by various authors to be a distraction, but I appreciated the diversity. Regardless of differences in style, there is a notable consistency of quality.

I very much appreciated the chapter on climate-smart conservation science (Marra, Zuckerberg, and Both). In fact, this subject merits more attention than the book provides. After all, bird conservation has probably been the primary driver of scientific (and certainly public) interest in the effects of climate change on birds, just as the broader study of human-caused climate change has been driven by concern over its broader impacts. The editors make this clear in the introductory chapter, which begins the book as most works on climate change begin, with a cautionary sentence: "Climate change is considered the largest environmental problem of this century, and it is likely to have severe consequences for our environment." In their defense, the editors have focused the book on reviewing knowledge about climate change effects, not conservation, but their hope is that "...readers will find some new perspectives and questions in this book that will inspire them to better understand and conserve bird populations." Given the emphasis on both

understanding and conserving birds, I view 15 chapters on understanding and one on conserving as something of an imbalance.

Make no mistake, Marra, Zuckerberg, and Both do an excellent job of reviewing conceptual and practical approaches that link the science of climate change ecology to bird conservation practice, given the space they were afforded. If I could ask for any single new theme to add to the book, their chapter might have been paired with another that goes further in exploring what is known about climate-smart conservation practices on the ground—their real-world promise and challenges, progress so far, and integration with pre-existing ecosystem management regimes. Not only would this help illustrate the science–management linkages that are so badly needed and perhaps afford space for case studies, it would drive home the value of the conceptual frameworks, analytical approaches, and evidentiary bases for climate-smart conservation that the existing chapter provides.

Dunn and Møller make a very welcome plea for more integrative science in the brief concluding chapter. Four of the five areas they identify as future research priorities concern the need to better understand the effects of climate change in a complex world where multiple phenomena act and interact, including (1) weather and climate effects must be examined together with land use and landscape change, (2) multiple climatic drivers must be considered together (not just temperature, but also precipitation, wind, and others), (3) effects on multiple interacting species must be considered together—effects on individual species cannot be fully understood without also accounting for the effects on their prey, predators, parasites, competitors, and so on, and (4) integration of effects across life cycle stages and across the annual cycle is required. Their final priority is for a more careful accounting of complexity and uncertainty in future predictions, and clearer communication of these to the public and to decision-makers. One can hardly argue with any of these priorities, which lay out a daunting, but exciting and wide-open, field for new research.

Chapters in this volume are uniformly of high quality, and each is worth reading in its own right. Figures and tables are helpful and nicely laid out, as well as being of high-quality and free of typographical error. Moreover, bringing the major themes in avian climate change biology together under one roof is an important achievement. The greatest challenge for any such effort is synthesis: What makes the whole greater than the sum of its parts? What can each sub-discipline learn from the others, and what are the unified themes that the discipline as a whole provides to its various audiences? Much remains to be done, but this new edition brings us closer to meeting that challenge while also providing a unique resource and reference for a wide variety of education and research uses.

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