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## Birds are shifting migration timing, but how, why, and is it enough?

Wood, Eric M., and Jherime L. Kellermann, editors. 2015. **Phenological synchrony and bird migration: changing climate and seasonal resources in North America**. CRC Press, Boca Raton, Florida. xiv + 228 p. \$110.46 (hardcover), ISBN: 978-1-4822-4030-6.

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Bird migration is one of the most impressive navigational feats in the animal kingdom and a stunningly complex life history strategy for taking advantage of spatiotemporally variable resources. The timing of this journey is a complex balance of selection pressures involving the accumulation of sufficient fat stores, passing through critical stopover sites, enduring severe weather conditions, establishing high quality territories, and raising offspring at a time of abundant resources. Given the heterogeneous nature of climate change around the globe, the optimal times for migratory passage and breeding have been shifting to various degrees, making migratory birds potentially vulnerable to *phenological asynchrony* with the resources and conditions on which they depend. *Phenological synchrony and bird migration*, an edited volume of 12 chapters, considers this potential for temporal mismatch, the putative drivers, the traits that might make species more or less susceptible to mismatch, and the conservation implications, all with a focus on North American birds.

The chapters in this volume help highlight the fact that the underlying cause of phenological mismatch between birds and their resources is a complex spatiotemporal problem, and collectively they provide complementary approaches for considering this complexity. For example, is migration timing more influenced by conditions on wintering grounds, passage areas, or breeding grounds? And by conditions during migration itself, or conditions during some period preceding migration? Which conditions (e.g., temperature, precipitation, vegetation green-up, food resources) are most relevant and have greatest predictive power? Which types of species are more at risk, and perhaps even which subpopulations? This volume provides a snapshot of the state of the field in 2012 when the editors and authors participated in a symposium at the North American Ornithological Conference from which this volume emerged. Unfortunately, this is a fast-growing field, and so it is regrettable that the authors include very little discussion of any of this recent (post-2012) literature.

The book's 12 chapters are grouped into four sections: "Conservation and management," "Migratory

connectivity," "Spring migration," and "Fall migration." The "Conservation and management" section was perhaps the least cohesive of the four, with only one chapter (Chapter 2. "Landbird stopover in the Great Lakes Region: integrating habitat use and climate change in conservation") directly related to the section heading. The other two chapters in this section certainly have conservation and management implications, but in the same way that every chapter in the volume does—managing for phenological synchrony is far more difficult than preserving suitable habitat. Chapter 1 was actually quite interesting from a basic science perspective, exploring how the rate of climate change varies latitudinally within the Western flyway and the different implications for species using chain versus leapfrog migration.

The "Migratory connectivity" section included two chapters investigating how conditions on wintering grounds influenced migration timing on passage areas (Ch 4. "Spring resource phenology and timing of songbird migration across the Gulf of Mexico") or breeding grounds (Ch 5. "Climate on wintering grounds drives spring arrival of short-distance migrants to the Upper Midwest"). In the first case, the authors found that arrival time on the Gulf Coast in spring was predicted better by vegetation phenology on the nonbreeding range than vegetation phenology of the U.S. Gulf Coast itself. In the second case, the authors found further evidence that migration timing in spring is driven at least partly by conditions on the wintering ground, but that the specific conditions (e.g., winter temperature, spring precipitation) that provided the most reliable cue varied by species. These chapters both make clear the importance of considering the teleconnections in time and space between different seasons and geographic locations for a complete understanding of migratory timing.

The final sections focus on phenological synchrony between birds and the climate or resources they experience in passage areas during "Spring migration" (4 chapters) or "Fall migration" (3 chapters). Six of these seven chapters go beyond climate and examine avian phenology in relation to the phenology of their food resources or the plants that make up their foraging substrates. This focus on phenological variables that most appropriately reflect the "yardstick" of interest (Visser, M. E., and C. Both. 2005. Shifts in phenology due to global climate change: the need for a yardstick. *Proceedings of the Royal Society B* 272:2561–2569) is a tremendous strength of these chapters, however, they are rather uneven in quality. For example, Chapter 9 ("Shorebird migration in the face of climate change") seems to be a reprint of a 2012 Master's thesis chapter

(Stutzman, R.J. 2012. *Stopover decisions of migratory shorebirds: an assessment of habitat use, food availability, behavior and phenology*. Master's Thesis. University of Nebraska at Lincoln) in which statistical methods are poorly described and the conclusions do not always follow naturally from the presented figures.

One issue with this chapter and many others in these final two sections was that, despite the book's title, there was no effort to actually assess phenological synchrony in any quantitative manner. Instead, authors "eyeballed" the raw data, or in some instances a fitted curve through the data, making assessments like "peak shorebird migration occurred immediately prior to peak resource availability." But interpreting whether the difference between the phenologies of two species or groups of species is large or small is a difficult task. Should you base each phenological curve on parametric functions that don't always fit the data well? Should you measure differences between peaks, or areas of overlap of the curves? How do you incorporate error? These are nontrivial issues and so I don't completely fault the authors for failing to dig into this complexity. However, had the editors included a chapter (or even an entire section) on such important methodological issues, they may well have had a much greater impact on the development of this exciting field.

Another important section that I felt was missing from the book was one focused on phenological synchrony between migratory birds and their resources, not during migration which is covered extensively here, but while raising young on the breeding grounds. Certainly, asynchrony between bird arrival in passage areas and peak resource availability in those areas may impact a bird's survival probability or subsequent breeding condition, but it is hard to imagine a more direct phenological impact on a bird's fitness than the asynchrony that leads to low resource availability during the period of peak resource demand of nestlings. Indeed, this is the very

"yardstick" referred to in Visser and Both (2005), the only citation in this book's Preface. This has been a major focus of the work on phenological synchrony and birds coming out of the Netherlands and the United Kingdom, so it was surprising to find it absent here.

Finally, an edited volume of this sort in a rapidly-growing area of research would have benefited greatly from both some synthesis of the component chapters, as well as a vision for productive areas of future research. With respect to synthesis, it would have been quite useful to draw out any general themes or lessons from the individual studies, and to shed light on discrepancies among them (e.g., why might species in Chapter 6 not exhibit phenological shifts in migration, whereas species generally do in most of the other chapters?). As for future directions, my own take away from this volume is that a true understanding of the causes and consequences of phenological asynchrony in migratory birds will be difficult to achieve with studies limited to narrow temporal and spatial extents. Thanks to long-term banding stations (Chapters 4, 11, 12) and large-scale citizen science networks like Project Feederwatch (Chapter 5), we have a reasonable picture of avian phenology over space and time in North America. Scaling up the collection of on the ground phenology data for vegetation (Chapters 6, 7, 8) and food resources (Chapters 6, 9, 10)—see, for example the National Phenology Network (Chapter 3)—into long-term, geographically-extensive datasets will ultimately pay great dividends toward understanding, and ultimately managing for, phenological synchrony in migratory birds.

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