BOOK REVIEWS

Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence, by Darryl I. MacKenzie, James D. Nichols, J. Andrew Royle, Kenneth H. Pollock, Larissa L. Bailey, and James E. Hines. 2006. 324 pp. Elsevier, Amsterdam, Netherlands. $64.95. ISBN 978-0-12-088766-8 (hardcover). A review by Paul F. Doherty Jr.

Since the seminal paper of MacKenzie et al. (2002) on occupancy estimation and modeling, there has been great interest in applying these methods as is indicated by the recent special section in the *Journal of Wildlife Management* (Vojta 2005). Occupancy and related parameters are fundamental quantities in many areas of research, including monitoring, habitat modeling, macroecology, metapopulation theory, and multispecies interactions (outlined in Chapter 2). However, data collected to address these research questions often are collected under the WYSIWYG (what you see is what you get) principle and detection probabilities associated with the observation process are not properly integrated into data analysis. The authors have a lengthy history of thinking about the general problem of incorporating detection probabilities into parameter estimation and modeling, and in this book they focus on the collection and analysis of presence–absence data, or more precisely presence–apparent absence data, recognizing that a recorded absence could represent nondetection and not a true absence.

Although only a short time has expired since the introduction of this occupancy estimation and modeling approach, the authors' rationale for publishing a comprehensive book at such an early stage is two-fold. First is their observation that comprehensive treatments for important analytical advances, along with user-friendly software and workshops for practitioners, often serve as vehicles for a swift integration of such advances into practice. A few well-known examples of this strategy are methods associated with closed capture–recapture models, open capture–recapture models, and distance sampling (for an interesting article on one person's use of this strategy, see Nichols [2004]). The second reason is that with such a comprehensive treatment, additional, rapid, methodological advancement can occur.

The book has 10 chapters, which I will briefly outline before providing some of my summary thoughts. Chapters 1–3 focus on introductory material, including the roles of modeling in management and science, historical uses of occupancy concepts in ecology, and general statistical methods. I especially enjoyed Chapter 2, which outlined many possible applications of these methods. Chapters 4–6 focus on the analytical techniques and study design associated with estimating occupancy for a single species at a single point in time. The discussion of the effects of, and approaches to, modeling heterogeneity in detection probabilities was of particular interest to me as dealing with such heterogeneity has been a historical problem in much of the population parameter estimation literature. Chapter 6 discusses important aspects of study design, and provides useful tables and equations to calculate the number of sample sites to visit, as well as the number of repeated visits to sites, when designing an occupancy study. Chapter 7 expands the methodology to estimating dynamics associated with changes in occupancy—namely extinction and colonization. Chapter 8 introduces methods associated with modeling species interactions, and Chapter 9 extends the general methodology to multiple species questions. Readers interested in community-level questions will want to read Chapter 9, as this chapter provides fresh insights and methods to estimation of species richness and associated metrics. In keeping with the authors' wish to use this book as a catalyst for additional rapid developments, Chapter 10 outlines 5 areas ripe for future developments.

The authors have performed a valuable professional service in writing this book in a way that furthers their first goal of swift integration of these novel methods. The authors' target audience is primarily the practitioners working at the "coal face of wildlife and ecological research," who may not have a strong statistics background. I think the authors have done a good job keeping this target audience in mind throughout the book by keeping discussions simple and providing useful analogies as well as examples. A short appendix provides "Important Mathematical Concepts," including notation, vectors and matrices, differentiation, and integration for those readers who may need a refresher or an introduction. I believe readers will be able to follow and understand the basics underlying the methodology. Improved study design and data collection will result from practitioners paying attention to the details on study design (Chapter 6).

The authors also have hit their mark on producing a thought-provoking book to stimulate additional advances, not only in the biological realm, but in the methods themselves. As I read the book, drinking an Arthur Guinness product (which I noted was acknowledged as a stimulus in the Acknowledgments), I found myself posing a few methodological questions: In addition to the goodness-of-fit tests developed (Chapter 4) would the development of a closure test, possibly something similar to Stanley and Burnham's (1999) work, be useful? In essence, could a 6-visit–single-season survey be split into a 3-visit–2-season or a 2-visit–3-season survey to test for closure using the multiple-season framework given in Chapter 7?

When reading the section on modeling heterogeneity in detection probability, I found myself wondering if there is a way to split out the component of variation in detection associated with abundance (i.e., if there are more individuals, then detection of the local population is more likely than with a population having fewer individuals) and other, or residual, components of variation (Chapter 5). It is not obvious to me whether this could be done, but perhaps there is someone out there who can tackle this issue.

I was especially interested in the chapter focused on