Spatial Ecology and Conservation Modeling: Applications with R

By Robert Fletcher and Marie-Josée Fortin

Cham, Switzerland: Springer, 523 pp., 2018
ISBN: 978-3-030-01988-4 (hbk)

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The last few decades of ecological research were marked by a growing recognition of the importance of space in shaping ecological patterns and processes. This is not only reflected by the emergence of subfields like landscape ecology and metapopulation/metacommunity, but also by the development of an array of statistical methods and models for spatial analysis. Such progress has resulted in the release of several books, software, and packages on how to perform spatial statistics in a vast range of disciplines ranging from environmental studies and conservation biology to ecology, geography, and landscape ecology. Nonetheless, the study of spatial processes and their ecological consequences remains an intricate task and the growing number of statistical tools to do so can be overwhelming. By linking spatial ecology concepts with spatial statistics approaches, *Spatial Ecology and Conservation Modeling: Applications with R* by Robert Fletcher and Marie-Josée Fortin provides an overview of the issues often faced by ecologists and conservation practitioners when dealing with spatial analysis. The book will help scientists and practitioners learn the right tools to conduct their research, identify the challenges they face with their datasets, and circumvent those challenges by linking spatial analysis to ecological processes. As such, Fletcher and Fortin's book is an extremely valuable introduction to spatial ecology and both basic and more advanced methodological tools to conduct spatial analyses in R.

Because space is much more complex than simple geographical coordinates, the first half of the book focuses on quantifying spatial patterns and features. Scale being one of the prominent and pervasive issues in spatial ecology, it is only natural for it to be the topic of the opening chapter. As they do for every chapter, Fletcher and Fortin first introduce the key concepts and approaches to understanding the topic at hand, and then illustrate the topic's importance in ecological studies by providing ecological examples. For instance, rather than only explaining scale dependence in abstract terms, the authors provide several examples where the ecological conclusion

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changed with the scale at which the data was analyzed, stressing the importance of selecting the appropriate scale for the ecological question of interest. Once the key concepts are explained, the readers are provided with hands-on ecological examples in R to help familiarize them with the R code (and packages) required to address the issue at hand (e.g., scale dependence), but also to demonstrate how to interpret and understand the R output. Such a learning-by-doing approach allows readers to go beyond the examples provided in the book and to replicate the analysis in a way that is tailored to their own research, to provide answers to their own specific ecological questions.

The book also focuses on issues related to land cover data and point data analysis. As these two types of data present drastically different challenges, best tackled by their own sets of statistical approaches, they are presented in their respective chapters where the most common metrics are showcased along with different null model strategies and modeling techniques. Once again, the book goes beyond the plain mathematical definition of the metric by bridging the gap between spatial statistics and ecological interpretation. This first half of the book ends on the most challenging issue in spatial statistics: spatial dependence, as stated in Tobler's first law of geography, "everything is related to everything else, but near things are more related than distant things." While this is partly why spatial ecology is so rich and interesting, it also violates the assumption of independence that is required for most standard statistical tests. Fortunately, there are multiple methods to quantify and account for such spatial dependence. On this particular issue, the book strikes a good balance: providing just enough information on the different methods in order for the reader to understand them and decide which is more appropriate for their specific goals, without going into heavy statistical definitions. By the end of the first part of this book, the reader will have developed a fair set of tools to deal with spatial data, and should have a good idea of when to use them.

Building on the methodological tools of the first part, the second part focuses on common areas of investigation in spatial ecology. The authors first review the most common approaches to model species distribution and animal movement, highlighting the benefits and pitfalls of the different approaches using applied examples. Though the book does not address more advanced issues directly in the examples, it presents them at the end of the chapter, thereby directing the reader to the relevant literature on these issues. Such a strategy is used throughout the book, allowing the authors to strive for breadth without sacrificing depth in the topics covered. The authors then spend an entire chapter discussing connectivity, as it is one of the key concepts in conservation. They present a great diversity of metrics and modeling approaches, ranging from patch-level to landscape-level connectivity and from simple to more data-intensive approaches. This chapter on connectivity then sets the context for the chapter on spatial populations. Although metapopulation theory accounts for the bulk of this chapter, the authors also discuss spatial demography concepts such as source–sink dynamics. As data on spatial populations can range from simple occupancy data (presence–absence) to more complex abundance data (with or without different life stages), the book showcases several approaches, each suited for different types of data and/or different ecological questions (e.g., population synchrony, metapopulation viability). The book caps things off with spatially structured communities, where biogeography and metacommunity concepts are discussed. It is only natural that this topic comes at the very end, as it integrates several concepts from previous chapters (e.g., metapopulation, species distribution models). Though only the most common approaches are presented, the book provides the reader with a very strong basis that will allow them to explore and understand more advanced approaches.

By first introducing the fundamental topics in spatial statistics and then linking spatial statistics with spatial ecology, this book provides an accessible overview of spatial ecology, but also a great practical guide. Indeed, the learning-by-doing approach of the book leaves the reader with a ready-to-use toolset to investigate spatial ecology questions. Although this book is an introduction by design and little prior statistical training is required, spatial ecologists with more training would also benefit from the broad view of spatial ecology that it puts forward. Such breadth distinguishes this book from other recent publications like Gergel and Turner's *Learning Landscape Ecology* (2017), which strives for an in-depth coverage of technical and methodological tools used in landscape ecology. Fletcher and Fortin's book is relevant for graduate students, researchers, and practitioners addressing ecological, environmental, and conservation issues as well as land management, though the first section would be equally relevant for social scientists, as it provides an overview of spatial statistics. As we are entering the Anthropocene, such a book is an essential read to anyone interested in studying anthropogenic impacts on ecological systems, as human activities are inherently spatial.

References

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This text is taken from *Human Ecology Review, Volume 26, Number 2, 2020*,
published by ANU Press, The Australian National University, Canberra, Australia.