# Learning Landscape Ecology

Sarah E. Gergel • Monica G. Turner
Editors

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## A Practical Guide to Concepts and Techniques

Second Edition

Springer

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# Preface

Landscape ecology continues to grow as an exciting discipline with much to offer for solving pressing and emerging problems in environmental science. Much of the strength of landscape ecology lies in its ability to address challenges over large areas, over spatial and temporal scales at which decision-making often occurs. As the world tackles issues related to sustainability and global change, the need for this broad perspective has only increased. Furthermore, spatial data and spatial analysis (core methods in landscape ecology) are critical for analyzing land-cover changes worldwide. While spatial dynamics have long been fundamental to terrestrial conservation strategies, land management, and reserve design, mapping and spatial themes are increasingly recognized as important for ecosystem management in aquatic, coastal, and marine systems. For these reasons, there is great demand for training in spatial analysis tools accessible to a wide audience.

The first edition of this book, *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*, was the first "hands-on" teaching guide for landscape ecology. The book introduced a diversity of tools and software in the field. The text sold over 5000 copies worldwide, was used at more than 55 universities, and had its second printing in 2006. However, landscape ecology has grown and quantitative methods have advanced substantially in the ensuing 15 years. In addition, this revised second edition of *Learning Landscape Ecology* complements the release of the second edition of *Landscape Ecology in Theory and Practice* (Turner and Gardner 2015), which pairs nicely with this updated "hands-on" teaching guide.

This second edition of *Learning Landscape Ecology* is purposefully more applied and international in its examples, approaches, perspectives, and contributors. It includes new advances in quantifying landscape structure and connectivity (such as graph theory), as well as labs that incorporate the latest scientific understanding of ecosystem services, resilience, social-ecological landscapes, and even seascapes. Of course, as before, the exercises emphasize easy-to-use, widely available software. We have also included introductory exposure to spatial analyses using R programming language in several labs.

What remains similar to the first edition is our dedication to making seemingly complex ideas easy to understand and use for scientists from diverse intellectual backgrounds and particularly for those early in their careers.

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# Advice for Instructors

All necessary files, data, software, as well as any corrections and updates can be downloaded from the book website: http://landscape.forestry.ubc.ca

For a complete copy of the Instructor's Notes (with Answer Key), please email Sarah E. Gergel (SEG): sarah.gergel@ubc.ca and supply your course number, title, and affiliation.

The first edition is accessible via the Springer website. Teaching materials originally supplied on the CD-ROM from the first edition can be obtained directly from SEG.

## Audience and Difficulty Levels

The content in the second edition spans a range of difficulty levels. These difficulty levels were assessed based on a combination of factors: the complexity of content, any assumed prior knowledge and technical expertise of students, and the amount of time likely needed to complete a lab. All of these factors also influence the amount of in-class supervision and oversight a lab likely requires, as well as instructor "prep" time prior to class. Each chapter is built around the idea of occupying a 2–3 hour lab period, with various exceptions noted below. We've also made suggestions for portions of labs suitable for "take-home" assignments, recognizing that in-class laboratory time at the computer can often be limited.

While there are far too many chapters for use in any one course, the variety of courses that could benefit from, or be built around, these labs include:

- Landscape Ecology
- Watershed Management and Monitoring
- Wildlife Conservation
- Forest Disturbance

- Conservation Planning
- Landscape Modeling and Spatial Analysis
- Landscape Sustainability and Resilience
- Spatial Statistics in Ecology
- Biogeography, Spatial Ecology or Macroecology
- Marine Spatial Planning
- Social-Ecological Systems and Ecosystem Services

As with the first edition, we have extensively beta-tested all of these labs and asked all contributors to create detailed Instructor's Notes (available by email directly from SEG). However, various glitches are always a possibility—thus we strongly suggest instructors spend the necessary time in advance of teaching to "click" their way through the material prior to use in the classroom as well as check the website for the latest updates.

To assist in understanding the suggested audience for each lab, we have grouped chapters into four categories based on their level of difficulty. These suggestions are meant to assist instructors with course planning and time allotment. We also noted any chapter prerequisites as well as suggested corresponding readings from the companion text, *Landscape Ecology in Theory and Practice* (*LETP*).

## Quick and Fun

These shorter and/or low-tech, technically simpler chapters are especially suited for a shorter class period (perhaps 1–2 hours) or a course without a dedicated computer lab. These may even be suitable to use as a take-home assignment. Generally, little to no computer skills are required with the exception of entry-level familiarity with programs likely available on the laptops of all students (such as Excel, Google Earth, or a web browser). Very little prior knowledge of landscape ecology is assumed. Students may also appreciate these more straightforward labs as a break from the otherwise very challenging chapters in the rest of the book!

## Undergraduate

These labs are suitable for upper-level undergraduate students from a wide variety of environmental sciences (e.g., Geography, Ecology, Forestry, Zoology, and Botany). These labs might also be very reasonable choices for a graduate course (e.g., a course-based MSc program) depending on the background of the students. These labs might be a good way to begin a graduate course and ensure students from different disciplinary backgrounds are all "on the same page."

## Graduate

These lab topics and tools include those used in research and applied conservation situations. These exercises assume a higher level background in environmental and/or ecological science as well as knowledge of basic statistics. There are options for using R software (if desired) in addition to options utilizing freeware/shareware with provided data. Instructors are wise to expect some software installation and plan for basic troubleshooting prior to teaching as versions of operating systems and permissions may change.

## Advanced

These labs primarily explore research-oriented tools and fit well with a PhD-level pedagogical approach in terms of the levels of independence and critical thinking required. These exercises assume substantive prior knowledge of students *as well as instructors*, including one or more of the following: statistics including multivariate statistics, basic working ability in R, and/or comfort with GIS and geomatics tools (such as Arc). Most also have one or more lab prerequisites (completion of other chapters in this book). For these labs, instructors should also be well prepared in advance and anticipate troubleshooting for the particulars of their computer lab setup. These labs can easily occupy two full weeks of a regular (2–3 hour) lab period.

| Chapter | Title | Contributors | Suggested audience | | | | Software requirements | *LLE* Chapter pre-requisite | Chapters in *LETP* |
|---|---|---|---|---|---|---|---|---|---|
| | | | Quick and fun | U | G | A | | | |
| 1 | Introduction to Remote Sensing | Coops and Tooke | | X | | | ArcGIS, Google Earth | | 1 |
| 2 | Historical Aerial Photography for Landscape Analysis | Morgan et al. | Part 1 | X | | | | | 1, 2, parts of 4 and 6 |
| 3 | Citizen Science for Assessing Landscape Change | Cardille and Jackson | X | X | | | Google Earth, Google Docs, browser with Internet connection | 2 is a nice complement | |
| 4 | Understanding Landscape Metrics | Cardille and Turner | | X | X | | Fragstats | | 4 |
| 5 | Scale Detection Using Semivariograms and Autocorrelograms | Palmer and McGlinn | | | X | | Excel (R is optional) | | 5 |
| 6 | Characterizing Categorical Map Patterns Using Neutral Landscape Models | Gardner | | | X | | QRULE (R is optional) | | 3 |
| 7 | What Constitutes a Significant Difference in Landscape Pattern? | Remmel and Fortin | | | | X | R | 5 or 6 with R option is helpful | Part of 3, as well as 4, 5 |
| 8 | Introduction to Markov Models | Urban and Wallin | | X | X | | Markov.exe executable (R is optional) | | 2, 3 |
| 9 | Simulating Management Actions and Their Effects on Forest Landscape Pattern | Gustafson | | X | | | Harvest Lite | | 3 |
| 10 | Regional and Continental-Scale Perspectives on Landscape Pattern | Cardille and Turner | | | X | | Google Docs, browser with Internet connection | 6 | 4, 6 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | Using Spatial Statistics and Landscape Metrics to Compare Disturbance Mosaics | Turner and Simard | | | X | X | Excel and GS+ | 5 | 5, 6 |
| 12 | Assessing Multi-Scale Landscape Connectivity Using Network Analysis | Lookingbill and Minor | X | | | | | | 4, 7 |
| 13 | Systematic Conservation Planning with Marxan | Watts et al. | | X | | | Marxan | | 7 |
| 14 | Connectivity as the Amount of Reachable Habitat: Conservation Priorities and the Roles of Habitat Patches in Landscape Networks | Saura and de la Fuente | | | | X | Conefor (optional exercise with ArcGIS) | 12 | Parts of 4, 7, 9 |
| 15 | Linking Landscapes and Metacommunities | Bennett and Gilbert (each contributed equally) | | | | X | R | Either prior R labs (5, 7) | 5, 7 |
| 16 | Modeling Spatial Dynamics of Ecosystem Processes and Services | Gergel and Reed | Part 1–2 | Parts 3–4, Ex4 | Part 4, Ex5 | | Excel | | 3, 8, part of 9 |
| 17 | Heterogeneity in Ecosystem Services: Multi-Scale Carbon Management in Tropical Forest Landscapes | Kirby et al. | Part 1 | Part 2–3 | | | Excel | 8 not required, but pairs nicely | 8, 9 |
| 18 | Regime Shifts and Spatial Resilience in a Coral Reef Seascape | Selgrath et al. | | | X | | Excel | | 6 |
| 19 | Understanding Land-Use Feedbacks and Ecosystem Service Trade-Offs in Agriculture | Schulte and Tyndall | | | X | | Google Chrome or Mozilla Firefox with Internet connection | | 3, 8, part of 9 |
| 20 | Social Networks: Uncovering Social-Ecological (Mis)matches in Heterogeneous Marine Landscapes | Bodin and Crona | | | | X | NetDraw trial version of Ucinet | 12 | Part of 4, 10 |

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