

Preface

Forest landscape maps provide the foundational information for managing, conserving, and utilizing forests—one of the most important global resources. Use of the spatially and temporally explicit knowledge generated by these maps, once limited to professionals engaged in research, management, and education, is now possible for nonprofessionals, including the general public. Recent interest in global issues such as conserving biodiversity, the impacts of anthropogenic activities, and the effects of climate change have further increased the demand for mapped information about forest landscapes. This demand is being met by a rapidly expanding capability to supply that information readily and inexpensively. Given this positive and dynamic scenario, and the growing enthusiasm of academics and students, it is perhaps time to pause and ponder the status quo for using mapped information. Thus, in this book, we examine the mapping of forest landscapes with the goals of providing a broad overview of the current status of mapping and highlighting some advances in the techniques available for obtaining and visualizing this information. It is not intended to be an exhaustive review of the state of our current knowledge of forest landscape mapping, but rather a recap of some key aspects related to the utility and use of these maps.

The book is composed of eight chapters. We begin with a broad introduction to mapping forest landscapes, which will serve as a primer for readers who are either not well versed in this topic or who need a refresher course in the basics. Chapter 1 reminds the reader that maps are abstractions of reality, and that the degree of the abstraction is influenced by the map's scale and the developers' decisions regarding the geometric projection and representation; forest landscapes represent a high level of ecological organization that includes many hierarchically structured elements at multiple scales, and the elements we map are often fuzzy and heterogeneous with respect to their attributes and geometry. Data for maps are gathered from numerous sources at multiple scales; the collection can span many sources, so assessments of the inherent errors and of map accuracy are essential for defining the validity and credibility of maps.

Chapter 2 describes the concept of mapping forest landscapes as fuzzy elements, since both classification themes and the boundaries of mapped entities are often

unknown or imprecise. This chapter describes the approaches that can be used to obtain probabilistic and membership values for mapped ecosystems, how the membership functions that provide these values can take many forms that depend on the spatial resolution, and the consequences for the uncertainty of mapped themes and spatial details.

Chapter 3 addresses the specific case of mapping wildfires in forest landscapes as discrete but complex objects. It describes how wildfire footprints, despite commonly being mapped as simple polygons with a uniform interior and a definitive boundary, are highly complex with respect to their internal composition and spatial attributes. This complexity results from the heterogeneous and stochastic nature of the processes that underlie fire behavior. Accurate portrayal of these processes is scale-dependent.

Chapter 4 describes the utility of three-dimensional mapping of forest landscapes using airborne light detection and ranging (LiDAR). This chapter compares the uses of discrete and full-waveform LiDAR data collection and discusses the types of summary statistics about forests that each can provide, including various characterizations of tree crowns and the development of canopy and terrain models. Having access to 3D forest landscape data has implications for mapping biomass and stem density that go beyond traditional two-dimensional stand-level genus or species classifications.

Chapter 5 explores the mapping of outputs from spatial models to understand the interactions among processes from the resulting spatial patterns. Such mapping often extends into the construction of mathematical surfaces, for which the mapped quantities represent the outputs of a model (e.g., CART, Random Forests) and are themselves abstractions of a landscape. In such cases, the spatial patterns can be used as a surrogate for studying complex ecological processes, and ensemble methods can be used to integrate data within analyses of growing archives of spatial data.

Chapter 6 continues the discussion of landscape abstraction through the use of landscape metrics in two, three, and four dimensions. Although numerous metrics exist, most capture some aspect of the landscape's composition or configuration by summarizing the size, density, shape, core, edge, or connectivity characteristics of specific land cover types. Transition zones (e.g., ecotones, edges) can be visualized as concentric bands, which are conceptually simpler than fuzzy membership functions in terms of how they describe changes with respect to the distance across an interface, since fuzzy membership functions can take on highly complex forms.

Chapter 7 explores the automation of data processing to standardize the production of forest maps and to ensure both consistency and more rapid map development. Ensuring the effectiveness of such workflows will require consistent terminology in the context of an increasingly automated environment. In this chapter, we reiterate the distinction between land *use* and land *cover*, particularly since the important information obtained from land use classification remains difficult to extract from remote-sensing imagery. The chapter concludes with a discussion of tools that can integrate this imagery with LiDAR data in a logistic regression model to allow interpretation of fractional tree cover, which connects neatly with the con-

cept and fuzziness or mixed pixels that contain various combinations of land cover types.

The book concludes with a brief synopsis of the need to improve the application of forest landscape maps, particularly in terms of the efficiency and effectiveness of using the mapped information. In this epilogue, we remind readers that all applications of maps are scale-related; the best information is not necessarily the most detailed or presented at the highest resolution, but rather uses the optimal (most appropriate) scale for a specific application. We also reiterate that maps are abstractions and simplifications of complex natural systems, and that these abstractions depend on many assumptions and are undermined by the many sources of error that are associated with any map.

Our target audience for this book is readers who are involved with generating and using forest landscape maps. We anticipate this volume to benefit readers from the communities of developers and users of geospatial data about forest landscapes. Throughout the book, we emphasize how creators and users of maps must actively and continuously communicate their needs and interact to achieve those needs, with the ultimate goal being to improve the efficiency and effectiveness of creating and using forest landscape maps.

On behalf of all authors who contributed to this book, we thank the colleagues who critically reviewed drafts of the chapter manuscripts and suggested improvements: Raivo Aunap, Den Boychuk, Nicholas Coops, Christoph Fischer, Curtis Gautschi, Wendy Goetz, Emilie Henderson, John Lindsay, Jed Long, Kevin McGarigal, Don McKenzie, Scott Mitchell, Achilleas Psomas, Marc Simard, Christoph Straub, and Hannah Wilson. Finally, we gratefully acknowledge Geoff Hart for improving the clarity of the messages in several chapters, Marc Ouellette for refining many images and illustrations, and Janet Slobodien for guiding the publication process.

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Mapping Forest Landscape Patterns

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2017, XIV, 326 p. 125 illus., 94 illus. in color., Hardcover

ISBN: 978-1-4939-7329-3