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0521650828 - Forest Dynamics and Disturbance Regimes: Studies from Temperate  
Evergreen-Deciduous Forests  
Lee E. Frelich  
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## **Forest Dynamics and Disturbance Regimes** Studies from Temperate Evergreen–Deciduous Forests

More than a quarter of the world's forests lie within the cool-to-cold temperate zones of the northern and southern hemisphere. Their distinctive mosaics of evergreen conifers and deciduous hardwood species have been shaped by fire, wind and herbivory over thousands of years. In the last few centuries human activities have increasingly changed the dynamics of these mosaics: fire suppression and exclusion have reduced fire frequency, harvesting and grazing have increased, and a changing climate may be leading to a change in the frequency of high winds. While the exact influence of these changes remains to be determined, this book provides a major contribution to the study of forest dynamics by considering three important themes:

- The combined influence of the three main disturbance types – wind, fire and herbivory – on the successional trajectories and structural characteristics of forests.
- The interaction of deciduous and evergreen tree species to form various mosaics which, in turn, differentially influence the environment and disturbance regime.
- The significance of temporal and spatial scale with regard to the overall impact of disturbances.

These themes are explored via case studies from the forests in the Lake States of the USA (Minnesota, Wisconsin and Michigan) where the presence of large primary forest remnants presents a unique opportunity to study and compare the long-term dynamics of near-boreal, pine and hemlock–hardwood forests. The comparability of these forests to forests in other cool-to-cold temperate zones allows generalizations to be made that may apply more widely.

LEE FRELICH is a Research Associate in the Department of Forest Resources at the University of Minnesota, St Paul and Founder and Director of the University of Minnesota Centre for Hardwood Ecology. His research experience spans studies of the impact of acid rain on forest growth, paleoecological studies of forest change, tree population dynamics, old-growth forest dynamics and forest disturbance ecology, including the effects of fire, windstorms and grazing.

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## *Preface*

In a nutshell, this book covers the natural and settlement history of the forests in the deciduous-to-boreal forest transition zone of the Lake States (Minnesota, Wisconsin and Michigan) of eastern North America, the different types of disturbances that occur there, and how to study disturbances at the stand and landscape scales. Then several case studies from the Great Lakes Region are used to develop important concepts about the dynamic interactions between disturbance and forest size structure and composition. The dynamics of different forest types within this region are compared with each other. Finally, principles on forest response to disturbance are developed that may be generalized to temperate forests around the world. These include the dynamics of conifer–hardwood mosaics, sensitivity of stands and landscape to changing disturbance regimes, and stability at different scales.

Chapter 1 describes the forest setting of the Lake States, and Chapter 2 follows that with basic information on disturbance regimes. Chapter 3 summarizes my experiences on how to sample and analyze stand disturbance history. The techniques presented there should be applicable in most of the world's closed-canopy temperate forests. Chapter 4 summarizes what we know about stand development and successional trajectories in response to disturbance. Chapter 5 jumps to the landscape scale, and shows how to study landscape age structure and composition. Chapter 6 looks at case studies of landscape dynamics in response to complex disturbance regimes and the sensitivity of the landscape to changes in disturbance regimes, a subject which also could be called succession at the landscape scale. Chapter 7 examines how human fragmentation of the landscape changes disturbance regimes and their effects on the forest. Chapter 8 ties all of the information in the book together by examining how disturbances and biotic properties of tree species interact to structure the forest at all spatial scales from the neighborhood or small

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grove to the stand to the landscape. It demonstrates that four categories of landscape dynamics exist in the Lake States study area, and also that many types of forests around the world fit these same categories.

Although many excellent books have been written on individual disturbance types (e.g. Johnson 1992, Whelan 1995 and Agee 1993 on fire), few books published to date have done much synthesis of the combined effects of different types of disturbance. Therefore, I attempt to integrate the effects of disturbance regimes that are complex, with more than one type of disturbance operating at the same time. Interactions between fire and wind, and between physical disturbances and herbivory, are two interactions that are not covered very well by existing books. I make an attempt to synthesize what we know about these interactions here, and where empirical evidence is not adequate, I have not shied away from using hypothetical examples, conceptual models, and extensions of theory. In many cases, hypothetical examples can do a good job of synthesizing a complex process that was originally described in small pieces, and I employ that technique in a few places.



## *Acknowledgments*

Although I never met him, John T. Curtis first sparked my interest in forest ecology through his 1959 book, now an ecological classic, *The Vegetation of Wisconsin*. It was this book that convinced me to become an ecologist. My Ph.D. advisor at the University of Wisconsin–Madison, Craig G. Lorimer, launched my studies into forest disturbance 18 years ago. Post-doctoral advisor James G. Bockheim at the University of Wisconsin introduced me to ecosystem dynamics in response to human changes in the environment. During a four-year post-doctoral with Margaret B. Davis at the University of Minnesota, I learned about long-term changes in stand and landscape development brought about by climatic change. My current collaborator, Peter B. Reich at the University of Minnesota, has generously included me in many of his research programs having to do with dynamics of the near-boreal and white pine forests of northern Minnesota. Bud Heinselman made his lifetime accumulation of knowledge on near-boreal forests available to me before his death in the early 1990s. Edward A. Johnson at the University of Calgary has been a friend throughout my career, while also unknowingly providing the inspiration to write this book by providing an example of his own Cambridge Studies in Ecology book, *Fire and Vegetation Dynamics: studies from the North American boreal forest*. Many others have helped over the years by challenging my ideas about how the forest works, including Shinya Sugita, Lisa Graumlich, Chris Peterson, and Jacek Oleksyn. Steve Friedman was very helpful in drawing the maps in the book.

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