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Studies from the North American boreal forest

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Preface

Two solitudes: fire behavior and fire effects

This book attempts to couple four characteristics of fire behavior in the boreal forest to their effects on boreal tree populations. The presentation is *unbalanced* with the discussions of fire behavior more detailed than the discussions of fire effects on the plants. This is because our knowledge of fire behavior (intensity, rate of spread, duff consumed, frequency of occurrence, etc.) has developed by a quantitative understanding of the physical processes of fire while our understanding of fire effects on populations has been largely descriptive. As ecologists, we have shown a surprising lack of curiosity about how the fires actually produced their ecological effects (Van Wagner and Methven 1978). This is a result of a strong phytosociological tradition in plant ecology in which an adequate explanation was description of species composition patterns and correlation with general environmental factors. No attempts were made to specify the causal connections between fire behavior and individual plants in terms of appropriate physical variables. Nor were the fire effects on individuals tied to population recruitment and mortality processes.

This book should be of interest to those who already have some knowledge of populations and community ecology but wish an introduction to fire behavior and how it might be coupled to population processes. I have made no attempt to review all of the fire ecology literature of the boreal forest, nor do I discuss all aspects of fire in the boreal forest. Instead, I have concentrated on studies which have coupled the specific physical understanding of fire behavior to individual plants and populations. The book might be seen as a demonstration of the need for fire effects research which takes this process–response approach. To the best of my knowledge, only fire ecology has a well-developed understanding of the physical

disturbance processes in the terrestrial environment although a process–response approach is developing in windthrow (Deans and Ford 1983, Petty and Swain 1985, Schaetzl *et al.* 1989, Blackwell *et al.* 1990). In the marine intertidal, Mark Denny's 1988 book *Biology and the Mechanics of the Wave-Swept Environment* stands as a classic of the process–response approach.

The book is divided into three parts. The first part (Chapter 1) gives the basic thesis of the book: that major aspects of the vegetation dynamics of the North American boreal forest can be understood by quantifiable aspects of forest fire behavior. The second part of the book deals with fire and how it is related to vegetation. Chapter 2 argues that the position of the Arctic airstreams sets the seasonal and geographic extent of the fire season in the boreal forest and that specific synoptic scale weather patterns are responsible for the ignition and spread of large fires.

The next four chapters give the relationships between specific physical processes of fire behavior and the population processes of recruitment and mortality. Chapter 3 discusses fire spread and its dependence on fuel, weather and topography with implications for seed dispersal and mortality. Chapter 4 considers the heat output from the flaming fire front, and its effect on plant mortality. Chapter 5 deals with the consumption of duff by the fire and its effect on recruitment and mortality. Chapter 6 discusses fire recurrence and its effect on survivorship and forest age patterns. Finally, the last part of the book (Chapter 7) combines fire behavior and an understanding of its effects on population recruitment and mortality to explain the observed tree age distributions in the boreal forest.

The book will consider mostly tree populations since more is known about their dynamics and coupling to fire behavior than herbs and shrubs. I have limited myself to primary sources and ideas supported by empirical data. I have tried not to use hypothetical diagrams which do not have explicit empirical tests. Further, I have restricted myself almost completely to fire behavior and effects studies in the boreal forest (see Figure 1.1). By doing so, I hope to minimize the danger of using studies which are not appropriate or comparable to the boreal forest. In the past, we have all used research and arguments from other vegetation types and fire regimes to bolster our interpretations when we lacked our own empirical data. Without confirmatory studies, this approach has led to serious confusion. I will also try to develop a quantitative understanding of fires and populations since both fires and populations are not easy subjects to develop intuitive feelings about and the development of equations often

exposes the level of sophistication in our understanding of the processes.

The chemical aspects of combustion do not play a central role in our discussion of forest fires because of the small variation in composition of woody and herbaceous matter. However, the availability of these fuels (generally determined by their drying rates) and heat and mass transfer rates associated with fire do play a central role. If we were interested in nutrient cycling instead of population dynamics, our focus would of necessity include more of the chemistry of combustion and resulting soil and plant chemical changes.

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A reading of this book will indicate the importance to me and the field of fire behavior and effects of Charlie Van Wagner. Without his outstanding research over the last 30 years, we would all be significantly poorer.

The manuscript was carefully and expertly typed innumerable times by Eileen Muench. The editorial assistance of Maria Murphy and Jane Bulleid was most helpful.

Finally, I should like to dedicate this book to my daughter Joanne who has helped me in the field since she could count and write.

Tree species mentioned in the text

English name	French name	Botanical name
Ground juniper	Genévrier commun	*Juniperus communis* L.
Balsam fir	Sapin baumier	*Abies balsamea* (L.) Mill.
White spruce	Epinette blanche	*Picea glauca* (Moench) Voss
Black spruce	Epinette noire	*Picea mariana* (Mill.) BSP
Jack pine	Pin gris	*Pinus banksiana* Lamb.
Red pine	Pin rouge	*Pinus resinosa* Ait.
White pine	Pin blanc	*Pinus strobus* L.
Speckled alder	Aulne rugueux	*Alnus rugosa* (Du Roi) Spreng.
White birch	Bouleau à papier	*Betula papyrifera* Marsh.
Trembling aspen	Peuplier faux-tremble	*Populus tremuloides* Michx.