PREFACE

Traditional approaches to the study of fire behavior and fire ecology (by foresters and ecologists) have been strongly rooted in a descriptive tradition in which fire behavior has been described in a very informal way, using loosely defined terminology such as "hot/cool fires" or "flammability" with no dimensions or units of measurement given. With this approach, the coupling of fire behavior and fire effects on individuals, populations, or communities could be, at best, qualitative or categorical. Furthermore, even when more quantitative measures of fire behavior have been attempted, many studies have used less than effective measures for attempting to understand the relationship between fire behavior and fire effects (e.g., the use of color-changing temperature-recording paints to correlate temperature with tree mortality). To effectively relate fire behavior to ecological effects, it is necessary to show that such instruments or measures are meaningfully related to the way that organisms are affected by fire. In other words, such studies should incorporate some model of heat transfer to the organisms or particular living tissues (e.g., to serotinous cones or to the tree cambium through bark).

In wildfires, variation in the response of the organism can result from variation in the appropriate measurements of fire behavior variables and variation in the organism's physical characteristics which affect heat transfer processes from the fire to living tissues. Many ecological studies cannot separate these components of variation and thus cannot make useful statements about the causes. On a different scale, studies of the spatial pattern of tree mortality within large burns (i.e., unburned "islands") have often looked for explanations of these patterns in differences in usual environmental factors such as topography, hydrology, and vegetation composition. While such differences may account for some unburned patches, in many cases these unburned islands do not appear to be related to any of these factors. Again, an understanding of the physical behavior of fire (e.g., coupling of fire and three-dimensional convection above the fire) might provide a useful approach to understanding some of these unburned islands.

Since the 1950s, the body of literature on fire behavior has been growing in journals of engineering, geophysics, meteorology, etc. Foresters and ecologists have not used much of this literature on the physical aspects of fire behavior to understand fire effects on individual organisms, populations, or communities. Part of the reason may be that their interests lie in the ecological responses to fire rather than in the physical processes of fire itself. Nevertheless, as indicated above, an understanding of the ecological effects of fire will necessarily involve some understanding of the processes involving the fire in order to ask appropriate research questions and to measure meaningful fire behavior variables. The *purpose* of this book is to provide an introduction to this literature and to convince those working in fire ecology of the importance of understanding these physical fire processes. The book is not meant to be a definitive coverage of the topic of fire behavior and ecological effects; some important topics are not covered because of space limitations. Possible future editions of the book may include other aspects of fire behavior and ecological effects.

This book attempts to bridge the gap between elementary texts on fire for foresters, ecologists, and other environmental specialists (e.g., Brown and Davis, 1973; Luke and McArthur, 1978; Pyne, 1984; Trabaud, 1989) and the technical combustion and heat transfer literature (e.g., *Journal of Fluid Mechanics, Symposium on Combustion, Combustion and Flame, Combustion Science and Technology*). We assume that the reader has an elementary knowledge of physics, chemistry, and biology and an introduction to calculus. Derivations of equations are shown when necessary for an understanding of the processes and relationships between variables. All fields have conventions (i.e., terminology, symbols, ways of presenting relationships) that are often difficult for outsiders to penetrate. Also all fields tend to take for granted that the reader knows why certain things are being done. For individuals outside the field, this is rarely the case. The contributors come from a wide range of different fields and they have tried to explain the conventions and approaches used as they arise in each chapter.

Although the contributors were instructed in writing their chapters to keep in mind the primarily non-physical-science background of the intended audience, we also wanted to provide enough detail and depth to allow the reader to grow into the material. Thus, the book may be read on different levels. A first reading of a chapter may provide some readers with a general intuitive grasp of the topic and its relevance without necessarily a complete understanding of the details and equations. We hope this first reading will entice the reader to delve further into the topic and to use some of the suggested readings to develop an understanding at a deeper level.

Development of this book was aided immeasurably by a workshop attended by all of the contributors in which first drafts of each chapter were discussed in terms of the general objective of the book, the intended audience for the book, and overall coordination of the connections between the chapters. The workshop was held at and funded by the National Center for Ecological Analysis and Synthesis in Santa Barbara. We also gratefully acknowledge Louis Trabaud and Paul Zedler, who, as representatives of the intended audience, provided invaluable feedback to all of the contributing authors.

REFERENCES

Brown, A. A., and Davis, K. P. (1973). "Forest Fire: Control and Use," 2nd ed. McGraw–Hill, New York.

Luke, R. H., and McArthur, A. G. (1978). "Bushfires in Australia." Australian Government Publishing Service, Canberra.

Pyne, S. J. (1984). "Introduction to Wildland Fire: Fire Management in the United States." Wiley, New York.

Trabaud, L. (1989). "Les Feux de Forêts: Mécanismes, Comportement et Environment." France-Selection, Aubervilliers Cedex, France.

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