FOREST

Health and Protection

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FOREST HEALTH AND PROTECTION

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PREFACE

Health is a good thing. When people are ill, they are usually diagnosed with symptoms such as a fever or unusual blood pressure or physical injury. The treatment in most cases, based on the diagnosis, is successful. People appreciate good health and advanced societies have provided a clear mandate for maintaining it.

Forest health also is a good thing. The diagnosis of the status of forest health, and its improvement if needed, is clearly a technical issue, but forest health is not as easily defined as issues of human health. Dead trees, for example, play an important role for wildlife in forest ecosystems, so some decadence in a forest is desirable. Even if people agree on a definition of forest health, and a diagnosis of poor forest health, there is no clear social mandate for maintaining forest health. We leave this latter issue for forest policy makers, and in this text focus on the technical issues concerning forest health and forest protection.

The idea for this book came out of our teaching efforts in the College of Forest Resources at the University of Washington. Over the years we have taught individual courses in our respective disciplines of fire (Agee), insects (Gara), and diseases (Edmonds), and we also offer a forest protection course integrating fire, insects, and diseases. Although there are excellent texts available for each discipline, no single integrative text is available. We finally decided to write a text to fill this need and to do it within the context of applied forest protection, which involves ecology, forest health, and ecosystem management. Just as modern forest management has taken an integrative approach embracing the concept of ecosystem management, there also is a need to take an integrated approach to forest health issues where fire, wind, insects, and diseases and their interactions are treated holistically.

This volume, to our knowledge, is the first integrative text in this field. The first two introductory chapters cover concepts of forest health and principles of forest ecology. Chapters 3 through 7 cover fire as a physical process, fire ecology and fire regimes, fire management, fire strategies for forest health, and wind and forest health. Chapters 8 through 16 discuss forest diseases and cover an introduction to diseases, abiotic and animal-caused diseases, disease-causing organisms, nursery diseases and mycorrhizae, root diseases, foliage diseases and rusts, stem and branch diseases, forest declines, and management of forest diseases and deterioration of forest products. Finally, Chapters 17 through 25 cover entomological aspects of forest health: an introduction to forest entomology; basic entomology; principles of forest insect management; insect defoliators; bark beetles and their management; ambrosia beetles and their management; wood products insects;

insects of seed orchards, nurseries, and young plantations; and forest insect quarantine. Where appropriate the interrelationships between insects, diseases, fire, and wind are stressed. A glossary of terms also is included to assist the reader.

Fire, wind, insects, and diseases are natural disturbance agents in forests. An understanding of natural disturbances in forests is essential to any forest management plan, whether the objective is timber production, wildlife conservation, or wilderness management. However, human activities have strongly influenced forests worldwide, and will continue to do so. Fire regimes have been altered by cutting, forest management, and fire suppression policies of the 20th century. When fires do occur, they are more commonly catastrophic and stand replacing. Native insects and diseases now often play increased roles in forest ecosystems because of the absence of natural fires. Alien insects and diseases, many introduced inadvertently, have reduced the health of North American forests. This is a concern for present as well as future generations; more of these introductions are inevitable.

In North America forest succession has been dramatically changed by fire suppression and introduction of pests, and the resulting forests now contain species mixtures that are different from those at the turn of the century. A similar situation has occurred in Australia and other countries. In addition, air pollution, including gases such as sulfur dioxide and ozone, acid rain, and excess nitrogen inputs have negatively impacted forests in many regions including the eastern United States and Canada, Eastern and Western Europe, Latin America, and Asia. In some areas trees have been killed directly by air pollutants or placed under so much stress that they are more susceptible to insects and disease organisms. The management approach to these forest health issues will vary by country, and by land management classifications, but the principles of the problem will be similar regardless of geography.

This book is intended for students of forestry, natural resources, and conservation in the United States and Canada. But we hope it will be appealing and appropriate for students in other countries. We have used international examples in the book where appropriate. The book is aimed at advanced undergraduate students who have some knowledge of forest ecology, although we have provided a brief introduction to ecological principles in introductory chapters. Graduate students also will find this book useful, but it is not intended to be a research review. Adequate documentation is provided throughout, but the book is not designed to be an exhaustive review of the primary literature. The course for this book is intended to be a one-term offering, but the material can easily be spread across two terms, giving more time to discuss chapters and reference readings in depth. We hope we will stimulate students to look in greater detail into the fascinating world of fire, wind, insects, and diseases and their interactions—that is, forest health and protection.

Finally, we would like to thank those people who contributed to the production of this book. They include Greg Filip, Oregon State University, Mark Petruncio, Heritage College, and R. Jay Stipes, Virginia Tech, along with several other anonymous reviewers whose comments were much appreciated, and the students

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CONTENTS

DEFINITIONS OF FOREST HEALTH

"Forest health" or "forest ecosystem health" are terms that are increasingly being used in relation to the management of forest ecosystems (Kolb et al. 1994, Oliver et al. 1994, Sampson and Adams 1994, Vogt et al. 1997, Rapport et al. 1998). Ecosystem management implies that land is not managed for a single species and that it involves (1) ecosystem complexity, (2) biological legacies (including structures such as green trees, logs, and snags) that are important in reestablishing ecosystems after major disturbances, and (3) a landscape perspective (i.e., large space and time scales) (Christensen et al. 1996, Sampson and Knopf 1996, Kohm and Franklin 1997). We discuss this in more detail in Chapter 2.

There are many definitions of forest health, ranging from utilitarian to ecosystem perspectives as shown in Box 1.1 (Sampson 1996, Rapport et al. 1998). From a utilitarian perspective a forest is healthy if management objectives are satisfied and unhealthy if not (Kolb et al. 1994). Under this traditional line of thinking, insects and diseases are generally considered to interfere with intended human uses of forests. This utilitarian definition may be appropriate where the production of wood fiber is the main objective—for example, in poplar plantations or in intensively managed southern pine forests—but when managing for multiple objectives, this definition is too narrow and an ecosystem perspective with a broader definition is preferable. It is our intent to provide the scientific basis of forest health, leaving the policy implications aside since they are so closely tied to land management objectives (Oliver et al. 1994).

With so many definitions of forest health, it is not surprising that questions have been raised about the concept. For example, the community structure of forests in the southeastern United States was radically altered by the chestnut **blight** (Callicot 1995), but were energy capture, primary production, and nutrient cycling changed? It is possible that if one tree species replaces another the ecosystem may still remain healthy. But this may not always be the case, and significant reductions of keystone species can have catastrophic consequences on ecosystem health. For example, white pine blister rust has devastated the population of whitebark pine at high elevations in the western United States (Figure 1.1). Whitebark pine seeds are a major source of food for grizzly bears, red squirrels, and birds (Clark's nutcracker), and the absence of seeds could drastically affect these wildlife populations if no alternative food source is found (Schmidt and McDonald 1990).

Maintenance of biodiversity is an important aspect of ecosystem management, and it is argued that biologically diverse ecosystems are healthy ecosystems (Vogt et al. 1997). What is the relationship between biodiversity and ecosystem health? The chestnut blight appears to have reduced biodiversity with the loss of the chestnut, but if you add the new fungus there was no net loss in species richness (Callicot 1995). Tree biodiversity may in fact have increased because the chestnut was such a dominant species. Thus biodiversity measured only by species richness should not be the sole criterion of ecosystem health.