Creating a Forestry for the 21st Century

The Science of Ecosystem Management

Edited by Kathryn A. Kohm and Jerry F. Frankl

Foreword by Jack Ward Thomas

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Foreword

Two separate but connected factors have combined in recent decades to dramatically alter the practice of forestry in the United States. The first has been a rising environmental consciousness among a significant and politically effective segment of the population. The second was a spate of environmental legislation enacted in the 1960s and 1970s. Among laws that changed the practice of forestry are the National Environmental Policy Act of 1969, which requires the federal government to perform a detailed assessment of costs and benefits of all federally financed activities; the Endangered Species Act of 1973, which established a government policy that species should be preserved; and the National Forest Management Act of 1976, which sets high standards for management of national forests.

Of particular note is the statement of purpose included in the Endangered Species Act. Twenty years after passage of the act, that statement has emerged full-blown, with far-reaching consequences for federal land management. That statement is: "The purposes of this act are to provide a means whereby the ecosystems upon which endangered species and threatened species may be conserved" and not merely the welfare of the single species identified as 'endangered' or 'threatened.' In addition, there were regulations promulgated by the federal government pursuant to the National Forest Management Act that called for the retention of viable populations of vertebrate species well-distributed on national forests with particular emphasis on habitat.

In combination, these laws and regulations have had a profound effect on forest management on federal lands. These changes came about over a period of 25 years as governmental agencies (most notably the Forest Service and Bureau of Land Management) struggled to maintain or increase historic timber sale levels, satisfy the needs of traditional constituencies (such as grazers, hunters, fishers, and recreationists), and simultaneously remain in compliance with environmental laws. Under the U.S. legal system, citizens may challenge the government's compliance with law. Over the past 25 years, there have been numerous such challenges to federal land management activities—many of which have been successful. These federal court decisions have forced federal land management agencies to change some of their traditional approaches to forest management.

The most noted of these legal challenges is the case of the northern spotted owl (Thomas et al. 1990). This subspecies of the genus *Strix* was declared by the U.S. Fish and Wildlife Service to be "threatened" in early 1990. It is considered closely associated with the habitat conditions most commonly found in the late-successional/old-growth forests of the Pacific Northwest. These forests have been diminished significantly in amount and quality through timber harvesting (most commonly clearcutting) and losses to fire, blowdown, and other natural events since the late 1800s (Thomas et al. 1990). The late-successional/old-growth forests of the Pacific Northwest are extremely valuable as a source of large volumes of high quality timber and as a significant source of employment (FEMAT 1993). The reservation of significant amounts of old-growth from timber harvesting to maintain a range-wide viable population of a subspecies of owl (Thomas et al. 1990, FEMAT 1993) has been fraught with social, economic, and ecological consequences that have translated into prolonged legal and political battles which

continue today. The details surrounding this continuing controversy have been described by Thomas et al. (1993).

As the political and legal drama over old-growth forests and the northern spotted owl evolved, it became more and more obvious that the issue, as clearly foreseen and prescribed in the Endangered Species Act, was not one of saving or maintaining viable populations of an individual subspecies. Rather, it was centered on public and scientific concerns with the maintenance of ecosystem functions. These evolving concerns of scientists (and in turn the public) also began to surface under other names and allied concepts such as "sustainable forestry," "biodiversity retention," "new perspectives in forestry," and "new forestry." But most recently and predominantly, these concepts have come to be known as "ecosystem management" (Thomas 1993).

Ecosystem Management

By mid-1993, both the Forest Service and the Bureau of Land Management announced that they were embarking on a course of ecosystem management. That pronouncement was made without a detailed assessment of what such a management approach might entail or how it might be accomplished. However, the chief of the Forest Service did say that the agency would move away from clearcutting (except in certain circumstances) as the primary silvicultural prescription for stand regeneration.

By 1993, repeated successful lawsuits by organized environmental groups essentially brought timber sales on federal lands in the Pacific Northwest to a halt. Federal court judges ordered federal land management agencies to cease selling timber on lands designated by the U.S. Fish and Wildlife Service as critical habitat for the northern spotted owl. This impasse prompted vocal public concern, and received attention from all three major candidates during the presidential election of 1992. In the course of that campaign, candidate Governor Bill Clinton of Arkansas promised that, if elected, he would convene a conference to devise a means of ending the court-ordered injunction—that is, he would break the "gridlock."

Shortly after his inauguration, President Clinton convened a forest conference in Portland, Oregon, on April 2, 1993. At the close of that conference, the president promised a solution to the impasse over forest management in the Pacific Northwest within 60 days. He instructed the secretaries of Agriculture, Interior, Commerce, and Labor to carry out that promise. Three teams were organized to formulate management options for the president's consideration. The instructions given to one of those teams, the Forest Ecosystem Management Assessment Team (FEMAT), stated that an "ecosystem management approach" was to be included in their report, and that late-successional/old-growth ecosystems and species associated with those ecosystems that were listed by the U.S. Fish and Wildlife Service as "threatened" (northern spotted owls and marbled murrelets) were to receive specific consideration.

Approximately 90 days after the conference, the president selected an option from among 10 presented to him (FEMAT 1993). The consequences of that selection have been ecologically, economically, and socially profound. Of the land in federal ownership within the assessment area (the range of the northern spotted owl), 7.05 million acres (2.85 hectares) of reserves were established where late-successional/old-growth forest conditions are to be preserved and enhanced over time. An additional 2.23 million acres (.90 million hectares) were designated as riparian reserves to meet water quality standards and protect and enhance habitat for native fishes—particularly anadromous fishes considered to be "at risk" of being listed as "threatened" or "endangered."

These late-successional/old-growth and riparian reserves were established in addition to 6.98 million acres (2.83 hectares) already designated as wilderness or national parks or otherwise withdrawn from timber management activities for reasons such as soil stability, scenic corridors, or recreation needs. Approximately 7.34 million acres (2.97 hectares) out of 24.26 million acres (9.22 million hectares) in the analysis area remained available for timber harvest (about 30 percent of the total area). However, it should be noted that significant portions of the total area support no trees, offer little potential for growing trees, or have fragile soils, steep slopes, or other circumstances that preclude timber harvesting.

The acreage available for harvesting yields a prob-

able sale quantity of approximately 1.2 billion board feet, with an additional 100–150 million board feet potentially available from thinning stands younger than 80 years for silvicultural purposes. This probable annual timber sale level compares to 4.6 billion board feet cut annually from 1980–1989, and 2.4 billion board feet cut annually from 1990–1992. However, a significant portion of the decline can be attributed to the accumulated experience of managers with conditions that precluded maintaining the sale quantities projected in the initial modeling efforts for forest plans.

Scientists doing the ecosystem assessments for President Clinton noted that despite the political and economic advantages of stable timber yields over time, experience has shown that this is unlikely over the long term. The world of forest management in the Pacific Northwest is, clearly and simply, inherently unstable—ecologically, economically, legally, and politically. Forest management plans are frequently changed and often unpredictable. They are subject to the vicissitudes of droughts, fires, insect and disease outbreaks, and volcanic eruptions, as well as funding shortfalls, frequent changes in laws and their interpretation, legal actions, court orders, public acceptance, and changes in policy. The only certainty seems to be the certainty of changing conditions—biological, social, economic, and legal.

The case of the spotted owl and old-growth/late-successional forests in the Pacific Northwest is but one example of the dramatic changes in forest management that are occurring in the United States. State after state has, or is in the process of, tightening up regulations defining appropriate forestry practices for private and state lands. Much of this revision seems to be a response to public demands for forestry practices that are more aesthetically acceptable and more sensitive (realistically or perceptually) to actual multiple-use values—primarily those associated with fish and wildlife habitat—than past practices almost solely directed toward profit and job maximization from timber production, harvesting, processing, and utilization.

Of particular interest to ecologists is the emphatic shift in public interest toward concern for all species of wildlife along with an increasingly holistic sense of ecosystems. This broadened perspective replaces the historic, rather single-minded emphasis on habitat for game species such as white-tailed deer, mule deer, and black-tailed deer. There is every reason to believe that this trend will continue. As a result, biologists will have to broaden their interests, increase their expertise, and work with foresters to produce habitat conditions for a myriad of life forms and ecosystems.

There are, however, countervailing pressures at play. The changes in forestry currently underway come about at significant costs. Those costs are measured in higher prices for wood, jobs lost or foregone, loss of revenue to federal and county treasuries, and disproportionately negative impacts on rural communities dependent on the timber industry and timber harvest levels that existed from 1980–1992 on federal lands (FEMAT 1993).

Yet the trend toward ecosystem management and forestry that is more benign in environmental and aesthetic effects seems likely to continue for the foreseeable future. These changes reflect evolving public demand and current law as interpreted by the courts. There seems to be a distinct and growing distrust of natural resource managers—particularly government and corporate managers—by at least a vocal portion of the public. That distrust must be allayed if land managers are to retain any semblance of their historic management prerogatives. One lesson to be learned is that, in a democracy, forests are managed at the sufferance of the citizenry or at least by the majority of the minority of that citizenry that cares about the issue. The greatest challenge that foresters and other natural resource management professionals face in the practice of their professions may not be the technical aspects of forest management, but public acceptance of those practices.

These are among the many issues raised and discussed in *Creating a Forestry for the 21st Century.* In this volume, well-qualified experts have combined to produce a comprehensive view of ecosystem management.

Ecosystem management is a concept whose time has come. But ecosystem management is only a concept for dealing with larger spatial scales, longer time frames, and many more variables (ecological, economic, and social) than have commonly been considered in past management approaches. To be useful, a

concept must be rendered operational. That requires placing the concept in context and in operational terms.

This book is an attempt to take that critical next step—to move the concept of forest ecosystem management into an operational context. Other such efforts are underway. But this, in my opinion, is the best of such efforts to date.

This book can be likened to a river that is fed by many streams. It flows more strongly with the addition and mixing into the current of each stream. This volume has identified many of the contributing factors that must be considered and integrated to make up the first efforts of forest ecosystem management. It is an exciting prospect.

Jack Ward Thomas
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Contents

1 Introduction

Kathryn A. Kohm and Jerry F. Franklin

A student of forestry who picked up a textbook in the 1950s or 1960s would have found information on converting old-growth stands into even-aged regulated forests, preventing and suppressing fire, creating habitat for game species, or calculating optimum rotations. Little mention was made of institutional or social issues. The forester of the 20th century could go to his post in the woods, plan for a sustained flow of timber, mitigate the negative effects of harvesting, provide for other values where possible, and feel secure in the knowledge that he had carried out his professional duties.

Of course, the 21st century will not be such a time. And this is not such a book. As a whole, or in its component parts, this book is designed as a conversation about the future of forestry. If 20th-century forestry was about simplifying systems, producing wood, and managing at the stand level, 21st-century forestry will be defined by understanding and managing complexity, providing a wide range of ecologi-

cal goods and services, and managing across broad landscapes. These are the themes that reappear throughout the book.

Those looking for a how-to book with patent answers are likely to be frustrated. There are still a great number of unanswered questions about the future of forestry, and many of the answers that we do have start with "It depends. . . ." So, how do we prepare for a future that we cannot know? The answer in part lies in drawing the distinction between looking for what to do and looking for how to be—that is, looking for new ways of thinking about our problems. The following chapters lead readers through a thinking process about what forestry might become and what considerations should be taken into account. In many cases, the authors do not tell us what to do—such as the exact number of trees to retain in a harvest operation or the best forum for resolving disputes. Rather, they give us an array of tools and ideas. That is the beginning of the conversation. Where it leads is largely up to those who read and debate the following pages.

The book has been divided into five sections. The chapters in the first section focus on ecological processes and principles. They cover a broad range of topics from stand structure and function and disturbance processes to the movement of organisms across landscapes. Together they portray the rich complexity of forest ecosystems. This knowledge provides much of the impetus for major changes in the practice of forest resources management.

Section two addresses silvicultural systems. The science of silviculture has focused on a narrow set of prescriptions throughout much of its history. The chapters in this section look beyond those bounds. The authors challenge such long-held assumptions as the rationale for clearcutting, the wisdom of short rotations, and exclusion of fire. In addition, some traditional silvicultural tools are examined in light of new and expanded goals for forest landscapes.

The chapters in section three explore different aspects of managing at larger spatial scales. To protect and provide for a wide array of ecosystem goods and services, we must manage in the context of large landscapes over long time periods. This has become one of the tenets of ecosystem management. Developing agreement over the concept is relatively easy; garnering the knowledge and resources to implement landscape-level management is far more difficult. Authors in this section offer some practical information and ideas to that end.

Finally, sections four and five take up economic, organizational, and political issues critical to ecosystem management. In the past, forestry professionals have relegated social issues in forest management to a secondary status—an approach that has erupted in controversies that have shaken the very foundation of the U.S. Forest Service and the forestry profession as a whole. As several authors point out, ecosystem management cannot be built on biological and technical science alone. Ecosystem management will succeed to the degree that we can integrate biological, technical, and social solutions and develop institutions to transform knowledge into action.

The geographic focus of many of the chapters is the Pacific Northwest of the United States. This is not because ecosystem management concepts and practices are confined to this region—quite the contrary. Examples and ideas can be drawn from other regions within the United States, as well as from around the world. However, Pacific Northwest forest resources (particularly old-growth and the spotted owl) have been at the center of recent controversies, and these have propelled us toward a future based on ecosystem management. The Pacific Northwest is also an area in which there have been tremendous advances in ecological research—particularly in such fields as ecosystem structure and function, disturbance and recovery, and landscape ecology. Most important, many of the underlying concepts and thinking processes presented in the following chapters are widely applicable.

As with any attempt to define such a broad and rapidly changing field, there are missing pieces and style differences. We have done what we could to ameliorate these and to stress common themes. Of these, four themes stand out as fundamental to the practice of ecosystem management.

Appreciating the Complexity of Ecological and Organizational Systems

The single most salient theme of this volume is complexity. The adoption of ecosystem management as a guiding philosophy for 21st-century forestry repre-

sents a move from simplified to complex conceptions of ecological and organizational systems.

Discovery and recognition of complexity have been particularly dramatic in the study of ecological processes and principles. For example, forest invertebrates and fungi traditionally have been treated as pests and pathogens. Yet these small organisms, which comprise a surprisingly large portion of the biomass of a forest (particularly belowground), perform critical functions such as nutrient capture and recycling, thinning, and biological control. One of the tasks faced by 21st-century foresters is to understand the interdependencies of these species and move from simply trying to eradicate them to managing a delicate balance between their positive and negative effects (Schowalter et al., Chapter 11).

Similarly, disturbance and recovery processes are far more intricate than we had ever imagined. One of the icons of 20th-century forestry was that clearcutting mimics fire. Yet we have learned that fire and other natural disturbances do not destroy everything in their wake. Rather they leave an array of biological legacies that typically provide strong linkages between old and new ecosystems (see Perry and Amaranthus, Chapter 3).

But the complexity issue is not limited to ecology. As Meidinger points out in Chapter 23, simple top-down organizational structures often are poorly suited to ecosystem management. Achieving new ecological and social objectives will require exploration of varied models of organization and politics.

Appreciating the complexity of systems and managing for wholeness rather than for the efficiency of individual components place forestry in the context of a much broader movement toward systems thinking. Systems theory has permeated such diverse fields as business, medicine, education, and physics. In these disciplines, as well in forestry, discreet disciplinary research has served us well throughout much of the 20th century. No doubt tremendous strides in scientific understanding have been achieved. But we are reaching the limits of such thinking. In the future we will need to take much more information into account when managing forested landscapes. This will require new, innovative computer models such as the SNAP II model described by Sessions et al. in Chapter 18, new analytical methods such as those identified by Haynes and Weigand in Chapter 19, and new organizational structures of the type discussed by Meidinger in Chapter 23.

Finally, appreciation of the vast complexity of forest ecosystems means confronting the limitations of our knowledge. This will require both learning to cope with uncertainties so that we are not paralyzed to act, and adopting a sense of humility in forestry endeavors.

Developing Site-Specific Knowledge

A corollary of the importance of recognizing complexity is improving site-specific knowledge and management prescriptions. This is a key lesson of 20th-century forestry: Beware of simple formulas applied over broad areas.

Americans have had a pragmatic tendency to find a strategy that works in one place and to apply it extensively over large areas. In forestry, the most visible example of this is clearcutting. By the 1950s, all new Bureau of Land Management and Forest Service timber sales in the Douglas-fir region called for clearcutting. The result is a fragmented landscape in which species have been pushed to the edge of extinction, the productive capacity of many sites has been depleted, and public outcries have originated over landscape aesthetics.

Perhaps under the singular goal of wood fiber production such a broad brush strategy made sense. But management goals have dramatically increased in number and complexity—ranging from providing for specific levels of ecosystem processes to restoring old-growth habitats to helping local economies diversify. This, coupled with our growing understanding of the heterogeneous character of natural forests (see Spies, Chapter 2), means that managers as well as scientists increasingly will be called upon to tailor their research and prescriptions to local ecological and social situations.

For example, the theoretical concept of forest succession has moved away from simple generalizations toward more site-specific constructs (Spies, Chapter 2). Understanding the ecological dynamics of a site and tailoring appropriate management strategies will require more local information on environmental conditions, site history, disturbance regimes, community dynamics, and species habitat requirements.

From a silvicultural perspective, variable retention harvesting strategies recognize the immense flexibility that has always existed but has been stunted by the traditions and terminology of silviculture. For example, the shape of small patches of forest (or aggregates) retained as part of a harvest operation can be customized to modify microclimatic conditions or reduce the risk of wind throw. Structural features can be retained in varying configurations and amounts to provide habitat for specific organisms or lifeboat ecological processes from one stand to the next (see Franklin et al., Chapter 7). In addition, individual sites need to be assessed and managed in the context of much larger landscapes (Diaz and Bell, Chapter 17).

All of this will require resource managers to be schooled in a growing body of ecological and social research and to be familiar with the idiosyncrasies of a site. Indeed, carrying out customized harvest prescriptions means that woods workers of the 21st century often will be called upon to understand as much about forest ecology as professional resource managers have in the 20th century.

Such requirements raise the issue of institutional decentralization. The more we expect managers to be better educated and to fit prescriptions to local conditions, the more flexibility they will need and demand. One of the central institutional questions for forestry in the next century will be building organizational structures that give managers the flexibility to be innovative and accommodate local conditions while maintaining national goals and standards of quality. Striking a balance between centralized and decentralized planning is certainly not unique to forestry—it is a key issue defining the move from an industrial age to an information age.

Linking Social, Biological, and Technical Information

Our increasing inability to isolate biological, social, and technical issues is reflected in years of bitter controversy over the management of national forest lands. Despite technical expertise and volumes of data, the $3 billion forest planning effort of the 1980s has become mired in court battles. If ecosystem management simply replaces one technical fix with another, we are bound to end up in the same quagmire.

We have learned that "good science" is necessary, but insufficient. Forestry in the 21st century involves "creating and using information networks, facilitating effective multiparty decision making, building broad coalitions of political support, and participating in cross-jurisdictional management arrangements" (Yaffee and Wondolleck, Chapter 24).

To the degree that the debate has shifted from whether integration of biological and social concerns is necessary to how we should accomplish such integration, we have already made some progress. But linking social and biological issues runs counter to deep-rooted disciplinary, professional, and organizational divisions (Behan, Chapter 26). Bridging those gaps will require experimentation and time.

One route toward improved integration will be the development and use of new decision models such as the SNAP program described by Sessions et al. in Chapter 18. Unlike past models that focused primarily (or exclusively) on timber harvesting, newer models allow users to manipulate a wide range of ecological, economic, and social parameters to come up with alternative management strategies. Similarly, the landscape analysis and design process described by Diaz and Bell in Chapter 17 can be used by managers to synthesize information about landscape character and resources with issues and policies that direct land management.

Technological advances in data management and manipulation also have made information sharing possible on a much broader scale than ever before. As part of a move toward ecosystem management, we need to develop ways to make forest resource information, modeling programs, and education on how to use them broadly available. By sharing data with stakeholders, public agencies not only can tap into a much larger knowledge base, but also can get out of the bind of having to single-handedly know and integrate all social and biological factors (see Yaffee and Wondolleck, Chapter 24).

Finally, science-based assessments have the potential to be vehicles for integrating biological, social, and technical concerns. The Gang-of-Four and FEMAT reports have pointed the way toward developing comprehensive measures for ecological, eco-

nomic, and social effects of alternative policies (Johnson, Chapter 25). Future assessments no doubt will build upon and improve these efforts.

Uncertainty, Humility, and Adaptive Management

If nothing else, the most important result of ecological research on forest landscapes and ecosystems has been an appreciation of their complexity and the limitations of our knowledge. Surprises and basic new insights into forest composition, structure, and function have been the hallmark of recent decades. And there is no reason to believe that the number and importance of new discoveries is likely to change.

From this we are reminded of the very tentative state of our current knowledge and the iterative nature of learning. We begin, finally, to appreciate that each management prescription is a working hypothesis whose outcome is not entirely predictable. And, hopefully, we adopt humility as a basic attitude in all approaches to forests—whether as scientists, advocates, managers, or policy makers.

Adaptive management is the only logical approach under the circumstances of uncertainty and the continued accumulation of knowledge. Management must be designed to enhance the learning process and provide for systematic feedback from monitoring and research to practice. Building the institutional structures and securing the necessary resources to accomplish this will be major challenges for forestry in the next century.

Finally, scientists, managers, and stakeholders must appreciate the idiosyncratic nature of each forest stand and landscape, as well as the limitations of general theory. All participants must understand and accept that new knowledge will almost certainly require continuing (and sometimes major) adjustments in our perceptions and treatment of forest ecosystems.

We hope that the following chapters will allow students as well as professionals to deepen and broaden their interests in ecosystem management—to become better informed and more effective. For skeptics, we hope this book will provide a compelling case for thinking creatively beyond the bounds of traditional forest resource management.