ORGANIZATION AND MANAGEMENT SYSTEMS FOR PROVIDING SUSTAINABLE FOREST RESOURCES

B. Bruce Bare
University of Washington, Seattle, USA

Keywords: forest management, forest certification, ecosystem management, environmental services, zoning, production, protection, sustained yield, sustainable forestry, even-aged, uneven-aged, decision making, plantations

Contents

Summary

To help manage complex forest systems, managers have adopted a variety of management aids including (a) aggregation, (b) systems perspective, and (c) hierarchical thinking. While these aids help promote sustainable management practices, broader social and political issues must also be considered. Complicating the forest manager's job is the shifting definition of what constitutes a resource. Issues such as land tenure, governmental regulations, economic incentives, and voluntary adherence to forest certification standards remain high on the list of factors exerting a significant impact on the practice of sustainable forest management around the world. Forests are owned (managed) by public or private organizations as either production or protected forests. Privately managed production forests follow the agricultural model, while publicly managed forests follow the ecosystem model. Sustained yield principles guide management practices under the agricultural model, while sustainable forestry is the guiding principle for ecosystem management. Forest management systems are classified as either even- or uneven-aged, and most all forests are managed under one of these two approaches. Either system may yield a sustainable forest if properly implemented. Recently, a blend of the two historic forest management systems has emerged wherein green trees are retained after a regeneration harvest operation with the intention to leave them for aesthetic or habitat purposes. Forest certification is another development that is beginning to have a significant impact on sustainable forest management activities around the world. As a voluntary program, it is a self-motivating process and offers an alternative to governmental regulation. Increasing world population and continuing rates of deforestation in the developing world suggest that plantations may be needed to satisfy future demands for timber products. The demand for forest-based leisure activities will rise, as will the expectation that forests will continue to provide a variety of ecological functions to provide environmental services such as carbon sequestration,

clean air and water. Thus, the conflict over how the world's forestlands will be allocated (zoned) to satisfy these different uses, and how those remaining zoned as productive forestlands will be managed, can be expected to continue.

1. Forest Management Systems

Organizing and managing forest systems are complex undertakings. Complexity arises because of many interrelated factors. The underlying physical and biological subsystems are inherently complex. Further, these subsystems are variable in both composition and reaction to perturbations (human caused and natural). Adding to the resulting uncertainty is the complexity introduced by consideration of the social and political subsystems within which forestry is practiced. Linkages between the various subsystems, as well as linkages between components within individual subsystems, are also complex. In addition, complexity arises from the variation in spatial and temporal scales over which forestry is practiced. In the past 10–15 years, multiple and conflicting objectives related to the sustainable management of forestlands have elevated forestry into the political spotlight around the world. Issues related to global warming, biodiversity, deforestation, restoration, endangered species, environmental services, wildfire, clean water, and forest health have stimulated forest managers to reexamine organizational and management paradigms to determine if they are still relevant to contemporary problems.

When confronted with the challenge of managing complex forest systems, forest managers pursue several courses of action. To understand the physical and biological subsystems, basic research is undertaken. Certainly, during the past century, our understanding of basic biological and ecological processes has greatly expanded. This new knowledge allows forest managers to understand the functioning of the system, as well as the interactions between various systems components. This knowledge is useful when making predictions concerning the consequences of planned management and naturally occurring interventions. Because forest managers know more, the level of uncertainty is reduced. However, due to inherent variability and lack of control of all relevant factors, significant levels of variability in predictable performance remain.

In spite of great advances in our understanding of forest systems, complications arising from a variety of social and political factors continue to vex forest managers. New issues and concerns keep surfacing to challenge our understanding of the physical, biological, social, and political subsystems. To cope with complexity, forest managers have adopted a variety of management aids including (a) aggregation, (b) systems perspective, and (c) hierarchical thinking. These aids help managers to understand and manage complex forests more efficiently and effectively. While they help promote sustainable management practices, the broader social and political issues continue to be extremely important. Complicating the forest manager's job is the shifting definition of what constitutes a resource and the consequences related to the adoption of different ways of reacting to these shifts. Issues such as land tenure, governmental regulations, economic incentives, and voluntary adherence to forest certification standards remain high on the list of factors exerting a significant impact on the practice of sustainable forest management around the world. These topics will be addressed later in this paper.

Aggregation refers to the grouping or consolidation of items in order to simplify or reduce the amount of information required for decision making. Historically, forest managers have aggregated groups of similar trees into stands; stands into working groups or age classes; working groups into working circles or forests; and so on. Today, however, it is widely recognized that such aggregation results in a loss of information. For example, by aggregating stands into working groups or age classes, we oftentimes lose geographical information. This lack of spatial sensitivity results in our inability to predict, control, and monitor environmental consequences of management actions on specific pieces of land. This leads to unintended damage to ecosystem functions and structures. Aggregation also results in loss of the ability to predict specific consequences of management actions. For example, by grouping all hardwood species into a single class or all stream types into a single grouping, the forest manager is unable to disaggregate species-specific or stream type-specific impacts at some time or spatial location if the need arises. Another example involves the identification of wildlife "indicator" species that require certain types of habitat for survival. Indicator species represent groups of similar species that have similar habitat requirements. While aggregation simplifies the job of the forest manager, it results in a loss of information. The increasing development of affordable computer technology and our ability to explicitly incorporate spatial information has resulted in less need for managers to aggregate.

To help understand complex forest systems, managers have adopted a systems paradigm. This approach leads to the identification of subsystems, their constituent components, internal linkages, and linkages and feedback between subsystems. This approach allows each complex system to be decomposed into a variety of subsystems. Since each subsystem is smaller in scale and less complex in structure, it is easier to understand, analyze, and manage. While not a panacea, this approach offers hope of a better understanding of individual system components, as well as the relationships between subsystems. Forest managers attempting to integrate biological and ecological information with social and political concerns often find that adopting this approach provides a convenient way for organizing information and analyzing tradeoffs inherent in most forest conflicts. Decomposition of systems helps forest managers to better grasp and understand the nature of the problems and conflicts that they face. It is also helpful when sensitivity analyses are performed to determine possible reactions to planned management actions. Sustainable forest management adopts the same holistic view espoused by the systems approach. Thus, a close fit exists between the two ideas. However, sustainable forest management incorporates a much broader array of components that involve issues of intergenerational equity, resource sustainability, and stewardship that cut across an array of forest products and services.

Lastly, managers have adopted a hierarchical approach in an effort to manage complex systems. Forest systems or subsystems are organized into a logical relational framework along spatial or temporal gradients. This allows the forest manager to gain control and understanding of system behavior in an organized manner. Linkages and feedback loops between the various subsystems may be difficult to identify, but they are central to the success of such an approach. A hierarchical approach also is consistent with the systems perspective in that decomposition and feedback controls are common to both approaches.

The three management aids of aggregation, systems perspective, and hierarchical thinking are consistent with the adoption of sustainable forest management practices. Yet, before sustainable management can be achieved, other critical elements must be considered. These involve land tenure, regulations, forest certification, and incentives.

2. Forest Management Organizations

Forests around the world are managed by a variety of public and private organizations. Objectives of management vary significantly among these classes of ownership. On private forestlands, the traditional agricultural model of forest production, tempered by wood flow, stewardship, and environmental constraints, is still the norm. On public forestlands, adoption of ecological objectives has resulted in an ecosystem model of forest management. Under this model, ecological processes, restoration, protection, and non-timber uses of the forest play an increasingly important role. Both paradigms of forest management involve multiple and incommensurate objectives of management that must be examined and evaluated. However, great differences exist in the importance attached to the various objectives under the two models.

In some parts of the world, land tenure relations preclude public forest managers from exercising the proper level of control over the use of the forestlands under their nominal control. In some of these cases, private ownership may lead to more control and better forms of forest management because property rights are better established. The development of community-based management organizations is gaining in popularity in both developed and developing countries. In other countries, where property rights are respected, both public and private forest owners may succeed. However, each is subject to vastly different pressures that affect how the forest is managed. In some countries, public forests are viewed as protected areas where limited exploitation is allowed. In such cases, the private forests are viewed as the primary suppliers of timber products. In other countries, both the public and private forests are used for timber production purposes, as well as many other uses.

Forests are also organized by structural type. Those established by planting or seeding, as part of an active forest production program, are referred to as plantations. Plantations are usually simple in biological structure. They are composed of one or two age classes, are generally relatively young, contain limited numbers of tree species that may be exotic, and are generally managed relatively intensively using the agricultural model. Natural forests refer to those forests that regenerate using natural means, are relatively extensively managed over time, contain mixed native species, have complex canopy structures with trees of different ages (or sizes), and may have substantial amounts of down woody debris on the forest floor. While both plantations and natural forests produce timber and non-timber forest products, natural forests are more subject to management using the ecosystem model. However, both forms of forests may be managed sustainably and both may offer a variety of forest structures in support of increased levels of biodiversity.

In addition to production forests as defined above, most countries also contain a wide variety of protection (that is, reserved) forests. These may be open to non-timber uses such as recreation, hunting, berry picking, and provision of floral greenery, but they are

usually reserved for scenic value, wildlife habitat, natural wonder, watershed purposes, or protection of biodiversity. Since forests reserved for these purposes do not involve significant levels of timber production, the systems of management are distinctly different from those employed in production forests. Generally, protection forests are set aside as reserves where the intention of management is to preserve and protect. Therefore, forest management is generally restricted to activities involving protection from exploitation and trespass, poaching, and fire. Oftentimes, the goal is to enhance environmental values that are produced by forests. Unanswered is the level of management intervention required to sustain the production of these values in the long-term. For example, it is now recognized that long-term protection from fire may have adverse impacts on the species composition, structure and ecological functionality of forests. Thus, protection forests that are not subject to some form of active stewardship may actually be diminished in their ability to produce environmental services in the long-term.

Forest management in both public and private forests is subject to a large array of laws and regulations that vary significantly from one country to another. They usually involve land use controls, protection of endangered species of plants and animals, environmental safeguards for water and air resources, protection from trespass, poaching, fires, insects, and disease, and regulations restricting the amount of timber, wildlife, fish, and so on that may be removed over a specific period. In many countries, enforcement of existing laws and regulations is not adequate. In such cases, illegal logging, poaching of wildlife, and disregard for water, soil, and air resources continues to contribute to overexploitation and resource degradation. The attainment of sustainable forest management is not possible if these deficiencies are not addressed. Either existing rules and regulations need to be enforced, or new incentives need to be put in place. In some countries, community-based forestry has been tried in an effort to transfer public property rights to local control. The idea is to allow the local community to exercise police powers and management authority over a forest that is used to provide local needs.

This discourages overexploitation by both the local communities and outside groups. In other countries, efforts are under way to provide landowners with economic incentives if they adopt sustainable forest practices. One such effort is forest certification. This voluntary approach offers the landowner the ability to gain public support, market share, and perhaps increased sales revenue by adhering to management practices that satisfy prescribed standards. Several organizations such as the Forest Stewardship Council, American Forest and Paper Association, International Standards Organization, Pan European Forest Certification Scheme, and the Canadian Standards Association offer competing alternatives for voluntary forest certification.

-
-
-

Bibliography

Aplet G. H., Johnson N., Olson J. T., and Sample V. A., eds. (1993). *Defining Sustainable Forestry*. 328 pp. Washington, DC: Island Press. [A broad discussion of the definition of sustainable forestry from a variety of ecological, social, and economic perspectives.]

Boyce S. G. (1995). *Landscape Forestry*. 239 pp. New York: Wiley and Sons. [Introductory text, which utilizes a systems dynamics approach to model landscape-scale issues in forest planning.]

Davis L. S., Johnson K. N., Bettinger, P., and Howard, T. E. (2001). *Forest Management*. 804 pp. New York: McGraw-Hill. [Introductory text book, which discusses the basics of forest management and valuation and how linear programming may be used to schedule forest operations and allocate land to its best use.]

FAO (United Nations Food and Agriculture Organization) (2005). *Global Forest Resources Assessment 2005*. Rome, Italy: Food and Agriculture Organization, United Nations, Forestry Paper 147. [A comprehensive assessment of the status and trends of forest resource use around the world.]

Lindenmayer D. E. and Franklin J. F., eds. (2003). *Towards Forest Sustainability*. 231 pp. Washington, DC: Island Press. [A collection of papers describing the transition and role of native temperate forests to provide both ecological and social services on a sustainable basis.]

Lindenmayer D. E. and Franklin J. F., eds. (2002). *Conserving Forest Biodiversity*. 351 pp. Washington, DC: Island Press. [Explores the thesis that proactive management of unreserved or production forests is the key to the maintenance of forest biodiversity.]

Hof J. and Bevers M. (1998). *Spatial Optimization for Managed Ecosystems*. 258 pp. New York: Columbia University Press. [An introduction to spatial optimization for resource scientists that emphasizes static and dynamic problem environments, sustainability, and diversity.]

Mower T., ed. (1997). *Decision Support Systems for Ecosystem Management: An Evaluation of Existing Systems*. 154 pp. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, GTR-296. [An evaluation of 24 computer-based planning tools useful for ecosystem management planning.]

National Commission on Science for Sustainable Forestry, (2005). *Science, Biodiversity, and Sustainable Forestry: A Findings Report of the National Commission on Science for Sustainable Forestry*. 52 pp. Washington, DC. [A set of findings in four areas are described that promote the attainment of sustainable forests. Oliver C. D. (1992). A Landscape Approach: Achieving and Maintaining Biodiversity and Economic Productivity. *Journal of Forestry* **90**, 20–25. [Outlines an approach to ecosystem management that relies on proactive management to produce both commodities and environmental goods.]

Oliver C. D. (1998). Passive versus Active Forest Management. In J. M. Calhoun, ed. *Forest Policy, Ready for Renaissance*. Institute of Forest Resources, Contribution No. 78, College of Forest Resources, Box 352100, University of Washington, Seattle, WA. pp. 237–257. [Describes the tradeoffs between proactive forest management versus a system that relies on set-aside reservations.]

Oliver C. D., Boydak M., Segura G., and Bare B. B. (1999). Forest Organization, Management, and Policy. In M. L. Hunter, ed. *Maintaining Biodiversity in Forest Ecosystems*. Oxford, UK: Oxford University Press. pp. 556–596. [Discusses a systems approach to forest management that emphasizes the organizational structure needed to provide for biodiversity and commodity outputs by using management science and adaptive management tools.]

Peterson D. L. and Parker V. T., eds. (1998). *Ecological Scale, Theory and Applications*. 615 pp. New York: Columbia University Press. [Addresses the theoretical and methodological importance of scale within a multidisciplinary context and synthesizes a diverse literature on scale in ecology.]

Romm J. (Sustainable Forestry Working Group) (1998). The Pursuit of Innovation. In *The Business of Sustainable Forestry Case Studies*. pp. 1-1:1-9. Chicago, IL: John D. and Catherine T. MacArthur Foundation. [A collection of case studies that examine different approaches to sustainability in the forest industry.]

Sedjo R. A., Goetzl A., and Moffat S. O. (1998). *Sustainability of Temperate Forests. Resources for the Future*. 102 pp. Washington, DC.: Johns Hopkins University Press. [Provides a current assessment of forest sustainability and forest certification issues in the temperate forest zones of the world.]

United States Department of Agriculture, Forest Service (2004). *National Report on Sustainable Forests – 2003*. 139 pp. Washington, DC: FS – 766. [A summary of the condition and trends of forests in the United States as measured by the criteria and indicators of the Montreal Process.]

Viana V. M., Ervin J., Donovan R. Z., Elliott C., and Gholz H., eds. (1996). *Certification of Forest Products, Issues and Perspectives*. 261 pp. Washington, DC: Island Press. [Comprehensive survey of the current status of forest products' certification.]

Weintraub A. and Bare B. B. (1996). New Issues in Forest Land Management from an Operations Research Perspective. *Interfaces* **26**(5), 9–25. [Summarizes major challenges facing forest managers around the world and how operations research methodologies can help solve these problems.]

World Commission on Environment and Development (1987). *Our Common Future*. Oxford, UK: Oxford University Press. [Far reaching analysis of the relationships between development and a sustainable environment. Calls for sustainable population level, more equitable distribution of benefits, sustainable development, economic growth, conservation of natural resources, and environmentally friendly technology.]

Forest Stewardship Council: www.fsc.org

Sustainable Forestry Initiative: www.afandpa.org

International Standards Organization 14000: www.iso.ch

Canadian Standards Association: www.sfms.com

Pan European Forest Certification Scheme: www.pefc.org

International Tropical Timber Organization: www.itto.or.jp

Rainforest Alliance Smart Wood Program: www.smartwood.org

Scientific Certification Systems Forest Conservation Program: www.scs1.com

Biographical Sketch

B. Bruce Bare is Professor and Dean, College of Forest Resources. He specializes in the areas of forest management, valuation, and operations research. Professor Bare has over 38 years experience in teaching and research dealing with a wide variety of forest management issues in the USA and elsewhere. He has published numerous technical and scientific papers and has been a consultant to the forest industry, research organizations, and governmental agencies.