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Foreword

The scientific conference on 'The Application of Scientific Knowledge to Decisionmaking in Managing Forest Ecosystems' convened in Asheville, NC from 3 to 7 May 1999. This conference was organized by the IUFRO Working Party 4.11.03, Knowledge and Information Management. The cosponsors were the USDA Forest Service, Southern Research Station, Asheville, NC and the Forest Resources Systems Institute (FORS), Clemson, SC. The purpose of the conference was to present the latest developments concerning the entire range of topics dealing with ecosystem management decision support systems.

The conference began with five keynote presentations designed to introduce decision support for forest ecosystem management from five different perspectives. The first keynote speaker, Dr Pete Roussopoulos, Director of the USDA Forest Service's Southern Research Station, provided the opening remarks. The fundamental intent of providing decision support tools to forest ecosystem managers is to provide efficient, explicit, and explainable means of choosing among alternative courses of actions based on available information and outcome preferences. Ecosystem management offers a conceptual framework in the human quest for a sustainable existence on this planet. It represents the latest attempt, in a century-long struggle between resource users and resource preservers, to find a sensible middle ground between ensuring the necessary long-term protection of the environment and protecting the needs of an ever-growing population to use natural resources to maintain and improve human life. Despite years of debate, ecosystem management remains today primarily a philosophical construct for dealing with larger spatial scales, longer timeframes, and devoting more attention to the social acceptability, economic feasibility, and ecological sustainability of management decisions. Because consensus is lacking on the fundamental principles that define ecosystem management, the most immediate challenge is to create explicitly defined, operationally practical processes that can be implemented, tested, and refined. Decision support systems have a role to play in this endeavor.

Why do we need the aid of computerized systems? Because the unaided human mind is not equipped to' deal with such large problems. The complexity of environmental dynamics over time and space; overwhelming amounts of informa-

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tion in different forms and qualities; and multiple, often conflicting, public values and management goals virtually guarantee that few individuals or groups of people can consistently make good decisions without powerful decision support tools. As this conference illustrated, a large number of decision support systems for ecosystem management are under development. It is probably fair to say that to date none of these systems, is capable of addressing the full range of support required for comprehensive ecosystem management. It is just not practical, nor is it necessary, to expect any single decision support system to do it all. Dr Roussopoulos believes that a variety of decision analysis methods and related modeling tools will be required. Yet these different modeling tools can no longer be little ‘islands of automation’, unable to easily communicate with each other. We need an integrated suite of tools to address the full range of decision analysis needs and we need a common software communications standard to make it all work together.

An interoperability standard would provide the means for two or more software components to cooperate by exchanging services and data with one another, despite heterogeneity of language, ‘interface, and hardware platform, Such standards have received considerable attention outside the realm of natural resource management. We need to become familiar with these methods and use them to our advantage. We need to create a universal communications standard for supporting ecosystem management decisions and then invite any and all developers to provide problem-solving software tools compatible with this standard. By this means we can embrace new advances in an inclusive rather than exclusive framework. No one yet knows how best to support ecosystem management, and no one can ever know where the next brilliant problem-solving solution will arise. But we can and must design open, inclusive software systems that can invite these brilliant solutions to take their rightful place among a growing family of powerful decision support tools.

The second keynote speaker Dr Chris Risbrudt, Director. of the Ecosystem Management Coordination staff for the USDA Forest Service, presented ‘A Management Perspective on Forest Ecosystem Management Decisionmaking’, focused on the differences in process and content that are required for National Forests to make decisions within the framework of ecosystem management compared to traditional forest management. Primary among the differences are the greater geographic and temporal scales that must be considered in the decisionmaking process and the increased complexity of information needed to address ecologically based decisions. A national hierarchy of ecological units ranging from millions of square miles down to a few acres assists in organizing analyses at appropriate scales.

Forest Service managers must shift the emphasis of their planning process to address the issues of ecosystem management. Formerly, planning focused first on where and when to conduct management activities, and only later determined how to accomplish an activity, exactly what to do. The final step was to justify what was being done by explaining why it was necessary. Ecosystem management requires a change in the order of these steps by first emphasizing the goal of any activity and asking why something needs to be done. It then follows to determine what to do, where to do it, when, and finally how. Making the goal-driven nature of ecosystem management explicit allows decisions to include more factors such as ecological and socioeconomic considerations.

Because decisions under ecosystem management include more factors in complex systems, the techniques of adaptive management are necessary to maintain the ability to address uncertainty. Because no predictions are perfect, monitoring and adaptation are necessary. These techniques are feasible because the long-term goals are identified, and either changes in target conditions or deviations from the expected path can be addressed by adapting planned activities to meet newly identified needs.

The third keynote speaker, Dr Clyde Holsapple of the University of Kentucky, in his presentation ‘Decision Support Systems: A Knowledge Management Perspective’, emphasized the importance of decisionmaking in shaping the future by impacting success in meeting responsibilities, achieving objectives, and filling roles. Following a review of the historical progression of decision support systems (DSS) from transaction-oriented systems through management information systems, the idea was proposed that current DSS aim at augmenting the user’s knowledge management capabilities. Knowledge-oriented DSS can present knowledge in customized ways in response to ad hoc requests, and can interact directly with the decision maker, allowing flexibility in the choice and sequencing of knowledge management activities.

Knowledge management is concerned with the representation and processing of knowledge, and aims at ensuring that the right knowledge is available in the right forms to the right entities at the right times for the right costs to help ‘manufacture’ a decision. Proficiency in knowledge management is increasingly important to competitiveness, and is based on several key activities: knowledge acquisition, selection, derivation, discovery, internalization and externalization.

Future directions of knowledge management tools and techniques will lie in increasing the intelligence of interfaces, computer learning, knowledge discovery, and intelligent agents. Systems will become multiparticipant, promoting infrastructure adjustments and proactive coordination through organizational DSS. Systems will make increasing use of the World Wide Web. More details may be found in Dr Holsapple’s recent book entitled ‘Decision Support Systems: A Knowledge-Based Approach’ published by West Publishing Company.

The fourth keynote speaker, Dr Gregory Greenwood, research manager of the fire and resource management program of the California Department of Forestry, in his presentation entitled ‘The ‘Realpolitik’ of Ecosystem Management’, discussed some of the practical issues associated with ecosystem management decisionmaking and how these issues impact the desired properties of ecosystem management decision support systems (EMDSS). Theoretical discussions of EMDSS are frequently based on a number of unexamined assumptions including: (1) ecosystems exist as real entities; (2) goals are definable; (3) the understanding of whole ecosystems is possible; (4) management of the whole system is under command and control; and (5) optimal actions can be solved for. These assumptions are often wrong and therefore lead to the development of systems that do not actually support real decisionmaking. Such a dissonance between these ideals and actual practice can lead to failure of implemented systems.

In actual ecosystem management, the nature of the processes leading to the act of making the decision is central. Alternative interests ('stakeholders') are convened, often in response to crisis situations. Features of actual ecosystem management include: (1) negotiation, rather than analytic solution, is the central characteristic; (2) negotiation is the principal mode because no institutional basis exists for imposition of solutions at the landscape scale; (3) beyond that, there exists little or no ability to fully predict the impact of solutions ecologically, economically and politically before they are worked out in practice; and (4) the negotiation process is therefore a 'search for fitness' along multiple dimensions. In this context the ecosystem management process may be seen as one of discovery and adaptation. The role of the decision support system, therefore, is to facilitate this process of negotiation. The negotiation process involves uncertainty, hegemony, politics, and disagreement. One important role of the DSS is to make clear the underlying conceptual model arising from these different interests. The DSS must provide a fair and impartial platform for estimation of the consequences of alternative practices, as well as a sensitivity analysis of the assumptions and parameters. Most real ecosystem management decisions involve allocating money and resources to competing activities, and in this context a DSS should be able to calculate costs or at least commensurate impacts to facilitate the assignment of financial responsibility.

In addition to these operational requirements, there are functional requirements associated with the fact that most ecosystem management decision support systems are computer programs managed, or at least accessed, by regulatory bodies. As such, the computer program should have an architecture open enough to serve a growing and idiosyncratic institutional network and must be able to interact with multiple file and database formats. It must support technical requirements as established in laws and regulations. As an agent of the enhancement of mutual trust among participants in the negotiation, it must be transparent and accessible to parties with different interests, and must support the incorporation of local knowledge and expertise for both accuracy and acceptance. In summary, the development and use of EMDSS represents an example of the dual role of scientists as both impartial information providers and active participants in the process. The decision itself is the most important part of the process of ecosystem management decision support, and as such the decision support system, if it is to be successful, must be designed and developed with full cognition of the process and constraints associated with ecosystem management in the real world.

The final keynote speaker was Dr Hamish Kimmins, a professor of the Department of Forestry of the University of British Columbia, Canada and author of the recent book 'Balancing Act: Environmental Issues in Forestry', published by the UBC Press. A world population of 6 billion, a 40% loss of global forest cover, and increasing demands on forests for a wide variety of wood and non-wood products and values demands the development of a sustainable relationship between humans and forests. To be successful, this relationship — sustainable forest management — must be based on a respect for nature. This respect involves: (1) a qualitative, value-based interpretation (respect: to revere, esteem, honor) as a basis for establishing objectives of management; and (2) an analytical, scientific, quantitative interpretation (respect:

to take due regard of, to notice with attention) as a basis for designing ecosystem management to achieve these objectives.

The global human society must develop a more ethical approach to resource management and the application of scientific knowledge and technology if it hopes to avoid a variety of future environmental and social problems. However, as in the case with 'respect for nature', declaring one's intention to act ethically is much easier than deciding what this means and how to manage particular ecosystems and landscapes. Defining sustainability as a 'non-declining pattern of change', the design of sustainable forest management requires the identification of site-specific combinations of disturbance severity, disturbance frequency, and ecosystem resilience — embodied in the concept of 'ecological rotations'.

Certification of sustainable forest management involves monitoring and adaptive management. This implies that we know the temporal pattern of change in ecosystem attributes that constitutes sustainable forest management — embodied in the concept of 'temporal fingerprints of change'. The evaluation of both ecological rotations and temporal fingerprints of change is difficult. Such evaluations, and forecasting ecosystem conditions under alternative management scenarios, requires the development and use of ecosystem management models and decision support systems. Dr Kimmins concluded that as forestry enters the 21st century, use of ecosystem management models and decision support systems will become both accepted and required.

The rest of the conference was organized around the following themes: data management, knowledge management, quantitative and qualitative simulation modeling and decision support systems. The papers in the data management section of the conference will be published in the Winter 1999 issue of the FORS COMPILER. For further information, please contact FORS at PO Box 1785, Clemson, SC 29633, tel.: + 1-864-6567723, or visit their internet site at www.forsonline.org. The remaining papers are found in this special double issue of Computers and Electronics in Agriculture.

The papers dealing with knowledge management and quantitative and qualitative simulation modeling make up the first part of this special double issue. Ellis et al., Plant and Vayssieres, and Potter et al. present knowledge-based systems on agroforestry planning, using rules to drive a landscape level state-transition model, and an internet-based expert system for Gypsy Moth risk assessment, respectively. Kim et al. present a PROLOG-based development environment for the knowledge-based systems. To round out the knowledge management section, Thomson presents two papers dealing with the important problem of how to elicit knowledge successfully from human experts. The quantitative and qualitative simulation section begins with a forest landscape change model called LANDIS presented by Shifley et al. King et al. model non-catastrophic individual tree mortality using three different approaches, Wilds et al. model the distribution of species and communities in the Great Smoky Mountain National Park, Lexer et al. model the effect of forest site conditions on suitability of tree species, Dennis analyzes public values using an ordered probit analysis approach, and Moore et al. investigate whether loss of simulation system resolution leads to a loss of optimality.

The papers dealing with decision support systems and related issues make up the second part of this special double issue. Twery et al. and Rauscher et al. present the

NED family of DSS for ecosystem management and propose a practical decision analysis process for project-level planning. Kurz et al. and Klenner et al. present the scenario analysis tool TELSA and use it to analyze habitat patterns in forested landscapes. Li et al. present LEEMATH, a scenario analysis model that evaluates the effects of management activities on timber and habitat. MacLean et al. present the Spruce Budworm (SPW) DSS and review the lessons learned in its development and implementation. Reynolds et al. present the Ecosystem Management Decision Support (EMDS) system and illustrate its use to assess watershed conditions. Riedl et al. briefly summarize MapModels, a new approach for spatial support in silvicultural decisionmaking. Van Raffe briefly summarizes TACTIC, a DSS for forest management planning. Liu et al. present the use of DCOM to support an interoperability framework that would provide the means for two or more software components to cooperate by exchanging services and data with one another, despite heterogeneity of language, interface, and hardware platform. Nute et al, explore the meaning of taking a goal-oriented rather than a problem-oriented approach to DSS development and application Finally, Shaw et al. present a social ecology perspective. They evaluate how science and scientists interfaced with policy making and the planning process that lead to the Tongass Land Management Plan.

H. Michael Rauscher,
Bent Creek Experimental Forest,
USDA Forest Service,
Southern Research Station,
1577 Bervard ***Raod,***
Asheville,
NC 28805,
USA
E-mail: rauscher-srsbentcreek@fs.fed.us

Richard E. Plant,
Department of Agronomy and Range Science,
The University of California,
Davis,
CA,
USA

Alan J. Thomson,
Pacific Forestry Centre,
Canadian Forest Service,
Victoria,
BC,
Canada

Mark J. Twery,
USDA Forest Service,
Northeastern Forest Experiment Station,
Burlington,
VT,
USA