AN INTEGRATED APPROACH TO MODELING AND ASSESSING THE IMPACTS OF WILDLAND FIRE ON EASTERN LANDSCAPE

Christine M. Stalling
Rocky Mountain Research Station, FSL, Missoula, MT.

Public concerns regarding wildland fire management in the United States reflect myriad issues including the costs of fire suppression, landscape rehabilitation under pre- and post-fire conditions, structural damage and loss, health and cultural effects of smoke emissions, effects of insect and disease in association with fire, impacts of fire on aesthetic values, and risk of fire to human life to name a few. From the eastern United States to the west wildland fire impacts must be assessed within the context of the sustainability of forest resources. Issues relating to sustainable forest management are often exacerbated by patterns of ownership, population, and housing densities across landscapes. The ability to display the science of landscape change and the influences of natural processes and management treatments over time are needed to effectively assess the impacts of wildfire on resource sustainability and address concerns at multiple geographic scales. An integrative approach to landscape level planning and management can be accomplished by bringing together knowledge from many disciplines and effectively communicating that knowledge to stakeholders and the public; public participation is critical to sound environmental policy and decision-making (Videira et al. 2003). Clearly, managing forests for sustainability must be considered from an ecosystem approach because the social, economic, and biophysical facets of forest systems are directly linked (Kimmins 1997).

Natural resource managers can better understand the interdependence of ecosystem variables by using an integrated approach to landscape level modeling. This approach includes using the most recently remotely sensed data along with the best available knowledge of natural resource sciences to address sustainability concerns. A model must be flexible enough to accept many forms of data input because, while data availability continues to increase and become more easily accessible, the "best" available data changes frequently and will continue to do so into the future. In 1997, the U.S. Forest Service compiled its first approximation report for sustainable forest management which indicated that data was completely lacking, or had been only recently collected making it impossible to determine trends, or data collection had been conducted using inconsistent definitions or methodologies across study locations so that conclusions could not be drawn in regard to national criteria and indicators of sustainability (USDA Forest Service 1997). More recently, appendix 3 of the National Report on Sustainable Forests—2003 (USDA Forest Service 2004) discusses continuing data issues and the need for better data management and availability specific to each criterion specific to the Montreal Process.

The modeling system SIMPPLLE (SIMulating Patterns and Processes at Landscape scales) is a management tool developed to help land managers integrate the best available knowledge of vegetation change resulting from disturbance processes such as fire, insects, and diseases as well as fire suppression and management treatment activities (Chew et. al. 2004). The system is adaptable to the use of data from many sources including satellite imagery, stand level database inventories, measures of risk, expert knowledge, and others to represent current landscape conditions and changes over time. The model represents vegetation change as a result of the interacting disturbance processes and management actions across spatial units, or polygons by linking to GIS; this dynamic approach to modeling landscapes provides a tool to aid users in visualizing how a landscape can change over time and space with and without the influence of management applications. By linking with other inventory and assessment techniques such as the Structure Ignition Assessment Model (SIAM) (Cohen 1995), SIMPPLLE can represent the probabilities of landscape scale fire disturbances spreading to specific sites and structures. A treatment optimization and scheduling model, MAGIS (Zuuring 1995), can be linked to SIMPPLLE to assess the economic efficiency of fuel treatment allocations. This approach to modeling helps quantify the level of resources and the realistically attainable future conditions that meet the goals of sustainable forest management. However, a platform for representing sustainability is needed.

The utility of national scale criteria and indicators (C&I) programs represent complementary tools for conceptualizing, evaluating, applying, and communicating sustainable forest management (Reynolds et al. 2003; Wright et al. 2002). Modeling with SIMPPLLE is a systematic approach to compiling and displaying information from national scale C&I, such as those articulated in the Montreal Process, which provide a general framework for measuring forest management practices across landscapes, analyzing current forest conditions for sustainability into the future, evaluating acceptable current conditions, and measuring trends to track subsequent changes over time. Notably, no single criteria or indicator is an absolute indication of sustainability, rather individual C&I must be considered in the context of all other C&I (Montreal Process 1995). The fundamental connection between people and forests is at the center of this ecosystem approach to management; the C&I provide a comprehensive overview of forest conditions, a common data source for further analysis, and a basis to discussing forest sustainability across diverse levels of expertise. The C&I are broad yet provide a standard base from which forest managers can work on landscapes ranging from highly populated, industrialized conditions to sparsely populated, non-industrialized conditions.

Defining forest sustainability within the context of public values must be broad enough to account for changing needs and forest conditions into the future and across landscapes of variable scales. The U.S. Forest Service defines sustainable forest management as “the stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality, and their potential to fulfill, now and in the future, relevant ecological, economic, and social functions at local, national and global levels, and that does not cause damage to other ecosystems” (USDA Forest Service 2004). Similarly, the Canadian Forest Service considers C&I as useful for assessing forest health since the sustainability of forests are based on the forests being healthy and “in general terms, a healthy forest is one that maintains biodiversity, resiliency, wildlife habitat, aesthetic appeal and resource sustainability” (Canadian Forest Service 1999). According to Kimmins (1997) a healthy forest ecosystem can by measured by the underlying ecological processes operating within a natural range of variation so that these processes function dynamically and are resilient to disturbance at any temporal or spatial scale.

Given the far-reaching concerns about sustainable forestry, managers, policy-makers, and others are faced with the challenge of deciding the best management practices for sustainability. The number, diversity, and interconnectedness of the C&I developed in the Montreal Process reflect the complexity of managing forests sustainably. The forest management issue of escalating wildland fire throughout the United States is a single indicator of how the social, economic, and ecological aspects of natural resources are intertwined to clearly display where sustainability is not being achieved on many forested ecosystems. While fire, flood, drought, climate change, insect and disease processes played key roles in forests of the northeastern U.S. and Canada historically, human activities such as fire suppression, introductions of insect and disease, land use changes, atmospheric pollutants, carbon dioxide and other greenhouse gasses, and many other influences all have contributed to forest conditions that are much less resilient to disturbance (Canadian Forest Service 1999).

Although human activities are evident in more recent historical analyses of northeastern forests, records indicate that they were heavily influenced by Native American burning, with the arrival of European settlers, fire activity was reduced and harvesting increased tremendously along with conversion to agriculture (Delcourt and Delcourt 2000). Today, population growth, changing land uses, and the influences of past land use have altered fire behavior and the associated risks to the ecological, economic, and social integrity of forest ecosystems; private ownership mixed with State and Federal brings a divergence of forest management goals. The complexity of natural systems, however, is difficult to convey even from a single discipline to an audience already familiar with the medium. Integrating knowledge from multiple disciplines and communicating that information to the public introduces yet another level of complexity. Accomplishing the goals of sustainable forest management requires a multi-disciplinary approach and given the interdependent nature of the variables on which sustainable forestry depends, integration of the knowledge and sciences is a necessity. The modeling approach developed SIMPPLLE addresses these needs and provides a tool for greater understanding of sustainable forest management.

Author Bio

Christine Stalling is with the Rocky Mountain Research Station, Ecology and Management of Northern Rocky Mountain Forests Research Work Unit in Missoula, Montana. Her working interests include technology transfer and development of a knowledge based modeling system, which provides users with the ability to integrate resource knowledge and to simulate vegetation change at landscape-scales with and without the influence of disturbance processes and management treatments; simulation logic and output are both spatial and temporal. Christine has recently been accepted into a PhD program at the University of Montana in which she will use landscape level ecological modeling as well as GIS as tools for more effective public-private collaboration among diverse stakeholders. She will emphasize a social perspective in the ecology and management of landscapes focusing on integrating the current understanding of ecological change and management principles with place-based social and economic values.

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