

ECOSYSTEM MANAGEMENT - A SCIENCE PERSPECTIVE

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ABSTRACT

The concepts of ecosystem management are broad and complex. While they are consistent with theory, they are largely derived from the synthesis of knowledge from many sources rather than the result of an abundance of explicit experimentation. There is significant scientific uncertainty about ecosystem management, but this is not different from our approach to most of the forest resources management strategies of the past—including sustained yield management, multiple use and others. Decisions to adopt and implement ecosystem management are questions of policy—not science.

Science will be part of the implementation and the refinement of ecosystem management. Implementation will provide the large scale activities necessary for critical scientific testing of ecosystem management concepts and practices. Science will provide the framework for monitoring and the analysis of results to determine progress towards attainment of ecosystem management goals. Success in ecosystem management will require an integration and involvement of science and management of unprecedented proportion. We have as much to learn about how to integrate research and management as we do anything in the bio/physical/social arena of this topic. How we proceed with all of this and what is accomplished will be the yardstick our society will use to evaluate us and our various professions as stewards of the public trust and the resources entrusted to our care.

Keywords: ecosystem management, forest policy, ecosystem research

INTRODUCTION

Ecosystem management is an increasingly popular term. The concepts are being widely evaluated and adopted in different forms for many and often quite different biological, physical and social/political reasons. Examples include USDA Forest Service (Robertson 1992), Society of American Foresters (SAF 1991, 1993), forest industry (McMahon 1992), Ecological Society of America (Lubchenko et al. 1991), The National Woodland Owners Association, and many others.

There are numerous perspectives and much controversy about ecosystem management. The fact there are so many perspectives, and so much controversy, should tell us something. Many like its

contemporary tone and political appeal, but are afraid of what it might mean in practice. Others see it as a positive vision for the future around which the forestry profession can build credibility, but others lack confidence it can be implemented, see it as "criticism of the past" and fear loss of private property rights. Interestingly, even those who condemn it on the one hand will tell you they are already doing it on the other. I heard one person comment that "nobody seems to know what ecosystem management is, but everyone is pretty sure they are doing it!" A bit overstated I think, but not without some truth.

I think the problem is that both the term and the concepts are relatively new. Maturation will result in better definitions, broader understanding, and specific examples that can be understood in the context of a resource management that emphasizes various objectives for many kinds of properties. In my opinion, it will provide the basis for the forest resource management of the next century, and it will be the basis on which the forestry profession retains, or regains if you prefer, the trust and credibility of our society.

Among the many perspectives on ecosystem management, there are indeed science perspectives (several—as you might have guessed). The purpose of this paper is to provide a few of those perspectives. The emphasis, is more on science than it is on ecosystem management—although obviously they are linked.

THE ROLE OF SCIENCE

Science has played a key role in the development of many of the concepts on which ecosystem management is based. Science will continue to play key roles in clarifying, testing and evaluating a) the basis for ecosystem management, b) the practices by which it is carried out, and c) the results it achieves. Equally important, science will provide the base for ecosystem management of the future.

Science is about knowledge. It is defined as the observation and explanation of natural phenomena. Expanding on this, it is additionally the gaining and organization of knowledge into cohesive units around a theoretical base. Research is the process by which new knowledge is produced. This is a broad view of science—including the biological, physical, and social sciences. Ecosystem management incorporates all of these sciences.

What Science *Can* and *Can Not* Do

What science *can do* is tell us what we know, and based on that, what we don't know, and what the points of uncertainty are. It can project what is likely to happen, and can identify and evaluate the risks of being wrong about the projections.

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Not all knowledge and projections have the same degree of certainty. Some have a high degree of certainty—for instance, those that are the result of specific experiments that have been repeated numerous times with consistent results. In some other cases, the knowledge may be the result of synthesis, or the result of the integration of individual bits of information to form a broader picture. The certainty of this knowledge, and the projections based on it, is more variable. But in many cases it is crucially important. This is particularly true where the questions involved are very difficult to answer by experimentation in the traditional sense, or where the answer is a projection of what will happen in very complex systems.

What science *can not do* is make natural resource management decisions. Science provides the knowledge that should be at least a portion of the basis for decisions, but it cannot incorporate the judgments and values that are crucial to making good quality decisions.

Making Ecosystem Management Decisions

People make decisions. The "best" decisions are usually those that have both a sound base of scientific knowledge and are, as well, socially and politically acceptable and are able to be implemented.

The hardest things about decisions are making them—and then living with them! Uncertainty and the consequences of being wrong are two of the reasons complex and far-reaching decisions are so hard to make. The reality is decisions are and must be made, today—and in the future. The best we can do is use the knowledge we have, and then be vigilant to detect that which was unsuspected or not predicted—adjusting as needed.

Decisions about ecosystem management are no different. Powerful social and scientific drivers are resulting in some fundamental changes in forest resources management. They are requiring decisions, today; decisions that embody both uncertainty and risks.

The job of science is to help in articulating options and in describing the uncertainties and the risks. When decisions are made, the job of science is to facilitate implementation and especially to assure that there is a scientific framework for evaluation of outcomes.

ECOSYSTEM MANAGEMENT AND SCIENCE

Ecosystem management is an important aspect of integrated forest resource management in interior forests. Science is important in its initial development and in its future.

Ecosystem Management

There are two themes common to most descriptions of ecosystem management.

Theme One—Management is coordinated over larger areas and for longer periods of time than has been the case historically.

Theme Two—The attainment of specific bio/physical conditions of the forest and the social community within which it is imbedded is a key management objective.

Theme One

Management on the basis of area and time are not new to forestry. In our traditional approach to sustained yield, we managed largely for outputs—of many kinds, such as visitor-days of recreation, acre-feet of water, board feet of timber, animal-unit months of grazing and so forth. We focused on stands of trees and considered a forest to be an aggregation of stands. The time frame was typically the length of the rotation of the stand.

These are perfectly good concepts if our focus is outputs and a) the forest behaves like a stand, b) there are no interactions among stands in a forest, and c) what happens in one stand has no influence on what happens in the stand that follows it. In the early stages of the development of the nation's forests this approach met society's needs, and served us well. But our society wants something more today, and I do not believe the traditional approach will suffice for the longer term future.

This is not a criticism of what forestry has done in the past—it is a look at what forestry is being asked to do in the future.

The move to ecosystem management is occurring both because a) we must provide for a broader array of values and b) because we have learned that forests and stands do not behave precisely the way we thought, especially in regard to integrated management of a broader array of resources. Thus, we are adopting the concepts of ecosystem management that have us coordinate management over much larger areas, and over longer periods of time.

Theme Two

Management to achieve specific bio/physical/social conditions of the forest also is not new. It is just that the set of conditions for which we manage is vastly different in ecosystem management. Historically, we managed the forest to achieve among other conditions, rapid regeneration, full stocking, early crown closure, minimum soil erosion, abundant elk, and a host of others. These, of course, mirror the objectives of traditional sustained yield management, which are expressed in terms of outputs.

Ecosystem management is indeed different here. Its objectives focus *first* on the condition of the forest and *then* on the outputs that can be achieved within these. The conditions that are the focus of ecosystem management include biodiversity at the species level, conservation of genetic variation within species, maintenance of soil structure and fertility, the flow of genetic information across the landscape, structural complexity and others.

The hypothesis is that these conditions allow the forest to a) resist short-term stress without collapse, b) adapt to long-term environmental change in a reasonably orderly manner, and c) retain the ability to meet the future needs of humans, shifting the emphasis of management if necessary.

There is a parallel emphasis that focuses on the social communities of people. Some of the conditional elements of the human community include economic stability, social harmony, healthy environment, government stability and many others. There are obvious linkages and interactions among these conditions of the human community, just as there are among the conditions of the biophysical elements of the forest.

Successful merging of elements of biophysical and social conditions is in its infancy, and there are many of these statements of conditions that appear to be in conflict. Some argue they are mutually exclusive. I reject these as expressions of idealism which are unrealistic and, therefore, unattainable. The challenge we face is to attain the *optimal mix* of elements of condition—in both the forest and human community. A challenge indeed.

To restate—in ecosystem management, achieving goals of condition come first. It is within these that the more traditional sustained yield approaches to management are implemented.

Science and Ecosystem Management

What kind of science has brought us to this point, and what kind will take us into the future?

Revolution and Evolution in Science

Science has both revolutions and evolutions. The myth of science is that the forefront of knowledge advances by an orderly process, building incrementally, by adding each new piece of information on to the last. A romantic notion I'm afraid, and one that is only partly true.

The most striking advances in knowledge (in science) are the result of *revolutions*. They occur when we realize that the framework we have been using to understand how the world works is not sufficient. The revolution is the discarding of the old framework and the development and adoption of a new one, one that provides a better and more complete understanding of natural phenomena. This is what Thomas Kuhn in his book *The Structure of Scientific Revolutions* calls a paradigm shift (Kuhn 1970). Once the revolution provides a new framework, then the evolution in science proceeds. Explicit experiments are used to fill gaps in specific knowledge in the broad framework.

Examination of the literature in the various forestry sciences over the last 50 years shows a preponderance of small scale, short-term and quite explicit experimentation. Most of this was evolutionary science. In fact, this type of science meshed well with the scope and scale of the management of forest resources that dominated the time. It was within the dominant paradigm or framework of understanding of that time.

When it began to be apparent that the traditional resource approaches might not be sufficient for the future, a revolution of science occurred (and is still occurring). A new framework is being developed—the one that is the theoretical and conceptual basis for what we call ecosystem management.

The Scientific Basis for Ecosystem Management—Some Comments

It is beyond the scope of this paper to give a detailed review of the scientific basis for ecosystem management. There are numerous references to this subject, none of which totally encompass this enormous and very complex topic. The following provide an entrée to the literature (SAF 1993; Journal of Forestry 1994).

In fact, there is little specific experimentation at the scope, scale and complexities involved in ecosystem management. This is not surprising. You can not explicitly experiment with something that is not being done! But the problems identified earlier remain to be addressed, and natural resource management policy and decisions have to be made.

Lacking specific experimentation, it is necessary to hypothesize based on broad principles and then test them—using not an explicit experiment, but by looking at the available evidence and from this drawing the best conclusions you can. Some argue this is not scientific. Do they mean it is not based on knowledge? I think they are rejecting all but the narrowest approach to science. An example is arguing that if you can't prove, by a side by side comparison, that one type of buffer strip works "better" than another one, then there is no basis for believing it will.

Nonsense! We can and do gain important new knowledge and understanding by applying the scientific method in precisely this way.

A common approach in science is to begin with a rather large problem and to disaggregate it into a series of smaller, but obviously related problems. Many of these will themselves be too large for experimentation, so further disaggregation may occur until we get to a series of individual studies or experiments.

This is the so-called reductionist approach to science and problem solving. It is time honored and, indeed, it is quite powerful because it focuses on specific questions. However, it is insufficient by itself to answer the more complex questions. Reaggregation of information from the individual studies are necessary to answer the higher level, typically more complex questions. An example from traditional forestry can help illustrate this idea.

A broad problem in forestry in the interior west might be achieving reforestation following harvest in the mixed conifer forests of eastern Washington. This problem has many sub-parts. They deal with such things as the nature of the site and the environment following the harvest; the genetic characteristics of the species most suited to the site and the management strategy; strategies for natural regeneration, and for the production, handling and planting of seedlings; strategies for early stand tending, and so forth.

Obviously, there are many questions or sub-problems in this broad problem. Many of these specific questions have been the basis for focused experiments, however specific answers or solutions to any one of these is not sufficient to answer the broad question. Yet today it is possible to achieve reforestation success

in this type with a high degree of certainty. The development of the successful strategies of today are not the result of any one specific experiment, but from the reaggregation of the information from all of the individual experiments to allow an answer to be formulated for the broad question.

Was all of this research done before harvesting and reforestation occurred in this forest type? Certainly not. Effective reforestation was recognized as an important goal of management and, using the best knowledge available, strategies were developed and tried. Once implementation began, did the search for additional knowledge cease? Of course not. Research on these issues continues even today, as does the acquisition of management experience! From these comes the refinement of the basic strategies adopted many years ago to ensure the goals of effective reforestation are achieved today.

Science provided the knowledge base for beginning, and science and management experience combined to provide the refinement needed to ensure that reforestation objectives could be met.

The role of science in the development of ecosystem management is not fundamentally different from this scenario. Contemporary forest resource management decisions must and are being made today—based on the individual pieces of evidence that, when combined within a generally accepted theoretical framework, provide the basis for decisions. Uncertainty and risk are part of the reality—and we recognize the decisions of today are only the best that can be made today.

CONCLUSIONS

The implications of the implementation of ecosystem management are enormous, and the role of science in ecosystem management is crucial. The development of ecosystem management concepts resulted from synthesis. Implementation is going to be the experimental stage! These experiments will be conducted at a "life scale".

What is essential for success in this venture are the following:

1. Clear articulation of the goals of ecosystem management. This means articulation in terms that lend themselves to testing and verification of accomplishment. This is within the concept of adaptive management, both as articulated in the President's plan for the west side (Journal of Forestry 1994) and in the National SAF Task Force on Sustaining Long-term Forest Health and Productivity (SAF 1993). I believe it also will be in recommendations and plans for the interior west.
2. An effective partnership between science and management. Implementation of ecosystem management will be difficult without the active involvement of, and interaction between, scientists and managers. Ecosystem management research requires science access to the lifescal experiments that are the result of the implementation of ecosystem management.

3. Comprehensive monitoring of results. Scientifically sound programs that will measure the response of forest and human systems to ecosystem management is essential in achieving the promise of adaptive management. Only the most naive will argue that ecosystem management, as it is initially implemented, will be fully successful. Knowing how we are progressing towards the goals, and the basis for adjustment, will come both from research and monitoring.
4. Funding for implementation and the corresponding research and monitoring. Funding for research and monitoring are needed for activities on all lands that are part of ecosystem management. The federal government can provide real leadership for this region through both appropriations and action programs, but regional and local partnerships are essential. This is an area in which we have limited experiences, but there are some "experiments" underway from which we can learn.

How we proceed with all of this, and what is accomplished, will be the yardstick our society will use to evaluate us, and our various professions, as stewards of the public trust and the resources intrusted to our care.

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