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Epilogue: What have we learned?

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EPILOGUE

What Have We Learned?

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Abstract

Although it is commonly implied that there cannot be a single, generally applied definition of ecosystem management (EM), recognition (1) of what constitutes a system, (2) that ecosystems are a special class of the genre called "systems," (3) of a definition of management, and (4) that natural resources on public lands and common-property resources are managed to satisfy societal values, means that EM can be defined as "the skillful manipulation of ecosystems to satisfy specified societal values." Definitions vary primarily in the value-satisfying aspect. Determination of ecosystem limits is arbitrary. Establishing management goals determines the ecosystem(s) to be managed.

To set some desired future condition or trajectory as a management goal, and extracting goods and services, implies an ability to predict. Prediction requires modelling and individuals capable of designing models and exercising them. Management will need to be adaptive and closely monitored.

Successful EM efforts are originated and planned at the local level, involve effective communication, and cooperation across land-ownership boundaries.

Characteristics of the Intermountain Region which the break-out groups considered likely constraints on EM are the diversity of public values, a positive attitude toward growth, competing values among the agencies, and inadequacy of scientific information. Positive traits include the high percentage of public land, growing recognition that the problems need to be solved, and a strong commitment to the land and its resources.

INTRODUCTION

The 17 presentations made at this symposium add to the already extensive flow of publications on ecosystem management (EM). There is a widespread impression among those who have kept up with this flow that what constitutes ecosystem management is in the eye of the beholder, and that each person's definition differs from the others. Dombeck comments that ten different people in a room will have ten different definitions.

In fact, there is a great deal of convergence within all of this literature, including the papers of this symposium, and one now begins to hear the same ideas put forward repeatedly. They may vary in detail or some particulars, but it seems clear that there is a limited set of principles emerging.

Some of those principles were referred to explicitly in the 17 papers of this symposium. Others were only implied by the speakers and have not yet been pointed up for emphasis. In yet others, implications for actually carrying out ecosystem management on the ground were not deduced and highlighted, but nevertheless were present.

It seems worthwhile here to distill out those principles and deduce those implications. The papers of this symposium, discussing both the natural-scientific and policy aspects, provide an especially useful collection for such a distillation.

WHAT IS ECOSYSTEM MANAGEMENT?

Although a number of the speakers—e.g., Salwasser, Kessler, Stanford, Stewart, Dombeck—and the Bentley et al. synthesis offered definitions of ecosystem management, the break-out sessions on the Great Basin (West and Rasmussen) and Colorado Plateau (Schmidt and Rusmore) both concluded that there is a need for a more succinct definition of the process. In order to develop a definition sufficiently general to embrace those of Salwasser, Stanford, Kessler, Dombeck, and the ten people in Dombeck's room, it is necessary to disaggregate the two words in the term, explore the meaning of each, and then recombine.

First, ecosystem. It is a special case of the more general category of entities called systems all of which are considered to have four characteristics. (1) A system is a collection of interacting parts that function together to produce one or more results or outputs. (2) Since the parts interact, the implication is always present that manipulating any one part will affect the other parts, and the results or outputs of the whole. (3) There are no closed or self-contained systems in the sense that they can continue to function without inputs and outputs of energy and/or matter. (4) Systems have limits through which the inputs and outputs flow.

This textbookish definition may seem wearisome. But it needed to be said because it has very important implications for carrying out ecosystem management in the real world. These are contained in Robert's paper, but were not highlighted by him; and by Stanford who does highlight them. I will point out these implications below.

An ecosystem is a special kind of system in which the entities are living and dead organisms, including people, and physical components such as water, geology, soils, and atmosphere. As with other systems, the components of an ecological system interact and function to achieve several results. Among the latter are the capture, transfer, and dissipation of energy; and the cycling of chemical elements and compounds. At a different complexity level, the results are to structure populations of plant and animal species, and plant and animal communities made up of those populations.

As with other systems, there are no closed ecosystems, and delimiting them is an arbitrary human act. Hence, an aquarium, a log, a pond, a watershed, a forest, a landscape, a biome can all be declared ecosystems without contradicting the above definition.

Next, the word management. My dictionary gives essentially the same definition as Salwasser's: "the process of taking skillful actions to produce desired outcomes." So we could pose the first iteration of a definition: ecosystem management is the skillful manipulation of ecosystems to produce desired outcomes. In my view, this is valid in principle and general enough to capture the many variations out there. But it is also so abstract as to carry very little informational content, and does not explain the variations. So we need to delve further.

When speaking of resource management in western U.S., more often than not we are referring to resources that occur at least in part on public land, or about public-property resources like wildlife, water, and air. In both cases, they are owned by society at large. Hence we are managing public resources guided by *public* policies. Public-policy analysts are increasingly pointing out that we do not manage public resources for themselves. Rather we manage the resources to satisfy societal values (Wagner 1994). Hence that satisfaction is the "desired outcome" of managing public resources. And we can now pose our second iteration of ecosystem management as the skillful manipulation of ecosystems to satisfy specified societal values.

It is in the value-satisfying aspect that definitions vary. As Salwasser comments, "Ecosystem management is variously defined by those who are shaping its course." And Thomas remarks that "Ecosystem management is more about people than anything else."

Definers commonly couch their definitions in terms of their own values, and it is the differences in individual and group values that produce the definitional differences. Members of the environmental community stress the values of preserving biodiversity (as have some of our speakers), ecosystem health and integrity, and sustainability; and make the production of goods and services for humans contingent upon these (cf. Grumbine 1994, Wilcove and Blair 1995). Adair et al. point out the emphasis on these criteria by Wilcox. Agency employees and others concerned with managing for goods and services emphasize that these outputs are an essential part of EM, again as have some of our speakers. Thomas emphasized that "We have no option but to move forward with natural-resources exploitation." Bentley et al. perceived that the definitions offered by the symposium speakers vary across a continuum between stress on preservation and stress on utilization.

Ecosystems vary across a spectrum of human use, bounded on one end by preservation and nonuse by humans, and on the other end by complete alteration, as in cultivated agriculture. Which of the above criteria are included in a definition of EM for a given area depends on where it falls along that spectrum. For an area managed as a nature reserve without commodity use, preserving biodiversity and maintaining ecosystem integrity would be appropriate goals for management, and criteria for an EM definition. Management for commodity production would not. But we can engage in ecosystem management on an Iowa cornfield or Idaho aquaculture operation. In these cases biodiversity and ecosystem integrity would not likely be management goals or relevant definitional criteria, but commodity output obviously would be.

In the Intermountain West, where cultivated agriculture is limited, the most extensive commodity uses are timber harvest and livestock grazing of native biotas. Human use is intermediate in the use spectrum, and management goals and definitions may well include all of the above criteria.

The bottom line is that most definitions are ad hoc, specific to the value-based management goals of each area. The only definition that embraces the many variants of ecosystem management, with their varying criteria, is something general on the order of Iteration 2. And there is no a priori imperative to include management for biodiversity, ecosystem health and integrity, and commodity production in every ecosystem-management effort, and therefore to specify them in a general definition. The one exception might be sustainability. Hence Iteration 3 might be the skillful and sustainable manipulation of ecosystems to satisfy specified societal values.

The value aspect is also an important determinant of what is ultimately delimited as an ecosystem to be managed. In order that management can satisfy values, it must be assigned management goals to achieve that end. If a management goal is to perpetuate a threatened or endangered species of pupfish in a Death Valley spring pond, the appropriate area to delimit as the ecosystem to be managed may be a limited surface area that affects the pond and perhaps a subsurface aquifer that feeds it. In terms of the management to be applied, it would not be useful or practical to declare the whole of Death Valley as the ecosystem to be managed.

On the other hand, if the goal is to manage the metapopulation of desert bighorn sheep which are distributed among, and interchange between, the several small mountain ranges of Death Valley, it could well be appropriate to delimit the entire valley as the system to be managed. But that broad focus might not be useful for intensively managing the small microcosm in which the pupfish occur, and the pupfish management perspective would not be useful for managing the bighorns.

The bottom line is that there is no a priori basis for circumscribing an ecosystem to be managed. Salwasser, Kessler, Roberts, and Risbrudt all make this point. Delineation of the system is determined by the management goal(s). A priori choice of a watershed or forest stand, an administrative unit such as a national-forest district or BLM management area, or some convenient, recognizable geographic area, independent of a specified management goal, may not coincide with some management goals, and others goals may exceed the limits of such an area. As Wilcox points out, the borders of the Greater Yellowstone Ecosystem are set to address management problems of highly mobile large mammals like elk and grizzly bear, and in the process subsume two national parks, parts of seven national forests, three federal wildlife refuges, and BLM, state, and private land. Stanford points out that water quality in Flathead Lake is the management goal. Hence the designated ecosystem is the Flathead Lake basin, or watershed, and its airshed.

In short, establishing management goals determines the ecosystem(s) to be managed. Those goals may include production of goods and services, and the desired present and future conditions or trajectory of the system (e.g., biodiversity, health and integrity, sustainability). Who establishes those goals is a separate question to be discussed below.

THE NATURAL-SCIENCE COMPONENT

Most authors writing on ecosystem management comment that the approach entails a stronger ecological or scientific component than has characterized much of traditional resource management. Risbrudt and Mosesso make this point. But it is Roberts' paper that raises awareness of just how demanding the scientific capability will need to be.

Numerous authors point out that the use and management of designated ecosystems must take place in the context of desired current and future ecosystem conditions: diversity, sustainability, health, integrity, resilience, etc. (cf. Salwasser, Kessler, Roberts, Risbrudt, Mosesso). Roberts speaks further of a desired future trajectory.

To set some desired future condition or trajectory as a management goal, while at the same time extracting goods and services, implies an ability to predict the effects of uses and management on such conditions or trajectory. (It was in anticipation of this point that the system definition above stressed the interrelationships of the parts, and the fact that manipulating one part would affect the others.) The implied ability to predict carries the further implication of a sufficient scientific understanding of the system's structure and function to permit prediction, and a mechanism for predicting. That mechanism, according to Roberts, is simulation modelling.

Stanford commented in his oral presentation that generalizing the behavior of a system from a long data set is preferable to predicting that behavior a priori with models. One can hardly disagree with that view. And the successful management steps that he describes were clearly guided by the ecosystem understanding provided by the many years of excellent research in the Flathead Lake Biological Station.

But there will not be extensive databases for most natural-resources systems that provide an understanding of their behavior empirically. Consequently, in order to get programs underway and predict the effects of management efforts, there will need to be models structured with what data are available, data on systems sufficiently like the one under consideration, and/or knowledgeable ecologists' best judgement. There is not time to wait for 20-year data sets in most cases.

Moreover, each area to be managed will require the services of individuals who can structure and exercise the needed models. Roberts' paper provides a preliminary outline of one unique, conceptual approach which, if used, would need considerable developmental effort before becoming operational. And once in operation for one area, it would need to be adapted for other sites with different ecosystems and management goals. It could not be considered an off-the-shelf, universally applicable package.

Roberts' innovative paradigm also has important implications for the question of delimiting an ecosystem to be managed. In his scheme, each management goal for an area is modelled and managed as a separate system ("element"). Hence the approach becomes a collage of variously interacting system models. There is no single spatial or geographic area that is modelled and managed as a discrete unit.

I am not aware that the subtlety, complexity, and magnitude of these scientific needs have been specified or pointed out by the many previous papers appearing on ecosystem management. Roberts' and Stanford's papers raise our awareness of these realities.

Risbrudt comments that there is not time to research all of the questions before moving forward with management. Hence models will need to be built and management will need to be initiated with what information is available, i.e., adaptive management as Salwasser and Kessler point out. This is clearly the approach described by Stanford for which there was little research information on the Flathead Basin system when the first management steps were taken.

Since management efforts will need to be provisional, or viewed as hypotheses, the systems will need to be monitored closely. Management directions will need to be modified if new research so indicates, or if monitoring detects trends away from management goals. Salwasser, Kessler, Wilcox, and Mosesso all comment on the indispensable role of effective monitoring.

HOW IS IT INITIATED, WHAT MAKES IT WORK?

While it is risky to generalize from the small sample presented at this symposium, it is tempting to infer the emergence of principles which point to conditions prevailing in those cases of where EM is working. Among the case studies presented in Session 2, the ones that appear to be working, or at least making some progress, are the Applegate Partnership described by KenCairn, the Trout Creek Mountain Project described by the Hatfields, and the Flathead Lake program described by Stanford.

One feature common to all of these is that the impetus to go forward arose at the local level, with representatives of the concerned interests coming together in recognition of a problem and willingness to collaborate in a solution. The one resounding failure among the case studies was the Greater Yellowstone effort described by Wilcox. As she pointed out, this attempt was initiated by administrators of the federal agencies with jurisdiction in the area.

Several of the other speakers commented on this same principle. In Dombeck's view, ecosystem management "... involves coordinated planning at the local level, forming partnerships ...." Stewart remarked that "... we are doomed to failure if we at the state or federal level see it as a mechanism of 'central planning.' We must involve local governments and citizens every step of the way." KenCairn decried the fact that "The political reality ..." facing community-based, resource-management efforts "... is the overwhelming momentum behind centralized, top-down approaches ...." And Schmidt and Rusmore reported the Colorado Plateau's break-out-session conclusion that implementation must begin at the local level.

What KenCairn calls "community-based, resource-management" approaches has been termed "constituency-based, multi-resource management" (Behan 1990) and "interest-group pluralism" (Wagner 1994) by other authors who consider it an emerging paradigm for policy setting in natural-resources management. It consists of local representatives of interest groups coming together to define goals, set policy, and plan management. Daniels and Walker, using their term "collaborative learning," provide an excellent example of how the paradigm could work in ecosystem management.

In commenting that an important role of science in ecosystem management is to define what outputs are possible from an ecosystem (Salwasser: "ecosystem capabilities"), Salwasser and Roberts both see a pivotal role for science at the very beginning of the planning process. And in projecting those outputs, the importance of modelling is once again implied. Moreover, these authors not only specify that the scientists in the process should project the consequences and feasibility of alternative management options, but they should also not advocate personal preferences among the options (Roberts: do not confuse value judgments with science).

The next question arises as to whether there is any general pattern as to what person or persons initiate the local group efforts. In the case of the Trout Creek Mountain Project, it was evidently the Hatfields who precipitated the Portland meeting. Jack Shipley, "a local environmentalist," apparently initiated the Applegate Partnership. Stanford attributes impetus for the Flathead Lake project coming from a "citizen-based steering committee." Thus, in one case it was two members of the user groups, in another a member of the environmental community, and in a third a committee of local citizens. In all cases, they were local people well known to the participants in the group dynamics.

Daniels and Walker describe at length the communication skills needed in collaborative learning, but do not generalize the nature or source of the initiator(s) or mediator(s). Behan (1978) contends that nonadvocating, impartial agency representatives should assume this role as do the Fitts et al. and Kelson et al. syntheses, and McAnninch and Parker (1991) describe a case where an agency representative does so.

A further implication of the voluntary, community-based approach is that it may be an answer to the problems that Coggins raises. The somewhat differing mandates and proprietary tendencies of the federal agencies have been written about by numerous authors (cf. Sax and Keiter 1987, Keiter 1989), and were commented on by Coggins and Wilcox. Wilcox and Kelson et al. remarked that the agencies will need to share decision-making power, and participants in the Colorado Plateau break-out session even advocated merging the land-management agencies. Both Thomas and Dombeck aver that the working relationships between their agencies will henceforth be more cooperative and harmonious. Mosesso commented on the need for interagency data sharing. According to Brunson and Reese, participants in the Northern Rockies break-out session sense a recognition among agency personnel at the state level that solution of complex problems now requires collaboration and cooperation across agency lines.

A potentially more problematic reality is Coggins' point that the federal agencies have no statutory authority to compel state governments and private landowners to enter into transboundary, ecosystem-management efforts. The solution to all of these problems may be the voluntary, local-level arrangements like the Applegate, Trout Creek Mountain, and Flathead Basin efforts.

Finally, a strong message voiced repeatedly during the symposium was the critical need for effective communication between, and enlightenment of, the participants in a management effort. Wilcox stressed this need; and West and Rasmussen, and Schmidt and Rusmore reported it as a strong message from their break-out sessions. Wilcox asserts that this is the responsibility of the agencies, and KenCairn spoke of "agency-directed education." Both the Fitts et al. and Kelson et al. syntheses see this as an important function of the agencies. Daniels and Walker point out the difficulties of communicating something as scientifically complex as ecosystem science to lay audiences. But the Flathead Lake project evidently succeeded, Stanford telling us that the local citizens had become comfortable with the nuance of limnological concepts and terminology.

In total, it now seems clear that putting ecosystem management into operation on the ground will involve a collection of individuals with different kinds of expertise and responsibilities:

(1) Initiating a program will require one or more individuals at the local level who can bring together the diverse interests to specify the management goal(s), and conceptualize and plan the effort. He/she/they will need communication and group-dynamics skills, and to have the trust of the constituents.

(2) The process will require the efforts of one or more highly capable ecologists who know and/or can access the scientific data available, carry out needed research, and perform the modelling functions. There may also be a need for one or more economists and sociologists to evaluate the economic and sociological consequences of different goal options.
(3) There will need to be hands-on managers to manipulate the ecosystem(s) once management goals are settled upon. This would appear to be the clear responsibilities of the agencies where public land is involved, and perhaps in the case of private land when and if private land owners voluntarily acquiesce in the broader system goals.
(4) There will need to be one or more individuals responsible for the monitoring. KenCairn recommends employing local people for this purpose. The modelling personnel should specify the parameters to be monitored and the monitoring protocols.

THEMES COMMON TO THE BREAK-OUT SESSIONS

The Introduction at the beginning of these proceedings set the context for the papers by enumerating the environmental and social characteristics of the Intermountain West which pose unique challenges for ecosystem management in the region. It is now of interest to review the extent to which the roughly 180 participants in the three break-out sessions viewed these same characteristics as important factors bearing on the paradigm.

In fact, there was a considerable amount of convergence among the three groups on the most significant challenges and opportunities, and these substantially coincided with the characteristics outlined in the Introduction. Among the lists of four characteristics prepared by each of the three groups as most likely to pose constraints on ecosystem management, the diverse, often conflicting, public values of the respective regions were included in all three. Moreover, Group 3 (Northern Rockies) cited the prevalence of a utilitarian, "growth-is-good" value orientation to resources, and an associated tendency for the political process to produce solutions that are not ecologically optimal.

All three groups rated the inadequacy of scientific information on the regions among their top four potential constraints. Group 1 (Great Basin) also listed as potential difficulties the nonlinear, unpredictable behavior of the ecosystems, and their slow ecological response times to management.

Groups 1 (Great Basin) and 2 (Colorado Plateau) also listed in their top four the conflicting goals and missions of the agencies, and the difficulties of changing these. Reminiscent of comments by Coggins, Thomas, and Wilcox, Group 2 commented on what it perceived as an inadequate legislative foundation for the agencies to operate.

The characteristics listed by each group as providing the greatest opportunities for ecosystems management also showed considerable convergence of thought. Both the Great Basin and Northern Rockies groups concluded that if the bureaucratic and statutory impediments can be circumvented, the high percentage of public land in the region should facilitate ecosystem management.

Both groups also opined that while public values attached to natural resources are diverse and contentious, they and associated political climates are changing, and there is a growing recognition of the need to solve environmental problems. The Northern Rockies group also detected a growing recognition among the agencies on the need for collaboration. The Colorado Plateau group perceived a strong grassroots tie and commitment to the land within the agency personnel.

All three groups recognized rich research opportunities, occasioned by the diversity of natural land types (Colorado Plateau), an extensive array of refuges and relicts that serve as benchmarks (Great Basin), a variety of data and monitoring sites already in place (Colorado Plateau), and a sophisticated scientific technology that is becoming increasingly available (Great Basin).

In total, the three groups pointed out a number of characteristics of the region that could act as constraints on implementing ecosystem management in the Intermountain West. But these same traits contribute to the interest and challenge of carrying it out, and the groups displayed a considerable amount of optimism over this new direction for natural-resources management.

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