Challenges to Using Ecological Risk Assessment to Implement Ecosystem Management

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Introduction

Two concepts currently dominate discussions over the future of natural resource management and ecological policy: ecosystem management and ecological risk assessment. Both concepts have many, often vocal, champions so it is not surprising that there are many efforts to adapt ecological risk assessment to help implement ecosystem management. In many respects the convergence of the two, somewhat related, concepts is an expected development. However, I contend that there are serious challenges to confront before there will be widespread, if not credible, use of ecological risk assessment to implement ecosystem management.

Some tout ecosystem management as a revolutionary paradigm that will fundamentally change public policy (Grumbine, 1994), but others argue the entire concept is little more than smoke and mirrors (Fitzsimmons, 1996). Still others contend that it is simply another stage in the evolution of our basic management paradigm -- a paradigm that society and natural resource professionals have followed for a hundred years (Lackey, 1997). There are competing visions of ecosystem management, arguments over fundamental assumptions, debates over who should set goals and objectives, and interminable haggling over exact definitions. The concept is evolving rapidly, but for my purposes I will use the following definition of ecosystem management: *The application of ecological and social information, options, and constraints to achieve desired social benefits within a defined geographic area and over a specified period* (Lackey, 1997). This and most other definitions of ecosystem management do not appear radical until terms such as "desired social benefits" are defined (Freemuth, 1996).

The second concept is ecological risk assessment. Risk assessment has been used effectively in many fields (i.e., automobile, casualty, health, and life insurance, flood management, nuclear accidents) as an aid in decision making. It is used to estimate the likelihood of an event occurring that is clearly recognized as *adverse*. Its typical use in decision making with regard to ecological issues is similar: estimating the likelihood of a certain, defined event occurring (e.g., the *event* of a species going extinct, as is outlawed by the Endangered Species Act). The key requirement is that the *consequence* is *adverse* by definition, which enables the analyst to conduct the risk assessment. In classical risk assessment this assumption of what is adverse is relatively easy to justify: a nuclear *accident* is universally accepted as adverse, as is an automobile *fatality*, a skiing *injury*, a heart *attack*, or an airplane *crash*. Achieving consensus on the analogous adverse event in ecological risk assessment has proved to be more elusive.

Ecological risk assessment also has enjoyed widespread support and become a commonly used tool in policy analysis (Molak, 1996), but its use continues to be controversial (O'Brien, 1995). Opinions are diverse; they range from fervent support to caustic dismissal. Much of the controversy with using risk assessment in ecological policy analysis revolves around defining the initial policy question or problem to be assessed (Karr, 1995), rather than technical details.

Like all analytical techniques used to assist management, ecological risk assessment has strengths and weaknesses; it is used appropriately in some circumstances, but not in others. Proponents, opponents, and those occupying various positions in a vast middle ground have presented opinions in the scientific and policy literature and at many conferences and symposia. The emerging consensus appears to be that ecological risk assessment will be useful in management for at least a certain class of policy questions: those dealing with the effects of chemicals, especially where there is a legislative or policy basis for defining what is "adverse" ecologically.

Problems of Definition

To be technically tractable and credible, the risk "problem" must be defined in fairly narrow policy and scientific terms. Even defined in fairly narrow terms, the analysis may be technically quite complex and require

sophisticated scientific information. Most often the narrowing is done by a legislative policy mandate. The risk problem then becomes relatively simple analytically [e.g., one chemical (or at most a few) is the stressor causing effects on a few biological components; the effects, if present, are "adverse" by definition]. To skeptics the vast majority of ecosystem management "decision" problems appear to be simply too complicated to be addressed by traditional risk assessment methods without resorting to arguable assumptions about societal values and preferences or technical simplification that shrouds the essence of the decision or policy issue. Even the traditional requirement of risk as a probability of occurrence of a defined, adverse event has been relaxed to merely predicting the response of a component of an ecosystem to a stressor of concern.

It would be easy to create a long list of challenges to confront, including needed research, for using ecological risk assessment to implement ecosystem management. Most of the individuals or groups creating such lists have strong "natural science" backgrounds and, not surprisingly, lists of research needs and priorities tend to reflect such an orientation. An implied premise of creating such a list is that insufficient research is the main limitation to "better" management or at least conducting better ecological risk assessments. It is not. Ecosystem management deals with policy problems that are every bit as challenging as those in welfare and economic issues. This is not to say that additional research on ecosystems, watersheds, and plant and animal communities would not be useful, but rather that lack of this information is rarely the primary limitation on using risk assessment. What is needed most is to better link research and technical information to the way society makes decisions in general, and how ecosystem management is implemented in particular.

The traditional risk analysis approach needs to be modified for maximum use in ecosystem management to reflect the realities of decision making: the concept of risk applied to natural resources will only work for a narrow set of problems where there is a clear public (and legal) consensus, and on issues where there is an agreed-upon time frame of interest (are benefits and risks defined over 10 years or 10 centuries?). In ecosystem management, a probability (of cause and effect or ecological change) is neither good nor bad, it is only a probability; ecological change or condition becomes risk only when someone defines the change or condition as adverse. Thus, the resolution of many ecosystem management decision problems is not limited by lack of scientific information, or technical tools, but by the conflict of fundamentally different values and social priorities (e.g., cheap food vs. irrigation water use; cheap power vs. free flowing rivers). If we are dealing with an ecological problem that is at an impasse because some of the stakeholders do not accept a shared set of values, much less preferences, we should not be surprised when risk assessment is of little use in resolving the issue. One modification that might help is to drop the concept of ecological risk and conduct *ecological consequence assessment.* This is not a magical solution but it does tend to focus debate over ecological values and priorities outside of the assessment process.

Many of the criticisms of ecological risk assessment apply to other tools used to assist decision makers. Whether or not it turns out that ecological risk assessment is useful for only the simplest ecological policy questions in implementing ecosystem management, it is important to come to a consensus. Right now there is a lack of consensus on its proper role. Some even argue that ecological risk assessment has little or no constructive use in ecosystem management because policy debates are almost always clashes over values and priorities and "the probability of an adverse event" is irrelevant until *someone* defines what is adverse. Even the definition of "ecosystem" is context and policy specific. What an analyst considers to be the ecosystem of concern must be defined and bounded by the policy or management question being assessed.

Challenges to Confront

Several specific and imposing technical challenges must be overcome before ecological risk assessment can serve a significant role in implementing ecosystem management. The challenges summarized below are not the only technical problems to be sure, but are the ones that currently limit the acceptance and use of ecological risk assessment.

First, the concept of ecological *health* needs to be better defined and understood by politicians and the public. Although fraught with serious conceptual, scientific, and semantic issues, ecological health is at the core of all visions of ecosystem management. The fundamental challenge with the use of ecological health is not lack of technical information, although scientific questions abound, but what is meant by health. Is a wilderness area defined as the base or preferred level of ecological health? Is the degree of perturbation by human activity the measure of ecological health? The concept of ecological

"degradation" is strictly a human (and value-based) one; the concept of ecological "alteration" is a scientific (and value-neutral) one. The identical ecological condition could be either "healthy" or "degraded" depending on the judgment of the person doing the valuing. Further, if we look at the consequences of cyclic climate change and chaotic events to ecosystems, what is "natural?" Without answers, it is impossible to define scientifically what is "adverse," thus hampering use of ecological risk assessment in ecosystem management, at least as it is presently formulated.

Second, we need better ways to use expert scientific and technical opinion. Most of the policy-relevant problems in ecosystem management are too complex for easy or rapid scientific experimentation or analysis. To paraphrase an old rule in policy analysis: if something can be easily and quickly measured with precision, it is probably irrelevant in ecosystem management. If management and policy problems are simplified to the point of making them scientifically tractable, then the result may lack policy relevance. Expert opinion must be used with all the pitfalls of bias, credibility, and charges of elitism, especially in defining who will be considered an expert. For example, how does the assessor incorporate "scientifically derived data" vs. observational information from long-term residents? Computer-generated maps and computer-assisted models may be elegant, but for many decisions in ecosystem management, only observational and judgmental information is available.

Third, we need to credibly evaluate and measure public preference and priorities to frame ecological (ecosystem management) issues. Public opinion polls consistently show that the public is very supportive of the "environment," as it is of "peace," "freedom," and "economic opportunity." More specifically, numerous polls document that the public is similarly sympathetic to preserving biological diversity. What does this mean? Preserving all species throughout some historic range? Preserving the ecological function of ecosystem components? Preserving certain highly prized species? Without specifying public preferences and priorities with greater precision, analytical tools such as risk assessment are of limited utility. Many of the decision issues in ecosystem management are exactly of this type. It may be that tools to credibly evaluate and measure public preference and priorities presently exist and they merely need to be applied; or it may be that innovative or modified tools need to be developed.

Fourth, there is a critical need to develop better ways to present options and consequences to the public, policy analysts, and decision-makers. Society is not well served by statements such as "it is a complicated problem and you need to have an advanced degree in ecology to understand it," or "you can select this option without significant cost to society" when there will be costs to some people. The main take-home message in risk assessment, in all decision tools for that matter, must be that there are no free lunches, and that decisions must be clearly framed as decision alternatives. Ecosystem management will not overcome the unpleasant fact that management decisions result in winners and losers, costs and benefits. The value of risk assessment or any other decision tool in ecosystem management is whether it can focus policy debate (and decision making) around costs and benefits, winners and losers, and accurately predict the ecological consequences of the range of decision options.

Conclusion

Risk assessment has been successfully used in many fields to assist in decision making, particularly in insurance, industrial operations, and business management. Application of risk assessment to ecological problems has been limited to certain types of narrowly constrained problems (usually associated with assessing the probability of adverse consequences of manmade chemicals). The principal technical limitation to wider use of risk assessment in ecological policy is to better define societal values and preferences in credible ways. To help overcome this limitation, four specific research needs are proposed: (1) to develop procedures to define ecological health; (2) to improve ways to use expert opinion; (3) to develop methodologies to measure public values, preferences, and priorities; and (4) to develop or improve ways to present decision consequences to the public in a decision-neutral manner

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