Ecological Risk Assessment:

Use, Abuse, and Alternatives

Robert T. Lackey

Department of Fisheries and Wildlife
Oregon State University
Corvallis, Oregon 97331

Citation: Lackey, Robert T. 1997. Ecological risk assessment: use, abuse, and alternatives. *Environmental Management*. 21(6): 808-812.

Email: Robert.Lackey@oregonstate.edu
Phone: (541) 737-0569
Web: http://fw.oregonstate.edu/content/robert-lackey

Ecological Risk Assessment: Use, Abuse, and Alternatives

R. T. Lackey. National Health and Environmental Effects Research Laboratory, US Environmental Protection Agency, 200 SW 35th Street, Corvallis, Oregon 97333, USA.[1]

Debates over the role of ecological risk assessment should start with agreement on a definition. Much of the confusion and divisiveness over risk assessment applied to ecological problems is caused by using the same terms but attributing different meanings to them. Indeed, in the classical applications of risk analysis (automobile, life, and health insurance; industrial failures; natural disasters; accident prevention; etc.), the definition, if not the practice, of risk assessment is different from that typically used in ecological risk assessment. The concept of ecological risk assessment I refer to here is best defined along the lines of ". . . a way of examining risks so that they may be better avoided, reduced, or otherwise managed" (Wilson and Crouch 1987); ". . . a process to evaluate the likelihood of undesirable effects on ecological receptors from exposure to one or more stressors . . . " (Regens 1995); and ". . . a series of questions directed to the available data to analyze the expected risk" (Patton 1995). There are many other risk assessment concepts, but these are beyond the discussion here: human health risk assessment, comparative risk assessment, engineering risk assessment, environmental risk assessment, risk communication, risk regulation, risk reduction, risk allocation or justice issues, and a suite of decision making paradigms.

Opinions on the use of ecological risk assessment in public policy analysis are diverse; they range from positive: ". . . scientifically credible evaluation of the ecological effects of human activities" (Suter 1993) to sceptical: ". . . one more hurdle on the road to a permit" (Webster and Connett 1990) to dismissive: ". . . risk assessment is a sham . . ." (Merrell 1995). The middle ground is populated by a disjointed array of

KEY WORDS: Ecological risk assessment; Risk decision making; Risk management; Ecological consequence assessment

[1]The views expressed here do not necessarily reflect those of the US Environmental Protection Agency or any other organization.

opinions because the debate over the proper role of ecological risk assessment defies the simplistic categorization of right versus left, conservative versus liberal, technocratic versus democratic, and green versus balanced use. Neither the debate nor the tool is new, but the intensity of the debate has increased as ecological risk assessment has become the policy tool of choice in some organizations (Lipton and others 1993, Lackey 1994, 1995, Regens 1995).

Some critics contend that risk assessment is "... deeply flawed and subject to abuse" (Montague 1995). Its use to help resolve public policy on human health issues is equivalent to "premeditated murder" (Merrell 1995). Some people will die or suffer disease by a policy decision when society makes a decision as to how many deaths will be tolerated for the benefits obtained. When used in making policy on ecological issues, the users of risk assessment have accepted a form of ecological triage, administratively deciding which individuals, populations, or species will live and which will die (Montague 1995).

Another type of criticism is the contention that ecological risk assessment as currently practiced is nothing more than "the paradigm of human health risk assessment, laying on an underlying, unsophisticated, ecological veneer" (Karr 1995). While not morally repugnant to such critics, many current applications of ecological risk assessment are inappropriate. Further, such a position questions the assertion that ecological "health" is analogous to human "health" and, thus, that the approaches and tools of human health risk assessment can be easily adapted to ecological problems (Menzie 1995).

Ecological risk assessment is not without strong supporters (Suter 1993). Generally, supporters tend to come from regulatory agencies and much of the regulated community. Some governmental agencies are strongly supportive, to the point of implementing policies and guidelines (Patton 1995). Much of the scientific and engineering infrastructure has embraced the approach. "How-to" training courses and symposia are plentiful. Books and technical papers explain in detail the technical intricacies of conducting ecological risk assessments (Suter 1993, Molak 1996).

Other advocates of ecological risk assessment, although far from effusive, acknowledge a useful role: "Risk assessment is a very flawed tool, but, given the current process of policy formulation, it has a legitimate role to play" (Funke 1995). In an ideal application, ecological risk assessment "... should be a purely technical analysis driven by scientifically acquired data, and free from social bias" (Fairbrother and others 1995).

What is the appropriate use of ecological risk assessment? When is its use inappropriate? How is it misused? What are the alternatives? Is it underused, and would its increased use bring rationality to public policy? I will argue here that ecological risk assessment: (1) has a legitimate, appropriate, but limited role in science, policy analysis, and policy implementation; (2) is often misused, and in some circumstances abused, both naively or intentionally; and (3) is not the only approach and others should be seriously evaluated.

Appropriate Use

Risk assessment has been used effectively in many fields as an aid in decision making. It is used to estimate the likelihood of an event (i.e., automobile fatality, flood, nuclear accident, etc.), 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., what are likely mortality consequences to biota of the use of a particular chemical?). The key requirement is that the consequence be adverse by definition, which enables the analyst to conduct the risk assessment (Bartell and others 1992, Lackey 1994, 1996a). In classical risk assessment the adverse consequence is easy to identify: a nuclear accident is universally accepted as adverse, as is an automobile crash, a skiing accident, a heart attack, or an airplane crash. The analog in ecological risk assessment is less clear.

To be technically tractable and credible, the risk problem must be defined in fairly narrow terms. Even when defined in fairly narrow terms, the analysis may be technically complex and require sophisticated scientific information. Often the narrowing results from legislative policy mandate [e.g., Comprehensive Environmental Response, Compensation, and Liability Act and its implementation (Lipton and others 1993, Friant and others 1995)]. The risk problem then becomes relatively simple analytically [e.g., one or a few chemicals are the stressor causing effects on a few biological components; the effects, if present, are adverse by definition (Regens 1995)]. Simplification, of course, begs the question of whether analysis leads to good policy options, but it does give the analyst a toe hold on what is desired or adverse (Friant and others 1995). Another way to state this perspective is that risk assessments assume a definition of health conditions. (Funke 1995).

Although beyond the scope of the debate here, an obvious potential role of risk assessment is to help allocate scarce resources. Risks need to be managed in our personal lives, companies, and government. How

does one compare risks? Potentially, risk assessment offers an approach for comparing, rather than measuring, individual risks. Such an approach has been used by the EPA Science Advisory Board (US EPA 1990). The four ecological problems with highest risk were habitat alteration, decrease in biological diversity, stratospheric ozone depletion, and global climate change. Risks such as herbicides, pesticides, toxic chemicals, and acid deposition were medium-risk problems. Oil spills, groundwater pollution, radionuclides, acid runoff, and thermal pollution were relatively low-risk problems. An obvious use of risk assessment would be as one tool to help allocate research and regulatory efforts from lower to higher risk problems. Risk, of course, is only one factor in allocating resources, so ecological risk assessment should be only one element in the decision-making process.

Whether ecological risk assessment is used to address relatively narrow, technical questions [e.g., toxicological effects of a chemical on a particular biotic component (Friant and others 1995)] or to allocate scarce government resources (i.e., comparative risk assessment), it is critical to recognize that risk assessment is merely a tool in the decision-making process. At best, and if used properly, it is a tool that can assist in presenting the likely consequences of various decision alternatives (Woodhouse 1995).

Abuse

Concerns about abuse in ecological risk assessment often revolve around the contention that the tool can be used to support a predetermined policy position (Merrell 1995). The metaphor often used to illustrate this concern is that of the tortured prisoner. A tortured prisoner will confess to any crime; the confessions are only limited by the creativity and persistence of the prison guards. The allegation about risk assessment and its practitioners is: given enough creativity, virtually any policy position can be supported by risk assessment. The most common allegation is that the policy questions are formulated in a way that will produce virtually any result and that the result has the aura of scientific acceptability (Montague 1995). Those who know the most about how to manipulate the procedures control the discourse, the questions asked, and how they are answered (Funke 1995, O'Brien 1995).

Another potential abuse is that technocrats and politicians will define risk problems in ways that can be solved technically but have little real relevance to the public policy issue. The metaphor often used is that of a risk assessor looking for his lost keys under the street lamp. Although the keys were most likely lost far from the street light, the risk assessor laments that he has little chance of finding the keys in the dark so why waste time looking there. Although this makes a humorous story, ecology is complex and our understanding is limited. There is a strong tendency to define problems in ways that we can handle scientifically, even though the formulation may be policy irrelevant (O'Brien 1995).

A potential abuse of ecological risk assessment is to apply the same analytical tool to every problem: if your only tool is a hammer, every problem must be a nail. If every ecological policy problem is viewed from a risk perspective, then it is not surprising that technocrats will try to force a fit. The useful role of ecological risk assessment is to help solve fairly narrow, well-defined technical questions, not to answer larger, more complex public policy questions.

One of the most serious types of misuse by technocrats is to substitute their values and priorities for those of the public or their elected representatives (Webster and Connett 1990, Menzie 1995). In philosophical terms, this is illustrated by shifting the scientific "is" to the political "ought." In science there are no "oughts." Animals, plants, and ecosystems are neither good nor bad, better or worse, or healthy or sick unless a value criterion is applied. "Risk" has no definition in ecology unless someone defines what is adverse (or healthy). Whether the introduction of wheat, horses, or zebra mussels to North America is good or bad depends on the value criteria applied, not the personal opinions of scientists and risk assessors.

Alternatives

One obvious alternative to ecological risk assessment is a modification to drop the idea of risk. Some have referred to this as benefits analysis, where the desired benefits are selected by the political process (Principe 1995). Others refer to consequence analysis, which simply assesses ecological consequences without defining good or bad, adverse, ecological health, or risk (Lackey 1996b). Eliminating the concept of risk in ecological policy problems reduces the number of value-based choices scientists and assessors must make; thus more choices are reserved for democratic processes through accountable decision makers. In some cases it may be that analysts are actually conducting something closer to ecological consequence analysis than ecological risk analysis.

Another, related approach is "ecological alternatives assessment" (O'Brien 1995, Pagel 1995). Alternatives assessment steps back even further from risk assessment and focuses on the questions being asked. Critical

public policy questions would not be buried in technical analysis. As with other analytical tools, whoever controls the questions asked in risk assessment constrains the policy options under consideration (Funke 1995).

The old concept of benefit–cost analysis, which suffered, justifiably, many of the same criticisms now leveled against ecological risk assessment (Schrecker 1991), is potentially a viable alternative to ecological risk assessment. Benefit–cost analysis is much closer to a decision-making framework than is risk assessment. Although, it is an illusion that public policy questions can be reduced to a single metric of value (money), the basic concept of trade-offs has appeal. Although fraught with analytical difficulty, benefit–cost analysis is closer to the kind of information decision makers actually need from technocrats, but it is subject to the same distortion by improper use of personal values as is ecological risk assessment.

Conclusion

Over the past few decades there has been a diverse array of tools and paradigms offered as the solution to ecological policy and decision-making problems. Is ecological risk assessment just another tool that will follow the fate of computer-based modeling, geographic information analysis, management by objectives, total quality management, management reengineering, Delphi, and organizational reinvention? Each burst on the scene and was advocated by some with near religious zeal, only to fall from favor in lieu of and be replaced by another, newer tool. Each did eventually assume a useful role as a tool appropriate for some problems under some circumstances but not as an overall panacea (Lackey 1996a,b).

Ecological risk assessment is a tool that might help resolve some kinds of public policy questions, although policy questions must be fairly narrowly defined and explicitly described to be analytically tractable. This does not mean that they are simple problems, merely analytically tractable. The most common use of ecological risk assessment will continue to be with questions where the definition of ecological adversity is provided by legislation, policy, or arbitrarily assumed by the analyst. Its potential for addressing more complex, and relevant, ecological policy questions has yet to be fully evaluated.

A serious allegation is that ecological risk assessment (along with many other technocratic tools) provides a route to subvert the democratic process (e.g., how does the public decide which ecological changes are adverse and which are beneficial?). The very nature of the process requires the analyst to make many value-based decisions, hence the charge that the process is elitist by its very nature (O'Brien 1995). In fact, the decision to use risk assessment is a heavily value-laden decision. Technical expertise cannot substitute for values and priorities in ecological risk assessment; these are issues of policy, not science.

Ecological systems are complicated and the ecological consequences of decisions are often difficult for the ecologist to grasp, much less those without this expertise. Furthermore, analysts and scientists involved in ecological risk assessment are using a tool that most of the public does not comprehend; thus the danger of misuse through miscommunication, unintentional or otherwise, is great. There is no scientific or ecological imperative in risk assessment; it is only a tool to help those charged with making decisions evaluate options.

Those of us involved in ecological research and assessment should remember that risk assessment is the latest of a large number of tools and approaches that have played on the scientific and management stage with great fanfare. These tools and approaches have each evolved to be useful in certain, clearly defined circumstances. Ecological risk assessment is undergoing a similar transformation.

Literature Cited

Bartell, S. M., R. H. Gardner, and R. V. O'Neill. 1992. Ecological risk estimation. Lewis Publishers, Chelsea, Michigan, 252 pp.

Fairbrother, A., L. A. Kapuska, B. A. Williams, and J. Glicken. 1995. Risk assessment in practice: Success and failure. *Human and Ecological Risk Assessment* 1:367–375.

Friant, S. L., G. R. Bilyard, and K. M. Probasco. 1995. Ecological risk assessment—is it time to shift the paradigm? *Human and Ecological Risk Assessment* 1:464–466.

Funke, O. C. 1995. Limitations of ecological risk assessment. *Human and Ecological Risk Assessment* 1:443–453.

Karr, J. R. 1995. Risk assessment: We need more than an ecological veneer. *Human and Ecological Risk Assessment* 1:436–442.

Lackey, R. T. 1994. Ecological risk assessment. *Fisheries* 19: 14–18.

Lackey, R. T. 1995. The future of ecological risk assessment. *Health and Ecological Risk Assessment* 1:339–343.

Lackey, R. T. 1996a. Is ecological risk assessment useful for resolving complex ecological problems? Pages 525–540 *in* D. J. Stouder, P. A. Bisson, and R. J. Naiman (eds.), Pacific salmon and their ecosystems: Status and future options. Chapman and Hall, New York.

Lackey, R. T. 1996b. Ecological risk assessment. Pages 87–97 *in* V. Molak (ed.), Fundamentals of risk analysis and risk management, CRC Press, New York.

Lipton, J., H. Galbraith, J. Burger, and D. Wartenberg. 1993. A paradigm for ecological risk assessment. *Environmental Management* 17:1–5.

Menzie, C. A. 1995. The question is essential for ecological risk assessment. *Human and Ecological Risk Assessment* 1:159–162.

Merrell, P. 1995. Legal issues of ecological risk assessment. *Human and Ecological Risk Assessment* 1:454–458.

Molak, V. 1996. Fundamentals of risk analysis and risk management. CRC Press, New York, 472 pp.

Montague, P. 1995. Making good decisions. *Rachel's Environment and Health Weekly,* No. 470, 30 November.

O'Brien, M. H. 1995. Ecological alternatives assessment rather than ecological risk assessment: Considering options, benefits, and dangers. *Human and Ecological Risk Assessment* 1:357–366.

Pagel, J. E. 1995. Quandaries and complexities of ecological risk assessment: Viable options to reduce humanistic arrogance. *Human and Ecological Risk Assessment* 1:376–391.

Patton, D. E. 1995. The U.S. Environmental Protection Agency's framework for ecological risk assessment. *Human and Ecological Risk Assessment* 1:348–356.

Principe, P. 1995. Ecological benefits assessment: A policy-oriented alternative to regional ecological risk assessment. *Human and Ecological Risk Assessment* 1:423–435.

Regens, J. L. 1995. Ecological risk assessment: Issues underlying the paradigm. *Human and Ecological Risk Assessment* 1:344–347.

Schrecker, T. 1991. Risks versus rights: Economic power and economic analysis in environmental politics. Pages 265–284 *in* D. C. Poff and W. J. Waluchow (eds.), Business ethics in Canada, 2nd ed. Prentice-Hall, Scarborough, Ontario, 533 pp.

Suter, G. W., II. 1993. Ecological risk assessment. Lewis Publishers, Boca Raton, Florida, 538 pp.

US EPA (United States Environmental Protection Agency). 1990. Reducing risk: Setting priorities and strategies for environmental protection. Science Advisory Board, United States Environmental Protection Agency, Washington, DC, SAB-EC-90-021.

Webster, T., and P. Connett. 1990. Risk assessment: a public health hazard? *Journal of Pesticide Reform* 10:26–31.

Wilson, R., and E. A. C. Crouch. 1987. Risk assessment and comparisons: An introduction. *Science* 236:267–270.

Woodhouse, E. J. 1995. Can science be more useful in politics? The case of ecological risk assessment. *Human and Ecological Risk Assessment* 1:395–406.

About the Author:

Dr. Bob Lackey is professor of fisheries science at Oregon State University. In 2008 he retired from 27 years with the Environmental Protection Agency's national research laboratory in Corvallis where he served as Deputy Director among other senior science and management jobs. Since his very first fisheries job mucking out raceways in a California trout hatchery, he has worked on an assortment of natural resource issues from various positions in government and academia. His professional assignments involved diverse aspects of natural resource management, but mostly he has operated at the interface between science and policy. He has published over 100 articles in scientific journals. Dr. Lackey has long been an educator, having taught at five North American universities and continues to teach a graduate course in ecological policy. Canadian by birth, he is now a U.S.-Canadian dual-citizen living in Corvallis, Oregon.