Appropriate Use of Ecosystem Health and Normative Science in Ecological Policy

Robert T. Lackey

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

Citation: Lackey, Robert T. 2003. Appropriate use of ecosystem health and normative science in ecological policy. pp. 175-186. In: *Managing for Healthy Ecosystems,* David J. Rapport, William L. Lasley, Dennis E. Rolston, N. Ole Nielsen, Calvin O. Qualset, and Ardeshir B. Damania, editors, Lewis Publishers, Boca Raton, Florida, 1510 pages.

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

Appropriate Use of Ecosystem Health and Normative Science in Ecological Policy

Robert T. Lackey*

INTRODUCTION

Complex, challenging, and important ecological policy issues confront society (National Research Council, 1997; Rapport et al., 1998; Science Advisory Board, 2000). Significant improvements in some aspects of the environment have been realized. Many of the more egregious forms of pollution in North America have been reduced, but the continuing increase in the human population and associated human activities have created a tangled array of ecological policy challenges (e.g., land use alteration, hydrologic modification, climate change, change in biological diversity, introduction of nonnative species [also called exotic or alien species], concern about ecological sustainability, cumulative effects of man-made chemicals, etc.) (U.S. Environmental Protection Agency, 1999). Further, the fact that commerce is increasingly international in scope complicates already befuddled ecological policy issues. Recent treaties, for example, address climate change, biological diversity, waste transport, and environmental equity — and the directives contained in such legally binding agreements must be considered when addressing domestic ecological policy issues.

Traditional approaches to implementing ecological policy typically follow the *command-and-control* (*promulgate-and-police*) paradigm (Carnegie Commission on Science, Technology, and Government, 1990). With the command-and-control approach, a narrow (e.g., water, air, chemical, or effluent), technically based standard is promulgated as a surrogate for a larger, often nebulous ecological or public health policy goal. Adherence to achieving the standard is enforced by a regulatory bureaucracy (Elliott, 1997). In practice, the typical result is a centralization of political power.

> This strategy may be characterized in simple terms as relying on an elaborate system of planning in which a central administration imposes production quotas on different plants and industries through directives specifying the amount of pollution allowed to escape into the air, water, and land (Carnegie Commission on Science, Technology, and Government, 1990).

Command-and-control approaches to implementing ecological policy tend to be reductionist, thereby limiting the kinds of policy problems that can be addressed effectively (Science Advisory

* The views and opinions expressed do not necessarily represent those of any organization with which Dr. Lackey is affiliated.

Board, 1990). Attempts to correct one environmental problem sometimes create or exacerbate others (National Research Council, 1997). The command-and-control approach fits reasonably well for comparatively narrow policy problems (e.g., water quality and air quality), but it does not mesh well with complex policy problems such as the consequences of land-use changes, maintenance of biological diversity, nor the impacts of the introduction of exotic species.

The command-and-control approach to implementing ecological policy is criticized frequently as ineffective or insufficient in addressing the most important ecological concerns. For example, the U.S. Environmental Protection Agency's Science Advisory Board (1990) concluded a decade ago:

> … controlling the end of the pipe where pollutants enter the environment, or remediating problems caused by pollutants after they have entered the environment, is not sufficient.

In some cases, command-and-control approaches have been effective (although perhaps not efficient cost-wise) at ameliorating the most conspicuous forms of pollution, but important ecological concerns today are not easily nor efficiently amenable to end-of-the-pipe and command-and-control approaches (Science Advisory Board, 2000).

Another criticism of the command-and-control approach is its tendency to polarize the public and rouse strong opposition to the proposed policy or regulation (Elliott, 1997). The very nature of the command-and-control approach engenders centralized decision making, top-down policy making, and public resistance (Carnegie Commission on Science, Technology, and Government, 1990). The U.S. Environmental Protection Agency (1998) has concluded:

> In the past, there has been a "command and control" approach to regulation.… As with centralized decision making, the regulations have been made clear, unbending, and applicable nationally.

Lack of public support is understandable, even predictable, because ecological issues and socioeconomic issues are intertwined. There are winners and losers in policy choices, so the prospect of authentic win–win solutions is illusory. Even so, many perceive that command-and-control approaches to implementing ecological policy create excessive societal strife.

Another widely voiced perception is that many command-and-control regulations are excessively intrusive, especially when the ecological benefits are not obvious or are of only local concern. Some efforts to comply with the U.S. Endangered Species Act, for example, can be expensive and socially disruptive for little apparent benefit to society or even the species being protected.

Other critics assert that command-and-control approaches do not effectively use new scientific and technical information (Elliott, 1997). Current understanding of the functioning of ecosystems, for example, has moved away from the assumption that the natural or climax condition of an ecosystem is fairly predictable, e.g., the old *balance of nature* idea (De Leo and Levin, 1997). Current thinking is that the state of ecosystems is less circumscribed (e.g., "chaotic" events are often decisive). Although rarely explicitly stated, much of the command-and-control approach to implementing ecological policy has been predicated, in part, on the balance of nature worldview.

Command and control, characteristically narrowly focused (e.g., policy reductionism), often reinforces the proclivity of many scientists to simplify science and research (e.g., science reductionism). That is, many scientists prefer to reduce complex policy problems into small, compartmentalized research pieces that can be addressed in scientifically credible ways. Thus, for scientists working in a command-and-control bureaucratic environment, there is a propensity for *both* scientists and policy makers to fall victim to the reductionist snare. Research reductionism results in excellent science that withstands rigorous scientific scrutiny, but it is not necessarily useful to policy makers in selecting from among policy options. Many scientists tend to eschew research problems that deal *directly* with complex policy problems, because such problems tend to be scientifically intractable: the results of such research would be unlikely to weather the scrutiny of other scientists.

ALTERNATIVE APPROACHES

Because the limitations of the command-and-control approach are widely recognized, many experts contend that effectively resolving complex, divisive ecological policy issues requires a different approach (Carnegie Commission on Science, Technology, and Government, 1990; Science Advisory Board, 1990). Issues in ecological policy are now less focused on relatively isolated questions, such as whether it is safe to license a certain chemical, whether it is good policy to build a particular dam, or whether we ought to spend resources to control exotic species such as the zebra mussel. Alternative and competing approaches are widely discussed in the professional literature (Norton, 1995; Gaudet et al., 1997). For example, as the National Research Council (1997) concluded:

> ... efforts to solve a specific problem must be considered within a broader context. This is particularly true of the growing number of regional- and global-scale problems associated with population growth, industrial development, and the corresponding pressure on limited natural resources.

Specific but disparate examples of popular modifications and permutations of the command-and-control approach are ecosystem management, community-based environmental protection, the Precautionary Principle, bioregional management, watershed management, and imposition of overarching public policy goals such as ecological sustainability, ecosystem integrity, or ecosystem health. Each alternative is championed, sometimes energetically, by its partisans.

In some alternatives (e.g., ecosystem management and community-based environmental protection), command and control is often viewed as one of several possible policy *tools* to help achieve the overarching policy goal. Other alternatives (e.g., bioregionalism) are the antithesis of the centralized, bureaucratic command-and-control philosophy. Taylor (1991) portrays the political propensity of adherents to bioregionalism as one of devolved decision making:

> Bioregionalism envisions communities of creatures living harmoniously and simply within the boundaries of distinct ecosystems. It criticizes growth-based industrial societies preferring locally self-sufficient and ecologically sustainable economies and decentralized political self-rule.

It is easy to dismiss as scholarly quibbling the arguments about which of the competing approaches for implementing ecological policy or natural resource management ought to be adopted, but that would be a mistake. It is unfortunate that the discussion about the competing concepts has the flavor of "a battle of buzzwords" (Noss, 1995), because the discussion is more than a mere scholarly debate; the future direction of ecological policy will be determined, in part, by which concept wins.

ECOSYSTEM HEALTH

Ecosystem health is the most popular of the emerging modifications of command and control (Gaudet et al., 1997; Belaoussoff and Kevan, 1998; Rapport et al., 1998). Many of the popular alternatives and modifications to command and control (e.g., ecosystem management and ecosystem sustainability) have notions of ecosystem health at their core (Lackey, 1998). Adoption of ecosystem health as a public policy goal could have major, although often unclear, ramifications:

> ... an ecosystem health focus sets the stage for a new environmental ethic — one in which actions may be judged by their contribution to maintaining or enhancing the health of the regional ecosystem (Rapport, 1995).

Ecosystem health enjoys a wide following, especially in the popular press and with some environmental advocacy groups (Gaudet et al., 1997). Part of the appeal is that it appears to be a simple, straightforward concept (Ryder, 1990; De Leo and Levin, 1997). Applying the human health metaphor to ecosystems, it proposes a model of how to view ecological policy questions. By implication, the metaphor also defines what types of scientific information are essential to help decision makers (Shrader–Frechette, 1997).

Ecosystem health, especially in the 1970s and 1980s, was often defined in nebulous terms — definitely not as clearly articulated constructs (Steedman, 1994). It was typically depicted as a broad societal aspiration rather than a precise policy goal or management target. Lacking precise definition, it was difficult to consider the concept as a practical public policy goal. As the concept emerged from semantic ambiguity with more precise definition and description, it became a serious topic for discussion and, predictably, a lightning rod for conflict.

The most alluring feature of the human health metaphor is that most people have an inherent sense of personal health (Ryder, 1990). By extension, many proponents argue that most people almost instinctively envision a "healthy" ecosystem (e.g., a forest, lake, or pastoral landscape) as pristine or at least appearing to be minimally altered by human action.

Most concepts of human health focus on the *individual* human, whereas ecosystem health treats the *ecosystem* as the unit of policy concern, not the individual animal or plant (Schaeffer et al., 1988). Concerns about *individual* animals or plants — the typical focus of animal rights and animal welfare policy — are usually not the level at which *ecological* policy is debated.

There remains considerable variation in the concept conveyed by the words *ecosystem health* (Calow, 1992; De Leo and Levin, 1997). Karr and Chu (1999), for example, reflect a common, but not universal, position that concepts of ecosystem *health* and *integrity* are fundamentally different. They define ecosystem *health* as the *preferred* state of ecosystems modified by human activity (e.g., farmland, urban environments, airports, managed forests). In contrast, ecological *integrity* is defined as an *unimpaired* condition in which ecosystems show little or no influence from human actions. Ecosystems with a high degree of integrity are natural, pristine, and often labeled as the baseline or benchmark condition. *Natural* ecosystems would continue to function in essentially the same way if humans were removed (Anderson, 1991).

Others make no such clear distinction and may describe ecosystem health and integrity as different words for the same general concept. Regier (1993), for example, concludes that:

> … the notion of ecosystem integrity is rooted in certain ecological concepts combined with certain sets of human values.

and, thus, a desired ecosystem condition:

> … other than the pristine or naturally whole may be taken to be "good and normal."

Hence, if one accepts that there are multiple (and equally acceptable) benchmarks for ecosystems with integrity, then the terms *ecosystem health* and *ecosystem integrity* would be conceptually the same. However, for the remainder of this chapter, I will use the concepts and definitions of ecosystem health and ecosystem integrity used by Karr and Chu (1999), where the two notions represent different but related intellectual constructs.

The majority of ecological policy debates concern ecosystem *health* rather than ecosystem *integrity* (Westra, 1998). Such an emphasis on health (altered ecosystems) is understandable because the vast majority of ecosystems are not pristine; hence, according to the definitions used here, altered ecosystems lack at least some integrity. Westra (1998) clearly describes the relationship between the two concepts:

> … an ecosystem can be said to possess integrity when it is wild — that is, free as much as possible from human intervention today, and "unmanaged," although not necessarily pristine. This aspect of integrity is the most significant one; it is the aspect that differentiates the wild from ecosystem health, which allows support and manipulation.

NORMATIVE BASIS

The concept and implementation of ecosystem health are surrounded by controversy (Jamieson 1995; Wicklum and Davies, 1995; Callicott, 1995; Belaoussoff and Kevan, 1998). Addressing questions of ecosystem health might appear to be a fairly scholarly, perhaps even arcane, activity, free from the policy intrigue that dominates much of the science and policy underlying environmental management, but such is not the case. Concepts of ecosystem health are seldom afforded the luxury of dispassionate discussion because, as Wicklum and Davies (1995) observe:

> The phrases ecosystem health and ecosystem integrity are not simply subtle semantic variations on the accepted connotations of the words health and integrity. Health and integrity are not inherent properties of ecosystems.

Wicklum and Davies (1995) realize that the words *health* and *integrity* elicit powerful, positive images even if their meanings are ambiguous. Therefore, they argue, a precise understanding of these words is essential because they are likely to be used, and given a variety of meanings, by policy advocates, politicians, bureaucrats, and the general public. In practice, it may fall to scientists and other technocrats to provide operational clarity to these perplexing, value-laden, normative concepts that appeal on an intuitive level to nearly everyone. Unfortunately, but typically, normative ecological concepts, such as ecosystem health, become general perceptions, perhaps useful in general conversation but impossible to quantify (Ryder, 1990).

Ecosystem health and other normative concepts have become highly charged political terms (Jamieson, 1995), often to the extent that they have become shorthand descriptors for one faction in political debates. Even in the relatively isolated venues of academic and government laboratories, an assertion that ecosystem health and integrity are not intellectually sound concepts may be sufficient to have the perpetrator branded as a political reactionary. Conversely, proponents may be categorized as zealots whose political aspirations have corrupted the sanctity of the scientific method. As Callicott et al. (1999) maintain, "partisans of a single normative concept try to make it cannibalize or vanquish all the rest."

Some (Shrader–Frechette, 1997; Kapustka and Landis, 1998) have counseled against using the concept of ecosystem health to communicate to the public about environmental issues. To be sure, thoughtful discussions about ecosystem health and similar concepts are usually abstract, often contentious, and rarely lead to consensus; but is the use of the health metaphor, even as a heuristic tool, ill-advised? Kapustka and Landis (1998) exhort against the metaphor because it is misleading and based on the chosen values and judgments, not an *independent* scientific reality. Conversely, Callicott (1995) concludes that ecosystem health is intellectually defensible and heuristically valuable; but he concedes that the *value*, thus the calibration, of ecosystem health is subjective. Indeed, Callicott et al. (1999) classify it as an "ill-defined normative concept" that reflects the "occurrence of normal ecosystem processes and functions;" but most discussions rarely explain clearly how current policies would change if attainment of ecosystem health became a public policy goal. Perhaps one way to make progress would be to move discussions beyond policy platitudes and definitional nuances and toward assessments of the specific *implications* for individuals and society of implementing the concept.

Most frustrating to some critics of the health metaphor is the charge that they have rejected a concept but not offered an alternative. Even many supporters of the utility of the notion of ecosystem health concede that it is easy to identify its conceptual limitations (Callicott, 1995). Developing alternatives that overcome the shortcomings has been much more difficult. If critics end up spurning ecosystem health, what do they offer as an alternative? Better alternatives are not obvious.

Regardless of the merit and direction of the scholarly debate, notions of ecosystem health frame important public policy issues (i.e., sustainability of agriculture, overuse of marine ecosystems, scarcity of water for domestic and agricultural use, and ecological consequences of introduced species) (Shrader–Frechette, 1997). Ecological policy issues are not mere abstract intellectual concerns, but matters that affect people's daily lives.

IMPLICIT ASSUMPTIONS

At the core of the debate over ecosystem health is a number of implicit but highly contested assumptions. First and foremost is the long-debated assumption that ecosystems are *real* (Calow, 1992; Callicott, 1995). Kapustka and Landis (1998), however, assert that "no human has ever seen an ecosystem" because it is not a discrete unit like individual birds, trees, or worms, or even populations of organisms. When a science or policy problem is specified (i.e., a "salmon" issue), then the ecological boundaries (i.e., the *ecosystem*) follow intuitively. Thus, ecosystems are context-specific because they cannot be delimited without a science or policy concern or issue; therefore, they may have heuristic and problem-solving value but are not analogous to the patient in medicine (Suter, 1993).

Although rarely stated explicitly, in most formulations of ecosystem health there is a premise that *natural* systems are healthier than human-altered systems (Wicklum and Davies, 1995). For example, consider a defined geographic location and, given the alternatives of a pristine woodland, a housing subdivision, or an industrial complex, which is the healthiest? The subdivision may be necessary, even somewhat aesthetically pleasing, and the industrial complex may serve a worthy purpose; but almost everyone implicitly considers the "unaltered" woodland to be the *healthiest.* Tacitly, the assumption is that pristine, or the less altered, is good and preferred; highly altered ecosystems, in contrast, are less desirable, if not *degraded.* Thus, recognizing the normative basis for ecosystem health, Fairbrother (1998) concludes: "use of the term ecosystem health as a definition of an idealized state is not an appropriate paradigm."

Another common assumption involves the importance of biological diversity to *society.* Biological diversity is certainly an important element in understanding the structure and function of ecosystems, but the key policy assumption revolves around the level of importance *society* assigns to biological diversity or its constituent elements. For example, some argue that biological diversity is such a core (i.e., societal) policy value that scientists should actively lobby for it. As Meffe and Viederman (1995) bluntly recommend:

> Scientists can take a clear stand that biodiversity is good, that functioning and intact ecosystems are good, that continued evolutionary change and adaptation are good, and that diversity and variation in general is good. Scientists cannot and should not remove themselves from these usually unstated value judgments.

Meffe and Viederman (1995) assert that values in science are always present, whether admitted or formally expressed by scientists, and that the policy process merely focuses values more clearly and honestly. Therefore, scientists should drop the facade of policy neutrality and lobby for those policies they deem to be in the best interests of society.

Invariably, concepts of ecosystem health implicitly assume that certain ecosystem features such as biological diversity have an *inherent* policy importance (Schaeffer et al., 1988). Ecosystems are complex, typically in both structure and function, and the diversity of species within an ecosystem is important to determining how that particular ecosystem functions; but biological diversity is *inherently* no more important to ecosystems than are nutrient cycling, carbon storage, or the rate of photosynthesis. As a public policy priority, and apart from its ecological function, society collectively may ascribe high (or low) value to preservation of certain, perhaps all, species based on *human* values and preferences.

Although not universally assumed, a common implicit assumption is that there is a *natural* ecosystem state (i.e., balance of nature) akin to the simple homeostatic dynamics of physiological systems (Anderson, 1991). The existence of such a natural state is appealing because disruption of ecosystem balance — deviation from the natural state — could be used to define and measure health. Unfortunately, this idealized view of ecosystems does not typically exist. Ecosystems may not predictably approach single-point equilibrium but may oscillate over time in a fairly indeterminate manner.

Another assumption concerns the degree to which human activities should be considered *natural*. Many proponents of ecosystem health contend that a fundamental goal of managing ecosystems is to maintain or restore their *natural* structure and function (Hunter, 1996). Outside of ecosystem reserves, some deviation from natural would be tolerated to meet human needs, but the benchmark would be the *natural* state of the ecosystem in question (Anderson, 1991). Even defining the *natural* state of an ecosystem is *de facto* an implicit policy preference when used in policy discussions. For example, in North America, is the natural condition that which existed at the time of initial human arrival (~13,000 to 15,000 years ago) or at the time of European and African arrival (~500 years ago)? To a dissimilar degree, both groups of immigrants and their offspring altered ecosystems (Hunter, 1996). Selecting which of these two benchmarks (or another one) is *natural* is a value-based decision.

NORMATIVE SCIENCE

Few challenge the assertion that societal aspirations drive the environmental management goals inherent in implementing ecosystem health, but the question remains: Which societal aspirations will be selected (Gaudet et al., 1997)? Society is not a monolith, and there are many competing opinions of what is important.

The language and discussion of ecosystem health is value laden (Jamieson, 1995), but how are societal values and preferences to be incorporated when using ecosystem health in public policy? The crux of the policy challenge is deciding which of the diverse set of societal preferences is to be adopted. Resolving policy issues always consists of trade-offs, partially or entirely exclusive alternatives, winners and losers, and plenty of compromises.

Consider any specific ecological policy issue and ask: Who are the stakeholders and how would their input be used to define ecosystem health? The task is relatively easy when policy problems are defined narrowly, such as licensing a particular chemical or authorizing a timber harvest rate for an individual forest, but what about for achieving a broad societal aspiration (like ecosystem health)? For example, are the stakeholders for a national forest local or national? Obviously, local residents are most directly affected by policy decisions, but the land is "owned" by everyone in the nation. The policy preferences of local residents are likely to differ from those with a national perspective.

What role should science and scientists play in defining ecosystem health? Scientific information is important, even essential, but it is only part of what is needed (Gaudet et al., 1997). Most important ecological policy issues involve coarse scales. Unfortunately, most scientific information is finely scaled and narrowly focused, thus not directly relevant to many ecological policy questions. Further, political institutions (legislative and regulatory agencies) must balance competing values and preferences, so scientific information is merely one facet of decision making. For adjudicating conflicts over values and preferences, science offers no moral or ethical guidance (Kapustka and Landis, 1998).

An argument is sometimes advanced that, because ecosystem health shrouds difficult and painful trade-offs under the guise of science, its use inhibits incorporation of societal values and preferences by not forcing an explicit selection from competing policy options. As Suter (1993) observes in evaluating various attempts to implement ecosystem health:

> Use of unreal properties (particularly unreal properties with imposing names) in environmental regulation obscures the bases for decision making; increases the opportunity for arbitrariness; and decreases the opportunity for informed input by the public, regulated parties, or advocacy groups.

Toll (1999) unequivocally concludes that "environmental problems cannot be solved without applying some sort of value system." Shrader-Frechette (1997) charges that the concept of ecosystem health does little, in spite of the volume of rhetoric, to improving decision making because proponents have failed to:

> ... clarify the precise respects in which the term yields additional scientific explanation beyond those provided by assessments of production, biodiversity, and so on.

APPROPRIATE USE

Regardless of the precise notion of ecosystem health asserted, it is important to understand its use in implementing ecological policy. The most redeeming feature is its ability to help clarify complex policy questions (Calow, 1992). The metaphor of health applied to ecosystems is simple whereas ecological policy problems are complex; the decision options are many and sometimes counterintuitive; and the consequences of implementing each option are rarely certain.

Although not essential, concepts of ecosystem health *may* help explain to the public the ecological consequences of policy choices, thus potentially reducing the likelihood (to the public) of *unexpected* consequences. Helping avoid surprises that result from policy decisions is a useful characteristic of any decision-support tool; but unfortunately, surprises are a common trait of ecological policy decisions (National Research Council, 1997). If society decides, for example, to have a dam constructed which causes an *unexpected* (to the public) loss of a migratory population of fish, then society lacked the appropriate scientific understanding of the consequences of the decision. If, on the other hand, loss of the fish population was *expected* (by the public), then the benefits of dam construction were judged by the public to be sufficient to warrant the loss of the fish population.

Another feasible use of ecosystem health is that it potentially allows society to understand more easily complex ecological policy questions (Shrader-Frechette, 1997). If the ecological information is complex, as is often the case, it is difficult to provide helpful, understandable information to decision makers unless there is a relatively simple intellectual organizing framework such as ecosystem health. However, excessive simplification of scientific information has the risk of misleading decision makers. Thus, the complexity of ecological systems should not be overlooked in an attempt to provide helpful information to decision makers (National Research Council, 1997).

There are properties of ecosystem health that make it prone to misuse. Misuses may be intentional and done in an effort to achieve advantage in policy debates, or simply be due to ignorance of the fact that the concept has a normative basis.

The most pervasive misuse of ecosystem health and similar normative notions is insertion of personal values under the guise of *scientific* impartiality. Most concepts of ecosystem health require a benchmark (i.e., a *desired, preferred,* or *reference* condition) of an ecosystem. Often, the implicit assumption is that an undisturbed or natural ecosystem is somehow superior, thus preferable to an altered one (Anderson, 1991). An ecosystem, once altered by human activity, is different from the previous state, but there is nothing *scientific* that compels any ecological state to be considered preferred or better (healthier). Lele and Norgaard (1996) caution those searching for scientifically derived benchmarks for ecosystems: "Naturalness as the benchmark is neither value-free nor logically or practically usable."

Practical expressions of ecosystem health and ecosystem integrity should reflect societal values and preferences (Gaudet et al., 1997). A misuse of the concepts is the situation in which professionals, usually operating from bureaucratic positions, *de facto* determine healthy (i.e., preferred) target ecosystems conditions. Concepts of ecosystem health or ecosystem integrity are normative because someone must decide what ecosystem condition or function is *good* (Sagoff, 1995). Ecosystems have no preferences about their states; thus preferred states or *benchmarks* must come from the individuals doing the evaluation (Jamieson, 1995). One common approach is to arbitrarily select reference sites to serve as the benchmarks for the ecosystems in question. Kapustka and

Landis (1998) conclude that the principal danger for scientists attempting to define healthy ecosystems comes from the incorporation of beliefs, morals, values, and ethics as *properties* of ecological systems.

Another less obvious but disconcerting use of the concepts of ecosystem health and integrity is defining a public policy goal in vague terms that engender broad public support, labeling it ecosystem health or ecosystem integrity, but camouflaging the ramifications of its adoption. Indeed, there is general public support for the idea of maintaining ecosystem health, but few members of society grasp the consequences of such a policy approach. The implications for democratic processes are rarely revealed, much less debated. Westra (1996), for example, candidly stated some far-reaching political consequences:

> ... no country's unilateral decision, no matter how representative it might be of its citizens' values, should be permitted to prevail, unless it does not conflict with the global requirements of the ethics of integrity, thus with true sustainability.

Another inappropriate use of the concept of ecosystem health is pejoratively categorizing opposing policy choices. After all, the competing policy choices must, by definition, not be appropriate for achieving ecosystem health. One policy choice then becomes identified as promoting *health,* with the alternatives struggling to avoid being dismissed as arguing for *sickness.* For example, a policy decision to drain a wetland to create a cornfield might legitimately be categorized as appropriate to maintain ecosystem health. Either the wetland or cornfield could be healthy, depending on the societal preferences embraced. Because *health* conveys a positive political connotation, the common practice in policy debates is to capture the high ground by labeling *your* policy choices as necessary for health and those of your opponents as leading to sickness or ecosystem degradation.

Environmental managers are culpable, often unintentionally, of misusing the concept of ecosystem health. Understandably, those responsible for making difficult, controversial policy decisions may be reluctant to define their goals clearly; so they sometimes, perhaps unintentionally, embrace ecosystem health in the belief that it is a scientifically operational term. After evaluating the potential uses of the health metaphor in environmental management, Suter (1993) concludes:

> ... environmental managers are active agents, translating the inchoate norms of the current generation and the poorly predicted needs of future generations into specific actions to protect or restore real, valued properties of actual ecosystems.... Hence, the decision to abandon ecosystem health as a goal is not just a matter of semantics.

As Kapustka and Landis (1998) admonish: "If we are to manage the environment, it should be done with the clear knowledge that choices will have to be made, not fueled by misplaced desires or myths."

ALTERNATIVES

Ecological policy issues such as managing the consequences of human land use, reduced biological diversity, or the cumulative effects of chemical use, are real and demand serious attention by society (Science Advisory Board, 2000). Concepts based on normative science can be compelling, but even most proponents concede that there are serious conceptual or operational difficulties with such concepts. What are the alternatives, if any?

The most direct alternative to using normative science is to cease using words such as ecosystem health and simply describe what is proposed. More specifically, rather than propose a policy objective of managing a forest for health, express exactly and clearly the management objective.

Another alternative is to demand coherent, clear definitions of the normative concepts of ecosystem health. There are multiple definitions for the same words, so consensus on the exact meaning is essential to focusing policy debate on societal trade-offs, not semantic niceties. The Environmental Protection Agency (1998), for example, defined ecological *integrity* as the "ecosystem structure and function characteristic of a reference condition deemed appropriate for its use by *society*" (emphasis added). Thus, by adopting this definition, the appropriate ecological reference condition — the benchmark for normative evaluation — is decided by society, not by scientists applying their own policy preferences.

Regardless of whether normative concepts are used in ecological policy deliberations, public involvement (even as fractured as the public often appears to be) is essential because *values* drive policy. Public involvement should be at the essence of using normative concepts because of their requirement for *inherent* value judgments. As Rykiel (1998) explains:

> In a simplistic sense, science deals with true and false, whereas society deals with good and bad. Science can delineate the possibilities and describe the system that is likely to result from a policy, but it cannot decide if the resulting system is good or bad.

Thus, policy *decisions* are, by definition, normative because values and preferences were used by the decision maker to select a particular option.

Another alternative to using ecosystem health is to treat ecological policy issues as yet another complex public policy question and not to rely on any metaphor. Other policy issues (e.g., welfare, education, energy, transportation) are also complex and challenging, but overarching, explicit heuristic models or metaphors are not typically used.

CONCLUSION

Ecology has become much more than a scholarly discipline; it has impacts far beyond simply enhancing our understanding of ecosystems. Many uses of ecology have a strong normative flavor. As Worster (1990) observes:

> The science of ecology has had a popular impact unlike that of any other academic field of research. Consider the extraordinary ubiquity of the word itself: it has appeared in the most everyday places and the most astonishing, on day-glo T-shirts, in corporate advertising, and on bridge abutments.

The future role of normative science (and ecosystem health in particular) is uncertain. At the ideological extreme, there are stark opinions. Some argue that normative science is desirable — even essential — for implementing ecological policy. Scientists, they assert, have an obligation to incorporate *policy* value judgments into ecology, even to the point that such *science* concepts as ecosystem health should be adopted as the cornerstone of ecological policy (Callicott, 1995). Some scientific disciplines and professions (e.g., conservation biology, restoration ecology) unapologetically embrace normative science postulates as the core of their trade (e.g., biological diversity is inherently good; extinction of populations and species is inherently bad; ecological complexity is inherently good; evolution is good; biological diversity has intrinsic value) (Soulé, 1985).

Others, however, assert that normative science (e.g., ecosystem health) hides, under a veneer of science, the reality of trade-offs involving competing personal and societal values and preferences (Kapustka and Landis, 1998). The proper role of science is to help lay out options and assess the consequences of various choices, and it is only part of the needed input (Tingey et al., 1990; Shaw et al., 1999).

Scientists and scientific information will continue to play an important role in resolving ecological policy, but the role, in my opinion, should be carefully circumscribed (Lackey, 1999). Often, even among scientists, ecology has been treated more as a belief system than a science. It is easy, even encouraged, for scientists to abuse privileged roles in ecological policy debates by surreptitiously labeling personal values and policy preferences as "science" (Salzman, 1995).

Understanding the values and preferences of society is crucial to appropriately implementing concepts of ecosystem health, but obtaining such understanding credibly is difficult. Political institutions do not provide such understanding or guidance in efficient ways. To assert that concepts of ecosystem health are merely scientific constructs is incorrect. As Russow (1995) concludes, "the claim that scientific descriptions in general or measures of ecosystem health in particular are value neutral is simply false." The likely alternative to public involvement is that the values of scientists and other technocrats will be used as surrogates for societal values and preferences.

Perhaps the term *ecosystem health* has already become a political term, a code word for a particular policy or political position. Even now, invoking ecosystem health often is equated with a green political position. Becoming identified as a political term is unfortunate because the word and concept lose usefulness in serious policy, public, and scientific debate.

A different risk for the future of ecosystem health is that it becomes co-opted and, ultimately, marginalized. For example, if everyone adopts the term and becomes an advocate of ecosystem health, then the term and concept have lost their usefulness. In policy deliberations the terms are now political rhetoric — encompassing a suite of meanings that everyone readily accepts as reflecting each's individual, though divergent, policy positions.

The ecological policy concerns that engender widespread debate over ecosystem health and other normative constructs will not disappear. These concerns need to be addressed because of the increasing demand on limited ecological resources (Salwasser et al., 1997). The resolution of ecological policy is likely to become increasingly challenging because interactions among the planet, its nonhuman inhabitants, and its large and still expanding, human population constitute a dynamic system of increasing complexity (National Research Council, 1997). Whether one finds intellectual sustenance in the notion of ecosystem health, the policy concerns it attempts to confront are genuine.

REFERENCES

Anderson, J.E., A conceptual framework for evaluating and quantifying naturalness, *Conserv. Biol.,* 5:347–352, 1991.

Belaoussoff, S. and Kevan, P.G., Toward an ecological approach for the assessment of ecosystem health, *Ecosyst. Health,* 4:4–8, 1998.

Callicott, J.B., A review of some problems with the concept of ecosystem health, *Ecosyst. Health,* 1:101–112, 1995.

Callicott, J.B., Crowder, L.B., and Mumford, K., Current normative concepts in conservation, *Conserv. Biol.,* 13:22–35, 1999.

Calow, P., Can ecosystems be healthy? Critical consideration of concepts, *J. Aquat. Ecosyst. Health,* 1:1–5, 1992.

Carnegie Commission on Science, Technology, and Government, *E³: Organizing for Environment, Energy, and the Economy in the Executive Branch of the U.S. Government*, Task Force on Environment and Energy, Carnegie Commission on Science, Technology, and Government, New York, 1990.

De Leo, G.A. and Levin, S., The multifaceted aspects of ecosystem integrity, *Conserv. Ecol.,* 1:3, 1997. (Available online at http://www.consecol.org/vol1/iss1/art3.)

Elliott, E.D., Toward ecological law and policy, in Chertow, R.M. and Daniel, E.C., Eds., *Thinking Ecologically: The Next Generation of Environmental Policy,* Yale University Press, New Haven, CT, 1997, pp. 170–186.

Fairbrother, A., Establishing the health of ecosystems, in Cech, J.J., Wilson, B.W., and Crosby, D.G., Eds., *Multiple Stresses in Ecosystems*, Lewis Publishers, Boca Raton, FL, 1998, pp. 101–107.

Gaudet, C.L., Wong, M.P., Brady, A., and Kent, R., How are we managing? The transition from environmental quality to ecosystem health, *Ecosyst. Health,* 3:3–10, 1997.

Hunter, M., Benchmarks for managing ecosystems: are human activities natural? *Conserv. Biol.,* 10:695–697, 1996.

Jamieson, D., Ecosystem health: some preventative medicine, *Environ. Values,* 4:333–344, 1995.

Kapustka, L.A. and Landis, W.G., Ecology: the science versus the myth, *Hum. Ecol. Risk Assess.,* 4:829–838, 1998.

Karr, J.R. and Chu, E.W., *Restoring Life in Running Waters: Better Biological Monitoring*, Island Press, Washington, D.C., 1999.

Lackey, R.T., Seven pillars of ecosystem management, *Landscape Urban Plann.,* 40:21–30, 1998.

Lackey, R.T., The savvy salmon technocrat: life's little rules, *Environ. Pract.,* 1:156–161, 1999.

Lele, S. and Norgaard, R.B., Sustainability and the scientist's burden, *Conserv. Biol.,* 10:354–365, 1996.

Meffe, G.K. and Viederman, S., Combining science and policy in conservation biology, *Wildl. Soc. Bull.,* 23:327–332, 1995.

National Research Council, *Building a Foundation for Sound Environmental Decisions*, National Academy Press, Washington, D.C., 1997.

Norton, B., Ecological integrity and social values: at what scale? *Ecosyst. Health,* 1:228–241, 1995.

Noss, R.F., Ecological integrity and sustainability: buzzwords in conflict, in Westra, L. and Lemons, J., Eds., *Perspectives on Ecological Integrity,* Kluwer Academic Publishers, Dordrecht, 1995, pp. 60–76.

Rapport, D.J., Ecosystem health: exploring the territory, *Ecosyst. Health,* 1:5–13, 1995.

Rapport, D.J., Defining ecosystem health, in Rapport, D.J. et al., Eds., *Ecosyst. Health*, Blackwell Science, Malden, MA, 1998, pp. 18–33.

Regier, H.A., The notion of natural and cultural integrity, in Woodley, S.J., Kay, J.J., and Francis G., Eds., *Ecological Integrity and the Management of Ecosystems*, St. Lucie Press, Boca Raton, FL, 1993, pp. 3–18.

Russow, Lilly-Marlene, Ecosystem health: an objective evaluation? *Environ. Values,* 4:363–369, 1995.

Ryder, R.A., Ecosystem health, a human perception: definition, detection, and the dichotomous key, *J. Great Lakes Res.,* 16:619–624, 1990.

Rykiel, E.J., Relationships of scale to policy and decision making, in Peterson, D.L. and Parker, V.T., Eds., *Ecological Scale: Theory and Applications*, Columbia University Press, New York, 1998, pp. 485–497.

Sagoff, M., The value of integrity, in Westra, L. and Lemons, J., Eds., *Perspectives on Ecological Integrity,* Kluwer Academic Publishers, Dordrecht, 1995, pp. 162–176.

Salwasser, H., MacCleery, D.W., and Snellgrove, T.A., The Pollyannas vs. the Chicken Littles — enough already! *Conserv. Biol.,* 11:283–286, 1997.

Salzman, L., Scientists and advocacy, *Conserv. Biol.,* 9:709–710, 1995.

Schaeffer, D.J., Herricks, E.E., and Kerster, H.W., Ecosystem health: I. Measuring ecosystem health, *Environ. Manage.,* 12:445–455, 1988.

Science Advisory Board, Reducing Risk: Setting Priorities and Strategies for Environmental Protection, U.S. Environmental Protection Agency, Publication SAB-EC-90–021, 1990.

Science Advisory Board, Toward Integrated Environmental Decision-making, U.S. Environmental Protection Agency, Publication SAB-EC-00–011, 2000.

Shaw, C.G., Everest, F.H., Swanston, D.N., Julin, K.R., and Allen, S.D., Independent scientific review in natural resources management: a recent example from the Tongass Land Management Plan, *Northwest Sci.,* 73:58–62, 1999.

Shrader-Frechette, K., Ecological risk assessment and ecosystem health: fallacies and solutions, *Ecosyst. Health,* 3:73–81, 1997.

Soulé, M.E., What is conservation biology? *BioScience,* 35:727–734, 1985.

Steedman, R.J., Ecosystem health as a management goal, *J. North Am. Benthol. Soc.,* 13:605–610, 1994.

Suter, G.W., A critique of ecosystem health concepts and indexes, *Environ. Toxicol. Chem.,* 12:1533–1539, 1993.

Taylor, B., The religion and politics of Earth First! *The Ecologist,* 21:258–266, 1991.

Tingey, D.T., Hogsett, W.E., and Henderson, S., Definition of adverse effects for the purpose of establishing secondary National Ambient Air Quality Standards, *J. Environ. Qual.,* 19:635–639, 1990.

Toll, J.E., Elements of environmental problem-solving, *Hum. Ecol. Risk Assessment.,* 5:275–280, 1999.

United States Environmental Protection Agency, Ecological Research Strategy, EPA/600/R-98/086, Washington, D.C., 1998.

United States Environmental Protection Agency, EPA's Framework for Community-Based Environmental Protection, EPA 237-K-99–001, Washington, D.C., 1999.

Westra, L., Ecosystem integrity and the "fish wars," *J. Aquat. Ecosys. Health*, 5:275–282, 1996.

Westra, L., The ethics of integrity, in *The Land Ethic: Meeting Human Needs for the Land and Its Resources*, Society of American Foresters, Bethesda, MD, 1998, pp. 31–44.

Wicklum, D. and Davies, R.W., Ecosystem health and integrity? *Can. J. Bot.,* 73:997–1000, 1995.

Worster, D., The ecology of order and chaos, *Environ. Hist. Rev.,* 14:1–18, 1990.

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 currently teaches a graduate course in ecological policy at Oregon State University. Canadian by birth, he is a U.S.-Canadian dual-citizen living in Corvallis, Oregon.

Robert T. Lackey
Department of Fisheries and Wildlife
Oregon State University
Corvallis, Oregon 97331

OFFICE: (541) 737-0569
CELL: (541) 602-5904
EMAIL: Robert.Lackey@oregonstate.edu
WEB: http://fw.oregonstate.edu/content/robert-lackey