# RESTORING NATURE

## *Perspectives from the Social Sciences and Humanities*

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# THE LANGUAGE OF NATURE MATTERS: WE NEED A MORE PUBLIC ECOLOGY

*R. Bruce Hull and David P. Robertson*

The language we use to describe nature matters. It is used by policy analysts to set goals for ecological restoration and management, by scientists to describe the nature that did, does, or could exist, and by all of us to imagine possible and acceptable conditions of environmental quality. Participants in environmental decision making demand a lot of the language and terminology used to discuss nature. We expect it to be precise and valid (i.e., we expect it to allow accurate scientific descriptions of the environment and of environmental quality). We also expect it to be powerful and fair (i.e., we expect it to help stakeholders negotiate acceptable and achievable goals for environmental management). The problem is that the language of nature is often neither precise nor value neutral. There exist multiple, conflicting, imprecise, and biased definitions of the terms used to discuss nature. These vagaries of language can cause conflict that delays or derails well-intentioned efforts to restore and manage nature. This conflict results when people use the same terms to intentionally or unintentionally mean different things or use particular definitions to suppress or promote particular values.

What nature is and what it should be are questions that touch the heart of ecological restoration and management. The goals of a restoration project are often based on decision makers' ideas (and ideals) of what is natural, healthy, or otherwise best for nature. Yet there is no simple answer to the question "What is natural?" or "What is ecologically best for nature?" Ecological theory suggests that many alternative environmental conditions are equally possible, equally natural, and equally healthy for any given place at any given point in time. There exists no single ecologically optimum or naturally best environmental condition that can serve as an objective, unequivocal goal for ecological restoration projects (e.g., Botkin 1990; Callicott 1992, 1996; Wiener 1996, Zimmerer 1994). We learn from contemporary understandings of ecology that neither nature nor science (as a way to understand nature) can tell us what Earth should look like. Yet we use the language of nature generated by ecological science to imagine and negotiate acceptable environmental conditions. Thus the constructs of ecological science necessarily serve double duty: they are both descriptive (scientific) and prescriptive (political); they are used to describe what is and to prescribe what ought to be.

The first purpose of this chapter is to examine some of the values implicit in three terms that have currency in both scientific and political venues: naturalness, health, and integrity. Environments that have more of these qualities are presumed to have more value than environments with less of these qualities. Hence, these descriptive terms also serve as prescriptive goals for environmental management. We suggest that participants who hope to compete successfully in the negotiation of restoration policies need to recognize and understand the values, biases, and uncertainties embedded in the language used to discuss and describe nature. This purpose is not too different from what Ross et al. (1997) did for ecosystem health, Shrader-Frechette (1995) for ecological integrity, Peterson (1997) for sustainable development, Takacs (1996) for biodiversity, Lele and Norgaard (1996) for sustainability, Haydon (1997) for natural, and Shrader-Frechette and McCoy (1993) for ecological science as a whole.

Society must explicitly consider which definitions of nature and environmental quality have the most utility for restoring and managing nature. We argue that currently there is insufficient attention directed to the task of constructing an environmental knowledge that functions effectively in the prescriptive arenas of policy and management. Many mechanisms already exist to operationalize and assess the validity and precision of descriptive, scientific terms, and ample discussion of these qualities can be found in the methods sections of publications in scientific journals. But rarely do we see discussed the prescriptive qualities of these terms. The challenge to all stakeholders is to help construct an environmental knowledge that is meaningful within ecological science and effective within environmental policy. Hence, the second purpose of this chapter is to discuss dimensions of environmental knowledge that may facilitate negotiation of ecological restoration goals that are socially acceptable, ecologically meaningful, and managerially relevant. This more public ecology is the responsibility of all stakeholders, and its goal is to produce a more effective environmental knowledge. This purpose is similar to (and our analysis draws heavily on) what Norton (1998) and Sagoff (1988) suggest in their critiques of ecological science and what Bryant and Wilson (1998) suggest in their more general critique of environmental science.

The audience for this book is likely to be as diverse as the public involved in environmental decision making. Many readers of this chapter will find it unsettling that there exist multiple, biased, and contradictory definitions of nature. Those readers expecting impartiality in the scientific terms used to set environmental policy will be disappointed. Other readers will be familiar with the long-standing debate about science's (in)ability to offer impartial knowledge for subsequent use in the value-laden policy-making process (e.g., Eden 1996, Lele and Norgaard 1996, Norton 1998, O'Brien 1993). Some readers will be familiar with the controversial critique that all knowledge and language about nature is socially constructed and thereby both partial and limited (e.g., Escobar 1999, Evernden 1992, Proctor 1995, Shrader-Frechette and McCoy 1993, Soper 1995), and some will be familiar with the response to this critique (e.g., Soule and Lease 1995). We have attempted to craft this chapter so that it offers something to each segment of our diverse audience.

## Naturalness, Health, and Integrity

> For those who are less interested in preaching than in policy, less concerned with the philosophical ivory tower than with embattled wetlands or forests, environmental ethics must be grounded in precise science. They must also provide complex, rationally defended principles that are capable of clear, specific, practical applications. Alternative construals might produce very different restoration goals and outcomes (Shrader-Frechette 1995, 125–126).

The language of nature is a tricky thing. Recognizing the complexity of the idea of nature, authors of texts such as this one tend to preface their thoughts with cautionary statements. For instance: "Nature is perhaps the most complex word in the [English] language" is an oft-cited quotation originally penned by Raymond Williams (1976) as the first line in a six-page definition of the term nature. In a subsequent essay, titled "Ideas of Nature," Williams (1980) further explained that nature has the potential to mean many things, and it means something slightly different to most of us according to our various situations. In his instructive and illustrative prose, Williams cautioned, "[W]hen I hear that nature is a ruthless competitive struggle I remember the butterfly, and when I hear that it is a system of ultimate mutual advantage I remember the cyclone."

In this section of the chapter we will examine three ecological terms: naturalness, health, and integrity. There exists a variety (perhaps an infinite number) of ways to define each of these qualities. Each definition implicitly or explicitly reflects values and norms. We review several definitions of each term that seem most likely to conceal values and to promote conflict and confusion among stakeholders not engaged in the contemporary ecological literature where the definitions of these terms are being debated. In particular, we highlight definitions that reflect romantic notions of nature. While Romanticism reflects popular and long-standing traditions in American and European cultures (Callicott and Nelson 1998, Cronon 1995, Oelschlaeger 1991, Soper 1995), it is not the only way to define and discuss nature. Society's development and articulation of alternative visions of nature might be constrained if the key definitions used to describe environmental quality are too heavily steeped in romantic ideals and values. Such a tendency might hinder open dialogue about society's relationship with nature just at a time in Earth's history when such a discussion seems so critical.

At the conclusion of our discussion of each term, we draw attention to additional literature where ecological scientists and other scholars are currently negotiating more precise definitions.

## *Naturalness*

We buy "All Natural" cereal, "100% Natural" soap, and "Naturally Pure" drinking water. We practice natural remedies to cure what ails us. We reside at Woodland Hills, Evergreen Ridges, and Deerfield Meadows. We make billions of visits each year to natural parks and gardens. Obviously we value what is natural. Conversely, what is artificial, human-made, or developed has negative connotations. Referring to something as unnatural or artificial is often the harshest critique one can make.

But what does it mean for something to be natural or to possess naturalness? The concepts of nature and naturalness have been aggressively deconstructed, reinvented, reconstructed, and re-created (Callicott and Nelson 1998, Cronon 1995, Escobar 1999, Proctor 1995, Soper 1995). Among the many points made by those attempting to de- and reconstruct the idea of nature is that at least three broad definitions of naturalness exist: (1) naturalness is associated with a state of the environment that existed at some previous point in time (i.e., authentic or original nature), (2) it is a state of the environment that exists in the absence of human modification (i.e., pristine or wild nature), and (3) it is associated with a slow, or "natural," rate of change. We will attempt to show that these states of nature do not offer value-free referents to guide efforts to restore or manage nature.

*Previous point in time.* When nature is viewed from the perspectives of disturbance ecology and geological time, the only thing constant about it is change.

The nature present at a particular place has changed over time with accidents of geological, climatic, ecological, and evolutionary history. The nature present in the area we call Chicago, for example, has existed as mown city parks, Native American burned savannas, Ice Age glaciers, Jurassic dinosaurs, abiotic bacteria, and, for the first billion years or so of the Earth's history, rocks located at a very different latitude with no life at all. Which of these natural states is better than another? Why? These questions cannot be answered without invoking values.

It seems obvious (from a human-centered view) that humans do not wish to restore nature to a condition before the evolution of life or, for that matter, to any state existing for the approximately 5 billion years before the evolution of human life. Also, we probably do not wish to restore the nature that existed during the most recent Ice Age, given that most of us are unwilling to abandon our homes and cities to glacial moraines. Rather, the state we seem to most often idealize as natural is the state that existed during the last few thousand years, when the conditions of human habitation of North America were not too different from what they are now.

Even having narrowed our preference for nature to the postglacial, the selection of which nature to use as a benchmark is further intertwined with social values. Natural history, evolutionary biology, and paleoecology show that nature is dynamic, not static: for example, species have expanded their territories at different rates and in different directions from their most recent Ice Age refugia (Brubaker 1988). Thus, even within the last few thousand years, nature has been a moving target. Perhaps even more frustrating for those wanting to find value-free criteria to help select which state of nature to use as a goal of restoration are the conclusions from disturbance ecology that most states of nature are consequences of random events and accidents of history. The characteristics of a given ecological system are sensitive to its initial conditions and to the conditions of adjacent systems, both of which are influenced by random events (Botkin 1990, Pickett et al. 1992, Pimm 1991, Shrader-Frechette 1995). Wind, ice, fire, drought, hyperactive wildlife, and human action are just a few of the many factors that can set an ecosystem along a new trajectory of change and evolution. Botkin (1990) and others have refuted the idea of a balanced nature, where nature knows best and, if just left alone, will reach some optimal or ideal state. Today, nature is understood to be constantly changing, often in random and unpredictable ways. Balanced, stable, and permanent states of nature do not exist. Instead of one nature, we find that many possible, equally likely, equally valid natures could have existed at a given place and point in time. There is no value-free basis for picking one of these many possible trajectories of change and evolution to serve as the undisputed definition of what is natural and hence serve as a value-free goal for management and policy.

One common argument for valuing the most recently evolved nature over other possible states of nature is survival of the fittest: the assumption that the survivors are better because they survived. But nature is not necessarily objectively better in its most recently evolved state than it was in any of its previous states—evolution is not progressive. The most recently evolved nature is not the best possible nature; rather, it is merely the most fitting in the context of the most recent environmental conditions. The nature that was replaced was not necessarily weak, bad, or less desirable; it just could not compete in the context of the latest (often randomly caused) environmental conditions (Gould 1980). Stated another way, evolution does not necessarily mean betterment.

Because many possible natures exist, which nature is chosen to serve as the goal of restoration requires imposing human values and preferences for one time period and one set of initial, perhaps random, conditions. Such a decision may not be arbitrary, but it will no doubt reflect the values and preferences of the decision maker.

*Minimal human modification*. Another way to define naturalness is as the state of nature existing before human intervention (i.e., pristine, untouched, or wild nature). We will review several reasons why this is not a value-free definition either. When viewing nature through the lenses of anthropology and environmental history, one can find evidence of extensive and prolonged human-caused change (Crumley 1994, MacLeish 1994). Species extinction, fire, agriculture, and exotic (manipulated or imported) species have been part of the North American landscape for thousands of years. Before European settlement, millions of humans inhabited the American landscape (Denevan 1992). Native agriculture and commerce were extensive, and Native Americans transformed the landscape with cities, roads, hunting, and agriculture. In most places across the American landscape, the nature encountered by Europeans was managed, not pristine. Even the earliest European explorers of this New World rarely blazed new paths; instead they followed existing trails and provisioned their parties at existing villages (Snyder 1990). Thus the North American nature that existed before European settlement had not been pristine for perhaps 10,000 years, and the nature we know today is the result of many generations of human management. The task of establishing prehuman conditions is even more problematic on other continents where anthropogenic environmental change has been of longer duration and greater intensity.

A preference for non- or prehuman nature, the state of nature existing before any human contact, requires a normative judgment that humans, as the causal agent of environmental change, are bad. But what is objectively bad about human-induced environmental change? Populations have crashed, individual organisms have suffered, and species have gone extinct prior to, and in the absence of, humans. For example, it is only due to the chance development of photosynthetic bacteria several billion years ago that oxygen-breathing creatures are able to enjoy life today. At the time of its emergence, however, reactive oxygen literally burned other components of nature out of existence, causing enormous environmental change (damage?). Why is human-caused change worse than the change caused by beaver, lightning, volcano, or oxygen? Why does human involvement necessarily soil nature's purity? Following this path of reasoning is instructive because it helps us explore some of the biases inherent in the necessary process of selecting from alternative definitions of naturalness. One answer to these questions is that wild, dehumanized nature is healthier or has more integrity than nature manipulated by humans. This argument essentially shifts the burden from naturalness to the seemingly more scientific constructs of health and integrity that, later in this chapter, we will address as equally value-laden terms.

An alternative answer to these questions is that we do not trust ourselves: technology is out of control, caution is the better part of valor, we have but one planet and thus one chance, the intelligent tinkerer saves all the pieces, Murphy's Law. How much faith humans should place in their technology is a point of important debate (Ehrenfeld 1981, Lewis 1992, Simmon 1981). How much technology is enough and how much is too much? Do we really wish to ignore these cautions and create environmental conditions that are entirely dependent upon continued advancements in human technology? Looking toward the future, critics caution us about potentially massive and unforeseen environmental consequences stemming from technologies already implemented, not to mention the potentially devastating contingencies of uncorking the biotechnology genie. In contrast, technology advocates point to the dramatic and continuing increases in the human standard of living and see no reason why the ultimate resource, human ingenuity, will not solve any and all problems as they become socially and economically significant.

Obviously, one's faith in technology influences the degree to which one is concerned about environmental change. If one has little faith in human technology, one is more likely to prefer natural conditions—those that do not depend on human technology and intervention to ensure sustainability. In addition, one may fear that unbridled reliance on technology breeds the hubris and arrogance that will ultimately lead to society's demise (see Katz, this volume). In the end, however, these deliberations reflect concerns about the role of technology in society, not concerns about naturalness. These concerns about technology may be legitimate and should be discussed explicitly, not confused with ambiguous concepts such as naturalness.

McKibben (1989) provides another reason why the absence of human intervention is not helpful as a definition for naturalness or as a goal for ecological restoration. He contends that nature (i.e., pristine nature, unmodified by humans) is dead. Global warming, acid rain, groundwater pollution, biotechnology, and human-induced species extinction/migration have altered the entire biosphere. Human enterprise has produced the end of pristine nature. Nature can no longer be thought of as an autonomous other. Land ownership fragmentation, private property rights, and the urban growth machine increasingly pierce the preservationist armor surrounding even the largest bioreserves. Like it or not, nature is now a human artifact. Science and technology currently do not have the ability to re-create and maintain areas with minimal human modification or to shelter existing environmental preserves from the consequences of ubiquitous human-caused change.

*Slower rate of change.* The third definition of naturalness discussed here invokes a social preference for a slower rate of change. In this definition, preference is given to slower, more "natural" rates of change because they are presumed safer. Current, human-dominated environments, it is argued, are experiencing a rate of change seen only a few times during Earth's history. The preference for a slower rate of change reflects a concern that humans are soiling their nest faster than their technology can clean it up. Essentially it is a conservative argument grounded in a respect for tradition and a preference for caution rather than for a pedal-to-the-metal, head-first rush into the future. The argument here is similar to the one above about faith in technology. It may be a valid argument, but it is an argument about the rate of change, not naturalness per se. It is an argument that should not be derailed by an ambiguous term such as naturalness.

In conclusion, naturalness is a problematic goal for restoration to the extent that it can conceal values and social preferences about other issues such as faith in technology. There are many natures, and there are many reasons to value each of them. More sophisticated discussions about the definitions of naturalness are emerging in the scientific literature and may yet produce more precise goals for ecological conservation and restoration (see Anderson 1991, Angermeier 2000, Brunson this volume).

## Health

The concept of health implies that there exists an optimal, ideal, or normal state that defines what it means to be healthy (i.e., in good condition, sound of mind and body, robust, flourishing). The degree to which something is healthy is measured by the extent to which it approaches this ideal state. The effects of stress and disease are measured by how much they cause deviation from this state. Using the health of an ecosystem as a goal for restoration and management is problematic for several reasons: (1) defining an ecosystem is problematic, (2) ecosystems are not closed systems or organisms, and (3) health does not offer clear management prescriptions. In the following discussion we will show that attempts to overcome these difficulties necessitate embedding human values and social context into the definition of health (which may create a workable definition, but not a value-neutral one).

*What is an ecosystem?* The term ecosystem is a complex concept, with multiple definitions that have changed over the last century as the word has come into popular usage (Bocking 1994, Ross et al. 1997, Worster 1994). There are at least three very different types of definitions for ecosystem, and many variations within each type. In some contexts, ecosystem signifies the idea of interconnected parts, the web of life, Leopold's land community. In other contexts it means something of intrinsic worth, something to be valued, something that has the right to exist. A third definition for ecosystem, and the one of relevance here, refers to a place on the ground, something that has physical location and boundaries, a unit of nature.

The boundaries of this spatial unit have proved elusive and porous. They are elusive because ecologists interested in different species, different processes, and different theories will define different ecosystem boundaries. Nature exists at many spatial scales (from the microscopic to the biosphere), many temporal scales (from the diurnal to the glacial), and many organizational scales (e.g., organisms, populations, ecological processes). Which scale one chooses determines the ecological attributes one studies as well as the attributes' spatial, temporal, and organizational properties. For example, population-community ecologists tend to view ecosystems as interconnected networks of living populations existing in the context of nonliving components, whereas process-functional ecologists emphasize energy flows and nutrient cycling in their definitions of ecosystems. Nature can be conceptually organized at many scales; therefore, multiple definitions of ecosystem boundaries exist, and no one definition can be necessarily more correct or objective than another (Levin 1992; Norton 1995; Norton 1998; Ross et al. 1997; Wright, Murray, and Merrill 1998). There is no way to unequivocally define the boundaries of an ecosystem and thus no value-free definition of ecosystem health. The boundaries will reflect the conceptual system used to describe them and hence will reflect the values and ideals embedded in that conceptual system.

*Ecosystems are not closed systems or organisms.* Organisms, at least relative to ecosystems, are closed systems. Hence their health is more easily (but still not easily) defined. The boundaries of an organism are more clearly defined, the inputs and outputs are more obvious, and birth and death more exactly denote beginning and ending states. Also, organisms, in contrast to ecosystems, have multiple exemplifiers. For each species, multiple organisms exist that can be said to be an example of that species. Multiple exemplifiers allow calculation of average conditions or norms for acceptable ranges of key indicators of each species such as conception, rate of growth, size, blood pressure, temperature, food intake, and death. Ecosystems, in contrast, are not closed, defined, stable, clearly bounded communities with holistic properties consistent from one example to the next. Rather, ecosystems are open, multiscalar, dynamic, and transitory assemblages of biotic and abiotic elements that exist (or could exist) contingent upon accidents of environmental history, evolutionary chance, human management, and the theoretical perspective one applies to define the boundaries. As a result of these contingencies, there are no obvious, objective, measurable, normal qualities that can be used as referents to define good ecosystem health (Botkin 1990, Shrader-Frechette 1995, Shrader-Frechette and McCoy 1995, Suter 1993, Wicklum and Davies 1995).

Certainly people can develop definitions of ecosystem types. These definitions can be objective in the sense that complete agreement among all interested parties is possible, at which point these definitions can be used reliably to identify multiple examples of each type from which norms can be calculated. However, the construction of the definition and of the agreement is also clearly dependent upon the theories, values, and social context in which the definers are embedded. Ecosystems do not exist "out there" until humans agree on where to draw the line. Ecosystems are human constructions and as such reflect human value systems that should be made explicit in the values tournament of restoration and management decisions.

*Health is not prescriptive.* Despite the popular appeal of human health as an intuitive metaphor for ecosystem quality, closer inspection reveals that the medical profession does not measure or study health; it focuses on disease (Ickovics and Park 1998, Suter 1993). In medicine, parts of the organism are routinely sacrificed (organs removed, limbs amputated, cancer destroyed) so that the organism may live. Applying the health metaphor to ecosystem management implies that removal of organisms and species can be done for the good of the whole, which raises questions about the rights of these species and organisms (questions that have been raised by the animal rights movement). It also implies that without intervention, the ecosystem would die. However, while the invasion of an aggressive exotic species might dramatically change the biophysical characteristics of a piece of land (i.e., the cancer analogy), life will not stop. In fact, promoting the health of one ecosystem sometimes requires killing another, thriving ecosystem. Should we burn a forest to save a prairie, or do we suppress the fire to save the forest? The controversy surrounding the restoration of the Chicago Wilderness makes it clear that stakeholders have different opinions about who the patient is. Defining the patient requires invoking values.

The meaning of health depends upon which nature is being advocated. Consider the controversy over management goals for old-growth forests in the Pacific Northwest (Chase 1995). Two very different construals of health exist, one favoring a young forest, the other an old one. Both forests are considered by their advocates to be healthy. A young forest is healthy because the trees are growing quickly and are resistant to disease and insects, and because the forest floor contains little litter that might fuel a hot, tree-killing, soil-destroying burn. In contrast, an old forest is healthy when the trees are growing slowly and decaying inside, and hence providing habitat for insects and fungi, and when the forest floor contains a large accumulation of biomass that is slowly recycling nutrients. Ecologists publishing in *Forest Science* might study and use mean annual increment of tree diameter or absence of tree-destroying insects as indicators of health for the young forest. Ecologists publishing in *Conservation Biology* might study and use unimpaired cycling of energy and nutrients or abundance and diversity of insects as indicators of health for the older forest. Which constructs and processes an ecologist studies will depend upon which nature the scientist and society idealize as appropriate for the site. Many of these natures could be healthy.

In conclusion, health is a problematic goal for restoration to the extent that it can conceal values and social preferences. More sophisticated discussions about the definitions of ecological health are emerging in the scientific literature and may yet produce more precise goals for ecological conservation and restoration (e.g., Costanza 1995, Rapport et al. 1998).

### *Integrity*

Wicklum and Davies (1995) review the ecological science and management literatures and suggest that although many definitions for ecological integrity exist, most fall into three broad categories: (1) systems have integrity when their structure or processes stay at some acceptable (i.e., defined or negotiated) level or within some range of acceptable levels, (2) systems have integrity when they are permitted to change unaffected by humans, and (3) systems have integrity when they possess organizing and self-corrective abilities that give them resilience to perturbation. We will attempt to review the values and social preferences implicit in these definitions as identified by an excellent literature on the topic (Crossley 1996, Norton 1995, Rapport et al. 1998, Shrader-Frechette 1995, Westra and Lemons 1995, Wicklum and Davies 1995).

*Acceptable structures and processes.* According to the first definition, an ecosystem has integrity if it exhibits acceptable structures or processes. The task then becomes defining the term acceptable, which we will argue is a social, value-laden judgment, not an objective quality of nature. Acceptable structures and process can be defined as those exhibited in ecosystems having integrity, but this merely creates a circular definition. Typically, acceptable structures and processes are defined by observing (or theoretically reconstructing) some benchmark or baseline ecosystem: "The first hurdle in recognizing change in integrity is the selection of a benchmark state against which other states can be compared" (Angermeier and Karr 1994, 693). This definition requires, then, a benchmark or basis of comparison representing the state of integrity and against which the current ecosystem conditions may be judged.

To further simplify the argument being presented, we will narrow the choice of benchmark to two different conditions: (1) a natural, authentic, or pristine condition existing prior to or with minimum human modification [the benchmark advocated by Angermeier and Karr (1994)] or (2) a desired future condition managed by humans that produces socially valued goods and services [the benchmark advocated by Regier (1993) and described by Sagoff (1988)]. The first benchmark reflects many of the ideas associated with naturalness, which, as noted above, offers at best a problematic benchmark. Using naturalness as a benchmark for integrity amounts to little more than cloaking a subjective term in scientific garb. We will say no more about it. The alternative of selecting some desired future condition is not necessarily more useful, but perhaps it has the potential to be so. It requires definitions of terms such as resilience, diversity, and the functional and evolutionary limits of desired biota that in turn define the term acceptable. These terms, as discussed below, are found to be subjective and value-laden. Because many possible future conditions exist, there is not one objectively defined, value-neutral benchmark condition.

*Change unaffected by humans.* The second definition of integrity requires that the ecosystem be permitted to change, but in a manner unaffected by humans. Implicit in this definition is the value-laden position that human-induced change is bad. The values inherent in this position were discussed above with respect to naturalness.

*Resilience.* The third definition of integrity considered here suggests that systems having integrity possess organizing and self-corrective abilities that give them resilience to perturbation. One possible interpretation of this definition requires assuming that self-organizing and self-corrective properties exist for all ecosystems, which hints at the homeostatic, organismic, nature-knows-best model of ecosystems discounted above in the discussion about health. Certainly, it can be argued that ecosystems have numerous interdependent and coevolved properties that collectively exhibit complex and hierarchical organizing properties. But it becomes difficult to objectively define which of these many organizing properties deserve value and difficult to defend why less organized states of nature are necessarily less valued. Even if ecosystems have organizing and self-corrective abilities, it still is not possible to use these criteria to select among the many possible natures that have similar self-organizing properties, any one of which could exist at the same place and point in time.

Another possible interpretation of this third definition of integrity is that ecosystems existing with minimal human influence are better than ecosystems requiring extensive inputs of nutrients, water, and human management. This definition of integrity assumes that human inputs of nutrients, water, or whatever are evaluatively bad or that an ecosystem dependent upon humans for these inputs is less valuable than an ecosystem independent of humans. Clearly these definitions invoke value judgments that assume ecosystems dependent on human inputs are less valuable than ecosystems independent of human maintenance. Certainly one could be concerned about the intergenerational equity of taking nonrenewable resources (e.g., oil) from one ecosystem and importing it (e.g., as fertilizer) into another. Likewise, one could be concerned about the change required of one ecosystem and its inhabitants (e.g., a formerly free-flowing river that is dammed) to support another ecosystem and its inhabitants (e.g., irrigated agribusiness). But these concerns are issues of equity and justice and should be discussed as such. Important debates about the distribution of resources should not be hidden behind supposedly more objective constructs such as ecosystem integrity.

In conclusion, integrity is a problematic goal for restoration to the extent that it can conceal values and social preferences. More sophisticated discussions about the definitions of ecological integrity are emerging in the scientific literature and may yet produce more precise goals for ecological conservation and restoration (e.g., Schulze 1996, Westra and Lemons 1995).

## *Past, Possible, and Future Natures*

Which nature should be restored? For every given setting, one can choose to restore one of many possible natures, and each of the possible natures can have qualities of naturalness, health, and integrity. The choices include (1) the various past states of nature existing during the constantly changing and somewhat random history uncovered by environmental historians and paleoecologists, (2) the many other possible natures that could have existed at previous points in time given different random accidents of environmental history, and (3) the many future natures that might yet exist as the result of human- and nonhuman-induced change. Which of these many natures do we choose to be the one nature that defines the environmental conditions and processes that serve as goals of restoration? Which of these many natures is best? Constructs such as naturalness, health, and integrity, as well as many other forms of environmental knowledge and value, are used to help answer these questions and, for this reason, have significant influence on efforts to restore and manage nature.

How we think and talk about nature determines which nature we select as the goal of restoration projects. If we operationalize constructs such as naturalness, health, and integrity by imposing preferences for a dehumanized nature or for the nature existing immediately preceding European settlement, then we have unnecessarily restricted the number of possible natures that can be considered. Open and direct discussions about humanity's relationship with and responsibility for environmental quality have never been more critical. Many states of nature can have naturalness, health, and integrity; we should consider them all when negotiating which nature we want to live in and with.

## Toward a More Public Ecology

Contemporary understandings of ecology and science suggest to us that a value-free definition of environmental quality cannot be determined by objective criteria from nature or from science as the study of nature; thus human values and preferences will necessarily be paramount. Obviously, these values and preferences cannot be judged as objectively right or wrong by comparison with some external or scientific criteria; rather, these values and preferences are competing visions and justifications for which nature should exist. In this open-for-negotiation context, this tournament of values, stakeholders need environmental knowledge that will facilitate their deliberations of possible and desirable future natures. In this section, we argue that a more public ecology—a body of environmental knowledge that is normative, contextual, multiscalar, integrative, adaptive, and accessible—is necessary for negotiating "which nature?" Adapting ideas presented in the literature on environmental knowledge, we outline below our recommendations for how each of these qualities might be applied in making more effective restoration and management decisions.

### *Recognize That All Environmental Knowledge Is Normative*

This chapter, as well as other chapters in this book, illustrates the inevitable value-ladenness of environmental knowledge. If we are motivated (by moral, aesthetic, or ethical reasons) to protect and restore nature for nature's sake, we might attempt to develop a knowledge base that includes normative ideas such as naturalness, health, and integrity. This is evident in the constructs advanced by the paradigms of conservation biology and restoration ecology as well as in the biocentric and ecocentric ethics of environmental philosophy. Likewise, if social preferences and market values motivate us to protect and restore nature, we will develop a knowledge base that includes concepts such as sustained yield and risk to human health. This tendency is displayed by the paradigms of ecological economics and risk assessment, and within product-oriented ecological fields such as silviculture and game-species wildlife management. Recognition and acceptance of this normative aspect of environmental knowledge is a prerequisite to achieving a more public ecology.

### *Construct Context-Specific Knowledge*

While environmental quality may be conceptualized in the abstract (as naturalness, health, or integrity), the specific goals and objectives of restoration must be determined in the context of the place-based projects to which they apply (Shrader-Frechette 1995, Shrader-Frechette and McCoy 1993, 1994). All restoration projects are unique in that both the people involved and the places where the projects occur are unique. If environmental knowledge is to have utility in environmental decision making, it must be particular to both the people using it and the places where it is used. In ecology, universal theory is nonexistent (Sagoff 1988); there are no generalized, mathematical models of ecosystem structure and process to tell us what nature looks like and how it works in real places. Therefore, the restoration and management of nature requires knowledge that is constructed in the context of the specific places involved, as well as knowledge reflecting more generalizable ecological theory (McNeely 1992, McNeely and Pitt 1985, Pimbert and Pretty 1997). In addition, stakeholders in the process should include local people, but may also include stakeholders at the regional, national, or even international levels when restoration and management decisions affect these broader communities of interest (e.g., Greater Yellowstone Ecosystem or the Chesapeake Bay Watershed).

### *Knowledge Must Apply at Multiple Scales*

Scale is an essential and confounding issue when constructing and applying environmental knowledge. As mentioned above, scale is understood in three dimensions: spatial, temporal, and organizational. The decision about what scale to manage is not a given but must be negotiated, and the scale that is selected will influence the desired outcomes of the project. Environmental knowledge will be most useful if it reflects scales that are relevant to specific management cases. Ecological research has tended to focus on ecological factors influencing selected species over brief time horizons (years) and small sites while ignoring the ecological factors influencing less interesting species, longer time horizons (decades), and large, politically fragmented landscapes (Norton 1998, Pimm 1991). Studies conducted at larger spatial scales and longer time frames are often too general or lack sufficient detail to support decision making in land management. Thus, management decisions require information not only about the site at hand, but also about trade-offs among many potential species, located at multiple sites, over decades of periodic anthropogenic disturbances.

## *Integrate Knowledge Across Disciplines, Professions, and Scales*

Informed environmental decision making requires the multiscalar integration of a vast array of environmental knowledge across disciplines and a diverse public. This integration is often hindered because environmental knowledge is collected, produced, and interpreted by multiple language communities (subgroups of natural scientists, social scientists, humanities scholars, environmental professionals, and citizen activists) using incompatible units of analysis. If this mixed bag of environmental knowledge is to be managerially relevant, the units of analysis in one discipline (area of inquiry) must be compatible with those of others. If environmental research is to serve environmental management, the units of analysis need to be made compatible from one study to the next regardless of the specific discipline.

Norton (1991, 1995, 1998) has consistently argued these points and has developed a place-based approach to environmental knowledge and decision making. He contends that specific places exist in the context of multiple hierarchical scales (spatial and temporal) and that for information to be meaningful and useful, it must permit aggregation or disaggregation from one scale to the next as management issues are reconceptualized according to different boundaries of space and time. He suggests that we consider management goals and outcomes from a place (home)-based perspective that looks outward to consider progressively larger scales of space and time. Norton and Hannon (1997) offer a triscalar theory that identifies three spatial scales of environmental valuation: local, community, and global. And, following Leopold, Norton (1995, 238) defines three time horizons particularly relevant to management decisions: "individual, experiential time [as experienced by the human body]; ecological time; and geological, evolutionary time." Recognition of these expansive scales of space and time is essential for meaningful discussions about sustainability and the goal of sustaining ecosystems in situations where individuals are asked to think beyond their immediate and local self-interest.

A body of environmental knowledge that is contextual, multiscalar, and integrative will be difficult to achieve, and we should not expect that it will be perfect or complete. Our knowledge of the environment will always be partial and limited. Therefore, a more public ecology must also be adaptive and capable of learning by doing.

## *Promote Learning with a Knowledge Base That Can Adapt*

Adaptive management has been promoted as a flexible and self-conscious process of management whereby practitioners of environmental management learn about the nature of the place for which they are responsible through well-intentioned and systematic trial and error. Under a paradigm of adaptive management, landscapes become laboratories for cautious experimentation. The lessons learned through adaptive management will be documented and advanced through case studies of specific projects and places. This inductive approach to ecological knowledge will allow for the conceptualizations of places, projects, and problems to evolve as new knowledge of each is acquired. [There is a loosely organized but expansive body of literature in the field of adaptive management (Walters 1986, Walters and Holling 1990)].

### *Knowledge Must Be Accessible to Diverse Stakeholders*

A public ecology is also about creating a language that is accessible enough to support both broad participation and meaningful deliberation in environmental decision making. Language is essential to any negotiation, and if participants are to influence the goals and outcomes of management, they will need to communicate effectively with other participants. Effective communication demands a solid understanding of what values, norms, terminologies, and methods are acceptable or unacceptable to oneself and to others. This is one of the most serious challenges that a more public ecology will face. We need to develop a language that facilitates effective communication among diverse participants, a language that is sufficiently precise to allow scientific study and sufficiently accessible to encourage broad participation (Norton 1998).

This language needs to develop in several dimensions. First, the constructs used to study and manage nature need to be explicit. As we have argued above, negotiation will be improved if the values behind these constructs are made explicit, as opposed to implicit or concealed by ambiguous or scientized terms. Second, just as terminology should not be allowed to conceal values, it should not be allowed to conceal scientific uncertainty. Terminology should include information about the uncertainty and variability inherent in any attempt to describe, predict, or understand ecological systems.

Poorly constructed terms are a problem because agreement is superficial and confusion results if people using the same term mean different things or nothing at all. Likewise, and perhaps more sinister, the constructive negotiation of goals, objectives, and outcomes is undermined if terms that conceal values or uncertainty are used (intentionally or unwittingly) to deflect and confuse a dialogue about values by making it appear to be a strictly technical or scientific issue. Most critically, we believe that the will to participate in the negotiation is stifled when stakeholders do not have a meaningful language to use to engage in productive dialogue. Scientists, nonscientists, and other contributors to environmental knowledge need to know the intentions behind the concepts being used to set environmental policy so that they can develop the trust needed to implement that policy. Helford (this volume) notes that some critics of the restoration efforts in Chicago argued that poorly defined terms gave restorationists room to make mistakes and conceal true motives.

A meaningful language of a more public ecology must reference visible features of the landscape. Participants must be able to see and evaluate environmental quality if they are to judge whether they are making progress toward their desired future conditions. Nassauer (1988, 1992, 1995, 1997) has written extensively on this topic. The visual landscape is a powerful communications tool that can educate people about ecology and land stewardship. People learn from what they see. Constructs used to evaluate environmental quality should be visible and interpretable by stakeholders. Instead of hiding ecological processes behind buffer strips, land management should lay open, display, and exhibit ongoing ecological processes and the benefits of management. Such an aesthetic would help promote an ecologically literate public, which is critical for planning an environmentally sustainable future: "If we can see that the landscape is not healthy, we might do something about it. . . . But we are unlikely to do that if we can't see it" (Nassauer 1992, 240).

Finally, a more public ecology will bridge the gap between science and policy. A more public ecology not only will exist at the interface of science and policy, but also will function as a joint product of these sometimes disparate realms. The language of a more public ecology will facilitate the flow of ideas and information in both directions, from one side to the other and back again. Constructing this bridge is the responsibility of both science and policy (Norton 1998).

## Conclusion

Environmental decision making is a tournament of competing conservation agendas in which some values and beliefs are held up and exalted, others are dismissed and ignored, and still others are left implicit and unnoticed. Stakeholders compete in the tournament to advance their value systems through the science they advocate or practice, through the definitions of environmental quality they use or study, and through the management goals they champion. It is our contention that participants who hope to compete successfully in this tournament of values should understand the rules of the game, which includes understanding the language used to discuss and describe nature. In particular, participants should understand that the terms used to describe ecological conditions are value-laden.

Perusing the editorials in professional environmental science journals, one frequently encounters the lament that the public is ignoring "our science": "If only we could educate the public, they would agree that we know what is best." In this chapter we have argued that "what is best" is negotiable; neither science nor nature provides value-free directives for management, and many people are equally well qualified to participate in the negotiation about values.

We contend that ecological scientists, professional environmental managers, and involved citizens are all stakeholders with an essential role to play in developing a body of managerially relevant environmental knowledge. This more public ecology will draw on established ecological theory and existing environmental policy and ultimately must fit within that context. A more public ecology will be a more powerful ecology. It will facilitate the negotiation and construction of restoration and management goals. It will help make ecological science relevant to ecological management. It will level the playing field in the tournament of values so that participants have a better command of the rules of the game and a clear vision of what it means to succeed. It will get stalled projects out of the courts and into adaptive management, where active and well-intentioned stewardship can be practiced and valuable lessons learned sooner rather than later. Ultimately, the trials and tribulations of restoration and management projects boil down to a debate about which nature we want and why. We hope that this chapter, with its focus on ecological definitions of environmental quality and its vision of a more public ecology, will improve the quality of this debate.

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