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Essays

Beyond Biology: toward a More Public Ecology for Conservation

DAVID P. ROBERTSON AND R. BRUCE HULL*

Department of Forestry, College of Natural Resources, Virginia Tech (0324), Blacksburg, VA 24061, U.S.A.

Abstract: *The ultimate purpose of conservation science is to inform and affect conservation policy. Therefore, conservation biologists and all the people who produce, review, and apply conservation research should evaluate the success of their knowledge according to its ability to influence conservation decisions. In addition to possessing conventional "scientific" attributes such as validity, generalizability, and precision, conservation knowledge must also possess qualities that make it effective in the political arena of decision making. "Public ecology" is a philosophy and practice of conservation science that goes beyond biology and beyond the norms of modern science to construct knowledge that is useful for environmental decision making. As post-normal conservation science, public ecology is defined by the following six attributes: evaluative, contextual, multiscalar, integrative, adaptive, and accessible. We discuss the need for a more public ecology and describe the qualites that make it a more powerful ecology.*

Más allá de la Biología: Hacia una Ecología más Pública para la Conservación

Resumen: *El propósito fundamental de la ciencia de la conservación es el informar y afectar las políticas de conservación. Por lo tanto, los biólogos conservacionistas y toda la gente que produce, revisa y aplica la investigación en conservación debería evaluar el éxito de su conocimiento de acuerdo con su capacidad de influenciar las decisiones sobre conservación. Además de poseer atributos "científicos" convencionales (validéz, generalización, precisión), el conocimiento sobre conservación debería también tener cualidades que lo hagan eficiente en el entorno politico de la toma de decisiones. La "ecología pública" es una filosofía y una práctica de la ciencia de la conservación que va más allá de la biología y de las normas de las ciencias modernas para construir el conocimiento y que es útil para la toma de decisiones ambientales. Como la ciencia post-normal de la conservación, la ecología pública se define por los siguientes seis atributos: evaluativa, contextual, multiescala, integrativa, adaptativa y accesible. Discutimos la necesidad de una ecología más pública y describimos las cualidades que la convierten en una ecología más poderosa.*

Introduction

In recent years, a variety of people have come together to establish conservation biology as a distinct academic discipline and professional activity. The members of the Society for Conservation Biology, the readers of this journal and related conservation literature, and conservation practitioners (professional and lay) are a diverse and heterogeneous group. What these many conservation biologists share in common is a desire to protect Earth's biodiversity. In addition, and equally important, these conservation biologists share a certain degree of faith that science is a cognitive authority with solutions to current and future environmental crises. We must bear in mind, however, that conservation biology is more than science (Hunter 1996; Noss 1996; Saberwal & Kothari 1996; Allendorf 1997).

Our intention is to introduce the readers of *Conservation Biology* to "public ecology." Drawing on the earlier work of Soulé (1985), Jacobson (1990), and Hunter (1996) we contend that conservation biology "is not just a subset of biology"; rather, it is "cross-disciplinary, reaching far beyond biology into subjects such as philosophy, economics, and sociology—disciplines that are concerned with

*Address correspondence to R. Bruce Hull, email hullrb@vt.edu
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the social environment in which we practice conservation—as well as into subjects such as law and education that determine the ways we implement conservation" (Hunter 1996:14). We agree that knowledge must derive from a multidisciplinary science; it also must influence public decisions about conservation. The ultimate purpose of conservation biology knowledge is to inform and affect conservation policy (Meffe 1998). Therefore, the people who produce, review, and apply conservation knowledge should explicitly evaluate it for its ability to influence conservation decisions.

We use the term *public ecology* to draw attention to the public decision making context to which conservation knowledge is applied. In addition to possessing reliability, validity, generalizability, theoretical rigor, and other "scientific" qualities frequently discussed in the pages of this journal, public ecology knowledge also must possess qualities that make it effective at influencing conservation decisions. Public ecology, thus, is an attempt to push conservation biology to become a post-normal science (Funtowicz & Ravetz 1990; 1991; 1995), a science that stems from the normative goal of biological conservation and reflexively evaluates the knowledge it constructs for the qualities that make it effective at influencing conservation decisions. In this essay we seek to (1) justify to an audience of conservation biologists the need go beyond biology toward a more public ecology and (2) discuss criteria that make knowledge effective at influencing conservation decisions.

Nature and Science

Implications of Disturbance Ecology and a Humanized Earth

Recent ecological theory tells us that nature is both chaotically complex and continuously changing. The landscape is dynamic at all scales of space and time and thus many conditions of nature have existed and can exist. Ecological science cannot identify one of these many possible conditions of nature as being better than another without invoking some value system that answers the question "better for what purpose?" There are many possible natures, many of which possess health, integrity, diversity, and other desirable qualities (Botkin 1990; Pickett et al. 1997).

In addition, contemporary understandings of ecology recognize that extensive and intensive human-wrought changes have irreversibly propelled all ecosystems along new trajectories of change (e.g., Cronon 1983; Denevan 1992; Crumley 1994). Few if any current ecosystems are, or ever have been, pristine. "Wilderness" is an ideal (Callicott & Nelson 1998). As such, biological integrity and wild nature are insufficient and ambiguous benchmarks for contemporary conservation (Cronon 1995; Callicott et al. 1999). Furthermore, human society is not necessarily incompatible with biological diversity and ecological integrity (Gómez-Pompa & Kaus 1992; Saberwal 1996; Zimmerer & Young 1998; Pykälä 2000).

Throughout most of the twentieth century, both ecological science and conservation philosophy have tended to ignore the historical fact that people are part of nature. Conservation biology, however, cannot afford to overlook the active role of humans as an integral component in ecological, evolutionary, and environmental processes. In the midst of fragmented ecosystems, invasive species, and global warming, conservation biology needs a vision of nature, ecological science, and environmental management that includes human society. If we hope to stem the tide of environmental degradation and biodiversity loss that is rapidly flooding the planet, then we should turn our attention to the managed landscape, to the places where we live, work, and play (Di Castri & Younès 1996; Szaro & Johnston 1996). We should not assume that nature, if left alone, will take care of itself. Rather, if we want the environment to be a certain way, we must actively manage for the conditions we desire. People must be part of the equation.

What is a good-quality environment? What should be the goals of conservation? There are no simple answers to these essential questions. There are no "natural imperatives" or "scientific laws" that answer these questions; rather, conservation goals derive from people's values and beliefs about nature and human society. The problem is that although science is widely accepted as a cognitive authority in the modern world, science alone cannot provide valid goals and objectives for conservation decision making (Beck 1992; Irwin 1995; Policansky 1998). Hence the need for a more explicitly public ecology.

Critique of Science

Relatively speaking, modern science is a young intellectual pursuit (Butterfield 1957; Merchant 1980; Shapin 1996). The scientific revolution and the Enlightenment project of modernism are only several hundred years old. Contemporary science scholars, including philosophers, historians, and sociologists of science as well as self-reflexive, practicing scientists, have critiqued the ideals of modern science—objectivity, value neutrality, and logical positivism—as wishful thinking and naïve optimism (e.g., Latour 1987; Longino 1990; Haraway 1991).

Until recent decades, the scientific enterprise was significantly more idealistic than it is today, and many scientists and science advocates overlooked the need for modesty and humility as prerequisites to the pursuit of truth (Appleby et al. 1994; Shapin 1994; Anderson 1995). Times have changed however, and so have our expectations of science. Today, science scholars, working scientists, and the general public are more aware of the limitations that prohibit society from ever achieving a complete, objective, and universal knowledge about the world and how it works. Science is increasingly accepted as both partial and incomplete, a sometimes privileged but forever limited body of knowledge.

Science scholars have compiled extensive empirical evidence to support their claims that science is a historically situated cultural practice, and the knowledge constructed by scientists inevitably reflects the social context in which it is produced and used (Tobey 1981; Kingsland 1985; McIntosh 1985; Sagoff 1988; Golley 1993; Barbour 1995; Bocking 1997). These science scholars see scientific knowledge less as an objective reflection of the way the world is and more as an intersubjective social activity that (re)produces and extends particular visions of reality through and with networks of power (Latour 1987; Haraway 1991; Golinski 1998). For example, throughout the past several centuries the scientific literature has been full of debate about the order and classification of nature. Competing definitions about what constitutes a species (e.g., Linnaeus and Buffon in the eighteenth century; Hankins 1985; Stemerding 1993; Foucault 1994), a community (e.g., Clements and Gleason in the early twentieth century; Whittaker 1962; Tobey 1981; Journet 1991; Barbour 1995), and an ecosystem (in the mid-twentieth century; Golley 1993; Bocking 1997) reflect the struggles for power and the historic contingencies that produce ecological knowledge (see also Saarinen 1982; McIntosh 1985; Real & Brown 1991; Worster 1994).

Many of these scholars contend that scientific knowledge is not only contingent but also purposeful. Knowledge is closely coupled with power, and all knowledge is knowledge for some purpose. They argue that science is a persuasive discourse constructed to serve specific sociopolitical goals. In this sense, knowledge is more powerful (i.e., effective) the more finely it is tuned to its intended use.

In addition to recognizing the limitations of science resulting from its contingent and purposeful qualities, scientists have increasingly recognized the extent to which uncertainty limits the role science can play in many environmental decisions. Uncertainty, in the face of overwhelming complexity, is increasingly accepted as a given (Lemons 1996; Eden 1998). The world and how it works is so complex, chaotic, and changing that, relative to what might be known about it, we now know very little, and we are not likely to ever know all that much.

Based on earlier work by Wynne (1992), Yearley (2000) defines four levels of uncertainty. Conservation decisions are and must be made at each level, but the role of science in the decision differs dramatically depending on the level of uncertainty. At the first level of uncertainty, risk is estimated and characterized through science with statistical estimates of error, reliability, and precision. The next level involves more uncertainty because the system is not understood well enough to have quantified its properties, but most of the main parameters likely to affect the outcome are known. (Ecosystems are difficult to define as ecologically significant units because of their dynamism and their indefinite boundaries, but we know that energy flow, population dynamics, and keystone species are important parameters for most ecosystems.) The third type of uncertainty is ignorance. In cases of ignorance, we don't know what we don't know. In other words, we don't even know the main parameters (e.g., the impact of global warming on biodiversity). Lastly, indeterminacy is the highest level of uncertainty. It is impossible to know or predict how some systems will work because the system's operation depends in large part on human behavior that is likely to change in the future and thus is entirely outside the scope of scientific prediction (e.g., the effect of climate change on evolutionary processes).

From Positivism to Post-Normal Science

> In [the] "normal" state of science, uncertainties are managed automatically, values are unspoken, and foundational problems unheard of. The post-modern phenomenon can be seen in one sense as a response to the collapse of such "normality" as the norm for science and culture. As an alternative to post-modernity . . . a new, enriched awareness of the functions and methods of science is being developed. In this sense, the appropriate science for this epoch is "post-normal" (Funtowicz & Ravetz 1995: 146).

Historically, scientists working within the framework of a positivist philosophy of science (i.e., the ideals of logical positivism; Barry & Oelschlaeger 1996; Lélé & Norgaard 1996; Roebuck & Phifer 1999) have been notoriously unwilling to take a stand against issues such as environmental degradation and biodiversity loss. Under the hegemony of positivism, it is difficult to formulate and defend conservation goals on "scientific" grounds. Advocates of positivist science consider the explicit embrace of normative goals and concepts anathema to the scientific enterprise. From a strictly positivist outlook, science and policy, like facts and values, are considered incompatible and distinct discourses. This is one reason why many conservation biologists are unable to see the values inherent in their science and why many other scientists will not publicly advocate biological conservation and other forms of environmental protection.

Post-positivist scientists, including many conservation biologists, are striving to bridge what appears (from the viewpoint of positivism) to be a gulf, but is actually a fine line, between science and policy, facts and values. When scientists embrace normative conservation goals and concepts, however, they risk exposing to criticism the privileged status of their knowledge (Lélé & Norgaard 1996). For example, although many conservationists argue for more science and more scientific decision making (e.g., Lubchenco et al. 1991), it is the veiled role of science in setting conservation policy that has come under serious critique in popular books with subtitles such as *Dismantling the Fantasies of Environmental Thinking* (Kaufman 1994), *The Fight over Forests and the Rising Tyranny of Ecology* (Chase 1995), and *Philosophies of Paradise* (Takacs 1996).

The critique of modern, positivist science is unsettling and controversial, and the response of many scientists and science advocates has been defensive. Others have more gracefully or gratefully accepted the criticism as an opportunity to pursue a post-normal science. Many conservation biologists are characteristic of this new breed of self-reflective, normative scientists: practitioners who recognize and accept the fact that their science and the scientific knowledge they produce are never truly objective or universal but are always inherently uncertain, purposeful, and emergent. As a post-normal rather than positivist approach to knowledge, public ecology does not require conservation science to be objective or universal; rather, it requires that the knowledge constructed for conservation decision making reflect the pluralist and pragmatic context of decision making while striving for the rigor and accountability that earns scientific knowledge its privileged place in the sociopolitical arena where conservation decisions are made.

Conservation as a "Tournament of Value"

Conservation science may be uncertain, purposeful, and contingent, but conservation decision making involves a much larger and even more pluralistic body of knowledge, information, and belief. Conservation decision making is a "tournament of value" wherein many stakeholders, including conservation biologists, compete to advance their various agendas. In the tournament, many contestants reify "science" and "nature" and wield these ideals as if they held the sharp and definitive reality of swords. The tournament never ends, and although no human blood is shed, some values are held up and exalted, others are dismissed and ignored, and still others remain implicit and unnoticed.

An important and defining characteristic of conservation is the large number of stakeholders with diverse interests willing and able to involve themselves in decision making by setting and negotiating the goals of conservation. One way these goals are negotiated, and power exerted, is through definition and adoption of key terms. Many synonyms of environmental quality exist: *sustainable*, and *healthy ecosystems*, *biodiversity*, *naturalness*, and *ecological integrity* are just a few. These terms are important because they (1) direct scientific inquiry, (2) are used to set policy goals and evaluate management outcomes, and (3) inform and reflect public perceptions and expectations of environmental quality. These terms are both descriptive and prescriptive; they are used to describe what is and to negotiate what ought to be.

For example, the tournament is being fought on the pages of this journal and similar publications through active debate over the definition of key terms (Noss 1995; Callicott & Mumford 1997; Callicott et al. 1999; Redford & Richter 1999; Angermeier 2000; Hull & Robertson 2000). A recent review of conservation concepts by Callicott et al. (1999) demonstrates the normative dimensions of conservation knowledge and suggests an elegant scheme for organizing it around two schools of thought: compositionalism and functionalism. These two schools generate different understandings of ecology, have fundamentally different assumptions about the role of humans in nature, and are used to support dramatically different conservation decisions and agendas.

"Compositionalists perceive the world through the lens of evolutionary ecology, an essentially entity-oriented, biological approach to ecology that begins with organisms aggregated into populations" (Callicott et al. 1999:23). Humans are considered to be distinct from nature, and thus environmental quality is best when human modification is least. Conservation decisions based on the compositionalist school of thought emphasize the conservation of species and historically natural conditions (e.g., ecological restoration, biological integrity, native species).

In contrast, "Functionalists perceive the world through the lens of ecosystem ecology, an essentially process-oriented, thermodynamical approach to ecology that begins with solar energy coursing through a physical system that includes but is not limited to the biota (Odum 1968)" (Callicott et al. 1999:23). Humans are embedded within and not easily distinguished from nature, and human management can improve, or at least not degrade, environmental quality. Conservation decisions based on the functionalist school emphasize efforts to provide sustainable ecosystem services and processes (e.g., ecosystem health and sustainable development). The debate over which school—compositionalism vs. functionalism or some combination of both—is the correct way of knowing and valuing nature is evidenced in the rebuttals and rejoinders that followed publication of the 1999 article (Callicott et al. 2000; Hunter 2000; Willers 2000).

Those unaware of the values and ambiguity inherent in the normative knowledge identified by Callicott et al. (1999) may unknowingly bias policy deliberations when they define *nature* in ways that privilege some stakeholders while discouraging and eliminating other positions from consideration. The darker side is that the ambiguity may be used to intentionally deceive or obscure negotiations (Peterson 1997). Furthermore, vague descriptions of desired future conditions become ineffective goals when seemingly similar terms produce dramatically different environmental conditions and seemingly different terms produce remarkably similar conditions. These issues are critical in that (mis)communication and (mis)perception of ecological quality and how it is affected by management actions are sources of conflict that often derail and delay efforts to make and implement conservation policy.

Therefore, a more public ecology requires that conservation scientists share with a larger community of stakeholders the responsibility and the privilege of defining their research programs and constructing their knowledge, including their choice and definition of normative constructs. This extended peer community should review conservation knowledge according to traditional scientific criteria and other factors that make science effective at influencing conservation decisions.

Toward a More Public Ecology

What counts as a meaningful knowledge for conservation decision making? We believe that environmental decisions will be more useful and effective if the knowledge on which they are based is explicitly evaluative, contextual, multiscalar, integrative, adaptive, and accessible.

Evaluative Knowledge

The challenge to ecological science, and conservation biology in particular, is to develop constructs that are not just descriptively precise and hence powerful scientifically at describing situations, but also evaluatively rich and hence powerful politically for deciding which situations are best. "Integrity" and "health" are two conspicuous examples of evaluatively rich constructs in that they embody, display, and defend particular social values (Norton 1998).

Conservation decisions are decisions about socially valued environmental conditions. They are decisions that require society to make tradeoffs, not just between environmental conditions producing different types of environmental qualities, but between environmental quality and other socially valued qualities such as education, human health, and the economy. To be effective in the arena of conservation decision making, the terms describing ecological conditions must describe conditions valued by society and must explicitly connote those values to the people using the terms to negotiate land-use decisions (Norton 1998).

Indicators of environmental quality are a powerful and increasingly common tool for environmental management (Rapport et al. 1995; Sandhu et al. 1997; Bergquist & Bergquist 1999; National Research Council 2000). Indicators, which are too often defined only by scientists, illustrate why values must be explicitly and intentionally associated with key constructs that ecological sciences use to describe environmental conditions. Indicators are the measures, or aggregation of measures, that influence social decisions, actions, and allocation of resources. They are the measures of the environment that, through negotiation, have been identified as defining acceptable environmental quality. Indicators are the qualities of the environment that science monitors (e.g., fecal coliform for water quality for threatened and endangered species for biodiversity loss). Indicators trigger corrective management action when they exceed some negotiated level (e.g., ban on fishing and swimming or habitat restoration). Indicators enhance accountability by providing measurable evidence of progress toward agreed-upon goals (e.g., Are water treatment facilities protecting public health? Is a habitat restoration program working?). And, indicators engage affected and concerned communities in dialogue about the desired future conditions for their environment. Conservation biologists, local community and government leaders, national environmental organizations, development interests, land management agencies, and other stakeholders must negotiate a vision of what they consider acceptable environmental quality.

If they are to be effective, these measures of environmental quality cannot be free of social value and contextual relevance. They must reflect the values, norms, and goals of the society for which the environment is being managed. They must reflect the qualities of the environment that society cares about and is willing to allocate its limited resources to maintain. Regardless of how descriptively precise, reliable, and theoretically rigorous a measure might be, it is likely to be ignored or ineffective at influencing conservation decisions if it fails to reflect environmental qualities society understands and cares about.

Contextual Knowledge

Although environmental quality may be conceptualized in the abstract (e.g., biological integrity and ecosystem health), the specific goals and objectives of management must be determined in the context of the place-based projects where the management occurs. Management situations are unique in that both the people involved and the locations are unique. Because there is no universal theory of ecology—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 as there are in physics (McIntosh 1985; Sagoff 1988; Shrader-Frechette & McCoy 1993)—understanding nature for the purpose of making decisions about the goals and objectives of management requires a more case-specific knowledge (National Research Council 1986; Sagoff 1988; Shrader-Frechette & McCoy 1993, 1994; Shrader-Frechette 1995). Environmental knowledge thus should be particular both to the people using it and to the places where it is used. Scientists, professionals, and citizen experts who are engaged in constructing environmental knowledge should be cognizant that their research will be used by specific people, for specific purposes, in specific contexts (e.g., Escobar 1995). Therefore, environmental research must strive not only to be generalizable but must seek to be specifically applicable (Fleishman et al. 1999; Trulio 1999).

Multiscalar Knowledge

Scale is an essential and confounding issue in the construction and application of environmental knowledge (National Research Council 1986; Szaro & Johnston 1996). Nature exists at many scales: spatial (microscopic to biospheric), temporal (diurnal to geological), and organizational (e.g., genes, species, ecosystems, communities, landscapes, and their processes and functions). Which scale(s) one chooses determines the ecological attributes one studies as well as its spatial and temporal boundaries. Similarly, the decision of what scale to manage is not a given; it must be negotiated. The scale selected influences the outcomes of management.

Ecological research has tended to focus on ecological factors influencing selected species over brief time horizons (years) and small sites and to ignore the ecological factors influencing less interesting species, longer time horizons (decades), and large, politically fragmented landscapes (Pimm 1991; Norton 1998; Rapport et al. 1998). The restricted scope of these studies is due not only to issues of complexity but also to funding limitations. Studies conducted at larger spatial scales and over longer time frames are often too general or lack sufficient detail to support decision making in land management. Knowledge likely will be most useful to conservation decision making when it reflects scales that are relevant to specific management cases. Management decisions require information not only about the site at hand, but also about tradeoffs among many potential species, located at multiple sites, over decades of periodic anthropogenic disturbances.

The work of hierarchy theorists (e.g., Holling 1992), Norton (1991; 1995; 1998) 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) delimits 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 expansive scales of space and time is essential for meaningful discussions about sustainability and the goal of sustaining ecosystems where stakeholders are asked to think beyond their immediate and local self-interests (Folke et al. 1996; Rapport et al. 1998).

Integrative Knowledge

Informed environmental decision making requires the multiscalar integration of a vast array of knowledge across disciplines and a diverse public. If this mixed bag of environmental knowledge is to be relevant to management, then the units of analysis (at a minimum) must be compatible across disciplinary, institutional, geographic, and temporal boundaries. This integration is often hindered because environmental knowledge is produced within specialized disciplinary and institutional boundaries. This knowledge may be ineffective for policy or management because it is not meaningful outside of its context of origin and it is not transferable across the multiple language communities participating in decision making (i.e., groups and subgroups of natural scientists, social scientists, humanities scholars, environmental professionals, politicians, industry representatives, and citizen activists) (Bryant & Wilson 1998; Scoones 1999). Environmental research will be more useful to decision makers if the units of analysis are compatible from one study to the next despite their source of origin. Ideally, these units of analysis might be aggregated or disaggregated from one scale, location, or situation to another, according to the management decision at hand.

Adaptive Knowledge

A body of environmental knowledge that is contextual, multiscalar, and integrative will be difficult to achieve, and it will never be complete or finalized. Just as knowledge of the environment is always normative, it will likewise be forever partial and limited. Therefore, public ecology must be adaptive: it must be a body of knowledge that is open and alive rather than closed and dead (Bowker & Star 1999).

Adaptive management has been promoted as a flexible and self-conscious process of stewardship whereby practitioners of environmental management learn about the place for which they are responsible through well-intentioned and systematic efforts of trial and error (Holling 1978; Walters 1986; Walters & Holling 1990; Lee 1993; Szaro 1996; Norton 1998; Callicott et al. 1999). Under a paradigm of adaptive management, landscapes become laboratories. The environment itself is a place for cautious experimentation. The lessons learned through adaptive management are documented and advanced through case studies of specific projects and places (National Research Council 1986; Shrader-Frechette & McCoy 1993, 1994). This inductive, hands-on approach to ecological knowledge allows for conceptualizations of places, projects, and problems to evolve as new knowledge of each is acquired. Adaptive management, and adaptive knowledge more generally, are a cornerstone of a more public ecology.

Accessible Knowledge

A public ecology is also about creating a language that is accessible enough to support broad participation and meaningful deliberation in environmental decision making. Language is essential to any negotiation. 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, assumptions, errors, and methods are acceptable or unacceptable to oneself and to others (Throgmorton 1991). This is one of the most serious challenges facing public ecology.

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. This language needs to develop in several dimensions. First, the constructs used to study and manage nature need to be explicit. 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, but closely related, the terminology of public ecology needs to be precise. Just as terminology should not be allowed to conceal values; it should not be allowed to conceal scientific uncertainty or level of error (Yearley 2000).

A meaningful language of public ecology might also reference visible features of the landscape. Various stakeholders in the decision-making process must be able to see and evaluate environmental quality if they are to judge whether they are making progress toward their desired future conditions. "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). Nassauer (1988; 1992; 1995; 1997) contends that the visual landscape is a powerful tool for educating people about ecology and land stewardship. People learn from what they see. At some level, the constructs used to evaluate environmental quality will need to be interpretable by stakeholders who must act on the information. For example, instead of hiding ecological processes behind buffer strips, land managers should display and exhibit on-going ecological processes and the benefits of active management. Such an aesthetic would promote the ecologically literate public that will be critical for planning an environmentally sustainable future (Hull et al. 2000).

Conclusion

Both nature and science are dear to the heart of conservation. They are the ontological (what we know) and epistemological (how we know it) foundations on which conservation programs are built. Conservation biology is a most striking example of this affinity. As conservationists are increasingly aware, however, the epistemology of traditional modern science and the ontology of nonhuman nature are cultural ideals increasingly called into question (Cronon 1995; Soper 1995; Soulé & Lease 1995; Escobar 1999; Scoones 1999). We have explored some of the opportunities and constraints that conventional ideas of nature and science pose for conservation.

Ultimately, environmental politics and conservation decision making are a tournament of value wherein stakeholders compete to advance diverse agendas. The tournament is inherently political and shamelessly unscientific. If conservationists wish to accomplish their goals, then they must adopt a philosophy, science, and practice of conservation that will allow them to compete effectively and win the tournament.

Public ecology is a more powerful ecology. It is a body of environmental knowledge that seeks to bridge the gulf between science and policy. Public ecology not only exists at the interface of science and policy but functions as a joint product of these generally disparate realms. The language of public ecology facilitates the flow of ideas and information from one side to the other and back again. Constructing this bridge is the responsibility of everyone involved, particularly conservation biologists and other informed citizens (Meine & Meffe 1996).

Perusing the editorials in professional environmental science journals, one frequently encounters the lament that science is being ignored by the public: If only we could educate the public, then they would agree that we scientists know best. However, what counts as environmental quality is negotiable. Mother Nature nor science (as the study of nature) can provide value from directives. Moreover, a variety of stakeholders are qualified to participate in the negotiation of environmental quality.

Conservation science has taken a leadership role in shaping the discussion and definition of environmental quality. To maintain this leadership, we recommend that conservation biologists actively participate in the political and social arenas to gain feedback about developing a more public ecology. Extended peer review is one way to receive input from people outside academia and the scientific community. Regulators, policy analysts, and litigants should actively influence the environmental debates on the pages of this and similar journals. The self-serving goal of conservation biologists should be to make the science of conservation biology more relevant to the regulation, politics, management, and litigation of biological conservation. Noss (1990:243) argues that the debate within conservation biology about which way to understand nature should at least be informed by sociopolitical concerns about "which approach will save the most biodiversity in the shortest time."

We contend that ecological scientists, professional environmental managers, and involved citizens are all important stakeholders with an essential role to play in developing a body of managerially relevant environmental knowledge. Public ecology draws on established ecological theory and existing environmental policy and ultimately must fit within that context. Public ecology facilitates the negotiation and construction of management goals. It helps make ecological science relevant to ecological management. It levels the playing field in the tournament of value so that participants have a better command of the rules of the game and a clear vision of what it means to succeed. It orders 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. We encourage conservation biologists to actively join in the construction and critique of this conservation knowledge.

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