Public Ecology: Linking People, Science, and the Environment

David Porter Robertson

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Robert Bruce Hull, IV, Co-Chair
Mark V. Barrow, Co-Chair
Paul L. Angermeier
Timothy W. Luke
Patrick A. Miller

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(ABSTRACT)

Truly unique and innovative solutions are needed to resolve today's complex and controversial environmental issues (e.g., biodiversity loss, global warming, cultural evolution, etc.). In response to these concerns, a variety of applied science programs have emerged to help people make better decisions about the environment. Each of these programs (e.g., conservation biology, restoration ecology, sustainable forestry, environmental toxicology, and others) produces specialized knowledge that is used to achieve specific social and environmental goals. For example, the peer-reviewed, scientific analyses published in *Conservation Biology* are most likely concerned with the goal of preserving biological diversity, whereas the equally scientific and respected analyses published in *Forest Science* are most likely concerned with the goal of sustaining timber yields. Likewise, studies in environmental toxicology investigate risks to human health by environmental pollutants, while studies in ecological restoration serve to maximize the integrity of natural systems. Unfortunately, these diverse forms of knowledge offer multiple and often conflicting ways of thinking about the environment. *Public ecology* is a response to this dilemma. The primary goal of public ecology is construct common ground between people's diverse beliefs and values for the environment. Toward this end, public ecology is an interdisciplinary and collaborative approach to environmental science and politics. Public ecology integrates perspectives from the social and natural sciences, the humanities, and public understandings of the environment. Public ecology is not only a cross-cultural and comparative form of environmental studies, it is also a citizen science that encourages all concerned stakeholders to participate with research specialists, technical experts, and professional decision-makers in developing creative solutions to persistent environmental problems.

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Preface

Observing the Geometry of Rainfall: A Lesson in the Order of Nature

In the summer of 1999, several friends and I canoed for a week in the glacial lakes along the Canadian-American border. On the fourth day of our trip, it rained hard and we decided to linger in camp. There was no wind that day and the rain fell straight and constant in solid but gentle drops. It was either mid-morning or mid-afternoon, I don't remember, but, Bruce Hull, my mentor and friend, was quietly hunched by the water's edge, the hood of his parka pulled over his head, his back toward me. I wondered, "What is he doing?" "What is he thinking?" Eventually, overcome with curiosity, I walked over and interrupted his solitude.

"What are you doing?" I asked. Bruce replied that he was "observing the geometry of rainfall" and that I should join him. I chuckled.

He suggested that I look at the surface of the water and tell him what I saw there. Not knowing exactly what I might see, but willing to entertain his propensity for mind games, I obliged. I sat down beside him and I stared at the water. I saw nothing.

I asked Bruce to explain. He said, "Relax and gaze with soft eyes just where the drops of rain touch on the lake's surface." This was not one of his usual gimmicks; he was absolutely serious. I looked again at the rainfall on the surface of the lake, resolving to be more patient. "What am I supposed to see," I muttered to myself. "What is it about the rain drops and the water?" Surely he must be teasing. Eventually, I thought and said as much. Bruce replied, "keep looking." I wanted an explanation—Bruce wanted me to learn something.

Within seconds, I saw it! Rather, I saw them—patterns: patterns emerging, everywhere, all across the surface of the lake. Straight lines, triangles, rectangles, other geometric shapes of all sizes, everywhere, connecting the drops. I was amazed. What was I seeing? Was there an order to the raindrops? Were they falling in patterns? Not possible! "What is happening? What am I seeing?" I thought, "certainly rain falls at random, not in an orderly, geometric fashion?"

I asked Bruce if the patterns were really there or if my eyes were playing tricks on me. He replied simply "I do not know."

Is there an order to nature? I do not know. What I do know is that the human brain will work hard to make sense out of chaos. Therefore, in observing nature, and the world around us, we should be critically aware of the power of mind and culture to find order where none may exist. My reaction to experiencing the geometry of rainfall is that many of the apparent patterns we see in the world are mere figments of our creative imaginations.

I am not so brazen as to claim that there is absolutely no order to nature, but I do believe that in observing the world around us, much of what we see will be in the form of our own making, reflecting a nature we wish to see and believe. Since that day in the rain, I have continued to learn that if and when people study nature, the things we discover will likely serve a purpose in our lives. Finding order in nature serves to diffuse the cognitive dissonance posed by a constantly changing environment. More significantly, the order we seek, find, and create will reflect our self identities, social aspirations, and cultural worldviews. This manuscript is an opportunity to reflect on these issues.

Acknowledgements

> I do not see how anyone can write about ideas and not develop at least some degree of ecological consciousness. Such writing inevitably leads one to realize just how much one's "own" ideas are a complex interactive function of the ideas that one has absorbed from others—others whose "own" ideas are, in turn, a complex interactive function of the ideas they have absorbed, and so on.
>
> Warwick Fox 1990

The questions entertained in this manuscript are the result of thoughts and experiences I have shared with many people. Bruce Hull deserves special recognition for having given me the opportunity to pursue these ideas. Bruce, as a boss, mentor, and friend, has been a constant source of inspiration and support. He leads by example, gently prodding as necessary. Together, we have muddled through six years of work, every minute of which seemed like play. Bruce's family—Constance, Quinn, and Liz—deserve equal applause for sharing their life and home with me during these years.

Many other colleagues have influenced this work. Denis Wood, in his own unique way, taught me the art of asking questions. Rob Pena shared his enthusiasm for acting with "intention" in all aspects of life. Steve Badanes encouraged me to be my own biggest fan! I thank Joe Roggenbuck for being a fine man and for teaching me the value of radical empiricism. Ann LaBerge will always be first among equals. Mark Barrow has consistently provided an open door, rocking chair, editorial pen, effusive recommendations, and otherwise genuine commitment to my intellectual development and well-being. Paul Angermeier has kept me honest regarding ecological theory, the imperative of naturalness, and my own wildness. Patrick Miller supplied exceedingly kind, encouraging, and timely words. Tim Luke has expanded my vocabulary and stretched my intellectual horizons.

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Closer to home, I'd like to thank friends and family: Bartlett Lincoln for being the voice of reason, Gilson Lincoln for yogic moments, Stuart Sherwood for philosophical reflections, Chris Gowen for science lessons, Stuart Massie for putting out fires, Sarah Wheeler for style and grace, and my nephews, Leighton and Taylor, for peace and quiet. Lastly, and most importantly of all, I thank my parents, Leighton and Kitty Robertson, for having faith in all things great and small.

Introduction

What is Public Ecology?

Truly unique and innovative solutions are needed to resolve today's complex and controversial environmental issues (i.e., biodiversity loss, global warming, and other forms of environmental change, etc.). In response to these concerns, a variety of applied science programs have emerged to help people make better decisions about the environment. Each of these programs (e.g., conservation biology, restoration ecology, sustainable forestry, environmental toxicology, and others) produces specialized knowledge that is used to achieve specific social and environmental goals. For example, the peer-reviewed, scientific analyses published in *Conservation Biology* are most likely concerned with the goal of preserving biological diversity, whereas the equally scientific and respected analyses published in *Forest Science* are most likely concerned with the goal of sustaining timber yields. Likewise, studies in environmental toxicology investigate risks to human health posed by environmental pollutants, while studies in ecological restoration serve to maximize the integrity of natural systems. Unfortunately, these diverse forms of knowledge offer multiple and often conflicting ways of thinking about the environment. *Public ecology* is a response to this dilemma.

The primary goal of public ecology is construct common ground between people's diverse beliefs and values for the environment. Toward this end, public ecology is an interdisciplinary and collaborative approach to environmental science and politics. Public ecology integrates perspectives from the social and natural sciences, the humanities, and public understandings of the environment. Public ecology is not only a cross-cultural and comparative form of environmental studies, it is also a citizen science that encourages all concerned stakeholders to participate with research specialists, technical experts, and professional decision-makers in developing creative solutions to perennial environmental problems.

The Public Ecology Project

In 2000, Bruce Hull and I co-founded *The Public Ecology Project* (PEP) at Virginia Tech to promote this vision of public ecology. The purpose of *The Public Ecology Project* is fourfold:

1) promote the theory, practice, and community of public ecology;
2) establish public ecology within a wide range of popular, academic, and professional institutions;
3) organize an international network of public ecology practitioners;
4) formalize public ecology as a self-supporting, membership society.

To accomplish this vision, we engage in networking and community organizing, public education, applied research, curriculum development, and produce publications, websites, and public forums (Appendix A contains more information about PEP). As part of this larger project of institutionalizing public ecology in the international environmental community, this manuscript describes the recent growth, current status, and future potential of this new field of work.

A Brief History of Public Ecology

The phrase *public ecology* was initially coined to describe "a body of knowledge for environmental decision making" (Hull & Robertson 2000). In a subsequent paper, public ecology was defined in more critical terms as a post-normal, postmodern science of ecology: an environmental science that goes "beyond biology" and "beyond the norms of modern science" to construct knowledge that is more useful and more powerful for contemporary decision making (Robertson & Hull 2001a). More recently, other scholars have helped to advance the field.

Most notably, Luke's (2001) interpretation of public ecology confirms the field's interdisciplinary qualities:

> A public ecology should fuse the concerns of public health with the activist engagements of a critical political ecology. By pushing past the exhausted conceptual divisions from the 1980s, which largely divided the more natural science-based "environmental sciences" from the more social science-focused "environmental studies," public ecology should mix the insights of life science, physical science, social science, applied humanities, and public policy into a cohesive conceptual whole.

Luke (2001) also confirms the biocultural dimension of public ecology:

> Public ecology must admit that the built and unbuilt environment are one and of a piece, not two and wholly separable.

Luke's (2001) major contribution to the development of public ecology is in linking this new form of interdisciplinary and collaborative biocultural science to the emergent

processes of globalization that exist in today's world risk society (Beck 1992; 2000). In particular, Luke (2001) is commended for extending public ecology to the post-national and subpolitical spheres of globalization:

> Unfortunately, most thinking about global studies does not fully reexamine how the uneven globalization of big technical systems has implanted this all-pervasive subpolitical domain beneath, beyond, and beside the tense sphere of politics. To manage the operational challenges of living with both the political and subpolitical, we need a public ecology that can work equally well in built and unbuilt environments, industrial and natural ecologies, social and biotic communities. The ethical imperatives of coping with inequality in such a public ecology should give a better perspective on safeguarding world health and the environment than remaining bogged down in outmoded devotions to a civic activism that is trapped in the parochial loyalties of the national political sphere.

My intention in writing this manuscript is to further establish this new science of public ecology as a guiding paradigm for interdisciplinary environmental research and education in the twenty-first century.

A Word about Methods and Presentation

The purpose of this manuscript is to explore, develop, and promote the theory, practice, and community of public ecology. To accomplish this goal, I have collected and synthesized a broad range of empirical evidence from a wide variety of sources. The research and writing presented here is a reflection and extension of the investigations that I have been conducting throughout the past ten years of my undergraduate and graduate studies. Much of this work has been a collaborative effort (see Acknowledgements).

The data collection methods fall into three principal categories: 1) ethnographic, participant-observation: participation in numerous public meetings, workshops, and community events; 2) interview: formal and informal interviews and focus groups with key informants; and 3) survey: academic, gray, and popular literature, historical documents, internet websites, research archives and related information databases. Data analysis and interpretation for the study has occurred iteratively and is perhaps best described in terms of interdisciplinary discourse analysis (e.g., Potter & Wetherell 1987; Peterson 1997). In general, the methods are consistent with those of other investigators in the field of environmental "science studies" (e.g., Takacs 1997; Dizard 1994; Helford

1999) For more information regarding methods of data collection and analysis see related publications (i.e., Robertson & Hull 2001b; Hull et al. 2001).

Style, Content, and Narrative Structure

In light of the complexity and controversy surrounding contemporary environmental issues, it appears that new forms of knowledge are appropriate for understanding environmental problems and guiding environmental decision making (Jasanoff 1996; Shrader-Frechette & McCoy 1993, 1994; National Research Council 1986). Therefore, in the research and writing of this manuscript, I seek to transcend traditional norms and conventions of modern, western thought in order to create a story that will be meaningful and relevant to contemporary environmental stakeholders. The elusive ideals of objectivity and truth have not been mine. Rather, I am advocating a plurality of pragmatic postmodern ecologies (ways of knowing the environment) for use in global society (Beck 2000; Gandy 1996; Murdoch & Clark 1994; Haraway 1991).

This work is designed to speak to as wide an audience as possible. Both the research and writing of this manuscript were performed strategically in order that they might appeal to popular, professional, and academic audiences representing a variety of disciplines, perspectives, and interests. This includes researchers, educators, students, and decision makers representing a variety of disciplinary, professional, cultural, and personal points of view.

The manuscript includes the present introduction, three chapters, and two appendices. Each of the three chapters is intended for publication as an individual journal article and has been written accordingly. As a whole, the dissertation provides a basic format for future publication of a book. The introduction describes the purpose, relevance, and scope of the study. Chapter 1 describes the social construction of the Southern Appalachian Ecosystem and advocates a biocultural ecology. Chapter 2 examines the politics of ecology through a case study of biodiversity science, the ecosystem concept, and ecoregional approaches to ecosystem management in a global society. Chapter 3 draws lessons form a wide variety of empirical studies to outline the key dimensions of a more “public” science of ecology. The conclusion summarizes the

current status of public ecology as presented in this introduction, the three chapters, and appendices.

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Chapter 1

Biocultural Ecology: A Case Study of the Southern Appalachian Ecosystem

> As argued by its earliest advocates the Appalachian movement was a plan to establish a great National Park. As advocated by Secretary Wilson and the forest Service it was a scheme to establish a series of National Forests with the three-fold objective of timber conservation, water regulation, and recreation grounds, with other incidental benefits. As finally authorized by Congress the plan is a project to protect the headwaters of navigable rivers, with other benefits to be considered as incidental. As the undertaking actually works out on the ground it is a movement to remake the Appalachians, transform the unfortunate social and industrial conditions which have long prevailed there, and set the region to performing the function for which it was clearly intended. Stream protection, forest conservation, human recreation, and social welfare are the important elements in the plan.
>
> William L. Hall 1914:323,326

Introduction

The Southern Appalachian Ecosystem (SAE) is a scientific fact.[1] A growing body of environmental discourse makes reference to this place (e.g., Davis 2000; Peine 1999; Ricketts et al. 1999; Boone & Aplet 1994). Global biodiversity science, international environmental politics, regional economic development, and local community identity are a few of the many interests with a stake in the ecosystem. However, despite its recent prominence and current appeal, the phrase "Southern Appalachian Ecosystem" does not reference one specific region. There are no boundaries and core area defining the ecosystem that are undisputed or easily identified either on a map or on the ground. The Southern Appalachian Ecosystem is not a distinct physical location and specific set of environmental conditions. The Southern Appalachian Ecosystem is not simply "out there" in the landscape. Rather, this sense of place is a socially constructed reality (Greider & Garkovich 1994; Evernden 1992). The Southern Appalachian Ecosystem, like all ecosystems (Golley 1993; Keller & Golley 2000), is an idea that exists in the collective conscious of a loose coalition of concerned, but diverse, stakeholders. This

study describes some of the history, philosophy, science, and politics behind the social construction of the Southern Appalachian Ecosystem.

Despite this deep ambiguity surrounding the ecosystem concept, the Southern Appalachian Ecosystem, for one, has become a relatively well-defined geographic region. The socially constructed reality of the Southern Appalachian Ecosystem is a strong consensus that has been negotiated and defined by boosters and promoters, albeit according to a variety of criteria. In recent years, the reification of the Southern Appalachian Ecosystem has been so successful that this particular sense of place is no longer novel nor highly controversial. At the moment, diverse and otherwise competing interests within the scientific, political, economic, and social spheres share a *public understanding* of the Southern Appalachia Ecosystem as "fact." However, people who are concerned about the future of this region should be critically aware that this implicit consensus is a fragile agreement, at best a social contract in need of constant upkeep. This and other socially constructed realities require maintenance on the part of people who care. To sustain the Southern Appalachian Ecosystem as a place worthy of scientific and political attention, concerned stakeholders must be willing to steward the idea and the sense of place at least as much as they are willing to engage in active management of the land itself. This paper is a contribution to this creative ecology.

Purpose

The idea of a Southern Appalachian Ecosystem is now so much a part of our everyday language that many of the people who talk, write, and make decisions about the Southern Appalachian Ecosystem are unaware of the long and complicated history behind the idea. Therefore, one primary purpose of this case study is to demonstrate how the idea of a Southern Appalachia Ecosystem (SAE) has been socially constructed and reified as a scientific fact in contemporary environmental discourse. In addition, I will discuss the implications of this particular sense of place for biodiversity, land use, and community development.[2] Ultimately, my goal is to help establish a common ground between the infinite number of competing visions that are possible and plausible for this one unique place. I will do so primarily by advocating a more biocultural worldview—a view of the world that seeks to transcend the dichotomous categories of nature and culture

perpetuated by modern, western thought. My intention is to contribute to the creation of not merely a sustainable but a truly desirable postmodern future rich in biocultural diversity. The unique socio-economic, cultural, and biophysical characteristics of Southern Appalachia have been described in great detail for several centuries, but it is only within recent decades that a coherent vision of the region as a discrete "biogeocultural" ecosystem has come into play (Gregg 1999; Hinote 1999).

Methods

The research methods for this study fall into three principal categories: 1) ethnographic, participant-observation: participation in numerous public meetings, workshops, and community events; 2) interview: formal and informal interviews and focus groups with key stakeholders; and 3) survey: academic, gray, and popular literature, historical documents, internet websites, archives and related information databases. Analysis and interpretation of this empirical data has occurred iteratively and is best described as interdisciplinary, environmental discourse analysis (e.g., Peterson 1997; Takacs 1996). Potter and Wetherell (1987) provide an overview of standard discourse analytic techniques. Primary source material and original empirical data support the claims made in this study. This "evidence" appears throughout the manuscript in the form of direct quotations and paraphrased text.

Implications

The general findings of this specific case study should be of interest to people involved in the history, science, politics, and management of ecosystems and similar landscapes throughout the United States and around the planet Earth (e.g., the Central Appalachian Ecosystem, the Greater Yellowstone Ecosystem, The Chesapeake Bay Watershed, The Pacific Northwest Bioregion, and others). This audience includes cultural geographers, landscape ecologists, environmental historians, conservation biologists, and a variety of other stakeholders including professional decision makers and local citizens. Related studies in other contested terrains include those by Dizard (1994), Senecah (1996), and Terrie (1997). One particular community that will likely be interested in this study is the contemporary bioregional movement (e.g., Sale 1985).[3] However, unlike the worldview

of postmodern biocultural ecology that is advocated in this paper, popular bioregionalism has tended to promote a conceptualization of environmental quality characteristic of anti-modern, Romantic wilderness idealism (Oelschlaeger 1991; Alexander 1990; Gandy 1996).

A History of "Southern Appalachia" as a Socio-Economic Landscape

> That areas can be carved into parcels as many different ways as there are persons to do the carving is not surprising, since there are an almost infinite number of criteria upon which to base a regionalization. The criteria used, of course, depend on the purpose of the regionalization. Thus, the boundary lines we create might enclose areas that are somewhat homogeneous in terms of culture, physiography, climate, agriculture, or planning jurisdiction. In short, a region is a mental construct: an area that has been bounded in accordance with the goals of those delimiting the region. In a sense, regions do not have truth—they only have utility.
>
> Raitz & Ulack 1991:10

Over the years, Appalachia has been defined according to the needs and desires of many different people. Numerous different methods have been used to redefine the boundaries, subdivide the interior, and rearrange the resources of the region. And yet, any way you slice it, Appalachia remains a contested terrain.

> Appalachia's boundaries have been drawn so many times by so many different hands that it is futile to look for a 'correct' definition of the region.
>
> Whisnant 1994:134

> The naming and redefining of Appalachia appears to have no end….
> Clearly there is no ultimate definition, only delineations that serve particular social, political, organizational, or academic interests.
>
> Walls 1977:71

Historically, the region known as "Appalachia" has been defined according to the distinctive attributes of its biophysical and cultural conditions (Ergood & Kuhre 1991). Early biocultural descriptions of the region date to the sixteenth century when European explorers first produced maps and written accounts of the unique places and people they "discovered" (Walls 1977).

As early as the sixteenth century, Mercator's "Map of the World" and other cartographic images included symbolic representations of this mountainous region (Walls

1977:62). In subsequent centuries, state and privately sponsored science, technology, and development programs (characteristic of European imperialism) developed more sophisticated descriptions of this and other regions for exploitative purposes (Latour 1987; Anderson 1991; Farber 2000). As a result, by the late nineteenth and early twentieth centuries, Appalachia had been divided into more precise and useful subregions (e.g., basic east-west physiographic regions include: Plateau, Ridge and Valley, Blue Ridge, and Piedmont).[4] These "scientific" studies were no doubt sponsored for pragmatic purposes (e.g., economic development of natural resources) as well as purely intellectual curiosity.[5] It was not long before utilitarian interests came to overshadow other aspects of Appalachian geography and the mountainous terrain was gradually turned into a landscape on which economic development schemes were painted (Whisnant 1994; Davis 2000).

By the late nineteenth century, socio-economic characteristics came to dominate the public understanding of Southern Appalachia. In fact, some scholars argue that Appalachia, and Southern Appalachia in particular, were first discovered as recently as the late 1800s when authors and artists created short stories and sketches depicting the unique conditions of mountain life (Shapiro 1991).[6] These "impressionistic accounts" focused on depressed socioeconomic conditions describing Southern Appalachia as "a discrete region, in but not of America" (Shapiro 1991:76). The feuding, moonshine, and other forms of lawless disorder emphasized in these popular stories and subsequent media portrayals set Southern Appalachia apart from the rest of a rapidly modernizing America. The emerging public image of Southern Appalachia reached an all-time low with descriptions of the region as a "retarded frontier" and primitive remnant of an earlier age (Vincent [1989] in Walls & Billings 1991).[7] It is from under the burden of this nineteenth century mythology that the people of Southern Appalachia have since struggled to identify themselves as a valuable component of contemporary American society.

The acute and prolonged poverty faced by individuals, families, and entire communities throughout Appalachia is an object of concern for people within and outside the region. Many theories explain Appalachia's depressive socio-economic conditions (Ergood & Kuhre 1991). One theory that rings loud is the claim that Appalachia's economic woes are the result of exploitation by outside interests. Absentee ownership is

an institution accused of having wantonly neglected local residents' financial need for access to the region's natural resources. In particular, the corporate ownership of land and development rights is often blamed for Southern Appalachia's depressed conditions. Economic development programs that have ignored this natural resource prerequisite to local economic development while attempting to "improve" the social conditions in Appalachia are criticized as naïve, flawed, misguided, self-serving, even corrupt efforts on the part of *outsiders* to "modernize the mountaineers" (Whisnant 1994).

In the twenty-first century, however, conditions in Southern Appalachia have improved such that the current generation is concerned with somewhat different issues. According to the Southern Appalachian Assessment (SAA) conducted in 1996:

> Job growth in the SAE is faster than in several other regions and the nation as a whole. Unemployment and poverty rates are lower than in many other regions. Rural unemployment rates are lower than in every other region of the country except for the Midwest and the Plains. The population is growing fairly rapidly, largely due to inmigrants attracted by the region's rural mystique, rich history, expanding and diverse economy, and range of environmental amenities and outdoor recreation opportunities.
>
> Jones et al. 1999:486

While socio-economic conditions may be improving, the Southern Appalachian region is now faced with new pressures. In particular, biodiversity loss, invasive exotic species, forest fragmentation, acid deposition, and other forms of environmental degradation resulting from *outside* forces, are major political issues rapidly displacing poverty on the region's list of priority concerns. In the following sections, I discuss this recent social construction of the Southern Appalachia Ecosystem as a globally significant biodiversity hotspot and the implications of a strictly ecologistic discourse for the future of this place.

The Southern Appalachian Ecosystem as a Biodiversity Hotspot

> The destruction of primary forests is well documented with a 95-98 percent loss in the continental United States. The Appalachian region is no exception. Before European settlement, the majority of this region was covered with closed-canopy deciduous forests, but today just over 50 percent remains forested and much of that is poor quality regrowth … . Many of these second- and third-growth stands bear little to no resemblance to the original forest cover. Intensive strip mining, fragmentation, deep mining, timbering and pollution have scarred much of

> Appalachia's forests. This region is considered critically threatened and at the top of the list of globally significant forest ecoregions (Ricketts et. al. 1999).
>
> AFRC 2001

Despite the extensive resource extraction that has occurred throughout Appalachia (e.g., mountain top removal and other methods of coal mining, modern commercial agriculture in the valley lowlands, and repeat clearcutting of forests), the region remains in a predominantly "natural" condition.[8] This is particularly true for the uniquely forested mountains of the Southern Appalachian Ecosystem.[9] While the landscape is by no means a pristine wilderness and the environmental conditions are heavily influenced by human presence, scientists value specific natural features and the ecosystem as a whole for the significant contribution they make to global biodiversity.[10] For example, some scientists claim that the ecosystem is but one of only twelve remaining areas in the lower 48 that is large enough and intact enough to maintain viable populations of large vertebrates (Salwasser et al. 1987; Salwasser 1988).[11]

In response to this sort of environmental concern, citizen activists, ecological scientists, and natural resource professionals have joined forces in an international effort to promote and protect the ecological integrity of the Southern Appalachian region. This coalition of concerned stakeholders is advancing systematic approaches to conservation in the name of local and global ecosystem management. The phrase "ecosystem management" is increasing popular in contemporary environmental discourse. It appears in discussions regarding the management of local landscapes and negotiations of international treaties regarding the health and sustainability of the biosphere (e.g., Convention on Biological Diversity). At minimum, ecosystem management implies "the theory and practice of managing ecological systems." Beyond this literal definition, the phrase connotes a variety of ideas and actions depending on the specific situation and people involved. While some ecologists consider ecosystem management little more than the latest buzzword, others see it as representing a fundamental and lasting paradigm shift in environmental science and policy from individual, localized species protection projects toward more systematic and collaborative attempts at ecosystem management (e.g., McCormick 1999). For example, the Appalachian Restoration Campaign (ARC) "cites the failure of traditional efforts to conserve biological integrity through piecemeal and

reactionary attempts at conservation and responds with landscape approaches to protect biological diversity and natural evolutionary processes" (ARC 1998a, 1998b).

Many of these ecosystem management strategies encourage decision makers to consider their actions within the context of ever larger scales of ecological space and evolutionary time. However, stakeholders should be mindful that when a specific place is conceptualized within larger scales of space and time, its unique particulars (including the humans who call it home) become increasingly abstract as they are simplified and categorized to fit within a theoretical model of the larger region. In this case, as Southern Appalachia is reconceptualized in terms of biodiversity science and ecosystem management, the region becomes privileged for its "natural" (e.g., biological and ecological) qualities to the exclusion of the social, cultural and distinctly human dimensions of the region. Descriptions of Southern Appalachia that emphasize "biologically diverse flora and fauna," "remnants of old-growth forest," "rare and endangered species," "air and water quality" tend to ignore the significance of human culture. Likewise, management priorities within the ecologistic discourse emphasize the negative impact of human presence (via recreation, tourism, residential development, etc.) on the "natural" ecosystem (Robertson & Hull 2001a). This revisioning of Southern Appalachia through the lens of an ecologistic discourse of biodiversity science and ecosystem management is an increasingly popular reconceptualization that has occurred in many other places throughout the world (e.g., Ricketts et al. 1999).

Ecologism describes the occurrence of literature, art, and popular culture that reflects an ecological way of thinking (e.g., Hayward 1994). At the extreme, ecologism is a worldview that privileges wilderness, or non-human nature, as an ideal environmental condition and preferred form of environmental quality. For example, contemporary natural resource professionals, including scientists, are often predisposed to see the places they manage and study through an ecological lens where the value of biodiversity tends to eclipse cultural history (e.g., Redford & Stearman 1993; Sellars 1997). This predisposition is largely the result of formal education and enculturation in the modern western scientific tradition that presupposes a human-nature dichotomy (Worster 1994; Berry 1999). More recently, biodiversity science, the latest and most powerful form of ecologism, is concerned with local and global assessments of biodiversity and the

coordinated integration of this data for centralized management of Earth's ecosystems (Takacs 1996; Heywood 1995; Bowker 2000).

For example, global biodiversity assessments, such as those conducted by World Wildlife Fund (WWF) and increasingly used as tools by environmental activists, characterize the Southern Appalachian Ecosystem as a globally significant ecoregion because of its biodiversity values (Ricketts et al. 1999). WWF recognizes the Appalachian/Blue Ridge Forests ecoregion and the adjacent Appalachian Mixed Mesophytic Forests ecoregion as representing "one of the world's richest temperate broadleaf forests…" (Ricketts et al. 1999:182-190). In fact, the entire Southern Appalachian region is classified by WWF as one of a few "Class I: Globally outstanding ecoregions requiring immediate protection of remaining habitat and extensive restoration" (Ricketts et al. 1999:86).

With five national forests, two national parks, and related "natural" areas at its core, it is easy to see how people have come to appreciate the Southern Appalachian region as a distinct and unique ecosystem in need of coordinated management and protection. Nevertheless, stakeholders and decision makers need to be aware of the implications posed by this bias. In the following section, I will discuss some programs that are working to balance this ecologistic appreciation of Southern Appalachia's "natural" features with the socio-economic concerns of the human communities that call this place home.

Toward a More Biocultural Worldview in Southern Appalachia

> [A] rather different perspective… emerges from the work of scholars and scientists who explore the history and sociology of the environment. Here the emphasis lies not with the notion of habitat as such but with concepts of landscape (land as understood in and through the human imagination, and shaped by human managerial activities). A landscape approach to biodiversity is justified by the frequency with which apparently pristine worlds, as yet little explored by science, prove on further examination to yield ready evidence of long-term human involvement.
>
> Guyer & Richards 1996:2

Obviously, there are many ways to understand and care for the Southern Appalachian region. Ecologism and ecosystem management for biodiversity conservation is one

method. However, we must remain aware that any one approach provides only a partial experience of the landscape and a limited vision of the future. The purpose of this section is to build upon the history of Southern Appalachia as a cultural landscape and the recent depiction of this region as a biodiversity hotspot in order to construct a more inclusive *biocultural* view of the Southern Appalachian Ecosystem.

Most simply, bioculturalism is a view of nature that embraces humans as active and integral components of the ecosystem (e.g., Berkes & Folke 1998; Heywood 1995). According to the biocultural worldview, people, their local communities and global economy, are an inextricable part of the environment and "natural" processes in the Southern Appalachian Ecosystem. When we look beyond the simplistic dichotomies of local vs. global, human vs. nature, or economy vs. the environment, we begin to see glimpses of this biocultural vision. Bioculturalism is a view of the natural landscape that encourages stakeholders to recognize human society as an integral component of ecological systems and find ways for people to interact with and live sustainably in nature. Bioculturalism is increasingly accepted by the international conservation community, which has long recognized the limited effectiveness of conservation strategies that privilege biological diversity over cultural diversity (West & Brechin 1991; Droste et al. 1995; Ghimire & Pimbert 1997).

For example, many of the programs that have helped to socially construct and reify the Southern Appalachian Ecosystem do so from a perspective that recognizes the place of human culture in the natural landscape and the implications of natural resource management regimes for the socio-economic status of local communities. Long established institutions such as the US Forest Service have a history of addressing local community needs (Sarvis 1993; 1994). Likewise, more recent programs such as the Southern Appalachian Biosphere Reserve, the Appalachian Forest Regional Center (AFRC), The Nature Conservancy (TNC) (each of these programs is discussed in more detail below) appear to embrace a perspective of ecosystem management that is sensitive to the place of people in natural areas, especially the livelihoods of local residents.[12]

> The Appalachian Forest Regional Center has expressed the following concerns:
>
> Natural resources within the Appalachia region have continued to be exploited for short-term gains. Little to no regard has been given to the regeneration capacity of these natural resources, compromising their natural balance. The immediate

> environmental consequences include loss of habitat, loss of biological diversity, change in species composition, erosion, increase in the greenhouse effect and degraded water quality. *Long-term social implications include impacts on local populations such as loss of livelihood, impoverishment and loss of cultural diversity.* (emphasis added)
>
> AFRC 2001

To address these issues AFRC is supporting community-based research to explore opportunities for sustainable forestry as a form of both economic development and ecological protection:

> There are numerous areas of concern in which research can be focused. Emerging issues revolve around the need to establish specialty wood markets while value adding, expansion of non-timber forest product markets, the need to address the lack of private forest landowner incentives and outreach programs, investigating the potential for timber based cooperatives, and the concerns with the ecological health and associated economic stability of the Appalachian forest region.
>
> AFRC 2001

The Nature Conservancy's Forest Bank Project is a recently developed program that shares similar goals. The mission of The Forest Bank is "to work in partnership with private landowners to promote the economic productivity of working forests while protecting the ecological health and natural diversity of the landscapes in which they occur" (TNC 2002).

Perhaps the most powerful example of bioculturalism in Southern Appalachia is the Southern Appalachia Man and the Biosphere (SAMAB) program. In 1988, the Southern Appalachian cultural landscape was named a "regional biosphere reserve" as a cooperative agreement on the part of the United Nations and several state and federal agencies. In 1996, a Southern Appalachian Assessment (SAA), "a five-volume report produced by a team of natural resource specialists" and coordinated through the SAMAB Cooperative, was conducted to support regional ecosystem management and sustainable development efforts (Randolph et al. 1999:63; SAMAB 1996). While SAMAB and the SAA are undoubtedly products of global environmentalism and biodiversity science, they have consciously embraced a "biogeocultural" perspective regarding the interface of wild nature and human society.

Describing the Southern Appalachian Man and the Biosphere cooperative, Bruce Babbit (1999:Foreword) asserts:

> In the southern Appalachians, quiet cooperation has truly paid off. There are no major environmental trainwrecks here between those concerned with protecting the environment and those representing economic development interests. … The lack of confrontation has allowed for the development of broad alliances that might not have otherwise so readily occurred.

This collaborative success is unusual considering the fact that disagreements regarding the appropriate role of humans in the natural landscape is one of the key factors polarizing discussions about environmental management (Ingerson 1994; Callicott et al. 1999).[13]

In order for bioculturalism to flourish as an effective conservation strategy in the Southern Appalachian Ecosystem and related landscapes, stakeholders representing local, regional, and global interests must first recognize the conceptual limitations imposed by the human-nature dichotomy and accept humans as an integral, functional, and adaptive aspect of the natural landscape (Allen 1988; Haverkort & Millar 1994; Phillips 1998).

The Role of The Ecosystem Concept in Biocultural Ecology

Ecosystems are not only spatially and temporally complex but also economically and politically defined. Western environmental science, ecophilosophy, and nature writing have tended to ignore the historical fact that people are part of nature and natural ecosystem processes. Contemporary decision makers, however, can no longer afford to overlook the active, functional role of humans as an integral and creative component in ecological, evolutionary, and environmental change. In the midst of today's fragmented ecosystems, invasive species, biotechnologies, and global climate changes, we need a renewed vision of nature, science, and environmental management, one that includes human culture.

Change is constant and wild nature is not nearly as stable as we might like it to be. The environmental conditions of our local and global ecosystems are in a continual state of flux (Heywood 1995; Botkin 1990). Therefore, it is ambiguous and potentially misleading to advocate the idea of a "natural state of nature" (i.e., biological and ecological integrity) (Cronon 1995; Callicott & Nelson 1998). In any given time and place, there are many equally possible and equally healthy environmental conditions; no one of these many possible natures, is necessarily more "natural" than another (Hull &

Robertson 2000). Nevertheless, many of the "scientific" constructs that we use to operationalize environmental quality arbitrarily define environmental quality in exclusive terms as the minimal presence or total absence of humans and human impacts (Hull & Robertson 2001b). Humans, however, (whether primitive, modern, or cyborg) and the environmental changes they introduce, do not necessarily degrade environmental quality. In many cases, human activity may even improve the diversity, stability, health, and overall quality of some ecosystems (Pykälä 2000; Saberwal 1996; Gomez-Pompa & Kaus 1992). Therefore, what counts as environmental quality is largely a matter of perspective, relative to the scope of one's vision and aspiration for a given ecosystem.

Because many environmental conditions have existed and can exist, it is easy to see that people cannot identify one set of environmental conditions as being better than another without invoking some value system that answers the question "better for what purpose?" Nature, the environment, if left alone, will evolve, grow, and develop in unpredictable ways. Therefore, even if we plan wisely for the conditions we desire, there is no guarantee that we can achieve our goals. Nevertheless, people and active management should be part of the equation (Szaro & Johnston 1996; Di Castri & Younès 1996). To say that humans by definition degrade environmental quality is an overly simplistic and highly pessimistic conclusion, one that is depressingly fatalistic in its consequences. Rather, we need to design ways of living that are meaningful and inspirational, not merely sustainable.

One place to look for further inspiration and direction is the innovative ideas of contemporary bioculturalists such as, William Jordan (1994), Frederick Turner (1994), and Michael Pollan (1991; 2001). These three thought-provoking writers are among a growing contingent of biocultural activists who are designing creative approaches to the human-nature relationship based on the belief that humans can be artful agents of landscape change. "Sunflower forests," coevolution, and "the cultivation of a new American garden" are among these bioculturalists' thoughts for a better, more democratic, sustainable, and desirable future.[14]

Evidence of bioculturalism in the Southern Appalachian Ecosystem is revealed in local residents' discourse of "cultured naturalness" (Hull et al. 2001), the literature of regional institutions (e.g., ARC 1998, Peine 1999), and the recent policy of national-level

institutions (e.g., USFS 2000). Each of these forums is fertile ground for the growth of a strong biocultural discourse of ecology in the Southern Appalachian region, and related natural landscapes. Each of the stakeholders and the interests they represent has an important role to play in establishing bioculturalism as a valid and powerful new approach to the environment. For instance, a small number of environmental scientists have begun framing their questions in terms of "human ecosystems" (e.g., Grimm et al. 2000; Pickett et al. 1997) while others are discussing the idea of "public ecology" (Robertson and Hull 2001b; Luke 2001). Escobar (1999:15), Goodman and Leatherman (1998), and their colleagues explicitly argue for a biocultural synthesis. This theoretical approach to "the question of nature" would not only enfold human society within ecosystem concepts but would embrace a new political ecology of "hybrid natures" founded on principles such as interdisciplinarity, antiessentialism, and embodiment. And, a new discourse of cyborgology reflective of these emergent hybrids, biotechnologies, and the breakdown of modernist dualities such as the human-nature dichotomy is advanced by authors such as Haraway (1991), Beck (1992), and Redclift (2001). Each of these perspectives represents novel biocultural approaches to understanding and constructing a desirable environmental future.

Conclusion

> [T]he southern Appalachians can be characterized as a biogeographical region because of the ecosystem types, flora, fauna, climate, geology, and related characteristics. … This large area is an appropriate "common ground" for cooperative management of many of the region's natural resources, because entire ecosystems can be treated, and more complete ranges of species can be included. Another advantage is that many people in the area feel the region is their "home," so they have a growing concern about what is happening to it.
>
> Gilbert 1988:184

The Southern Appalachian Ecosystem (SAE) is an increasingly popular concept in contemporary environmental science and politics.[15] However, we should keep in mind that this "ecosystem" will exist only as long as it remains a powerful concept in the minds of people who care. The social construction of the Southern Appalachian Ecosystem, as both a discursive and a material reality, is the result of a loose coalition of local and

international stakeholders concerned about the future of the region, its specific places, its mountains, forests, streams, wildlife, and the larger, global environment of which this landscape and its people are one small part.

In this paper, I have discussed at least three different social constructions of the Southern Appalachian Ecosystem: the ecosystem as 1) a socio-economic landscape, 2) a biodiversity hotspot, and 3) a biocultural region. Each of these discourses has specific implications for how people interact with the land. In the socio-economic landscape of Southern Appalachia non-local, colonial-minded capitalists have tended to exploit the natural resources for personal and nationalistic gains. As a biodiversity hotspot, the ecosystem is managed to preserve and maintain rare and endangered species and ecological processes that are considered of value to the global environment. In the discourse of bioculturalism, the Southern Appalachian Ecosystem is of value to local communities and global society for the distinct environmental conditions that make this cultural landscape a unique and desirable place on planet Earth.

Regardless of the preferred discourse, describing Southern Appalachia as a distinct "ecosystem" is a reification that has been influenced by socio-cultural factors at least as much as it is a reflection of the biophysical conditions of the local environment. This paper is based on the social constructivist premise that landscapes such as the Southern Appalachian Ecosystem, are not simply "out there," shaped by the wind and the rain; rather, they are constructed, discursively and materially, by people who care, albeit in different ways, about the future of the place. This social constructivist approach to environmental studies applies to both popular and scientific understandings of the world in which we live (Greider & Garkovich 1994; Evernden 1992).

"Appalachia," "Southern Appalachia," and, most especially, the "Southern Appalachian Ecosystem" are discursive and material realities that have been socially constructed and gradually reified in the minds and work of Americans. Popular understandings of these terms and the places they represent are the outcome of a long and complex history of biocultural interactions. Prior to the late twentieth century, the Southern Appalachian Ecosystem did not exist: Scientists, politicians, developers, and other authorities had yet to discover it. Granted, the physiography and biodiversity of Appalachia have long been in place, but the ecosystem *per se* had yet to be identified. In

a manner of speaking, the forest had not been seen for the trees. In this paper, I have demonstrated that the delineation and description of Southern Appalachia as a distinct ecosystem is a reification that has been influenced by socio-cultural factors at least as much as it is a reflection of any existing physiographic or biological conditions of the environment.

Among other things, ecologists and environmentalists, through their language, science, history, and other stories, actively create and facilitate the shaping of new visions for the landscape and the environmental conditions of our common future. Applied ecologists, such as landscape architects, environmental planners, and natural resource managers take over where God, Nature, Science, and Society leave off. The concepts they define and use to measure environmental quality, the management practices they advocate, and the policy goals they set will ultimately shape the environmental conditions of the "Southern Appalachian Ecosystem." This landscape, and others like it, is a work of living fine art and these environmental activists are the painters and curators this new garden.[16]

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[1] Facts are points of contention: "[M]any people think of facts as particulars, isolated from their contexts and immune from the assumptions (or biases) implied by words like 'theory,' 'hypothesis,' and 'conjecture.' This is the sense of 'facts' implied by Joe Friday's terse demand, 'Just the facts Ma'am.' On the other hand, … some people think of facts as evidence that has been gathered in the light of—and thus in some sense *for*—a theory or hypothesis. According to this understanding, facts can never be isolated from context, nor can they be immune from the assumptions that inform theories" (Poovey 1998:1). "Facts are not objectively given but collectively created. … A fact begins with a tentative signal of resistance by the collective. This preliminary signal of resistance is but the predisposition for an emergent fact. Through collective interaction this tenuous indication gradually becomes stylized, undergoes consolidation, and emerges as an accepted fact. Such a fact does not stand alone but becomes a new feature of an interlocked system of ideas all of which are congruent one with another on the basis of a given thought style" (Trenn & Merton 1979:157).

[2] The theoretical approach for this paper is largely influenced by the "social constructivist" prespective in science studies scholars (e.g., Golinski 1998; Helford 2000).

[3] I'd like to thank Mark Barrow for pointing out that bioregionalism has roots in early 20th century regional movement in America which was a response to the negative aspects of urbanization and modernization (Dorman 1993).

[4] Strictly physiographic descriptions of the Southern Appalachian Ecosystem began at least as early as the mid nineteenth century. Raitz and Ulack (1991) identify and review a

number of these studies: Guyot (1861), Powell (1895), Marschner (1935), and Fenneman (1938). Soon thereafter, life scientists joined in the effort. For example, The Southern Appalachian Botanical Club formed and published the first issue of its journal *Castanea* in 1936. At that time, the Club defined their region of interest as follows: "The name Southern Appalachian, as herein understood, comprises all of the upland region south of the limits of Pleistocene glaciation, hence including southern Pennsylvanie, western Maryland, and parts or all of the States of West Virginia, Ohio, Kentucky, Virginia, North Carolina, South Carolina, Tennessee, Alabama, and Georgia" *Castanea* 1936, V1, N2, page 23. Whereas, popular opinion had previously divided Appalachia into northern (i.e., sometimes called Alleghany) and southern portions, this is one of the earliest instances where biological scientists seem to agree on a scientifically distinct "Southern" Appalachian region.

[5] According to Proctor 1991:10 (as quoted in Tauber 1999:483-4), "Neutrality and objectivity are not the same thing. Neutrality refers to whether science takes a stand; objectivity, to whether science merits claims to reliability. … Certain sciences may be completely 'objective'—that is, valid—and yet designed to serve certain political interests. Geologists know more about oil bearing shales than about many other rocks, but the knowledge is no less reliable. … [T]he fact that their knowledge is goal-directed does not mean it doesn't work. The appropriate critique of these sciences is not that they are not 'objective' but that they are partial, or narrow, or directed towards ends which one opposes."

[6] In the case of the SAE, it seems that what was "discovered" were these cultural characteristics, not the area or knowledge of the area or even avid discussion of the area. One recent compilation of environmental writings on the Blue Ridge mountains of Virginia documents that people have been discussing the area for many years (Branch & Philippon 1998).

[7] Weaver (1996) documents how this caricature was exploited for the political purposes of first ignoring and later devaluing the individuals, families, and entire communities displaced by establishment of the Great Smoky National Park.

[8] There is much discussion in the contemporary environmental literature regarding the meaning of the words nature and natural (e.g., Hull and Robertson 2000). Environmental historians and historical ecologists have been particularly forthcoming in their critique of the myth of wild nature and pristine wilderness that has dominated public understandings of the environment in Western natural resource management and the "natural" sciences (e.g., Denevan 1992; Crumley 1994).

[9] Several studies contest to the naturalness of the ecosystem. For example, Boone & Aplet 1994: "The Southern Appalachians are recognized as 'one of the two great centers of forest diversity [in] the United States' (Whittaker 1972)." The US Geological Survey (USGS 2002): "The Southern Appalachian Ecosystem is a unique resource because of its rich genetic, species, community and landscape diversity. However, the integrity of the ecosystem is threatened by the cumulative impacts of a variety of anthropogenic stressors including silvicultural, agricultural, mining, road construction, and urbanization practices as well as acidic deposition, invasive exotic species and recreational pressures." And, the Environmental Protection Agency (EPA 1995): "Degradation and alteration of critical ecological components and processes due to the magnitude and distribution of land uses have occurred over the SAMAB Region. These alterations have affected several

important ecological resources within the SAMAB Region, including streams, wetlands, forests, estuaries, and breeding birds and other attributes of biological diversity. Landscape-scale processes that have been altered include fire, water flow and discharge, and extinction/colonization. These alterations have resulted in declines in water quality and certain components of biological diversity and have increased the risk of pest outbreak and catastrophic flooding. However, the extent and distribution of these forms of alternations across the SAMAB region are currently unknown. Further, no information is available on the relative degrees of risk and scales of impairment."

[10] "SA has been identified as one of seven critical ecosystems, nationwide, that should receive priority consideration for study by federal agencies. This recognition comes from the Administration, Congress and GAO" (USGS 2002).

[11] Related programs that share a more-or-less ecologistic vision of the Southern Appalachian Ecosystem include the Southern Appalachian Forest Coalition (www.safc.org, 10/10/01), The Southern Appalachian Biodiversity Project (www.sabp.net, 10/10/01), The Wildlands Project (Mann and Plummer 1993), Forest Watch (e.g., www.virginiaforestwatch.org, 10/11/01), and others that are in addition to the programs cited above such as the World Wildlife Fund, the Appalachian Forest Resource Center, the USDA Forest Service, and National Parks. For example, the Southern Appalachian Biodiversity Project (SABP), has among its goals: "permanent protection for the region's public lands and sustainable management of private lands" and "promote the reintroduction of native wildlife that has been extirpated from the Southern Appalachians, such as the red wolf" (www.sabp.net, 10/10/01). Each of these programs contributes to the social construction and reification of Southern Appalachia as a distinct ecosystem and one that is of value to the global environment for its biodiversity values.

[12] Programs such as Coalition for Jobs and the Environment, Appalachian Sustainable Development, and Citizens Task Force for National Forest Management are just a few of the many other organizations operating in the region to promote social justice, citizen empowerment, and a more humanistic vision of ecosystem management.

[13] Obviously not everyone will agree with my optimistic reading of SAMAB and ecosystem management. Paul Angermeier (personal communication, 4/19/02) argues that the collaborative success identified by Babbit (1999) is rhetorical rather than actual. Angermeier contends that there have been no trainwrecks in the SAE because economic development is the only train on the tracks. On a related but different tack, a recent critique in Eco-logic (1998) makes the following contentions: "Private property is an endangered species in Appalachia. … Day by day, throughout the land, highly-paid professionals, funded by prestigious environmental organizations, wage war on individual freedom and private property rights in the name of "protecting the environment." Their efforts are said to be "local initiatives," which reflect the will of the people. In reality, their efforts are carefully planned, well-coordinated, generously funded by foundations, national environmental organizations, or by the federal government, and are expressly designed to exclude participation by real land owners and real local citizens whose lives are directly affected" (Eco-logic July/August 1998). While much of the ecosystem management discourse in the SAE is highly rhetorical, it behooves us to listen carefully to these concerns. Regional ecosystem management strategies are necessary to ensure that biodiversity and natural resources are sustained, but sustainable development strategies must also ensure a flow of the many other cultural, amenity, and economic

benefits that local landscapes provide to communities in the region. Many people in local communities are more concerned about issues of cultured naturalness than they are about the impositions of Big Wilderness, Big Business, or Big Brother.

[14] Bioculturalism is offered as a distinct discourse of nature. It should not be confused with the concept of bioregionalism or other conservation strategies that are heavily steeped in the Romantic movement and ecologistic traditions.

[15] SAE serves as an acronym for both the Southern Appalachian Ecosystem and the Southern Appalachian Ecoregion. In some cases SAE the ecosystem and SAE the ecoregion refer to the same geographical area (e.g., Jones et al. 1999), but this may not always be the case.

[16] I thank Ted Harris, Director of the 500-Year Forest Foundation, for introducing the idea of "landscapes as living fine art."

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Chapter 2

Political Ecologies: The Biodiversity, Ecosystem, and Ecoregion Concepts

> Should we believe everything the science of ecology has to tell us about our relations with nature? Or should we examine the social construction of ecology itself … and find out if we would want the kind of world that ecology would construct for us if it were to win political hegemony in the sciences?
>
> Bird 1987:262

Introduction

In *The Order of Things*, Michel Foucault (1994), a notorious historian and philosopher of science, describes a peculiar ecology in which "animals are divided into:"

a) belonging to the Emperor,
b) embalmed,
c) tame,
d) sucking pigs,
e) sirens,
f) fabulous,
g) stray dogs,
h) included in the present classification,
i) frenzied,
j) innumerable,
k) drawn with a very fine camelhair brush,
l) *et cetera*,
m) having just broken the water pitcher,
n) that from a long way off look like flies.

Encountering this passage, the reader may be inclined to chuckle or, like Foucault, simply laugh out loud. Beware: the playful quality of this classification masks a more serious intention. The purpose is not only to tease but to stretch the modern/western/scientific mind, to make explicit the fallibility of one's own peculiar ways of ordering and making sense of the world. Foucault explains, "In the wonderment of this taxonomy, the thing we apprehend in one great leap, the thing that, by means of the fable, is demonstrated as the

exotic charm of another system of thought, is the limitation of our own, the stark impossibility of thinking *that*."

An equally important lesson is in the message that Foucault leaves unspoken: this foreign way of seeing the world, although fictitious, is perfectly valid. After all, "from a long way off," animals do, sometimes, "look like flies."

Expert versus Expert: A History of Scientific Controversy

> [It is important for us to keep] the *contingency* of our meaning making devices up front, even while we, laughing a little nervously, use them to do work we care about.
>
> Haraway 1995:337

The Ancients (e.g., Aristotle and contemporaries) were at each other's throats concerning *the order of things* (Golinski 1998). In like fashion, eighteenth-century Enlightenment natural historians (e.g., Linnaeus and Buffon) were conflicted as to the best method for defining, delimiting, and classifying species (Farber 2000). More recently, modern ecologists (e.g., Clements and Gleason) have wrestled to exhaustion concerning the right system for understanding biodiversity at organizational scales above the level of genes and species (Whittaker 1962; Saarinen 1982; Golley 1993). On-going debates in basic and applied ecology (e.g., compositionalists versus functionalists) are yet another historical episode of this philosophical and scientific controversy (Callicott et al. 1999; Keller & Golley 2000).[1]

While these experts disagree with one another they are clearly authorities within their respective fields and the debate is often a highly specialized discussion concerning the more (or less) refined aspects of their scientific belief systems.[2] Less clear, particularly to the non-expert and general audience, is that much of the disagreement is due to fundamental differences of opinion and *a priori* assumptions about the order of nature and the ability of science to reveal it (i.e., differing degrees of faith in the Modern, Enlightenment project and the potential achievements of contemporary scientific methods). As stated so aptly by Foucault (1994:126):

> [Q]uestions were asked that were almost always the same but were given each time a different solution: the possibility of classifying living beings—some, like Linnaeus, holding that all of nature can be accommodated within a taxonomy,

> others, like Buffon, holding that it is too rich and various to be fitted within so rigid a framework….

Often, the debate boils down to a difference of opinion regarding basic beliefs and values: What are the "natural" units of nature? Are there natural kinds? Do genes, species, and ecosystems exist? Are these entities real? How should they be defined? What are their identifying boundaries, processes and functions? Is there, in fact, an order to the natural world? These are no doubt essential questions, equally important to scientists and others. It is imperative that they be discussed. The problem is that these are questions that cannot be answered definitively and therefore, many scientists are all too willing to avoid dealing with them explicitly, choosing instead to ignore their historical recurrence and timeless intractability. Taking the opportunity to reflect on the historical, philosophical, and social dimensions of these questions will provide more than a few lessons for contemporary environmental science and policy.

Toward a More "Public" Ecology: A Philosophy of Knowledge

In this paper, my primary intention is to help breakdown conceptual barriers that exist between expert knowledges and public understandings of ecology. Today's environmental challenges (e.g., biodiversity loss, climate change, cultural evolution) are too complex to be solved by specialists working alone according to traditional professional norms and the confines of any single academic discipline. Environmental decision making demands that a host of generalists—both scientific citizens and citizen scientists, people with a deep concern for the environment and a profound understanding of the complexity of contemporary environmental science—participate in democratic deliberations regarding public policy (Fischer 2000; Irwin 1995, 2001; Funtowicz & Ravetz 1995). We need a more public ecology (Luke 2001; Robertson & Hull 2001).

Toward this end, the specific purpose of this paper is to empirically examine and critically evaluate the politics of ecological science through a case study of the biodiversity and ecosystem concepts as they relate to environmental management. In particular, I focus on the social construction of ecoregions.[3] The ecoregional dimension of biodiversity, defined as a geographic and temporally bounded region is significant in that it provides a framework for land use, natural resource management, and

environmental decision making at local to global scales (Wright et al. 1998; Ricketts et al. 1999).

One challenge is that are many different ways of defining biodiversity, ecosystems, and ecoregions (Worster 1994; Sagoff 1988; Keller & Golley 2000). The comparative validity of any one belief/value system depends on its particular purpose and the specific context (historical and cultural) of its use, not on lofty appeals to a universal objectivity or transcendent truth (Longino 1990; Haraway 1991; Golinski 1998; Bowker & Star 1999). This pluralist and pragmatic philosophy of ecology informs the remainder of this manuscript.[4]

The Politics of Biodiversity Science

> Billions of dollars have been spent in the name of biodiversity, and over 150 national governments have signed a treaty committing themselves to biodiversity conservation….
>
> Redford & Richter 1999:1246

> Biodiversity courses are now taught at innumerable colleges and universities in the United States and elsewhere. Natural history museums have rewritten their agendas to focus on the study and conservation of ecosystems and biotas. And conservation organizations routinely base their programs on conservation biology….
>
> Wilson 1999:ix

In little more than one decade, *biodiversity* has leapt from the margins of science to the center stage of global politics, capturing the imagination of the environmental movement and mobilizing a wealth of social capital and political will (Wilson 1999; Brown 1998; Redford & Richter 1999).[5] This brief and exceptional history of biodiversity has yet to be critically analyzed and interpreted. At present, there exists no comprehensive account of biodiversity's meteoric rise in popular and scientific discourse. However, several more specific studies offer us a window into biodiversity's apparent success (e.g., Takacs 1996; Guyer & Richards 1996; Bowker 2000; Farber 2000).

Takacs (1996:1) describes biodiversity to be the "result of a determined and vigorous campaign by a cadre of ecologists and biologists." He contends, "The term biodiversity is a tool for a zealous defense of a particular social construction of

nature…", a powerful rhetoric embodying the "factual, political, emotional, aesthetic, ethical, and spiritual feelings about the natural world" held by a core group of biodiversity scientists (Takacs 1996:1-2).

> As a result, anyone interested in the dwindling resources *biodiversity* represents must turn to conservation biologists for guidance. In the name of biodiversity, biologists hope to increase their say in policy decisions, to accrue resources for research, gain a pivotal position in shaping our view of nature, and, ultimately, stem the rampant destruction of the natural world. … Biologists hope to have a say in forging a new ethics, new moral codes, even new faiths. By staking out new sources of power for themselves, they ultimately hope to gain control over nature….
>
> Takacs 1996:2

Unfortunately, although perhaps not surprisingly, Takacs's "social constructivist" work is all but ignored by most of the biodiversity community. Only a minority of voices are explicit in stating their sympathies with Takac's critical point of view (e.g., Robertson & Hull 2001; Song & M'Gonigle 2001; Escobar 1998; Cronon 1995). Bowman (1993:163), for one, claims that "the term biodiversity is little more than a brilliant piece of wordsmithing." Others dismiss scholarship in the social construction of biodiversity as trivial, disingenuous, irresponsible, even dangerous (e.g., Soulè & Lease 1995). Controversy, however, is characteristic of the environmental sciences and whatever the outcome of these latent "science wars," the biodiversity community will likely remain a place of significant conflict and debate.

Biodiversity is a multi-dimensional concept that has been critiqued for being ambiguous, imprecise, "problematic", and "fraught with contested definitions and uncertainty" (Brown 1998:73-4; Redford & Richter 1999). [6] "For many aspects of biodiversity there are no generally accepted ways of characterizing or quantifying the constituent elements" (Heywood 1995:113). For example, genes, species, and ecosystems—the building blocks of biodiversity—are especially complex ideas, with multiple definitions that change as the concepts are used in discourse: There are at least three very different types of connotations for ecosystem, and many variations within each type (Ross et al. 1997; Golley 1993; Keller & Golley 2000); Species are even more ambiguously defined (Mayr 1988; Hull & Ruse 1998);[7] Genes are simply an unknown quantity (Commoner 2002; Beurton et al. 2000; Kevles & Hood 1992).[8]

As a result of this uncertainty, many scientists have rejected the biodiversity concept as unworkably vague (e.g., Lautenschlaeger 1997). Others appreciate the ambiguity as a challenge to further "*interpret* the meaning of biodiversity" (Bowman 1993:163). The following section is both an objective description and creative interpretation of one dimension of biodiversity—the ecosystem concept.

The Ecosystem Concept: One Dimension of Biodiversity

A Brief History of the Ecosystem Concept

> [*E*]*cosystems* … are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the atom.
>
> Tansley 1935:299 as quoted in Golley 1993:8

When Arthur Tansley first used and defined the term ecosystem in 1935, his goal was to resolve the ambiguity and tension that arose from conflicting paradigms in ecological science. In an attempt to steer his colleagues away from the clearly biased ideology of organicism (e.g., Clements)—yet not wanting to see holistically oriented research reduced in status to that of a less prestigious, merely descriptive (i.e., inductive, atheoretical, and nonpredictive), science—Tansley constructed a middle ground by promoting a mechanistic model of ecological systems (see Tansley in Keller & Golley (2000). This organic machine metaphor prevailed as a guiding light in ecosystem ecology throughout the proceeding several decades. By the 1960s, the ecosystem concept had become fully institutionalized in scientific and public understandings of ecology as a result of three principle influences: 1) the heuristic power of early research studies (e.g., Lindeman), 2) the successful extension of scientific networks (e.g., IBP), and 3) a widely distributed and highly accessible public education campaign (i.e., Odum's popular textbook) (see also: Hagen 1992; Bocking 1997).

Despite their apparent success in popularizing the ecosystem idea, ecologists continue to struggle with the precise meaning of the ecosystem concept as a relevant and workable construct for scientific research and public policy.[9] According to the Global Biodiversity Assessment (a publication edited by V. H. Heywood but co-authored by 300

"experts" from over 50 countries and synthesizing the work of more than 1500 contributors):

> Ecosystems are difficult to define since their size, composition, complexity and distribution change with scale in both time and space. Not surprisingly, ecologists differ in their descriptions and definitions of ecosystems….
>
> Heywood 1995:937

In the same text:

> [ecosystems] are more conceptual entities than genes or species; they do not exist as discrete units, but represent different parts of a highly variable natural continuum; they interdigitate and intergrade in complex ways, the perception of which is heavily scale-dependent; they change through processes of succession and degradation; and they do not perpetuate themselves, but are kept in existence or recreated by the species of which they are comprised and the abiotic factors that affect them.
>
> Heywood 1995:113

Even more significant is the fact that ecologists interested in different species, different processes, and/or different scales will define different ecosystem boundaries: Ecosystems are not only spatially and temporally complex, they are also economically and politically defined (Sagoff 1988; Bocking 1997; Golley 1993; Keller & Golley 2000).

In the following pages, I discuss several rationales (e.g., multi-scalar, dynamic, unbounded, and metaphoric) according to which ecosystems (and biodiversity more generally) are defined. Which attribute(s) one chooses to emphasize will depend on a variety of proximate and contextual factors and will contribute to different environmental outcomes.

Which Nature? Whose Science? Epistemic Alternatives in Ecosystem Science

Nature exists at many spatial scales (from the microscopic to the cosmic), many temporal scales (from the diurnal to the glacial), and many organization scales (e.g., population-community ecologists tends 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 defining ecosystems) (Callicott et al. 1999). Which scale one chooses determines the ecological attributes one studies as well as their spatial and temporal boundaries. Because of these many scales at which nature can be conceptually organized, there exist multiple definitions of ecosystem

boundaries, no one more correct or objective than another (Levin 1992; Norton 1995, 1998; Ross et al. 1997).

Perhaps even more important than scalar concerns is the realization that ecosystems are dynamic and in a constant state of flux. Recent ecological theory in the realm of disequilibrium studies indicate that there is no "natural" state of nature: There is no one set of environmental conditions that persists in place and through time in ways that can be characterized as stable, consistent, balanced, and unchanging. Nevertheless, there may be natural ranges of conditions and natural rates of change in those conditions. Daniel Botkin (1990; 2000) and Stuart Pickett (Pickett et al. 1992; 1997) are two of the most prominent scientists advocating this point of view. Botkin (1990:11-12) writes:

> to accept certain kinds of change is not to accept all kinds of change. Moreover, we must focus our attention on the rates at which changes occur, understanding that certain rates of change are natural, desirable, and acceptable, while others are not. As long as we refuse to admit that any change is natural, we cannot make this distinction and deal with its implications.

Even those who do not accept the theory of dynamic ecology would agree that ecosystems, at least relative to organisms, are open and ambiguous systems. According to one introductory textbook:

> For convenience, scientists often consider an ecosystem under study as an isolated unit. However, natural ecosystems rarely have distinct boundaries and are not truly self-contained, self-sustaining systems.
>
> Miller 2000:88

Compared to ecosystems, 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. That is, for each species there exist multiple organisms 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 size, rate of growth, conception, death, blood pressure, temperature, and food intake. Compared to organisms, ecosystems are not closed, defined, stable, clearly bounded communities with holistic properties consistent from one example to the next. Rather, they are open, multi-scalar, dynamic, and transitory assemblages of biotic and abiotic elements which exist (or could

exist) contingent upon accidents of environmental history, evolutionary chance, human management, and the theoretical perspective one applies to define the boundaries.[10]

As a result of these contingencies there are few, if any, measurable, normal qualities that can be used as objective referents to evaluate the stability, good health, quality, or integrity of ecosystems (Botkin 1990; Shrader-Frechette 1995; Suter 1993; Wicklum & Davies 1995).[11] Today, the ecosystem concept is, at best, considered a fuzzy category. In some contexts (e.g., at the interface of science and policy), the ecosystem concept connotes the idea of interconnected parts, the web of life, Leopold's land community. In other contexts it denotes something of intrinsic worth, something to be valued, something that has rights to exist (e.g., Nash 1994).

Another definition for the word ecosystem, and the one of particular relevance here, refers to a place on the ground, something that has physical location and boundaries in space and time.

Ecosystem Management: A Paradigm Shift in Science and Policy?

> Ecosystem-based approaches for setting conservation priorities have a number of strengths. For example, if representative ecosystems are conserved in large areas, the vast majority of species and much of their genetic diversity will be protected. In addition, ecological processes (e.g., nutrient cycling, …) are essential to the survival of many species. Only ecosystem-based approaches are likely to ensure the protection of these vital links to biodiversity. Finally, ecosystem-based approaches help conservation to protect biodiversity across a broad geographic spectrum that species-based approaches to conservation may overlook. If little is known about species distributions and endangerment, ecosystem-based approaches are the only realistic option for analysis.
>
> Heywood 1995:937

My interest in ecosystems is based on a recent paradigm shift in the environmental community from individual, localized species protection projects toward more systematic and collaborative attempts at ecosystem management (e.g., McCormick 1999; Lubchenco 1994). The phrase "ecosystem management" is increasing popular in contemporary environmental discourse. It appears in discussions regarding the management of local landscapes (e.g., the Southern Appalachian Ecosystem) and negotiations of international treaties regarding the health and sustainability of the biosphere (e.g., Convention on

Biological Diversity). McCormick (1999) identifies broad institutional acceptance of the ecosystem management paradigm at multiple political scales: international, national, regional and local.

At a minimum, ecosystem management implies "the theory and practice of managing ecological systems." Beyond this literal definition, the phrase connotes a variety of ideas and actions depending on the specific situation and people involved. While some ecologists consider ecosystem management little more than the latest buzzword, others see it as representing a fundamental and lasting paradigm shift in environmental science and policy. In the following section, I discuss *ecoregionalism* as one approach to ecosystem management.

The Ecoregion Concept in Biodiversity Science and Policy

> Government agencies and other interests concerned with natural resources have initiated cooperative programs and expanded ongoing efforts to manage resources holistically on an ecosystem basis. At regional scales, effective cooperation among diverse interests is now being demonstrated in large geographic areas, such as air sheds, watersheds, regional planning districts, ecoregions, and landscapes. The extent of these areas depends on the spatial and temporal scales of the particular issues of concern and the goals of the cooperating agencies and organizations
>
> Gregg 1999:23

As one particular type of ecosystem, ecoregions are defined and delineated according to a wide range of characteristics and a variety of scales. Therefore, numerous different methods of identifying, describing, assessing, and managing ecoregions are possible (see the history of the ecoregion idea as presented by Wright et al. 1998). Which method will depend on the specific people and the specific places involved.[12] For example, Omernik (1995:35) claims

> There is general agreement that these ecological regions exist, but there is considerable disagreement about how to define them…. Some of this disagreement stems from differences in individual perceptions of ecosystems, the uses of ecoregions, and where humans fit into the picture.

Omernik (1995:36-7) contends that a "large barrier" to developing a shared and more powerful (useful) understanding of the ecoregion concept is

> the common belief that to be scientifically correct, regions must be quantitatively developed and that they are objective realities …. Although this belief is being defused with increased understanding of ecosystems, the need to combine art with science in regional geographic research, including the development of ecoregions, continues to meet resistance…. The test of these regions is in their ultimate usefulness, rather than in the scientific rigor of a particular qualitative mapping technique.

Much as the famous natural historian Linnaeus used an "artificial" system of botanical classification based on the reproductive parts of plants as useful indicators of species boundaries (Farber 2000), today's biodiversity scientists delineate and classify ecoregions based on equally arbitrary, yet useful, characteristics (e.g., soil content, land form, vegetation, climate) (Smith 1996).

Regardless of the number and choice of characteristics employed in an ecosystem delineation/classification scheme, different methods produce different results, results that will not be reliable across multiple situations.[13] For example, ecosystems defined by watershed characteristics and ecosystems defined by biotic features rarely correspond (Omernik 1995). According to Ricketts et al. (1999:26-29), "An overlay of terrestrial and freshwater ecoregions reveals that there is little concordance between their boundaries."[14]

Wright et al. (1998:207) further emphasize this issue of ecoregional incompatibility in a recent study that examines two of the most prominent forms of ecoregional analysis as not corresponding well with ecological reality as it exists in the form of actual environmental conditions on the ground:

> the patterns of existing vegetation did not correspond well with the patterns of ecoregions. Most vegetation types had a small portion of their total are in a given ecoregion. There was also no dominance by one or more vegetation types in any ecoregion and contrary to our hypothesis, the level of congruence of vegetation patterns with ecoregion boundaries decreases as the level of classification became more general.

Wright et al. (1998:208) claim that not only do different methods produce incompatible results but the measures within any one method "are combined in a way that requires numerous subjective decisions on the relative importance of the different data layers. Because of this the results [of each method] are often not repeatable" (Ironically, this latter criticism is directed at Omernik who is quoted above as recognizing "the need to combine art with science" in ecoregional methodologies.).

To further complicate these issues, dynamic, disturbance, and disequilibrium theories of ecology, contend that there is no natural state of nature but that ecosystems are in a constant state of flux over very long, and sometimes very short, periods of time. In other words, what we easily recognize about marine ecosystems—that they are fluid—appears to apply equally well to terrestrial ecosystems when the time frame is extended.

In the following section, two distinctly different approaches to mapping the boundaries of Appalachian ecoregions in Eastern North America serve as an illustration of the possibility of multiple ecologies and the need for pragmatic approaches to biodiversity science and ecosystem management in global society.

A Case Study of Appalachian Ecoregions

> Enormous amounts of effort are invested in studying and managing ecosystems, even though the practitioners involved will usually confess when pressed that they cannot identify the boundaries or even the full composition of their "object" of study.
>
> Drury 1998:91

"Appalachia" is a contested terrain: Within the interdisciplinary field of Appalachian studies, there are numerous theoretical approaches for interpreting the history, current status, and desired future conditions of the region. The unique socio-economic and biophysical characteristics of Appalachia have been described in detail for several centuries, but it is only within recent decades that a coherent vision of the region as composed of one or another discrete ecosystems has come into play. The social construction of Appalachian ecoregions provides a case study for illustrating the politics of biodiversity in applications of the ecosystem concept.

In 1999, the World Wildlife Fund (WWF) published *Terrestrial Ecoregions of North America: A Conservation Assessment* (Ricketts et al. 1999). In this text, the WWF-sponsored scientists describe a "hierarchy of spatial units" that are used in a conservation assessment framework (Ricketts et al. 1999:12). These spatial units include four levels: major realms, biogeographical zones, major habitat types, and ecoregions.[15] Ricketts et al. (1999:435) define an ecoregion as

> A large area of land or water that contains a geographically distinct assemblage of natural communities that (a) share a large majority of their species and ecological

> dynamics, (b) share similar environmental conditions, and (c) interact ecologically in ways that are critical for their long-term persistence.

WWF promotes this specific approach to ecosystem definition, mapping and assessment as a "frame of reference" to be used "for action" in order "to conserve biodiversity" (Ricketts et al. 1999:xix):

> [B]y conducting an ecoregion-based assessment of biodiversity, WWF aims to speed up conservation planning and action …. At a minimum, this will help to focus our own actions as an organization …. The key message … is one of urgency.

The WWF's strategic approach to biodiversity science is intended for application in "global" ecosystem management. For example, in rating specific ecoregions as containing the "highest biodiversity values," WWF devalues the biodiversity interests of nation-states, regional cultures, and local ethnic groups in favor of the interests of a global society and global environment (Ricketts et al. 1999:84-85, 24). This is a consequence of global biodiversity science that has been identified by other scholars (e.g., Brown 1998; Escobar 1998; Guyer & Richards 1996).

From this global perspective, the WWF describes an Appalachian Ecosystem in terms of two adjacent ecoregions: The Appalachian/Blue Ridge Forests Ecoregion and The Appalachian Mixed Mesophytic Forests Ecoregion (Ricketts et al. 1999:182-190). According to WWF, these Appalachian ecosystems are merely two of 116 terrestrial ecoregions that, when combined, represent the continent of North America. As such, Appalachia is reduced to playing a minor role in WWF's globally comprehensive ecosystem classification scheme that divides the entire surface of the planet Earth into distinct, mutually exclusive ecosystems with clear, non-overlapping, mappable boundaries (Ricketts et al. 1999).[16]

In contrast to the WWF approach, there are other methods of delineating ecosystems in the Appalachian region. One such system is the Southern Appalachian Man and the Biosphere (SAMAB) approach sponsored by the United Nations Biosphere Reserve system (Peine 1999).[17] Biosphere reserves are intended to serve a broad purpose:

> Biosphere reserves focus attention on geographic areas that can serve as models for integrating conservation and sustainable development locally, while providing relevant information, technologies, and experience to help solve regional and global environmental problems.

Gregg 1999:24

The biosphere reserve approach to ecoregional delineation is described as "biogeocultural" (Gregg 1999). This approach defines the Southern Appalachian Ecosystem according to attributes of the local cultural heritage (e.g., cultural landscape features) and existing regional social institutions (e.g., state and federal parks and forest reserves) in addition to the more "natural" and "potential" biophysical conditions of the environment (Gregg 1999; Raitz & Ulack 1984).

As might be expected, the Appalachian ecosystem(s) as defined by the WWF ecoregions and UN biosphere reserve approaches do not correspond (i.e., the boundaries and core areas defined by these two approaches do not, even remotely, overlap). Likewise, choosing between these distinctly different biodiversity classifications for the purposes of ecosystem management will have profound implications for the future of the Appalachia (and the world). For instance, whereas the WWF ecoregions promote the preservation and conservation of globally significant biodiversity areas (where biodiversity is defined as non-human nature), the UN SAMAB biosphere reserve seek to enhance both the biological and cultural heritage of the regional landscape. Perhaps more importantly, unlike the WWF approach, the biosphere reserve system is not globally comprehensive in the sense of trying to map the entire planet. Also, in principle, biosphere reserves are not mutually exclusive ecoregions (in this sense it is like Borge's biodiversity classification quoted in the introduction to this manuscript); therefore, adjacent biosphere reserve ecoregions defined according to different locally significant characteristics can logically overlap and cross boundaries.

As illustrated above, biodiversity has multiple definitions and ecologists interested in different species, different processes, and/or different scales will define different ecosystems and ecoregions. Therefore, we might logically develop a plurality of scientific programs, each of which attempts to delineate, map, and assess the status of local and global ecosystems according to specific purposes.[18]

Conclusion

When problems lack neat solutions, when environmental and ethical aspects of

> the issues are prominent, when the phenomena themselves are ambiguous, and when all research techniques are open to methodological criticism, then the debates on quality [of knowledge] are not enhanced by the exclusion of all but the specialist researchers and official experts. The extension of the peer community is then not merely an ethical or political act; it can positively enrich the processes of scientific investigation.
>
> Funtowicz & Ravetz 1995:158

"Science studies" (e.g., the history, philosophy, and sociology of science) make it clear that there are many ways of knowing nature, and many of these ecologies are equally valid (Worster 1994; Heywood 1995; Sagoff 1988; Keller & Golley 2000). The comparative validity of these multiple ecologies depends on the specific context and purpose of their use (Longino 1990; Haraway 1991; Golinski 1998; Bowker & Star 1999). We should not be discouraged by such a pluralist and pragmatic approach to the science of ecology.[19] Rather, environmental scientists should explore opportunities to engage explicitly in the politics of biodiversity and thereby creatively construct knowledges that are useful to society for the purposes of policy and management.

Scientists can and do develop effective working definitions of biodiversity and ecosystem types (Nicolson 1989). These definitions can be objective in the sense that broad agreement among interested parties is possible, at which point these consensually established and intersubjective 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 are also clearly dependent upon the theories, values, and social context in which the definers are imbedded. Therefore, our environmental sciences and policies should make explicit the political ecologies that are reflected in biodiversity, ecosystem, and ecoregion concepts.

Toward this end, biodiversity and ecosystem studies must involve more than a wide range and diversity of specialists representing a variety of scientific disciplines. Interdisciplinary participation in environmental science and policy must extend to the social sciences and humanities and public understandings of the environment (e.g., Miller 2000). Scientists need to include not only their academic peers, but policy-makers, and most importantly, a wide range of citizens in their deliberations (Fischer 1999; Irwin 1995; Funtowicz & Ravetz 1995).

To some degree the studies identified in this manuscript are working toward this end. Jennings (2000:6) notes that "Working as cooperators in GAP, professional biologists, ecologists, computer scientists, geographers, and others have crossed disciplinary and institutional boundaries…." Likewise, the Global Biodiversity Assessment (Heywood 1995) involved some 1500 scientists, the United Nations, and numerous state agencies. Similarly, the World Wildlife Fund's ecoregional assessments involve transnational non-governmental organizations, national government agencies, and numerous individual scientists (Ricketts et al. 1999). While these collaborative efforts are to be commended, each of these efforts misses important opportunities to include the participation of local and non-professional stakeholders in their extended peer communities. Of the biodiversity programs cited in this paper, the "biogeocultural" ecosystem concept of the United Nations Biosphere Reserve program (Gregg 1999) may be the only one to explicitly and intentionally involve the participation of non-expert and local stakeholders in deliberating the politics of its particular ecology.

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[1] Callicott et al. (1999) and others make it clear that only rarely do contemporary ecologists adhere to a hardline resembling either a compositionalist or functionalist ideal. Rather, this dichotomy serves as an empirically-based conceptual framework for building a more complex discussion. In a similar sense, it is doubtful that Clements and Gleason or Linnaeus and Buffon or many of their adherents were blind devotees of their respective idealized systems and methods.

[2] As Nicolson (1989:174) concludes, "Nothing in this account should be read as detracting from the status of [biodiversity science] as carefully-observed and technically-successful representations of Nature. It is evidently possible for researchers to observe Nature in culturally-specific ways. It is also clearly within the capacity of human ingenuity to produce theories which fulfill many purposes at once."

[3] Ecoregional concepts are often closely aligned with the concept of bioregionalism. However, unlike ecoregionalism, bioregionalism and related environmental conservation strategies tend to be heavily steeped in anti-modern Romantic ideals of wilderness and pristine, non-human nature (Oelschlaeger 1991; Alexander 1990).

[4] Nicolson (1989:146, emphasis added) identifies some of these key issues in a historical case study of the specialized field of plant ecology and vegetation classification: "We may conclude that the nature of vegetation does not determine the character of the units into which any given piece of vegetation is classified. This conclusion, however, does not imply that the nature of vegetation is irrelevant to the manner in which is conceptualized by ecologists. It seems very likely that many major differences between European and American vegetation science do express differences in the vegetational character of the two continents. What the deficiency of the 'ecology of ecologists' explanation does

entail, however, is that *we must look at factors other than input from the natural world if we are to have a complete explanation of the differences* between the Clementsian and the Sigma schools. *We must look also at the cultural contexts and at what one might call the purposes, the social, professional and technical interests, of the respective research programs*."

[5] Prior to 1988, "biodiversity" did not exist (the word had yet to be coined).

[6] There is rhetorical power in ambiguity and ironically it may be this ambiguity, rather than precision, that makes the species concept so powerful within biodiversity science and politics (Peterson 1997).

[7] Species are widely and commonly understood by scientifically-educated people to be one of the basic units of nature and one of the primary building blocks of ecological systems. However, within the research community the question of what constitutes a species has always been controversial. In fact, there are dozens of species concepts, at least five of which are considered valid by most biologists (Mayr 1988; Heywood 1995). "There are currently five or six different species concepts in use and no agreement between the different practitioners on how to develop a coherent theory of systematics at the species level….In addition, species concepts differ from group to group and there are often national or regional differences in the way the species category is deployed" Heywood (1997:9, in Bowker 2000:669). Debate concerning where and how to draw distinctions and connections between these natural kinds (i.e., species as a fundamental and "natural" unit of nature) has been a primary topic of discussion since Ancient times. Throughout the twentieth century, the species concept has been both illuminated and obscured by evermore specialized research: "The clearest and least ambiguous concept [of] species is … the 'non-dimensional species concept' or the species of the local naturalist. As Mayr notes, the species found in any one place and time take care of themselves; the local naturalist rarely has any trouble sorting them out. It is only when the well traveled naturalist attempts to follow species through space or the paleontologically oriented naturalist to follow them through time that species begin to grade into one another and lose their clear boundaries. In order to deal with this problem different species concepts than those of the local naturalist are needed" (Kiester 1982:351). Following this lead, one textbook in the specialized field of dendrology (Harlow et al. 1996:6) illustratively states, "A species is a concept that is variously defined…. A species by one taxonomist may be a variety or subspecies by another and vice versa. These are taxonomic decisions and some taxonomists maintain a much broader view of the species than others. … A flexible species concept is obviously necessary to accommodate the complexity of nature as well as our level of understanding." Despite this enduring and confusing ambiguity surrounding the species concept, it remains "the focal point—the basic unit of taxonomy and classification," particularly in the applied biological sciences: "[The species] is the basic group of potentially interbreeding populations of individuals which share many characteristics and which are more or less distinct from related species …. To the conservation biologist, it is the basis of biodiversity" (Harlow et al. 1996:6). Understanding and accepting the subjective and situational ambiguity that lies behind the seemingly objective species concept, and biodiversity more generally, will help us to better understand the strengths and weaknesses of the "science" in environmental decision making. Implications of species ambiguity for public policy is well illustrated in the case of salmon controversies

in the Pacific Northwest (Scarce 2000). For additional reading on the species concept, see Hull & Ruse (1998) and Mayden & Wood (1995).

[8] Do genes exist? Commoner (2002) implies that the material reality of genes, as an "objective" phenomena, is uncertain. The findings of the Human Genome Project (HGP) seem to indicate that genes (defined as "segments of DNA that encode specific proteins that give rise to inherited traits" (Commoner 2002:40)) may not be real objects readily apparent and identifiable as tangible entities so much as they are abstract concepts (conceptual constructs with explanatory power to serve heuristic purposes much in the same sense that species and ecosystems are concepts rather than actual physical phenomena in the seemingly more objective way that organisms and cells are (and yet, organisms and cells as discrete, individual objects are also socially constructed scientific facts (Poovey 1998; Fleck 1979)).) The implication is that the world can be known, understood, organized, and constructed in a wild variety of ways. Mainstream contemporary science (e.g., modern, normal science) is only one of the many ways of knowing/constructing the world.

[9] In "Toward a More Exact Ecology," Grubb (1989:23, emphasis added) contends "*Ecosystem ecology is notoriously inexact* in the sense that very many of the published values for productivity and nutrient flows are presented without any measure of accuracy, and the problem is seriously aggravated by the common practice of quoting both primary data and derived values to excessively large numbers of significant figures, apparently without thought for what the errors might be."

[10] Paul Angermeier (personal communication, 4/19/02) notes that ecologists commonly identify ecosystem "types" for which multiple exemplifiers can then be found (e.g., temperate deciduous forest, alpine lakes).

[11] Paul Angermeier (personal communication, 4/19/02) notes that "many ecologists strongly disagree; even if there are no qualities that are useful in <u>all</u> ecosystems, qualities can be identified to assess health in pre-defined groups of ecosystems."

[12] Berthold-Bond (2000:16) quotes Alexander (1990:168): "The Great Lakes Basin has been designated a bioregion by bioregionalists, despite the fact that it is composed of two physiographic regions, three soil zones, and three vegetation zones, none of which respect its boundaries." Based on this and related evidence, Berthold-Bond (1990:16) claims "That is, the question of which topographical characteristics should serve as the criteria for a 'bioregion' is a matter of choice. Geographic regions emerge from decisions about how to categorize and characterize them—from choices we make about what is to count. Moreover, sometimes there are real disagreements about what these choices should be …, just as there are real disagreements on the part of warring people over the true regions of political and cultural borders."

[13] The least complicated method of ecoregion delineation/classification would use only one characteristic (e.g., dominant land cover type).

[14] And yet, incongruent ecosystem delineations are presented as compatible when this function best serves the purposes of allegiance and network extension (e.g., Ricketts et al. (1999) in their rhetorical approximations of incompatible ecoregions under the sections titled "Relationship to Other Classification Schemes").

[15] Other systems of classification reference yet other elements in their hierarchical descriptions. For example, the GBA (Heywood 1995) focuses on biomes, bioregions, landscapes, and ecosystems.

[16] In analyzing the WWF ecoregions and the UN Biosphere Reserves, it becomes clear that unlike the WWF methodology, the Biosphere Reserve approach does not attempt to be either comprehensive or mutually exclusive. Although the Biosphere Reserve system is initiated from the highest levels of international government (i.e., the United Nations), it is implemented locally in a way that recognizes the need for a flexible methodology capable of accommodating local contingencies and unpredictable characteristics peculiar to specific places and the people who care about them in a variety of different ways (Gregg 1999). In this sense, the Biosphere reserve approach allows for ecosystems to remain messy, fuzzy, ambiguous, and disorderly. Whereas the WWF approach can be described as top-down (a centralized and deductive system), the Biosphere reserve approach is more bottom-up (decentralized and inductive).

[17] Groups reifying the Central Appalachian Ecosystem employ yet other approaches to classification.

[18] Paul Angermeier (personal communication, 4/19/02) challenges this recommendation: "Although there is no single best way to define biodiversity of ecoregions, conservation success will surely be precluded if all definitions are equally acceptable; emphasizing the arbitrariness of these concepts ensures the continued control of environmental policy by opponents of conservation." Angermeier suggests that it would be "more helpful/prudent to suggest criteria for limiting the range of acceptable definitions of concepts."

[19] Nevertheless, many of these same scientists who engage in pluralist and pragmatic practices continue to call for unification. According to Jennings (2000:9), "The lack of a common classification for assemblages of plant species [i.e., ecosystems] has had a limiting effect on the application of ecology to problems such as loss of biodiversity…."

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Chapter 3

The Science of Public Ecology

> By pushing past the exhausted conceptual divisions from the 1980s, which largely divided the more natural science-based "environmental sciences" from the more social science-focused "environmental studies," public ecology should mix the insights of life science, physical science, social science, applied humanities, and public policy into a cohesive conceptual whole.
>
> Luke 2001

Introduction

Faced with the task of making difficult decisions, people frequently turn to science. For example, public policy makers often call for more and better science on which to base decisions. Reinforcing this notion that science knows best, environmental scientists lament: "If only we could educate the public;" implying that ignorance prevents decision makers from adopting the policies that scientists think best. On both counts, the implication is that the neutrality and objectivity of science is the appropriate vehicle for resolving complex and controversial issues. However, what this conventional view of science often overlooks is the fact that all knowledge, no matter how scientific, is actually a limited and contested terrain.[1] For example, Douglas Weiner (1992) warns of the potentially dangerous role of science, as "privileged knowledge," in environmental politics. Drawing empirical evidence from environmental history in Russia, Germany, the United States, and elsewhere, Weiner (1992:405-6) asserts,

> The danger of Valentin Rasputins, Vernadskii cultists, and Deep Ecologists everywhere is that they are arguing from a privileged knowledge. '*We* know what is *really* best for you, what will cure you,' they assert. They alone know the distinction between natural harmony and disorder, social health and corruption, pollution and purity, alienation and unity. They do not recognize the social construction of their ethical beliefs and political visions; they absolutize their individual truths. They may be right, but what if they are not…?'

In other words, when we appeal to science, it is important that we "be explicit about the moral and political agendas we embrace." (Weiner 1992:406).[2]

The point is that there are many different, and yet equally valid, ways of knowing nature and human nature. Within the many disciplines of the natural and social sciences, individual researchers and our respective schools of thought produce competing claims about the biocultural reality of our environment. The knowledge that scientists construct contains varying degrees of uncertainty (not to mention bias) and is usually restricted to specific temporal, spatial, and cultural contexts. As a result of these and other limitations, it is increasingly clear that science alone is capable of providing only partial assistance to decision makers. Ultimately, public policy must be made according to a set of beliefs, values, interests, institutions, and assumptions that extend beyond the boundaries of what is traditionally considered to be "good" science.

For example, in response to growing environmental concerns (e.g., biodiversity loss, forest fragmentation, global warming, etc.), a variety of applied science programs have emerged to help people make better decisions about the environment. Each of these programs (e.g., conservation biology, restoration ecology, sustainable forestry, environmental toxicology, and others) produces specialized knowledge that is used to achieve specific social and environmental goals. For instance, the peer-reviewed, scientific analyses published in *Conservation Biology* are most likely concerned with the goal of preserving biological diversity, whereas the equally scientific and respected analyses published in *Forest Science* are most likely concerned with the goal of sustaining timber yields. Likewise, studies in environmental toxicology investigate risks to human health by environmental pollutants, while studies in ecological restoration serve to maximize the integrity of "natural" systems. Unfortunately, these diverse forms of knowledge offer multiple and often conflicting ways of thinking about the environment (e.g., Callicott et al. 1999; Sagoff 1988). *Public ecology* explicitly addresses this dilemma.

Public ecology exists at the interface of science and policy. Public ecology is an approach to environmental inquiry and decision making that does not expect scientific knowledge to be perfect or complete. Rather, public ecology requires that science be produced in collaboration with a wide variety of stakeholders in order to construct a body of knowledge that will reflect the pluralist and pragmatic context of its use (decision-context) while continuing to maintain the rigor and accountability that earns scientific

knowledge its privileged status in contemporary society. As such, public ecology entails both *process* and *content*. The process is that of a postmodern scientific method: a process that values the participation of extended peer communities composed of a diversity of research specialists, professional policy-makers, concerned citizens, and a variety of other stakeholders. The content of public ecology is a biocultural knowledge of human ecosystems that directly relates to and results from the participatory, democratic processes that distinguish public ecology as *citizen science*.

The primary goal of public ecology is to build common ground among competing beliefs and values for the environment. In doing so, public ecology recognizes that human culture is a unique but essential ingredient of biological diversity, both locally and globally (e.g., Berkes & Folke 1998; Heywood 1995). And, public ecology maintains that all environments are not only spatially and temporally complex but also economically and politically defined (Hull & Robertson 2000; Escobar 1999). Therefore, public ecology is an interdisciplinary combination of the *social* and *natural* sciences, the humanities, and *public* understandings of the environment (see also Robertson & Hull 2001; Luke 2001).

The purpose of this paper is to justify the unique content and process of the science of public ecology. More specifically, the purpose is to 1) show that all ecologies and environmental sciences have normative processes and content, 2) justify the biocultural content and democratic process of public ecology, and 3) to further promote the theory, practice, and community of public ecology. Ultimately, it is my desire to stimulate the growth of public ecology as a vibrant international community of interdisciplinary and collaborative environmental scientists who are dedicated to achieving not only a sustainable but a desirable future for humans and all forms of biodiversity. The remainder of this paper describes and argues for the biocultural content and democratic process of this science of public ecology.

The Content of Public Ecology Needs to be Biocultural

Environmental science is transdisciplinary (and includes social science)

One very prominent and influential definition of environmental science states that it is

> the study of how we and other species interact with one another and with the nonliving environment…. It is a *physical and social science* that integrates knowledge from a wide range of disciplines including physics, chemistry, biology (especially ecology), geology, meteorology, geography, resource technology and engineering, resource conservation and management, demography…, economics, politics, sociology, psychology, and ethics.
>
> Miller 2000:44

According to this widely distributed textbook definition, environmental science "integrates" an array of disciplines, methodologies, and practitioners into a unified and interdisciplinary body of knowledge. The truth, however, is that environmental science, as currently practiced, is far from being either unified or interdisciplinary. There is no coherent set of actors and activities that define the field. Nevertheless, environmental science is far more than simply a disparate collection of the traditional biophysical disciplines (e.g., biology, geology, chemistry, and physics). While each of the great number of researchers, educators, professionals, and conscientious citizens working under the rubric of environmental science no doubt promotes a somewhat different definition of what it is they do, as a whole, this community of environmental scientists desires to be something more than a sum of parts. Miller's (2000) normative vision of environmental science may be more promotional than factual, but it does reflect a shared vision of a common future.

However, it is not enough that environmental science be transdisciplinary, it also must be intentionally *applied*.

> There are few pressing social issues that are as heavily dependent on scientific information as are environmental problems. Most scientists and policy makers agree on the importance of science in environmental policy debates …. Thus environmental scientists play a key role in society's responses to environmental problems, and many of the studies performed by environmental scientists are intended ultimately to affect policy.
>
> Kriebel et al. 2001:4[3]

Kriebel et al. (2001:4) are not alone in their call for a science that has explicit utility. For example, geographers Bryant and Wilson (1998) argue that the mounting criticism of professional environmental management can be attributed, in part, to the environmental sciences failure to address the day-to-day issues faced by environmental decision makers. They contend that managers involved in such areas as restoration, forestry, and pollution

mitigation have relied almost exclusively on "traditional" environmental sciences such as biology and chemistry for solutions to environmental problems. This trend continues despite the fact that managers increasingly find themselves imbedded in a political, economic, and social context, and that solutions often require guidance from other realms of environmental thought, particularly those that study and inform how people think about, act, and interact with the environment. Thus, environmental management, if it is to be effective, requires significant input from the social sciences and humanities (e.g., Gobster & Hull 2000; Scoones 1999; Endter-Wada et al. 1998).[4] Disciplinary traditions aside, if science is to play a significant role in contemporary environmental politics, then the people who produce this knowledge will need to critically evaluate it for its ability to achieve desirable results. This is not an easy task, however, and critics will likely continue to chastise the field of environmental science for not helping many of those who are most in need of its services.[5]

Ultimately, no amount of science, no matter how interdisciplinary and applied, will, in and of itself, solve environmental problems. Problems are identified and solved by people, not science. As will be explained below, concerned environmental scientists, who wish to improve the conditions of life on Earth, are encouraged to embrace the social construction and democratization of science by engaging extended peer communities (i.e., a wide variety of interested stakeholders) in collaborative processes of participatory research. The goal of these efforts is to build increased political will and social capital for informed and responsible environmental decision making.

There exist many ecologies, all having normative agendas

In seeking to develop an transdisciplinary and applied form of environmental inquiry, we should not overlook the pluralist and pragmatic attributes of contemporary environmental science. These attributes are easily identified in each of the field's many subdisciplines. For example, looking just at ecology, we find,

> Ecology has always been a polymorphic discipline, … plant and animal ecology, limnology and marine ecology, physiological, population and community ecology, and the several aspects of applied ecology, forestry, fisheries, agronomy, pest control, and wildlife management …. Some intrinsically ecological subjects, such as parasitology, have only recently, and somewhat grudgingly, seen themselves as allied with ecology. Given these heterogeneous origins, coupled

> with the common tendency of ecologists to subdivide along taxonomic or habitat lines, it is difficult to identify the unified science.
>
> McIntosh 1982:9

> Ecology ranges over many diverse areas—marine, freshwater, and terrestrial. It involves all taxonomic groups, from bacteria and protozoa to mammals and forest trees, at all levels—individuals, populations, ecosystems. Any of these levels and groups may be studied from various points of view—behavioral, physiological, mathematical, chemical. As a result ecology, by necessity, involves isolated groups of specialists.
>
> Smith 1996:8

Beyond the traditional sciences of ecology, there are great many "other" ecologies. Since Aristotelian times, social theory and ecological theory have mixed and matched in a number of ways such that ecology is more than a strictly academic discipline; it is also a popular way of thinking (e.g., Worster 1994). Theories, assumptions, and facts float back and forth (in both directions) across the boundaries constructed to separate scientific and lay ecologies.

Ecologism describes the occurrence of literature, art, and popular culture that reflects this ecological way of thinking (e.g., Hayward 1994). For example,

> [T]he environment about which we all argue and make policy is the product of the discourse about nature established by powerful scientific disciplines such as biology and ecology, in government agencies such as the Environmental Protection Agency and … in nonfiction essays and books such as Rachael Carson's Silent Spring and Paul Ehrlich's The Population Bomb …. Thoreau's Walden: Or Life in the Woods or television shows such as Mutual of Omaha's Wild Kingdom that we watched as children. The language of these various discourses determines what exists, what is good, and what is possible.
>
> Herndl & Brown 1996:3-4

Similarly, *deep ecology* is a phrase that describes a more-or-less coherent ecophilosophy (Fox 1990). *Political ecology*, which includes dimensions of *liberation ecology*, *feminist ecology*, and related *emancipatory ecology* programs, "highlights the interwoven character of the discursive, material, social, and cultural dimensions of the human-environment relation" (Escobar 1999:2). *Social ecology*, *human ecology*, *cultural ecology*, *landscape ecology*, *restoration ecology*, *conservation ecology*, *ecosystem management*, and *sustainable development* are just a few of the many "other" ecologies existing in contemporary environmental discourse.[6]

Each of these environmental specialties is finite in scope. Individually and collectively, these programs of study are unable to cover the full range of biological and cultural diversity. For instance, Pimm (1991:2) depicts the limited areas of space and time and that have been mapped by ecologists. More critically, Bowker (2000) reminds us that the populations and methodologies that tend to be the focus of environmental science studies are based on charismatic, exotic, or utilitarian qualities rather than other, less anthropocentric attributes.

> Humans are the measure of all things in the information world that we create. When entities have the misfortune to be small and generally disliked, then they will certainly not get the attention that others do.
>
> Bowker 2000:658[7]

Heywood (1997:9) underscores the anthropocentric dimensions of this critique: "… our current knowledge is largely demand-led in that we have tended to inventory and describe mainly those groups of organisms that are known or believed to be of value to or impinge on humankind." Lastly, Atran (1990:33 as quoted in Guyer & Richards 1996:2-3) illustrates the pragmatic aspects of this humanism: "Bugs simply lack phenomenal resolution for humans… they are phenomenally lumped together much as the light is at the end of the color spectrum." Whether intentional or not, these and other biases inevitably shape our scientific understandings of the environment. Unfortunately, this critique of environmental science as value-laden is a challenge that many scientists and science advocates have been notoriously unwilling or unable to embrace (Noss 1994; Roebuck & Phifer 1999; L'el'e & Norgaard 1996).

Biocultural Ecology: The Science of Dynamic Human Ecosystems

> Ecology has struggled since its inception with the issue of how to deal with humans. They have been considered on one side to be just another animal and therefore appropriate for inclusion in ecology. On the other side, they have been treated as so obviously different and socially complex as to be avoided at all costs.
>
> Pickett et al. 1997a:195

Change is constant and Nature is not nearly as stable as we might like it to be. The environmental conditions of our local and global ecosystems are in a continual state

of flux (Heywood 1995; Pickett et al. 1997b). Therefore, it is ambiguous and potentially misleading to advocate the idea of a "natural state of nature" (i.e., biological and ecological integrity) (Cronon 1995; Callicott & Nelson 1998). In any given time and place, there are many equally possible and equally healthy environmental conditions; no one of these many possible natures, is necessarily more "natural" than another (Hull & Robertson 2000; Botkin 1990). Western environmental science, ecophilosophy, and nature writing have tended to ignore the historical fact that people are part of these dynamic natural processes. Contemporary decision makers, however, can no longer afford to overlook the active, functional role of humans as an integral and creative component in ecological, evolutionary, and environmental change. In the midst of today's fragmented ecosystems, invasive species, biotechnologies, and global climate changes, we need a renewed vision of nature, science, and environmental management, one that includes human culture.

Human society plays a significant role in this environmental change (e.g., Crumley 1994; Denevan 1992), not all of it desirable (e.g., biodiversity loss, forest fragmentation, global warming). For at least the past few centuries, extensive and intensive human activities have irreversibly propelled Earth's ecosystems along new trajectories, making local and global environmental change increasingly unpredictable. Nevertheless, humans (whether primitive, modern, or cyborg) and the environmental changes they introduce do not necessarily degrade environmental quality. Many of the "scientific" constructs that we use to operationalize environmental quality arbitrarily define environmental quality in exclusive terms as the minimal presence or total absence of humans and human impacts (Hull & Robertson 2000). And yet, in many cases, human activity may even improve the diversity, stability, health, and overall quality of some ecosystems (Pykälä 2000; Saberwal 1996; Gomez-Pompa & Kaus 1992).[8] As stated above, at any given time and place, many different environmental conditions are possible, many of which possess desirable qualities. Therefore, what counts as environmental quality is largely a matter of perspective, relative to the scope of one's vision and aspiration for a given ecosystem.

Because many environmental conditions have existed and can exist, it is easy to see that people cannot identify one set of environmental conditions as being better than

another without invoking some value system that answers the question "better for what purpose?" Nature, the environment, if left alone, will evolve, grow, and develop in unpredictable ways. Therefore, if we want the world to be a certain way, we must wisely and actively manage for the conditions we desire. "Nature in the twenty-first century will be a nature that we make; the question is the degree to which this molding will be intentional or unintentional, desirable or undesirable" (Botkin 1990:193). Either way, people will be part of the equation (Szaro & Johnston 1996; Di Castri & Younès 1996). To say that humans by definition degrade environmental quality is an overly simplistic and highly pessimistic conclusion, one that is depressingly fatalistic in its consequences. Rather, we need a vision of nature and humanity that will allow us to design ways of living that are meaningful and inspirational, not merely sustainable. Do to so, we need a more biocultural ecology that recognizes the ecological value of healthy human ecosystems.[9]

The Process of Public Ecology Needs to be Democratic

Science is limited

> Of course, some sciences more than others—ecology is perhaps the best example—have an obvious and intimate involvement in social values. But all science, though primarily concerned with the "Is," becomes implicated at some point in the "Ought."
>
> Worster 1994:337

Ernst Mayr (1988: 284) claims, "Scientific theories are nearly always judged by criteria additional to truth or falsity, for instance, by their simplicity or, in mathematics, by their 'elegance'." In parallel, Mark Sagoff (1992:61) contends, "It is no coincidence that many of the best observers of nature—Audubon would be an example—were artists as well as scientists. Ecology may differ from painting less in its purpose or even in its methodology than in the symbols it uses and in the questions it asks." More recently, Daniel Botkin (2000:239) describes competing scientific theories as analogous to rival beauty contestants, each one different but nonetheless desirable: "… the beauty in the dynamics of nature can replace the beauty of the idea of stasis. In this case, nature's

ability to respond to change and life's demonstrated ability to persist for unimaginably long times—3.5 billion years—are ideas of great aesthetic appeal."

So, what is science and what role does it have to play in environmental decision making? For the past several hundred years following the advent of the so-called "scientific revolution," many different philosophies of science and many different scientific methods have come in and out of favor (Golinski 1998; Kuhn 1996). Today, there is no one scientific method and no one philosophy of knowledge to which all or even most scientists adhere (Longino 1990; Gieryn 1999). Science is a realm of contention and discensus as much as it is a body of coherent and accumulated knowledge: It is an interactive social activity and a dynamic cultural practice as much as it is a formalized procedure and set of agreed upon norms (Latour 1987; Haraway 1991). Recent studies in the history and sociology of science reveal extensive empirical evidence to support the argument that scientific knowledge is not fundamentally different from other forms of knowledge and that science cannot be separated from the many beliefs, values, interests, and institutions of which it is part ("science studies" that focus specifically on the environmental sciences: e.g., Tauber 1999; Takacs 1995; Murdoch & Clark 1994).[10]

Complexity and Uncertainty in Contemporary Environmental Theory

> Environmental scientists study highly complex, poorly understood systems. … In this complicated and contested terrain, it is useful to examine the methodologies of science …. It would, for example, be useful to policy makers if scientists were more explicit about the limits of knowledge, and about the nature and amount of uncertainty in research findings.
>
> Kriebel et al. 2001:7

Scientists are acutely aware of the complexity of their subject matter and the resulting uncertainty of their knowledge base. However, nonscientists (or nonspecialists) are often in a different position and may tend to perceive the science as more certain than it actually is (Shackley & Wynne 1996). The challenge for environmental scientists is to make explicit this complexity/uncertainty dilemma so that it may be more thoroughly explored by the people who advocate and use the information.

Looking again at the subfield of ecology as a particularly illustrative example, we see that despite the word ecology being coined over a hundred years ago and despite the many people and resources currently devoted to practicing one or another of ecology's many forms, there are no formal, consensually established, scientific laws of ecology. This is not a problem, so much as it is simply a fact, something of which to be critically aware when appealing to science for solutions to contemporary environmental issues.

Unlike the so-called "hard" sciences of physics and chemistry, ecology is painfully devoid of consensually established theory (Sagoff 1988; Peters 1991).[11] In this light, ecology (and environmental science more generally) is seen to be a science consisting mainly of hypotheses, models, case studies, and rules-of-thumb (Shrader-Frechette & McCoy 1993, 1994; Shrader-Frechette 1995).

> Ecological systems are so much more complex than the solar system, and the great minds of today have been so little concentrated on the subject of ecology, that we do not yet have an internally consistent, mathematically elegant theory of ecology to parallel the Newtonian laws of motion. … From where we stand, it is unclear whether such simple, elegant laws can indeed emerge for such complex systems.
>
> Botkin 2000:239

> The absence of simple, quantitative, predictive, law-like generalizations in ecology is simply a fact about nature and has nothing to do with the status of ecology as a science. Physicists have found such laws, of course, but they asked the easy questions that had easy answers. The presence of such laws in physics does not make it somehow more "scientific" than ecology, only less difficult. Ecologists function well as scientists so long as they observe the virtues of inquiry and solve (or try to solve) socially important and intellectually interesting problems.
>
> Sagoff 1988:161[12]

Throughout the environmental sciences, uncertainty, in the face of overwhelming complexity, is increasingly accepted as a given. The world and how it works is utterly complex (chaotic and changing); relative to what might be known about it, we now know very little, and it is likely that we may never know all that much. Complexity and its attendant uncertainty redefine the nature of environmental science and limit the role that such knowledge can play in many environmental decisions (Eden 1998; Lemons 1996; National Research Council 1986).

Based on the earlier work of Wynne (1992), Yearley (2000) defines four levels of uncertainty). Environmental 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 (e.g., ecosystems are difficult to define as ecologically significant units due to their dynamism and their indefinite boundaries but we know that energy flows, 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 and natural processes that are likely to change in the future and thus are entirely outside the scope of scientific prediction (e.g., estimations of the long-term health and sustainability of humanized ecosystems where energy consumption, waste production, tastes, and technological improvements in efficiency are not only unknown but likely to change in unanticipated ways).

Contemporary environmental theory can be unsettling in that it emphasizes how nature is both chaotically complex and continuously changing at all scales of space and time. Nevertheless, complexity and uncertainty appear to be defining characteristics of contemporary environmental theory, redefining our sciences of nature and human society.[13]

Public ecology is an explicitly democratic science

> I have come to think of science and democracy as compass and gyroscope—navigational aids in the quest for sustainability. Science linked to human purpose is a compass: a way to gauge directions when sailing beyond the maps. Democracy, with its contentious stability, is a gyroscope: a way to maintain our bearing through turbulent seas. Compass and gyroscope do not assure safe

> passage through rough, uncharted waters, but the prudent voyager uses all instruments available, profiting from their individual virtues.
>
> Lee 1993:5-6

In recognition of the complex/uncertain and normative/prescriptive aspects of environmental science, a more public ecology requires that professionals share with a larger community of stakeholders the responsibility and the privilege of defining the problems, the research needs, the decision process, and the content of the deliberation surrounding environmental issues. In this science/policy arena, "…uncertainty is not banished but is managed, and values are not presupposed but are made explicit. The model for scientific argument is not a formalized deduction but an interactive dialogue" (Funtowicz and Ravetz 1995:147). According to Song and M'Gonigle (2001:985), "the key to 'good science' is a participatory process with open dialogue and paradigmatic debate."[14]

Among other things, extended peer review demands that environmental inquiry and decision making acknowledge the requirements of competing forms of rationality, making room for both traditional scientific ideals (e.g., precision, accuracy, reliability, generalizability) and more pragmatic criteria (e.g., applicability, accessibility, adaptability) specific to the unique people, places, and issues involved (Renn et al. 1995; Moote et al. 1997; Hennen 1999).[15] Professionals, scientists, and other specialists who engage in *participatory inquiry* with an *extended peer community* typically find that ordinary people are capable of comprehending and making a positive contribution to resolving today's complex and controversial environmental issues (Fischer 1999, 2000; Kleinman 1998).

Dialogue among diverse stakeholders is no silver bullet, but empirical evidence does suggest that collaborative learning processes can be enhanced by involving a greater range and diversity of people (i.e., those marginalized within or located outside the institutional boundaries of professional and disciplinary practice) in science and policy decision making (e.g., Petts 1997; Maarleveld & Dangbègnon 1999; Finger & Verlaan 1995). This extended peer review is perhaps the most profound change facing environmental science and policy in the twenty-first century. Peer review is the process by which the scientific community has traditionally evaluated the validity of its work. As

such, it is the process that gives science its consensual, intersubjective, and seemingly objective qualities. Extending this peer community is essentially a request for the "democratization" of environmental science and policy (Kleinman 1998; Epstein 1991). Funtowicz and Ravetz (1995:147) contend,

> This extension of legitimacy to new participants in policy dialogues has important implications for society and for science as well. With mutual respect among various perspectives and forms of knowing, there is a possibility for the development of a genuine and effective democratic element in the life of science.

This participatory democracy aspect of public ecology opens up a whole set of opportunities and concerns: Just how far will the extended peer community stretch the boundaries of science? Will participatory inquiry on the part of an extended peer community lead to increased creativity and discovery? Will democratization erode science's cognitive authority? Is expertise really a social learning process? Many challenging and unresolved questions surround the science of public ecology.[16]

Conclusion

> The activity of science now encompasses the management of irreducible uncertainties in knowledge and ethics, and the recognition of different legitimate perspectives and ways of knowing. In this way, its practice is becoming akin to the workings of a democratic society, characterized by extensive participation and toleration of diversity. As the political process now recognizes our responsibilities to future generations, to other species and indeed the global environment, science also expands the scope of its concerns. We are living in the midst of this rapid and deep transition, so we cannot predict its outcome. But we can help to create the conditions and the intellectual tools whereby the process of change can be managed for the best benefit of the global environment and humanity.
>
> Funtowicz & Ravetz 1995:160

Public ecology is distinctive in that it explicitly and critically embraces its own normativity and uncertainty while striving to create a more democratic body of knowledge that will help us to understand the environment as a complex and dynamic biocultural system, one that can be interpreted from a variety of perspectives and points of view. Public ecology encourages citizens and all concerned stakeholders to participate with research scientists and professional policy-makers in the interdisciplinary, collaborative efforts necessary to resolve the uncertainty and conflict that surround

contemporary environmental issues. In this way, public ecology represents a more participatory approach to environmental inquiry and decision making (Fisher 2000; Irwin 2001, 1995; Lee 1993). The emergence of this more biocultural and democratic—this more "public"—ecology encourages all to look beyond a merely sustainable future to a future where the "social" and the "natural" are integrated in ways that enhance our understanding and experience of life on Earth.

Many of today's applied environmental professionals (e.g., conservation biologists) are characteristic of a new breed of self-reflective, explicitly normative, public interest scientists. These ecologically enlightened experts are citizens of the local and global environment 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 partial and purposeful (e.g., O'Brien 1993). Likewise, public ecology does not expect environmental science to be perfect or complete; rather, it asks that knowledge be constructed in collaboration with non-specialist peers (i.e., fellow citizens and concerned stakeholders) to reflect the pluralist and pragmatic context of its use (decision-context) while continuing to strive for the rigor and accountability that earns scientific knowledge its privileged place in the socio-political arena where environmental policy is made). When faced with such a challenge, scientists and their advocates are encouraged to remember that the scientific enterprise is still in its youth: The Scientific Revolution is flourishing (Shapin 1996; Kuhn 1996)[17], Enlightenment is in the making (Becker 1932), and "We have never [yet] been Modern" (Latour 1993).

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[1] Proctor (1991:10), as quoted in Tauber (1999:483-4), reminds us that "Neutrality and objectivity are not the same thing. Neutrality refers to whether science takes a stand; objectivity, to whether science merits claims to reliability. … Certain sciences may be completely "objective"—that is, valid—and yet designed to serve certain political interests. Geologists know more about oil bearing shales than about many other rocks, but the knowledge is no less reliable. … [T]he fact that their knowledge is goal-directed does not mean it doesn't work. The appropriate critique of these sciences is not that they are not "objective" but that they are partial, or narrow, or directed towards ends which one opposes."

[2] In similar fashion, Elizabeth Bird (1987:260-7) contends, "To cite the 'laws of ecology' as a basis for understanding environmental problems is to rely on a particular set of socially constructed experiences and interpretations that have their own political and

moral grounds and implications." Bird (1987:262) concludes by posing a series of very challenging questions: "Should we believe everything the science of ecology has to tell us about our relations with nature? Or should we examine the social construction of ecology itself … and find out if we would want the kind of world that ecology would construct for us if it were to win political hegemony in the sciences?"

[3] Meffe (1998) has made similar arguments about the political role of science in the field of conservation biology.

[4] Similar to the Miller (2000) definition of environmental science, Malcolm Hunter (1996:14) defines conservation biology as "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 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."

[5] Regarding agricultural research, which is one dimension of environmental science, Kloppenburg (1991:521) notes, "[C]riticism has been directed not simply at the priorities to which agricultural science has been directed, but at the validity and utility of the methodologies employed in research and the epistemic constitution of knowledge production itself…. [A]gricultural research of the sort performed by experiment stations can have only limited applicability to actual farming operations because of limitations intrinsic to the probabilistic extrapolation of experimental results to highly variable biological and social systems. A growing number of biological scientists are concerned that the reductionistic and positivistic approaches characteristic of modern science constrain pursuit of unorthodox but potentially productive research initiatives, obscure important connections between organisms and phenomena, and actively inhibit achievement of holistic understanding of ecological systems…."

[6] The lines that divide these many branches of ecological and environmental science from one another and from public policy are very fine and difficult to defend. If the goal of environmental science is to improve environmental quality, then it may not be in our best interest to perpetuate such artificial boundaries, boundaries that may do little more than to divide an already broad field (e.g., Shackley & Wynne 1996).

[7] Historians of science are well aware of the Comte de Buffon's nineteenth century classification of animals according to their significance to humans. In Buffon's scheme, dogs and horses are classified adjacent to man and prior to other less directly useful species (Roger 1997).

[8] I would like to thank Paul Angermeier (personal communication, 4/19/02) for astutely pointing out that diversity and stability are "anthropocentric measures of ecosystem health; many ecosystems are unhealthy precisely because of enhanced diversity and/or stability at some spatiotemporal scales."

[9] Escobar (1999:15), Goodman and Leatherman (1998), and their colleagues argue for a "biocultural synthesis." This theoretical approach to "the question of nature" would not only enfold human society within ecosystem concepts but would embrace a new political ecology of "hybrid natures" founded on principles such as interdisciplinarity, antiessentialism, and embodiment.

[10] This is a view of science that stands in stark contrast to the predominant *public understanding of science* as described by historian of science Bernadette Bensaude-Vincent (2001:106): "There is no alternative to science. Science is unique. Thus, the

world of knowledge is clearly divided into two categories: that of the scientists, who hold the monopoly of true, valid statements, and that of the rest, the numerous, anonymous, and amorphous mass forming the public." Obviously, not everyone shares this popular philosophy of science. For example, historian of science, Donna Haraway (1991; 1995:323) does not privilege the contemporary modern sciences (in this case biology) as a necessarily authoritative form of knowledge: "Biology is not the body itself, but a discourse on the body. 'My biology,' a common expression in daily life for members of the U.S. white middle class, is not the juicy and mortal flesh itself, but a linguistic sign for a complex structure of belief and practice, through which I and many of my fellow citizens organize a great deal of life. Biology is not a culture-free universal discourse…. Biologists are not ventriloquists speaking for the Earth itself and all its inhabitants, reporting on what organic life really is in all its evolved diversity and DNA-soaked order." And yet, even strong critics like Haraway retain faith that science is a powerful worldview with much to offer society now and in the future.

So, if science is not, at least primarily, the search for and discovery of objective and universal truth, then what is it? Among scientists and the people who study them, there is little consensus as to *what science is*: There is no one scientific method and there are no essential characteristics that make knowledge scientific. So, what exactly is science?

Gieryn (1999:21) identifies "a surprisingly large number of qualities and characteristics used to bound and locate science in distinctive ways …. science is practically useful but useless; quantitative and qualitative; experimental and observation based; holistically homogeneous throughout and texturally variegated; finite and infinite (in terms of what can be known scientifically); politically or ethically engaged and detached; driven by theory and data." Gieryn (1999:21) goes on to say "these are just several of many coordinates used … but never consistently so" to map the realm of science. Other science studiers (anthropologists in particular) contend that the common denominator of science is little more and no less than *what scientists do* (Latour 1987).

A more optimistic reading of the science studies literature reveals at least three enduring attributes of science: s*kepticism*, *creativity*, and *reflexivity*. Skepticism implies that "seeing is believing" and that support for hypotheses and truth claims should be based on empirical evidence rather than "blind faith." Conscientious scientists strive to be free of the conventions, customs, and normative behaviors that impose restrictions on their ability to be creative and bold thinkers. Likewise, science should be both reflexive and adaptive in response to new findings and novel ideas. These three qualities—skepticism, creativity, and reflexivity—are prominent and recurring themes in the history of science. It is these three characteristics, perhaps more than any others, that unify and define both what good science is and what good scientists do.

[11] The modern sciences of ecology remain young and emergent, despite the fact that ecological thinking (e.g., ideas about a "Great Chain of Being" and a "balance of nature") pre-dates Aristotle (Egerton 1973; Lovejoy 1936).

[12] "Physics envy," on the part of ecologists and other environmental scientists, is unfortunate and unnecessary. Simberloff (1982:85) contends: "The unease of ecologists vis-à-vis physics and the zeal with which they seek deterministic physical science models are misplaced. What physicists view as noise is music to the ecologist; the individuality of populations and communities is their most striking, intrinsic, and inspiring

characteristic, and the apparent indeterminacy of ecological systems does not make their study a less valid pursuit."

[13] Scientists often disagree amongst themselves, and the history of science is therefore a rich site of scientific controversy. 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: see, Sloan 1976; Foucault 1994; Stemerding 1993), a community (e.g., Clements and Gleason in the early twentieth century: see, Barbour 1995; Journet 1991; Tobey 1981; Whittaker 1962), and an ecosystem (in the mid-twentieth century: see, Bocking 1997; Golley 1993) reflect the struggles for power (be they intellectual, social, or political power(s)), the historic contingencies, and the values that produce environmental knowledge (see also, McIntosh 1985; Saarinen 1982; Real & Brown 1991; Worster 1994). These enduring controversies remain a key feature of contemporary environmental science and policy (e.g., the compositionalist versus functionalist debate identified by Callicott et al. 1999) (see also, Scarce 2000; Helford 2000).

[14] What counts as good science, bad science, and non-science is a topic of much debate (e.g., Jasanoff 1990).

[15] Bensaude-Vincent's (2001:109) historical perspective provides room for optimism regarding the development of a more public science of ecology: "Hopefully, the current decline of the prestige of physics … and the consequent increase of the prestige of biological and environmental sciences could bring about a deep transformation in the relations between science and the public. Indeed, a number of movements have emerged recently that testify to the increasing concern of citizens in the pursuit of scientific and technological research. Such movements as AIDS associations in the US, the consensus groups in Northern Europe, and the Swiss debate on science and policy issues such as the pursuit of researches on genetically modified organisms, are reviving the enlightenment notion of public opinion, of responsible citizens willing to fully exercise their own judgment on scientific and technological issues."

[16] These and similar questions are being explored by scholars studying in the following areas: "public science" (Romm 1994); "prolescience" (Fuller 1993); "citizen science" (Irwin 1995; 2001; Lee 1993); "specialized citizens" (Fischer 2000); and, "local knowledge" and "indigenous science" (e.g., Ford & Martinez 2000; Agrawal 1995; Berkes 1999; Hull, Robertson, & Kendra 2000).

[17] According to Steven Shapin (1996:1-3), "There was no such thing as the Scientific Revolution…. Many historians are no longer satisfied that there was any singular and discrete event, localized in time and space, that can be pointed to as 'the' Scientific Revolution." In a related, earlier work, Thomas Kuhn (1996:92) argued that scientific revolutions are "those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one."

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Conclusion

We Are Engaged in Political Work

> In seeking to explicate the nature of science and its sources of authority, … scholars are necessarily engaged in an enterprise that is as deeply political as it is intellectual, even when their case studies or historical projects seem to be remote from the driving political concerns …. How could a branch of inquiry that takes as its central preserve the making (or unmaking) of human knowledge be anything but *political* to the core?
>
> Jasanoff 1996:409

This manuscript is a story about how we know the world and our place in it. Despite our differences, we are all citizens of one planet—Earth. We share one world and one future. It behooves us to work together in making this place a better one in which to be alive. This manuscript, and the vision of nature and human nature that it describes, is intended to help members of local communities and the global society, in our individual and collective efforts, to achieve an environmentally responsible and socially just future.

The manuscript explores the natural and social sciences, the humanities, and public understanding of the environment in search of a holistic view of world society and all life on planet Earth. What emerges is a vision of a more "public" ecology. *Public ecology* is an interdisciplinary and collaborative approach to environmental inquiry and decision making. The primary objective of public ecology is to build common ground among diverse people's competing beliefs and values for the environment.

Public ecology draws on a broad foundation of historiography, sociology, and ecology to create shared understandings of nature, science, and society. The objective is to build a meaningful language and useful body of knowledge for environmental policy. In addition to conflict resolution, the purpose of public ecology is to improve ecological literacy and thereby facilitate participatory democracy in environmental planning and management.

Public ecology is premised on the assumption that today's complex and controversial environmental issues are socially constructed realities, realities that powerfully shape both the world and our experience of it. The point is that things could

be (and often are) other than they appear. Contemporary visions/versions of reality (e.g., maps) are *models for, rather than models of* what is "objectively 'there'" (Anderson 1991:173). In other words, "scientific" abstractions provide a simplified and distorted representation rather than a one-to-one correspondence to an a priori world outside of our minds and beyond our cultural systems of organization. In some cases, these models are creative and self-fulfilling, i.e., they speak reality into the world. The assumption is that our personal and collective experience of the world is mediated through language, culture, and society such that the environment, environmental problems, and environmentalism are all aspects of a socially constructed and continuously changing reality.

The social construction of nature, science, and society, on which public ecology is premised, is certainly more complex (and no less confusing) than the above cursory overview suggests. However, my point is not to deconstruct nature, science, and society (this has already been done all too well); rather, "public ecology" is an effort to reconstruct.

Public ecology is characteristic of the postmodernity (Funtowicz & Ravetz 1995), globalization (Beck 2000), and cyborgology (Haraway 1991) of the twenty-first century. It exists and must operate within the contested terrain of postdevelopment ecological capital (Escobar 1995) and world risk society (Beck 1992). The contemporary and future worlds, as defined by these scholars, remains a nebulous ground ripe for colonization. Public ecology is the seed that I am planting in this fertile but uncertain space.

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Appendix A: Strategic Plan for *The Public Ecology Project (PEP)*

Problem Statement

Today's environmental problems are wickedly complex. Biodiversity loss, forest fragmentation, and climate change exemplify the types of issues faced by society at local through global scales. Scientists and other experts working within increasingly specialized fields often fail to grasp the bigger picture needed to solve environmental problems, solutions that depend not only on the best physical and biological knowledge but also on expertise in public policy, ethics, and the social sciences. But integration among experts alone is not sufficient to successfully tackle these wicked problems. Experts need to work in concert with citizens, stakeholder groups, and policy makers to build solutions that take advantage of local knowledge and experience of what works and what doesn't and what alternatives are socially acceptable, economically compatible, and politically feasible.

Public ecology provides the ideas and tools to link people and science on complex environmental issues. Public ecology is an interdisciplinary and collaborative approach to environmental science and policy that seeks to 1) integrate perspectives from the social and natural sciences, the humanities, and public understandings of the environment and 2) encourage citizens and all concerned stakeholders to participate with research specialists, technical experts, and professional decision-makers in developing creative solutions to persistent environmental problems.

Objectives

The purpose of *The Public Ecology Project* (PEP) is

1) to promote the theory, practice, and community of public ecology;
2) to establish public ecology within a wide range of popular, academic, and professional institutions;
3) to organize an international network of public ecology practitioners;
4) to formalize public ecology as a self-supporting, membership society.

In order to achieve this mission we have formulated the following strategic goals and specific outcome objectives.

- Public education campaign: public speaking lecture tour; publications in popular, professional, and academic press; internet webpages.
- Network with environmental community: develop a mailing list and newsletter; host interactive websites via CDDC; organize seminars and conference sessions; build upon Advisory Council and existing collaborations; continue work with partner organizations (e.g., GLEN); explore opportunities for volunteer program.
- Professional and university program development: design and offer courses, seminars, and workshops; conduct applied research program; offer internships, scholarships, and fellowships; facilitate participatory inquiry and citizen science programs; design and implement "model" education programs; explore "certification" opportunities.
- Establish a membership organization (e.g., The Society for Public Ecology): develop strategic plan; pursue fiscal sponsorship and initial funding; recruit and enroll

members; design and implement programs (e.g., newsletter, events, website, annual meeting, conference(s), journal(s), etc.).

- Long-range strategic planning for Public Ecology: develop 5-10 year plan for Public Ecology Project; Journal of Public Ecology strategic planning; explore accreditation opportunities.

History and Past Accomplishments

The Public Ecology Project (PEP) was formed in 2000. Based exclusively on volunteer efforts and in-kind contributions, we have worked with local communities to help organize citizen-based environmental initiatives (e.g., The Greater Lynchburg Environmental Network); collaborated with the Center for Digital Discourse and Culture (CDDC) to design a series of interactive websites; established an advisory council of distinguished public ecology professionals; presented "PEP Talks" at colleges and international conferences; published popular, professional, and scientific materials with a circulation rate exceeding 70,000 subscribers; launched an informational website; conducted applied research; provided instructional services and curriculum development to over 300 students each year; trained three graduate students in public ecology. Collectively, these activities have made the public ecology message accessible to more than 100,000 individuals and organizations.

Current Activities

Currently working on the following projects: strengthening the ecological restoration community through workshops, a lecture series, and handbook for volunteer projects developed in conjunction with the New Academy for Nature and Culture; increasing opportunities for public participation in environmental science and politics with the USDA Forest Service (USFS); proposing a Ph.D. degree in Public Ecology at Virginia Tech to serve as a "model" university program; and, introducing public ecology to the international environmental community through partnerships with programs at the University of Melbourne, Australia and Bielefeld University, Germany.

The Public Ecology Project's affiliation with the Virginia Tech university system provides extensive institutional capacity in the form of administrative support, advanced communications technology, professional and technical expertise, research facilities, and library resources.

Demographics and Geography: International community of public ecologists: college students and faculty (e.g., University of Bielefeld, Germany, University of Melbourne, Australia, and Virginia Tech); professional societies (e.g., Society for Ecological Restoration); state agencies (e.g., USDA Forest Service Research Stations); citizen science programs (e.g., Save-Our-Streams, Earthwatch); local citizens' groups (e.g., Greater Lynchburg Environmental Network); concerned individuals.

Partner Organizations: Numerous individuals and organizations are involved in various aspects of this project.

Programs within the Virginia Tech university system include: *The College of Natural Resources, Department of Forestry; The College of Arts and Sciences, Departments of Political Science and History; The Center for Digital Discourse and Culture (CDDC); The Conservation Management Institute (CMI); The Center for Interdisciplinary Studies, Science and Technology Studies Program.*

Participating organizations outside the Virginia Tech system include: *Greater Lynchburg Environmental Network (GLEN); New Academy of Nature and Culture; Real-world Experiments, Bielefeld University, Germany; University of Melbourne, Australia; USDA Forest Service (USFS), North Central Research Station.*

Project Coordinators
R. Bruce Hull, PEP Co-founder and Professor of Forestry, Virginia Tech
David P. Robertson, PEP Co-founder and Research Specialist, Virginia Tech

Advisory Council
Paul Angermeier, Ecologist, US Biological Survey at Virginia Tech
Mark Barrow, Associate Professor of History, Virginia Tech
Daniel Bowman, Environmental Consultant, Bowman Environmental Services
Tim Luke, Professor of Political Science, Virginia Tech
Laura-Gray Street, Assistant Professor of English, Randolph-Macon Woman's College.

Virginia Tech
"Virginia's largest university with 25,600 students and one of the top 50 research institutions in the nation, it is an institution that firmly embraces a history of putting knowledge to work. That tradition is rooted in our motto, Ut Prosim: 'That I May Serve,' and our land-grant missions of instruction, research, and solving the problems of society through public service and outreach activities." The Virginia Tech system includes eight colleges and graduate school, 60 bachelor's degree programs, and 110 master's and doctoral degree programs. Virginia Tech's main campuses are located in Blacksburg and Alexandria, Virginia.

Appendix B: Six Attributes of Public Ecology

**Versions of the following material have appeared previously in publication, see Hull & Robertson (2000) and Robertson & Hull (2001).*

Science may be widely accepted as a cognitive authority in the modern world, but as the history and philosophy of science contend, "science" (in the modern, positivist sense) alone cannot provide valid goals and objectives for environmental decision making (Policansky 1998; Irwin 1995; Beck 1992). What counts as environmental quality? What should be the goals of environmental stewardship? There are no simple answers to these essential questions. There are no "natural" imperatives or "scientific" laws that answer these questions; rather, environmental goals must derive from people's values and beliefs about nature and human society. Hence, the need for public ecology. Below, I describe some of the attributes of public ecology that make it relevant to democratic environmental decision making. 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. Each of these attributes is described in more detail below.

Evaluative Knowledge

The challenge to ecological and environmental science is to develop constructs that are not just descriptively precise (hence powerful scientifically at describing situations) but also evaluatively rich (hence powerful politically at making trade-off decisions about 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).

Environmental decisions are decisions about socially valued environmental conditions. They are decisions that require society to make trade-offs, 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 environmental decision making, the terms describing ecological conditions must describe conditions valued by

society and explicitly connote those values to the people using the terms to negotiate decisions (Norton 1998).

Indicators of environmental quality are a powerful and increasingly common tool for environmental management (see, National Research Council 2000; Bergquist & Bergquist 1999; Rapport et al. 1995; Sandhu et al. 1997). These indicators, which are too often defined by scientists alone, serve as a case in point for why values must be explicitly and intentionally associated with the 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 have been identified, through negotiation, as defining acceptable environmental quality. Indicators are the qualities of the environment that science monitors (e.g., "acid" producing gases in the atmosphere; fecal coliform in water; threatened and endangered species for biodiversity loss; keystone species for ecosystem health). Indicators trigger corrective management action when they exceed some negotiated level (e.g., emission reduction; ban on fishing and swimming; habitat restoration; restriction of ecosystem fragmentation caused by road building). Indicators enhance accountability by providing measurable evidence of progress towards agreed upon goals (e.g., Is a habitat restoration program working? Are water treatment facilities protecting public health?). And, indicators engage the affected and concerned communities in dialogue about the desired future conditions for their environment (i.e., conservation biologists, local community leaders, national environmental organizations, development interests, land management agencies, and other stakeholders must negotiate a vision of what they consider acceptable environmental quality).

Obviously, these measures of environmental quality cannot be free of social value and contextual relevance if they are to be effective. 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 decisions if it fails to reflect environmental qualities society understands and cares about.

Contextual Knowledge

While 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 context of the place-based projects where the management occurs. Management situations are unique in that both the people involved and the locations where they take place 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; Keller & Golley 2000], understanding nature for the purpose of making decisions about the goals and objectives of management requires a more case-specific knowledge (Sagoff 1988; Shrader-Frechette 1995; Shrader-Frechette & McCoy 1993, 1994; National Research Council 1986).

Thus, environmental knowledge should be particular both to the people using it and to the places (and situations) 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). Environmental research must strive not only to be generalizable but must seek to be specifically applicable (Fleischman et al. 1999; Trulio 1999).

Multiscalar Knowledge

Scale is an essential and confounding issue when constructing and applying environmental knowledge (Szaro & Johnston 1996; National Research Council 1986). Nature exists at many spatial scales (microscopic to the biospheric), temporal scales (diurnal to the geological), and organizational scales (e.g., genes, species, ecosystems, communities, landscapes, their processes and functions or one of many other alternative forms). 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(s) selected will influence the outcomes of management.

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 (Rapport et al. 1998; Pimm 1991). The restricted scope of these studies is due not only to issues of complexity but also to funding limitations. Studies that have been conducted at larger spatial scales and longer time frames are often too general or lack sufficient detail to support decision making in environmental management. Knowledge will likely be most useful to 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 trade-offs among many potential species, located at multiple sites, over decades of periodic anthropogenic disturbances.

Norton (1991; 1995; 1998), drawing on the work of hierarchy theorists (e.g., Holling 1992), 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 tri-scalar theory which 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 environmental quality 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 managerially relevant, then the units of analysis (at a minimum) must be compatible across conventional 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, legislators, industry representatives, agency personnel, and citizen activists) (Scoones 1999; Bryant & Wilson 1998).

In particular, environmental research will be more useful to environmental decision makers if the *units of analysis* are compatible from one study to the next despite their source of origin. Ideally (although perhaps not practically), these units of analysis might be aggregated or disaggregated from one scale, location, or situation to the next according to the management decision at hand.

Bowker and Star (1999:16) identify such transferable units of analysis as "boundary objects."

> Boundary objects are those objects that both inhabit several communities of practice *and* satisfy the informational requirements of each of them. In working practice, they are objects that are able both to travel across borders and maintain some sort of constant identity. They can be tailored to meet the needs of any one community (they are plastic in this sense, or customizable). At the same time, they have common identities across settings. This is achieved by allowing the objects to be weakly structured in common use, imposing stronger structures in the individual-site tailored use. They are thus both ambiguous and constant; they may be abstract or concrete.
>
> Bowker & Star 1999:16

The idea of boundary objects and transferable units of analysis is important to understanding the dynamic nature of the key terms that serve as the goals and indicators of efforts to preserve, restore, maintain, and create environmental quality.

Adaptive Knowledge

A body of environmental knowledge that is evaluative, contextual, multi-scalar, and integrative will be difficult to achieve, and one should not expect that it will ever be complete or finalized. Our knowledge of the environment is forever imperfect, partial, and limited: it is perspectival (situated in localized cultural contexts). In addition, it is purposeful (constructed and used by specific people, in specific places, for specific outcomes). 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 ecosystem 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 (Callicott et al. 1999; Norton 1998; Szaro 1996; Lee 1993; Walters & Holling 1990; Walters 1986; Holling 1978). 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 (Shrader-Frechette & McCoy 1994, 1993; National Research Council 1986). 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 (reflexive and responsive) 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 accepted 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. 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, but closely related, is that 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 the visual landscape is a powerful communications tool that can educate 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 management should lay open, display, and exhibit on-going ecological processes and the benefits of active management. Such an aesthetic would promote the ecologically literate public that is critical for planning an environmentally sustainable and desirable future (Hull et al. 2000).

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Vita

David Porter Robertson was born in 1970 in Lynchburg, Virginia where he lived until graduating from public high school. In 1993, David graduated with a BA degree in Directed Interdisciplinary Studies from the School of Art & Architecture at Montana State University. In 1996, David completed a Master of Landscape Architecture (MLA) degree from Virginia Tech in Blacksburg, Virginia. In 2002, David completed his Ph.D. in Forestry at Virginia Tech where he studied the human dimensions (e.g., history, sociology, and politics) of environmental science.