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Dimensions of Ecosystem Management: A Systems Approach to Policy Formulation

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For the past sixty years, ecologists have been arguing about what an ecosystem is, and the debate continues (Blew 1996; Lenz and Haber 1996). Ecosystem management, however, is an entirely human process that entails not only manipulating and protecting ecosystems but also making private and public goals operational within a larger social environment of public needs, desires, and laws. Since many of the benefits people wish to derive from ecosystems (Table 1) are incompatible, conflicts over natural resource issues are rampant, especially in the Pacific Northwest (Curtis and Carey 1996). In this article, I present a brief overview of some of the societal and technological sources of conflict while examining three dimensions on which policy makers, in attempting to manage conflict, can evaluate ecosystem management proposals. Those three dimensions are intervention, general sustainability, and intentionality.

Table 1. Some human benefits derived from forested ecosystems in the Pacific Northwest.

Environmental	Social	Economic
Long-term site productivity	Employment	Return on investment
Viable populations	Rural communities and culture	Maximized net present value
Clean air	Revenues for school systems	Tourism
Clean water	Spiritual values	Fisheries
Waste assimilation	Natural laboratories	Property rights
Carbon sequestration	Medicinal herbs	Growth and development
Biological diversity	Recreation	Economic activity
Ecosystem resiliency	Social justice and equity	Trade and commerce
Landscape function	Human health	Taxes
Sustainability	Sustainability	Sustainability

Intervention

Intervention is the easiest of the dimensions of ecosystem management to understand. Humans have a long history of environmental manipulation in the well-developed sciences of agriculture and forestry, among others. In the present context, intervention is simply the methods we use—whether actively or passively—to protect and manipulate our forest ecosystems. Intervention encompasses fire, insect, and disease management; recreation management; silviculture and other forms of vegetation management; harvest (fish, wildlife, timber) regulation; road construction, maintenance, and repair; direct wildlife habitat improvements and restoration; and reintroduction of extirpated species (for example, under Federal Aid to Restoration and Wildlife programs); and other means. Through legislation, the U.S. government has promoted, enabled, and regulated environmental interventions for many decades (see, for example, USDA Forest Service 1983).

Although we have a long history of intervention for specific purposes or programs, we have little experience in managing ecosystems in a holistic way. Management has been fragmented along a continuum: parks, research natural areas, and wildernesses, to preserve natural values; national forests, for multiple uses and sustained yield; and industrial timberlands, to maximize net present value (NPV) of timber or return on investment in lumber or pulp mills. While this fragmented approach seemed to work for a while, it is not working well now. Conflict about allocation and regulation of the use of forested ecosystems has intensified as our population has grown; our standard of living, level of consumption, and production of wastes have increased; forest lands have been converted to human habitation, transportation systems, industrial sites, and agriculture; and our perception, as a society, has evolved to include the interdependence of humans, diverse forms of wildlife, and the physical environment.

If we accept that we have indeed approached the limits of sustainable throughout growth (i.e., we have no new land area to exploit), then we are faced with three challenges: reduce population growth, revise standards of living (consumption-to-waste ratios), and increase development technologically (sustain the production of all goods and services through increasingly sophisticated intervention). Thus policy makers have the option of promoting incentives and regulating intervention in the context of general sustainability. The status quo is not sustainable. Given marked uncertainty in outcomes based on the sciences of economics, ecology, and sociology, apparently the only frameworks available to policy makers are intentionality and adaptive management.

I am not suggesting that all lands be managed for all things. Severe challenges face the managers of parks, wildernesses, and refuges; many of these systems are being stretched to their limits by direct human use and indirect effects of adjacent land use. One need only visit our national parks in Washington State (Olympic National Park, Mount Rainier National Park, North Cascades National Park) to observe the impacts of recreation on environmental sustainability. Certainly investments need to be made and the degree of intervention must increase if these parks are to meet their mandates from society. Similarly, some industrial forest lands provide maximal contributions to general sustainability through agroforestry (see Curtis and Carey 1996 for a discussion). But I would argue chat the majority of nonreserved forest lands are not being managed in a way that maximizes their contribution to general sustainability.

General Sustainability

Ecological, economic, and social concerns meet head-on in the concept of sustainability (see, for example, Levin 1993; Alpert 1995). Nelson (1995) suggests that higher economic theory is too far removed from the real world to have practical consequences for policy decisions in government, and that economists and other social scientists inevitably form intellectual constructs and presuppositions that, at some level, become a matter of faith. He further states that in the contemporary policy debate “economically efficient” is equivalent to social legitimacy, thus equivalent to the blessing of God. However, economics, as such, is amoral and at odds with important religious traditions, “which consider parts of life as transcendent, above the daily routine of production and consumption.
…..It is said that ‘an economist is someone who knows the price of everything and the value of nothing.’” Clark (1995) writes that those who are the strongest advocates of sustainable economic development “ignore ecology and equity.”

The problem of burgeoning human populations has implications for sustainability also, for there is a limit to Earth’s carrying capacity to sustain human patterns of consumption (Pulliam and Haddad 1994). Economic, environmental, and social concerns cannot be dealt with independently of the formulation of public policy. Thus, to make sustainability a more useful and encompassing concept, Goodland (1995) proposes the term “general sustainability,” and his approach provides the impetus for much of the discussion in this section. General sustainability has three components: environmental, social, and economic.

Environmental Sustainability

Environmental sustainability has its origins in social concerns—seeking to improve human welfare by protecting the sources of raw materials and ensuring that sinks for human waste are not exceeded. Thus environmental sustainability equals biophysical security, and humans must live within the limitations of the biophysical environment. In other words, natural capital must be maintained as a source and sink: the life support systems of atmosphere, water, soil, and environmental service capacity must be maintained. Environmental sustainability is applied at the aggregate level of all values of the ecosystem—all the natural services of the sustained resource—and it requires regulation because of the dynamics of exploiters (Hilborn, Walters, and Ludwig 1995). For example, the largest net discounted economic returns in the Pacific Northwest forests have been achieved by rapid harvesting (mining of old growth), with the result that decreased harvest volumes are devastating to local communities (Ludwig 1993a). Even maximizing net present value in plantation forestry fails to capitalize on the productive value of the land; total production over time is reduced in quantity and quality (Carey et al. 1996a; Curtis and Carey 1996; Lippke et al. 1996).

For environmental sustainability, harvest rates of renewable resources must remain within the limits of regeneration rates. This restriction includes, but is not limited to, sustained yield. The optimum solution for a single value (such as sustained yield of wood products) usually results in declining utility or declining natural capital sometime in the future. Environmental sustainability is, then, the simultaneous sustained yield of interrelated populations (such as fish and trees) and ecological services. Depletion of natural capital does not produce income, but rather consumption of capital, liquidation, and disinvestment. The limiting factor for much economic development is now natural capital. Still, there are substantial opportunity incentives associated with a policy of rapidly achieving regulated forests and imposing harvest flow constraints (Ludwig 1993a; Carey et al. 1996a; Lippke et al. 1996). Assessment of who benefits and who pays the costs for equity is important (Johnson 1995; Carey et al. 1996a; Lippke et al. 1996; Carey and Curtis 1996). When many values accrue disproportionately to society, incentives can be used to provide equity for landowners.

Social Sustainability

Social sustainability is achieved through systematic community participation and a strong civil society (Goodland 1995). Society's cohesion and norms are social capital, or moral capital. Cohesion depends, in part, on whether members of subcultures feel they are being listened to and feel that their values are accepted as legitimate. Similarly, investments in education (and retraining), health, and nutrition are investments in human capital and contribute to building social cohesion.

What drives public policy? Science? No. Culture! That's axiomatic. Even current ecological theory is more a product of culture than science (see Barbour 1996 for a specific analysis). Indeed, ecologists have a culture noted for "nay-saying," for they have viewed ecology as a science of limits in a society based on growth; but this may be changing (Meyer 1996). If the culture of the broader society strongly influences movements within science, a logical question is: What is the state of culture in the United States?

Three streams of subcultural values and worldviews characterize present-day U.S. culture (Ray 1996). Heartlanders possess a nostalgic image of small-town, religious America; their early and rural roots provide a utilitarian view of natural resources. These traditionalists turn to fundamentalism and cultural conservatism in a reactionary rejection of modern relativism and complexity. Modernists, on the other hand, have a secular faith in technology and the ability of science to solve the problems of dwindling natural resources. They focus on the generic problems of mankind, from toil to disease to creating effective organizations, and have solved many problems, often brilliantly—but sometimes at the expense of traditional ways of life. Some short-term, solutions, however, have created a host of long-term sociological, economic, and ecological problems. The complexity of these problems has led to pessimism among both heartlanders and modernists and has set the stage for an emerging culture—transmodernism.

The transmodern culture centers on self-integration and authenticity, integration with community, connection with others around the globe, connection with nature, learning to integrate ecology and economy, and synthesizing diverse views and traditions. Thus transmodernism represents creation of an *integral culture*—forming a larger population of creative people with more positive ideas, values, and trends than in any previous renaissance period.

Thus these three streams of U.S. culture differ from each other in worldview and optimism. What are the implications for natural resource policy makers? First, all three subcultures are strongly represented in U.S. society; their worldviews clash; and conflict results. Sustainable policy (see Plummer, this volume), then, would require incorporation of all three worldviews in a win-win fashion. Attempting a compromise means that all three groups would be dissatisfied. Choosing one worldview from among the three would not be sustainable. Since the integral culture incorporates values from both the traditionalist and modernist cultures, policy makers may find it useful to examine further the syntheses proffered by this group, especially the concept of intentionality and the psychology of personality and cognition. These might be considered technological issues of police formulation and ecosystem management.

Economic Sustainability

Environmental sustainability does not allow economic growth, but does allow economic development. Economic sustainability is the maintenance of capital—keeping the capital intact while living off the income. Designing forest management systems that capitalize on the full productive capacity of the land (long versus short rotations, treatments designed to accelerate growth of trees and development of high quality wood products) provides an example of economic development. Sustainable development is the improvement of the quality of human life within the carrying capacity of the ecosystem (Goodland 1995). Poverty reduction can be achieved through qualitative development, redistribution, sharing, population stability, and community solidarity, but not throughput growth. (Throughput is defined as the flow of materials and energy from the environment, used by the human economy and returned to the environment as waste.) Intragenerational and intergenerational equity are central to sustainability. Intragenerational equity is particularly pertinent in global, intersocietal relationships; and intergenerational equity is the foundation of stewardship and land trusts. In the Pacific Northwest, then, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The criteria of sustainability and intentionality are interdependent and complementary in evaluating the social sustainability of natural resources policy and the potential efficacy of ecosystem management planning in meeting societal needs. Together the criteria provide the sociopsychological framework for ecosystem management. Intentionality allows the incorporation of various philosophies and worldviews; sustainability focuses on social justice. These social aspects of ecosystem management can be used in determining the degree of intervention (active manipulation) that public policy may want to encourage, ignore, regulate, or discourage.

Intentionality

I suggest that a major dimension of ecosystem management should be intentionality, wherein full consideration is given to the four ways of knowing defined by the intersection of the exterior-interior and social-individual continua (Wilber 1995). In other words, planning for ecosystem management could be evaluated by the extent to which it incorporates facts, well-founded scientific hypotheses, emergent properties of ecosystems postulated by theory, and sincerity in meeting the needs of members of society, attention to social justice, and goodness of cultural fit.

Is there any precedent for such an approach to management? Yes, particularly in the application of cognitive psychology to the workplace. In the 1970s, Ned Herrmann was the director of management training for General Electric. He had a strong interest in creativity and effective teamwork. Drawing on readings on evolution of the brain and the ways in which people think, he became intrigued with individual differences in the kinds of information, thought processes, and communication preferred by individuals in the workplace. Herrmann developed a psychological instrument to measure these differences (a questionnaire, subsequently named the Herrmann Brain Dominance Instrument, or HBDI), and his applied research resulted in a useful model of cognitive style (learning, thinking, communicating). He suggested that four quadrants (analytical, safekeeping-planning, interpersonal, and holistic-integrative) arose from factors metaphorically representing brain anatomy: limbic versus cerebral systems and left versus right hemispheres (see Figure 1). These four ways of thinking are

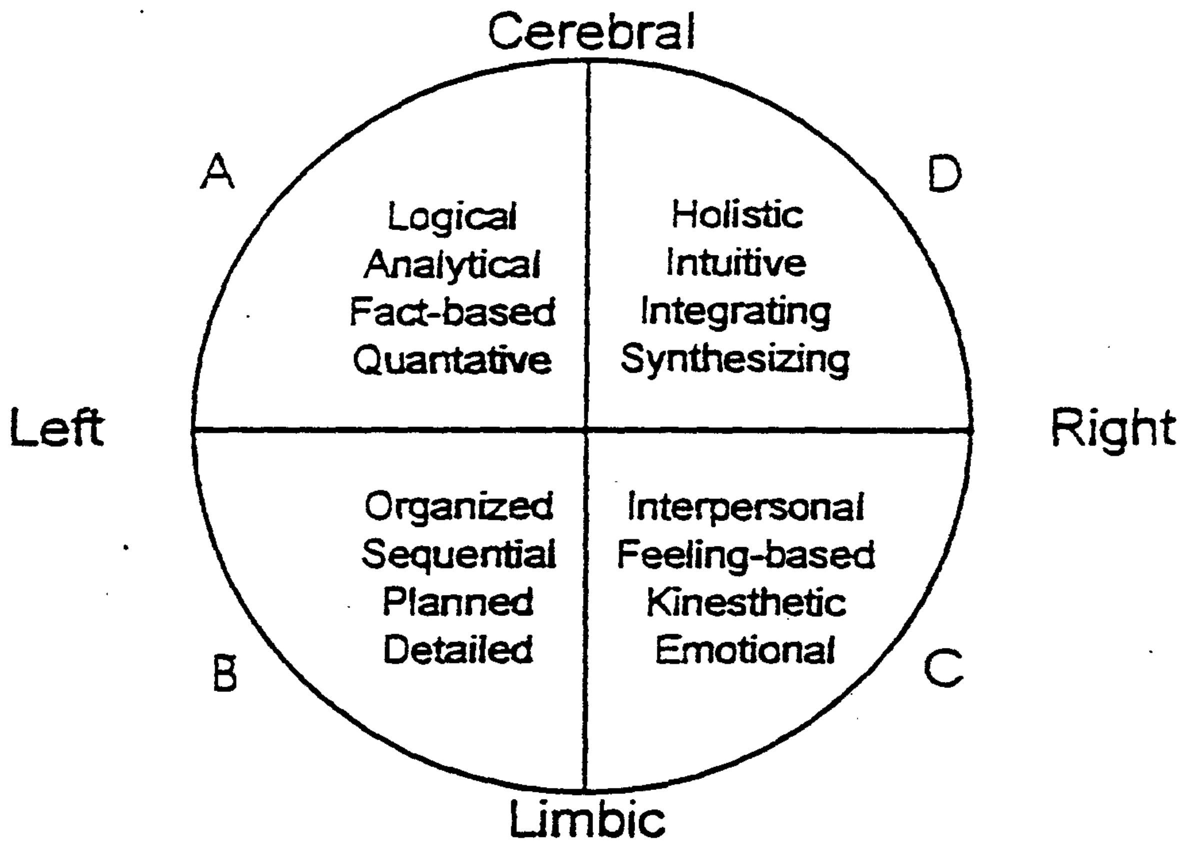

Figure 1. A four-quadrant model of human ways of thinking, with left brain-right brain and cerebral-limbic dimensions. Adapted from Herrmann (1996).

nearly correspondent with Wilber's (1995) four ways of knowing. Each person's cognitive style results from the strength of preferences (or avoidance) for each of the four quadrants; individuals may be single dominant, double dominant, "whole-brained," and so forth. Together, the ways of knowing and the ways of thinking form our worldviews. Similarity in cognitive preferences can lead to groupthink. Marked differences in cognitive style can lead to difficulty in communicating and conflict among individuals, but also to holistic thinking and creativity in groups, especially if understanding of individual differences has been developed and a "whole-brained," effective communicator is part of the group. The HBDI has been applied to more than 500,000 people in the workplace (Herrmann 1996).

The cognitive styles of scientists, specialists, planners, and policy makers differ (Figure 2). However, with training and practice, people can adopt different styles, groups can be formed to incorporate different styles, and documents (reports, plans, etc.) can be written to communicate effectively to people with diverse styles. The success in application of the HBDI and whole-brain technology in the world of business suggests that it might also be appropriate to science, ecosystem management, and policy formulation. Moreover, the demonstrated ability to overcome obstacles associated with cognitive preferences (with synergistic results) suggests similar success is possible in fruitfully incorporating differing worldviews in ecosystem management (also with potential for synergistic, positive results) . In other words, there are precedents and models for the application of intentionality in practical management situations.

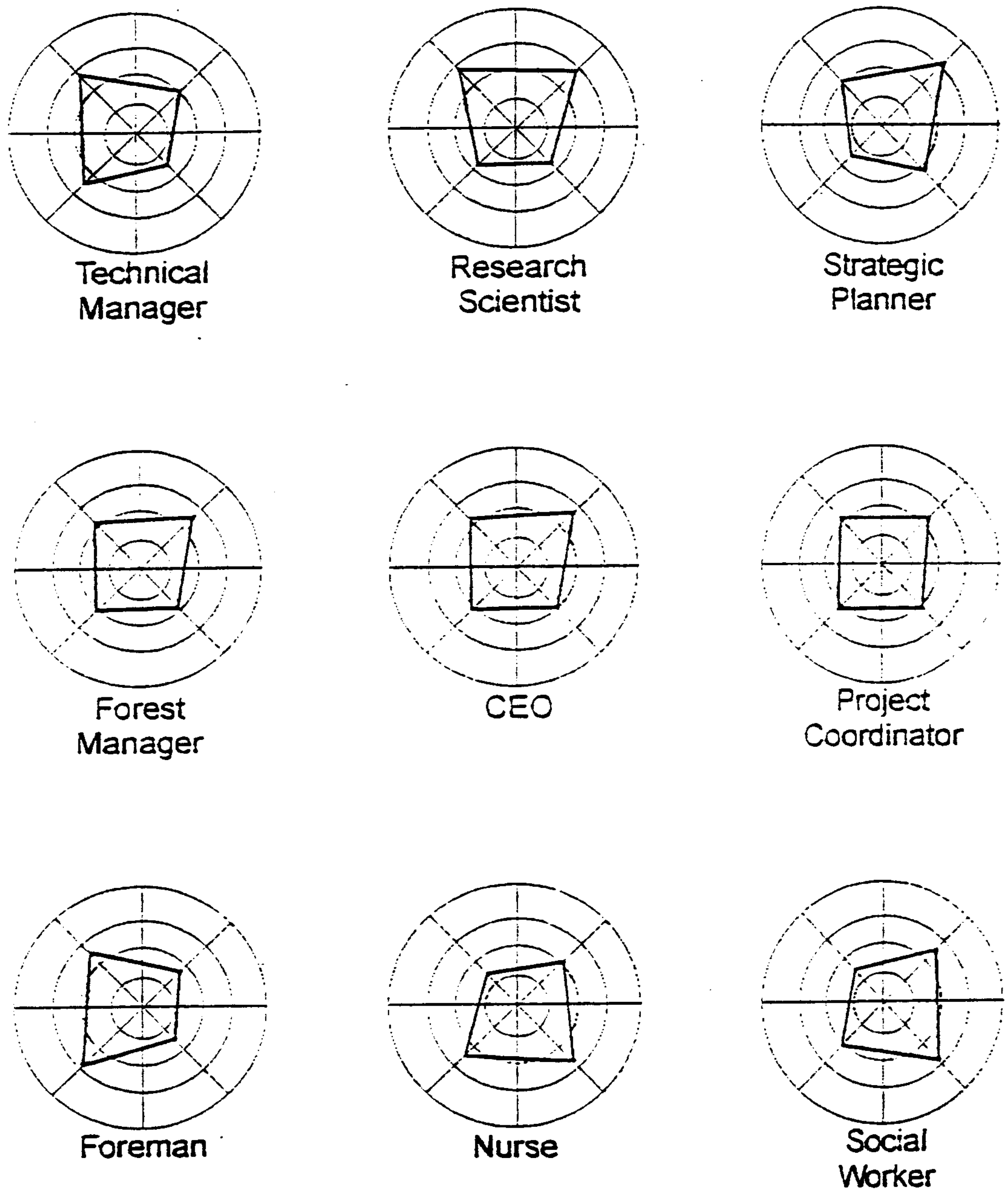

Figure 2. Cognitive style profiles of various professions with a progression from cerebral to limbic and left brain to right brain. Adapted from Herrmann (1996).

A Pragmatic Approach to Small-Landscape Management

Together; intentionality, general sustainability, and intervention can be used to define a "decision space" for policy makers. The degree to which solutions (management plans) fill that space is a measure of the degree to which society will benefit and the degree to which society should choose to encourage the implementation of the solution. Solutions that occupy only a limited part of the decision space could be neglected benignly (passive management) if they are neutral to general sustainability, or regulated or discouraged if they are adverse to general sustainability.

Are there any examples of such an approach to natural resources management? Yes. In 1992, the Washington Forest Landscape Management Project was chartered to explore such an approach (although not in the terminology used in this article). A diverse group of scientists, along with graduate students, technical staff, and support staff, was drawn from academia, research institutions, and management agencies (Carey and Elliott 1994). The group included different specialities: landscape ecology, ecosystem science, wildlife biology, fish biology, biometrics, silviculture, economics, policy and institutional analysis, forest engineering, planning, modeling, group facilitation, and social monitoring (a stakeholder representative). Some of the results are summarized below.

The project adopted the conservation of biodiversity paradigm in its approach to landscape management (Carey et al. 1996a). This paradigm is defined as "the management of human interactions with the variety of life forms and ecosystems so as to maximize the benefits they provide today and maintain their potential to meet future generations' needs and aspirations" (IUCN 1980; Reid and Miller 1989), and thus is of high intentionality. Biodiversity includes the building blocks of the living world (genes, organisms, species, communities, and ecosystems), the ecological and evolutionary processes that incorporate and shape these blocks, and the resulting ecological and economic goods and services (Reid and Miller 1989; di Castri and Younes 1990). Noss (1990) hypothesized that recognition of biodiversity as an end in itself could make biodiversity an eminently practical concept. We hypothesized that many of the perceptions of connects between management for commodities and management for wildlife were a result of a false dichotomy—that intervention, if used with high intentionality, could result in high general sustainability.

Methods

We thus developed a conceptual model of forest ecosystem development specific to the western hemlock and Douglas-fir forests of westem Washington. Key concepts were: (1) the eight successional (or seral) stages of forest development are: ecosystem initiation, competitive exclusion, understory reinitiation, developed understory, botanical diversity, niche diversification (niche being the function or role of an organism or population in an ecological community), fully functional managed forest, and old growth; old growth (late-seral forest) is a unique, natural legacy; (2) ecosystems develop differently depending on how the stand originated, and on subsequent management or no management; (3) traditional timber management begins with ecosystem initiation and ends with competitive exclusion; if left uncut, the forest may develop into the understory reinitiation, developed understory, and botanically diverse stages; (4) no manipulation along with protection results in slow development, with the trajectory depending on degree of old-growth retention during the stand replacing event; if clearcutting originated the ecosystem, for example, the timber pathway would be followed; and (5) ecosystem initiation stages with retained old growth have developed over time into stages that support diverse wildlife, but the competitive exclusion stage (during which competition for water and light usually results in the better-adapted species eliminating all the others in that niche) has been the most damaging stage to species diversity and to landscape function.

To test our hypothesis that maximum benefits accrue from intentional ecosystem management, we developed alternative management pathways that emphasized preservation, maximization of the net present value of timber (MAX NPV), and biodiversity (joint production of economic and ecological goods and services). Biodiversity pathways incorporated conservation of old-growth (late-seral) features at harvest; planting and natural regeneration; precommercial thinning; variable-density thinning for understory development, to add coarse woody debris, to underwrite cavity-tree development, and to remove wood products; and long (70 to 120 year) rotations.

In our active management scenarios, we imposed a constraint from the concept of general sustainability: in loose teens, active management scenarios would rapidly attempt to produce a sustained yield, steady flow of products on a decadal basis (i.e., would move toward a "regulated" forest). We developed four indices of forest ecosystem health: capacity to support vertebrate diversity; forest-floor function based on the integrity of the forest-floor mammal community; ecological productivity based on the abundance of the arboreal rodent community; and production of deer and elk. Economic measurements included net present value of timber (the maximum dollar amount that can be invested without reducing the rate of return below a specified interest rate), sustainable timber revenues, total and sustainable volume of wood products, and quality of wood products.

A harvest and scheduling model, SNAP-II, was adapted for 300-year landscape simulations; real data were used to start the simulation, including seral stages, distances to markets, suitability and restrictions on harvesting techniques, existing roads, and costs of new roads. The different landscape management scenarios included: no manipulation while protecting the entire landscape; alternative riparian management combined with MAX NPV; late-seral forest (LSF); and biodiversity pathways with alternating 70-year and 120-year rotations and a variable-polygon riparian scheme (VPS). A VPS is a system of narrow buffers (protective strips of timber alongside a river or stream) in which thinning but not clearcutting is allowed; they vary in size depending on the width of the stream and extend from streams to include contiguous mass-wasting areas (portions of hillsides prone to massive, sudden movement of soil, rock, and vegetation).

Results

The management scenario of protection but no manipulation resulted in long periods of competitive exclusion; these crunches could lead to species declines or extirpations. Wide buffers removed 35 percent of the landscape from active management; about 200 years were required to meet the 30 percent LSF goal; late-seral forests were badly fragmented by intervening intensively managed forest; and NPV was $48.5 million. Maximizing NPV resulted in no LSF, inadequate riparian protection, about 25 species at risk (not counting fish), and NPV of $70.3 million. Maximizing biodiversity provided: 30 percent LSF in 80 years and 52 percent in the long term; enhanced riparian systems; recovery of sensitive species; NPV of $58 million, 82 percent of maximum; and maximum sustained income (Table 2). Estimated present value cost (incentive) for each 10 percent increase in late-seral forest could be as low as $100 per landscape acre. Biodiversity management proved to be a net benefit solution for multiple-use public lands and trust lands.

Economic and Social Values

Lippke et al. (1996) presented a detailed economic analysis of the active management scenarios (maximize net present value and maximize biodiversity in a regulated forest).

Table 2. Comparative values of three simulated landscape management approaches: protection with no manipulation; maximizing net present value of wood products; and conservation of biodiversity through intentional, active ecosystem management.

Measure	No Manipulation	Max NPV	Max Biodiversity
Years to 30% LSF[a]	180	Never	80
Mean LSF last 100 yr	53	2	52
Mean ecological index at 300 yr[b]	100	35	85
Mean elk (deer) last 200 yr[c]	Not calculated	134 (423)	200 (401)
Dbh of wood products[d]	0	13-14	13-30
Net present value ($ million)	48.5	70	58
Decadal income last 200 yr ($ million)	0	24-28	37-47

[a]LSF: the percentage of the landscape in late-seral forest that produces high quality timber and high quality habitat for wildlife.

[b]Mean ecological index is a summary index of three indexes: capacity to support vertebrate diversity, completeness of forest-floor function, and ecosystem productivity.

[c]An index of local social and economic importance (sport hunting opportunities).

[d]Dbh: diameter at breast height in inches.

Salient points about costs were: (1) Transition costs to reach a regulated ("steady") state can be large and depend on the existing state of the landscape. (2) Net present value loss depends on timing of intervention (change in management approach): at harvest, costs are very low; at 30 years (decision to thin) costs are high. (3) Estimated present value cost (incentive) for each 10 percent increase in late-seral forest may be as low as $100 per landscape acre. (4) Costs per designated acre range from $500 at age 0 to $1,500-$2,000 at age 30. (5) Direct payments and other incentives—such as reducing regulatory uncertainties, changes in estate tax law, and carbon sequestration credits (incentives for industry to adopt methods that limit the release of carbon dioxide into the atmosphere)—could be used in conjunction with habitat conservation plans to attract voluntary involvement by private landowners. (6) Biodiversity management is a net benefit solution for public and trust lands.

Salient benefits of biodiversity management were: diversification of the wood products industry, increased secondary manufacturing, increased direct employment, increased indirect employment, reduced costs of unemployment compensation, and increased tax revenues. These gains are substantial compared to suggested incentive programs.

All the findings from the Washington Forest Landscape Management Project are hypothetical. The management hypotheses we examined can be tested in either experiments or adaptive management. One experimental test of scientific hypotheses is in its fifth year (Carey et al. I996b). A widespread adaptive management test of some of the hypotheses is being implemented through a partnership between the USDA Forest Service Olympia Forestry Science Laboratory (A. B. Carey and C. A. Harrington), the Olympic National Forest, and the Olympic Natural Resources Center.

Conclusion

I have attempted to provide a framework by which policy makers can formulate sustainable policy, and land management organizations can plan for general sustainability. My approach has been to move up and down and back and forth in a hierarchy composed of functional relationship units (individual humans to society; individual organisms to ecosystems, ecology to sociology, past to future) that interact to form larger wholes and the properties unique to these wholes that emerge through synergy. This is a systems approach to ecosystem management that recognizes that management is but part of a much larger system. The summary of the Washington Forest Landscape Management Project illustrates how ecosystem management can be dominatingly hierarchical when objectives are to maximize net present value of wood products—resulting in repression (possibly some loss) of some system components and their functions, loss of some system potential, and loss of many future benefits to society (low general sustainability). But I also tried to illustrate that intentional ecosystem management ("conservation of biodiversity") can be part of an actualizing whole that enhances the potential function of ecosystem components, promoting aggregation to a greater whole, with increased long-term benefits to society.

Disclaimer

The views expressed herein do not represent any agency policy; they are my own.

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Salazar: The answers were that "not all species are equally valuable in a functioning ecosystem," and that "*stability* and *no change* are different." Most people thought stability and absence of change were the same. Most people thought that all species were equally valuable.

Plummer: You described certain concepts that immediately sorted people out into opposite camps and had the effect of stopping discussions dead. One of the polls you cited seemed to suggest that the concept of wilderness does not have that polarizing effect. Are there other terms that are conducive to discussion and collaboration?

Salazar: I would be interesting in exploring that. The most revealing way to study these responses to issues would be through focus groups and in-depth interviews. Single-item questions in a survey cannot illuminate the importance of individual reactions to terminologies used as well as conversations with subjects.

Weihuan Xu: The active and passive management paradigms are reduced into one-dimensional concepts. Instead they are really more like a categorization of management regimes based on management philosophy. Why do you think they are conceived of as one-dimensional?

Salazar: The two paradigms serve as points that define a line. There are all these other possible positions along the line, but they are collapsed and simplified through reference to the two extremes.

John Calhoun: We seem to be evolving toward an overly simplistic and polarized dialogue. The organizers of this conference recognized that this trend is a source of forest policy gridlock, even though we are seeking the same outputs in different social, cultural, economic, and ecological terms.

Ajit Krishnaswamy: How would you suggest that social scientists move beyond the academic study of attitudes to present this information to policy makers in a way that is helpful? People have begun to question the value of social research because they see little of value coming our of the process.

Salazar: I have moments of ambivalence regarding the value of social research, but overall in addition to being interesting, it maybe useful. This kind of information reminds us that people are complex and that stereotypes are unreliable and can be obstructive.

Carey, *A Systems Approach*

Andrew Carey: My article in this volume originated as a paper presented in the context of the forest policy conference at Forks, in September 1996. Two events, one at the conference and one later, are worthy of mention as a kind of epilogue. First, the conference took place just prior to national elections. From the perspective of the approach taken in my article, the races were clearly between transmodernists and traditionalists: Clinton versus Dole for president, Locke versus Craswell for governor, and Baird (a psychologist) versus Smith (a conservative incumbent) for U.S. House of Representatives. The transmodernists handily won the executive races; the candidates for representative were separated by less than 0.5 percent of the vote. Nationwide, traditionalists achieved a narrow advantage in the Congress. Since conservative legislators have questioned the validity of ecosystem management, if it is to be promoted the executives will have to make the case that it is integrative of diverse cultural values.

The second event was the discussion at the conference of the role of scientists in public policy. I perceived overwhelming support for the position that scientists should be relegated to providing "facts," reporting their research but not their recommendations, and refraining from voicing their opinions and values. This attitude precludes scientists from an intentional role in ecosystem management. Such an approach is dominatingly hierarchical, preventing the scientist from making a full contribution; it could even be considered pathological to the management system (see Wilber 1995, cited in my bibliography).

Scientists not only have special expertise in their scientific discipline, but they are keenly aware (or should be) of the development and weaknesses of their science, the history of their discipline and its application to problem solving in the world, and their cumulative *experience* in the systems they study. In a social context, scientists are privileged members of society: they have availed themselves of a disproportionate share of the formal educational opportunities offered by society; they are highly paid (remunerated by society, most often with public funds); and they are allocated with a disproportionate share of public funds in the conduct of their investigations and the satisfaction of their curiosity. The early history of U.S. culture is one of privileged members of society accepting their responsibility for public service in all sectors of society.

Scientists, especially publicly funded scientists, have a special moral obligation to ensure that their full knowledge is made available to the public, policy makers, and legislators. The Ecological Society of America's blue ribbon Committee on the Scientific Basis for Ecosystem Management reported in 1996 that "it is [ecosystem] management that acknowledges the importance of human needs while at the same time confronting the reality that the capacity of our world to meet those needs in perpetuity has limits" (N.L. Christensen et al., *Ecological Applications* 6:665-691). They recommend greater communication between scientists and the public and greater numbers of natural resource professionals who have the ability to communicate with scientists, managers, and the public.

Finally, among the world's diverse cultures, there are only a few common themes in regard to personal public roles—the way in which individual citizens aggregate to a society. One of these roles is standing face to face with other citizens in the marketplace of ideas. I believe this is a crucial role for scientists, especially in a democracy, and is important for the growth of the person and the culture. The concept of democracy is not simply "one man, one vote" or "all individuals are equal," but that everyone has the opportunity to contribute fully to public debate. People who are scientists may play various roles in society besides that of scientist, each role requiring different behavior. I suggest that the role of the scientist in public debate is not one of posturing or vested interest, but one of critical free inquiry, intentionality, and rational advocacy.

Plummer, *Sustainable Forest Policy*

Peter Bisson: There seems to be a different hierarchy of policies and institutions protecting resources within various ownerships. At one end of the spectrum, federal forest lands are subject to a great deal of protection, and land uses are very limited. The state, in contrast, has a somewhat different set of land-use objectives. Private lands are subject to still other priorities. Forestry tends to bear a greater part of the burden of protecting salmon resources than some of the other land uses. How can society arrive at a policy that's fair and equitable and effective in the context of such a complex system with variable standards of responsibility for protection?

Mark Plummer: In an ideal world, people would be so enlightened and well informed that we could throw away all the law books, and design the perfect policy chat serves individual interests and the collective good. But that is not going to happen in the real world. Many of the elements of sustainability that have been identified pertain to the feasibility of sustaining the policies over a long time horizon. Whether these policies will achieve a particular goal is something that must be considered. The more fundamental issue is that of setting goals. When someone says, "Well that method isn't really going to get us an effective policy," usually the speaker is referring to the goal that he has in mind. In other words, "That policy isn't going to get what I want." The challenge to thinking in sustainable terms is to pursue a policy process that leads to a set of duties that we can live with and that are effective in serving the goals that we all can settle on. Sustainability in this sense would not be promoted by a process involving an expert panel which makes recommendations and delivers them into the public arena. Experts need to be in their place, and their place is not to formulate policy.

Weihuan Xu: The analysis you presented is largely related to the definition of property rights. Could you speak to the issue of the changing definition of property rights? For example, to what exact extent does the landowner own the property or the land?