CHAPTER 2

Culture and Conservation

Biodiversity was introduced into the scientific lexicon by Walter G. Rosen in 1986 during the national forum on biodiversity for educators and policymakers and quickly became integrated into the national vocabulary (Weber and Word 2001). But human fascination with the diversity of life certainly arose with human consciousness and continued throughout the evolution of human culture from hunting and gathering to agriculture to the present (Wilber 1995). Exploitation of natural diversity allowed the development of increasingly intricate social and economic systems (Diamond 1998, Hutchinson 1965). Aldo Leopold (1897–1948) wrote: "Wilderness is the raw material out of which man has hammered the artifact called civilization" (Leopold 1949).

The diversity of living things captivated early ecologists. Hutchinson (1965) recounts the studies of variation in Lepidoptera (butterflies) by Gilbert Henry Raynor (1854–1929) that led to the discovery of sex-linked inheritance almost concomitantly with Mendel's discovery of the genetic basis for inheritance. Fascination with the diversity of life led to the theory of evolution that underlies modern biology and biomedicine. The question of why there are so many species dominated ecology in the first half of the 20th century (Hutchinson 1959) and led to the concept of the multidimensional niche (Hutchinson 1957), community ecology (Whittaker 1975), and statistical-mathematical ecology (Pielou 1975, 1977, 1984).

Emphasis on conservation of biodiversity (nature, including biological diversity and ecosystems) certainly preceded 1986 by more than 50 years. Aldo Leopold (1949) formulated the *Golden Rule of Ecology* with "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." Leopold's writings contained many of the words and concepts (integrity, stability, health) that are now being used and contested in the great debate on how to conserve our natural heritage. He certainly recognized our different values (table 1): "I am amazed to learn what diverse characters different men impute to one and the same tree" (Leopold 1949). Leopold also acknowledged the countervailing tendencies of human nature and the paradoxes therein: "But all conservation of wildness is self-defeating, for to cherish we must see and fondle, and when enough have seen and fondled, there is no wilderness left to cherish" (Leopold 1949).

Still, we find ourselves in polarized, adversarial positions about conservation. The last 20 years has seen an explosion of philosophical, scientific, and technical discussions of conservation (Woolley and McGinnis 2000). What is important in conservation? How real is the need to conserve biodiversity? How might we best attempt to conserve our natural heritage? How should we implement adaptive management? What kinds of things should we measure and monitor? What research will best serve the conservation community, interested publics, and society at large? These are a few of the questions we need to address. A review of how we got here might help.

A History of Conservation Ideas

Donald Worster (1994) recounts five roots for today's ecology: *Arcadianism*, *Christian pastoralism*, *Arcadian imperialism*, *Thoreau's Romantic ecology*, and *Darwinian ecology*. Worster is summarized here, not to bore the reader with esoterica, but to highlight the power of ideas and demonstrate how most historical ideas about nature are still extant in contemporary culture. These ideas are far more than artifacts of the interaction of culture and nature. They may be psychologically fundamental (archetypal) and biologically based (evolutionarily selected), as suggested by some Jungian psychologists for the multiple bases of temperament and personality (Myers and McCaulley 1985, Ornstein 1993). If so, it is even more important to understand them because simple, rational discourse is unlikely to reconcile their differences.

Arcadianism and the Ecology Movement

In the mid-18th century, Gilbert White, a curate in Selborne, England, founded Arcadianism, advocating a simple, rural life and restoring man as part of nature. Ludwig von Bertalanffy later described this view as holism. Through recent Arcadian reactions against technology and the scientific paradigm, the ecology movement appeared with spokespersons like Rachel Carson, Paul Sears, Barry Commoner (sidenote 5), and James Connell. In 1935, Sears defined conservation as restoring biological order, maintaining the health of the land and well-being of the Nation, and establishing a lasting equilibrium of man with nature (Worster 1990).

Sidenote 5—Barry Commoner formulated the Four Laws of Ecology (Partridge 2000):

- Everything is connected to everything else.
- Everything must go somewhere.
- Nature knows best.
- There is no such thing as a free lunch.

Table 1—American values regarding forests and grasslands and their importance

Value	Mean (out of 5)
Individual values:	
People should be more concerned about how public lands are used.	4.8
I'm glad national forests are there even if I never see them.	4.7
Future generations are as important as the current generation in public lands decisions.	4.5
Wildlife, plants, and humans have equal rights.	4.3
Natural resources must be preserved even if some must do without.	4.1
Forests have a right to exist for their own sake.	4.1
We could get by with less and leave more for future generations.	4.0
Individual values group mean	4.2
Management values:	
We should conserve now to allow development in the future.	4.0
We should provide jobs.	3.2
The primary use of forests is products useful to people.	3.0
We should use economic decisionmaking.	2.9
We should harvest more.	2.9
Management values group mean	3.0
Public values and objectives:	**Objectives**
Improve and protect forests.	4.7
Protect ecosystems for wildlife habitat.	4.6
Preserve forests without timber harvest.	4.2
Preserve wilderness.	4.2
Allow for diverse uses.	4.1
Preserve cultural uses.	3.8
Provide resources to people.	3.6
Public values and objectives group mean	4.2

Source: Shield et al. 2002.

Christian Pastoralism, the Imperial View

This philosophy strips nature of all spiritual qualities. Nature's chief function is to serve the needs of man. With the imperial view of nature, modern man's most important end is domination over the Earth. An example is Francis Bacon's man-made paradise based on science.

Arcadian Imperialism

This root began in Carl von Linné's (1707–1778) *Systema Naturae*, the first of a series of tracts on rationalistic religion. Arcadian imperialism stresses the hand of God in nature, nature as cyclically static with symphonic precision, and all things for the sake of man—using other species vigorously, eliminating undesirable species, and promoting useful species. Ultimately, the Earth must be managed for maximum output. In the Age of Reason, this was the utilitarian philosophy.

Thoreau's Romantic Ecology

Henry Thoreau (1817–1862) was Gilbert White's inheritor. His view was fundamentally ecological, focusing on relations, interdependences, and holism. Thoreau's purpose was to reconstruct the actual condition of where we dwell to that of three centuries ago, in order to produce a single interrelated whole arranged by nature in perpetual balance. Thoreau's major efforts dealt with the phenomenon of forest succession—accepting nature as a teacher and accommodating oneself to her rhythms. This return to wilderness redefined man's place in nature. It was also a return to paganism with its fascination of the natural world and focus on animism and holism. Thoreau's Romantic ecology produced an ecological perspective—nature as a system of necessary relationships that cannot be disturbed without changing the equilibrium of the whole.

Darwinian Ecology

Charles Darwin (1809–1882) and his contemporaries, the botanist Alexander von Humboldt, the geologist Charles Lyell, and the demographer Thomas Malthus, had a holistic but less harmonious view of nature. Humboldt studied the geography of plants, grouping species into dominant life forms and in relation to their surrounding conditions. He constructed vegetation zones based on relationships between altitude, latitude, and vegetation. Darwin studied the severe environment of the Galapagos and the different roles assumed by various finches, turtles, and lizards. Humboldt and Darwin looked at nature comparatively, with a geographical approach, and formulated assemblages and systems. Nevertheless, both placed science within a larger framework of feeling and sensibility and, in the process, converted their contemporaries from Romanticism to science as religion. Charles Lyell observed the continuing play of natural physical forces and the nonpermanence of nature as well as long accumulated works of nature and periodic mass extinctions. He studied the fierce competition among species for space and food and rejected the Linnaean faith of lasting balance in nature. Thomas Malthus's essay on populations provoked Darwin's ideas of natural selection of the fittest and evolution of new species. Donald Worster (1994) suggested that Darwin's reading of Malthus's essay may have been the single most important event in the history of Anglo-American ecological thought and led to constructing a science to meet one's own emotional and psychological needs.

From Ecology to Conservation

Ecology has its roots in White, Linnaeus, Humboldt, Lyell, and Darwin. Ernest Haeckel, a disciple of Darwin, coined the term with reference to biogeography, and C. Hart Merriam contributed concepts of life zones and habitats. At the turn of the century, Victor Shelford called ecology the science of communities, and A.G. Tansley emphasized dynamic ecology and successional development of communities. Frederic Clements formulated a coherent and elaborate system of ecological theory, now often inaccurately portrayed (see Partridge 2000 for a discussion on how idealized concepts are important to science but often discredited through distortion or reductionism). Clements stressed that vegetation is essentially dynamic and that succession is not aimless, but a steady flow toward stability along a sere with its direction and progression determined by climate. He also introduced the concept of a climax stage based on the Spencerian philosophy of cosmic evolution, in which all phenomena progress toward differentiation and integration, from homogeneity to heterogeneity, and from differentiation to interdependence.

In the early 1930s, the American Dust Bowl and the economic collapse of stock markets produced a public and scientific willingness to subordinate economics to broader values. This included ecological integrity, as in the conservation philosophy articulated by Aldo Leopold:

> The fallacy that economic determinists have tied around our collective neck, and which we now need to cast off, is the belief that economics determines all land-use. This simply is not true. An innumerable host of actions and attitudes … is determined by the land-users' tastes and predilections, rather than by his purse (Leopold 1949).

Leopold continued, "The bulk of all land relations hinges on investments of time, forethought, skill, and faith rather than on investments of cash. As a land-user thinketh, so is he" (Leopold 1949).

At the same time, Leopold was a pastoralist devoted to husbandry: "…two spiritual dangers in not owning a farm … supposing breakfast comes from the grocery store, and … heat comes from a furnace" (Leopold 1949). He described, "… definitions of … a conservationist … [are] best … written not with a pen, but with an axe … what a man thinks about while chopping or while deciding what to chop" (Leopold 1949). In his 1933 text on game management, Leopold wrote: "Effective conservation requires … deliberate and purposeful manipulation…" (Leopold 1933). This philosophy is not dissonant. Just as Aldo Leopold harvested a lightning-struck oak for firewood two generations ago, contemporary Pacific Northwest forest activist, Andy Stahl, harvested his own mature oak to turn into cabinetry. One presumes that wilderness advocate John Muir had no compunction about burning wood in his wilderness campfires. What is most relevant in choices about using natural resources relates to frequency, intensity, scope, and scale of use.

Whereas Leopold focused on restoration of degraded, abandoned farmland in his famous treatise, *A Sand County Almanac*, his contemporaries, ecologists Roger Smith and Paul Sears focused on climax grassland communities. They argued that climax communities should be left unmanaged because they are resilient. However, the concept of untouched climax communities was antitechnology, and botanist Henry Gleason responded with his individualistic concept of plant associations as accidental groupings and repudiating succession (later expanded into a grand theory by Hubbell in 2001). Gleason described climaxes as haphazard, imperfect, and shifting, implying that climax communities were not special and need not be protected. Tansley chimed in rebutting monoclimax in favor of multiclimaxes (edaphic, biotic, fire, anthropogenic).

Progressive conservation was part of the political movement of Teddy Roosevelt. Gifford Pinchot supported doing away with reserves: "Forestry is handling trees so that one crop follows another." Efficiency and productivity were applied to public lands for the first time. John Muir opposed Pinchot's progressive agronomic perspective, as John Grinnell protested Leopold's predator control. Debate on how to integrate ecology into conservation was widespread. Ecological pragmatism sought to preserve natural checks and balances. Olaus Murie accepted the need for management but opposed emotional persecution of varmints.

Leopold's 1949 description of a land ethic ushered in the Age of Ecology by establishing a scientific, ecological, biocentric, and communitarian ethic that challenged the economic ethic. A concept of natural rights was derived from the Declaration of Independence. The Rights of Nature extended to all species and even to the Earth itself. Leopold suggested that unless man recognized the rights of the entire Earth, he might find his own survival threatened—"… the first principle of conservation: to preserve all parts of the land mechanism …" (Leopold 1949). He emphasized, "To keep every cog and wheel is the first precaution of intelligent tinkering" (Leopold 1949). Aldo Leopold's philosophy, however, remained agronomic even while reconciling rival worldviews. Worster (1994) explains: "Every generation writes its own description of the natural order which generally reveals as much about human society and its changing concerns as it does about nature."

In 1927, Charles Elton promulgated the sociology and economics of animals and five principles describing the economy of nature: (1) the food webs of producers, consumers, key industries, and interdependencies; (2) food size determining organism size; (3) pyramids of numbers; (4) the niche as occupation, especially what the organism is eating; and (5) competitive exclusion. A few years later, G.F. Gause promoted competition as the law of nature, and A.G. Tansley disputed synergy and the concept of community and favored ecosystems as physical systems of material exchange. In the 1940s, Ray Lindeman merged the ideas of Elton, Tansley, Chancey Juday, and Edgar Transeau into the *Trophic-Dynamic Aspect of Ecology*, describing the energy pathways (Worster 1994).

The 1960s "New Ecology" reflected the values of the modern economic order—corporate society with interdependence, primacy of efficiency and productivity, and a managerial ethos. A new breed of mathematical ecologists arose, including G. Evelyn Hutchinson, Robert MacArthur, and Eugene P. Odum as the scientists of natural

Sidenote 6—The other most important publication in biology in the 20th century was James Watson and Francis Crick's 1953 paper on the structure of DNA (Hardin 1969).

economics. Odum (1969) postulated that all ecosystems have a strategy of development directed toward achieving as large and diverse an organizational structure as possible based on mutualism, cooperation, and symbiosis, embellishing Clements' theories. This bioeconomic ecology owed a great deal to its larger cultural milieu but did not satisfy the communalism of Leopold's fellowship.

Then there came about a resurgence of philosophical idealism and a quest for transcendence, eternal harmony, and cosmic love. James Lovelock and Lynn Margulis wrote the Gaia theory. Rachel Carson, Paul Ehrlich, Barry Commoner, and Edward O. Wilson perceived an Earth in crisis. Rachel Carson's *Silent Spring* was one of the two most important publications in biology in the 20th century (Hardin 1969) (sidenote 6). The Ecological Society of America issued that *Silent Spring* "created a tide of opinion which will never again allow professional ecologists to remain comfortably aloof from public responsibility … its effect on public opinion, national scientific policy, and … professional societies … can hardly be overstated" (Hardin 1969). That well-meaning interventions in natural systems have caused great and unforeseen harm has the practical implication that "we can never do merely one thing" (Hardin 1969).

In the 1970s and 1980s, the focus of ecology moved to disturbance theory (Connell and Slatyer 1977, Drury and Nisbet 1973, Pickett and White 1985b). These "disturbance boosters" were population biologists, not ecosystem scientists, and as such focused on trees and not the forest. In doing so, they perceived no synergy and no emergent properties (Worster 1990). Constant change and incessant disturbance satisfied them ideologically more than Odum's ecosystem, with its stress on cooperation and social organization. Disturbance theory is more consonant with individuality, private enterprise, social Darwinism, and the generational transition from the politically conscious generation of the 1960s to the yuppie generation of the 1980s. The rise of disturbance theory is a triumph of reductive population dynamics over holistic consciousness and of social Darwinist entrepreneurial ideology over a commitment to environmental preservation. Edward Lorenz developed the scientific study of chaos in 1961, and the promulgation of nature as fundamentally erratic was a revolution against all principles, laws, models, and applications of classical science (Gleick 1987, Worster 1990). Robert May discounted the relationship between diversity and stability, John Wiens wrote of stochasticity, and Paul Colinvaux was antimanagement (Worster 1994).

This trend continues today—Hubbell (2001) presents a grand *Unified Neutral Theory of Biodiversity and Biogeography*. The wedding

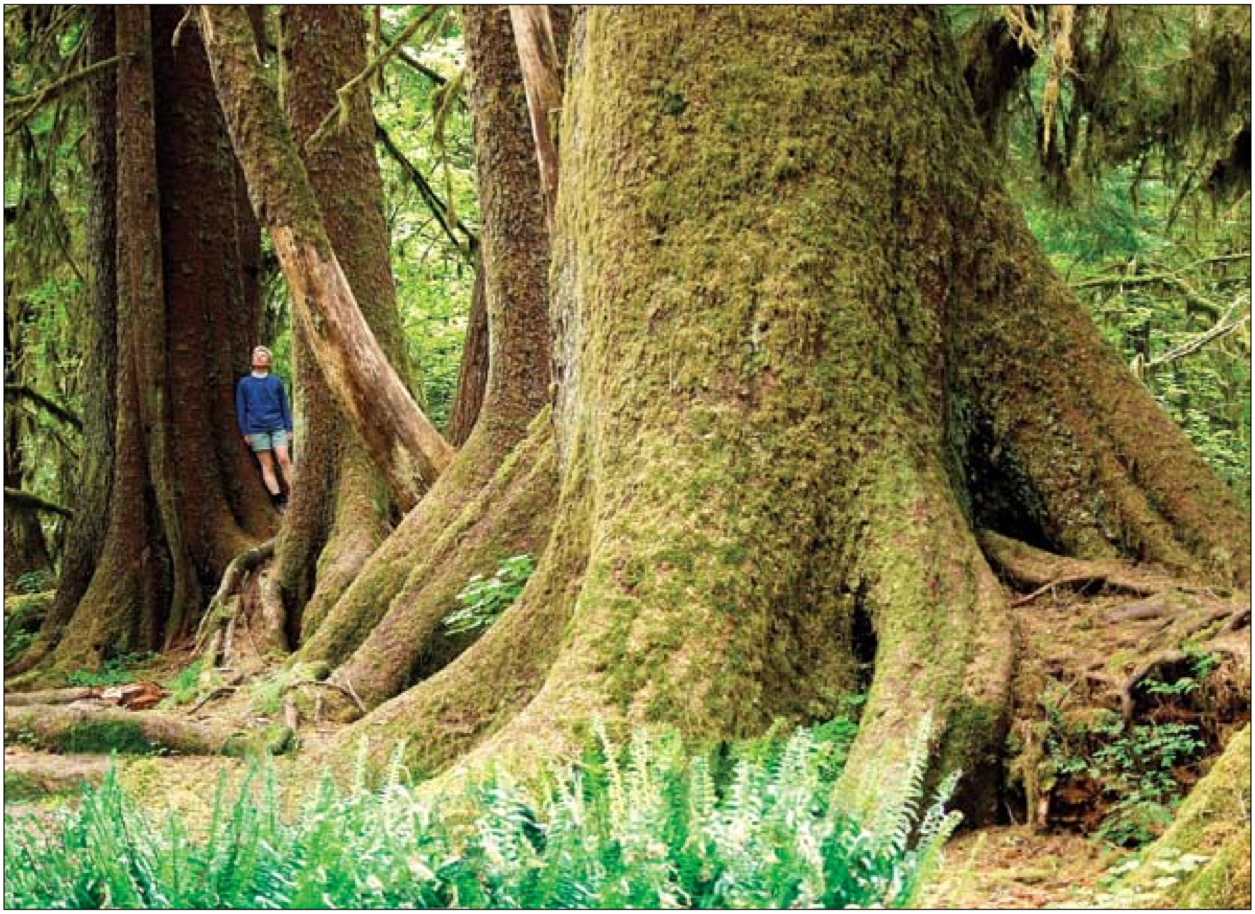


Figure 1—Regine Carey, the author's wife, leans against an old-growth tree in the Hoh Rainforest, Olympic National Park. Photo by A. Carey.

of evolutionary ecology and population biology produced conservation biologists and the cognitive dissonance they embody—nature is a finely tuned watch and every piece is important in a chaotic world with each species population being independent and with no emergent properties. The logical consequences of this train of thought are profound (Partridge 2000). Why preserve old-growth forests (fig. 1) if they are simply haphazard collections of independent species? What constitutes environmental degradation, or even environmental destruction, in a world of disturbance and chaos?

The history of ecology reveals interdependence between scientific thought and values of the contemporary society. Science and culture are not independent—science actually follows culture. History documents continuing threads over centuries in how people think about their relationship to nature and how science seems to spiral upwards cycling among philosophies but always gaining in complexity. The recapitulation of Worster's history only briefly describes the diverse and rapid intellectual and scientific development of ecology within the adult lifetime of today's senior academicians, scientists, administrators, and managers active in the conservation

Figure 2—Models of enduring human communities and their interactions with nature: (A) Maasai boys, on the Maasai Mara, prepare for induction into manhood by collecting, without weapons or snares, birds for their headdresses. The Maasai are herdsmen, and with the Kikuyu farmers and other agriculturally specialized ethnic groups, they partitioned the landscape into ecological zones and developed sustainable agronomic practices adapted to those zones. Colonization reorganized African societies and imposed European agricultural models on the landscapes with sometimes-disastrous results. (B) A cultural mosaic of suburban development, small farms, and industrial forest near Olympia, Washington. (C) A sustainable cultural landscape of farming communities, farms, and forest in Germany. Guttau was officially founded in 1238; the photograph is circa 1985 (from the collection of Regine Timm Carey). Herr Willi Timm, bauer and jaegermeister, managed the landscape for harvestable populations of grains, rapeseed, pheasant, partridge, hare, fox, roe deer, and red deer. (D) The rapidly growing urban area of Olympia, the state capitol of Washington, and its adjacent cities of Lacey and Tumwater (the first area in Washington settled by Americans of European ancestry) are having increasingly severe impacts on the South Puget Sound natural-cultural mosaic of Douglas-fir forest, native prairies, oak woodlands, kettle wetlands, riparian areas, and salt-water shoreline. Photos A, B, and D by A. Carey; Photo C courtesy of R. Carey.

arena. Quite contrary to the unspoken philosophy underlying disturbance ecology, Worster (1990, 1994) concludes:

- Nature works by the principle of interdependency—no organism or species can survive without the aid of others, and humans depend on other life forms.
- No single model, but a wealth of models represents nature. History reveals models of enduring human communities that created rules to govern behavior based on intimate local experience (fig. 2). Science cannot take the place of moral reasoning, and science needs to be critiqued from time to time to avoid its promotion of a few of our darker ambitions toward nature.
- Change is not only real but also various. Some changes work against us. Some changes are in our own enlightened self-interest, and some are consistent with our ethical reasoning.
- We can no longer locate nature in some timeless state of perfection.

Partridge (2000), in an independent analysis, drew similar conclusions. Odum (1969), Holling (1994, 2001), and other systems theorists also support this markedly different view of the world.

Contemporary Themes in Conservation

Our society supports multiple concurrent and overlapping themes in conservation. Most are overtly value laden (Callicott et al. 1999). Americans are moving from environmental beliefs and values based on technology to those based on ecology and human relations; 75 percent consider themselves to be environmentalists (McDonough 2003). One broad theme is a general social concern for quality of life relative to the environment in which we live (see also Czech et al. 2001, Ehrenfeld 2002) (sidenote 7). Environmentalism includes concerns about clean water, clean air, industrial pollutants, automobile emissions, home contaminants, food preservatives, toxic waste dumps, global warming, open space, wastewater treatment, watersheds, parks, and all other things potentially affecting human health and quality of life, such as oil drilling, mining, extensive clearcutting, use of chemicals in forestry and agriculture, tropical deforestation, desertification, destruction of major fisheries, and global loss of biodiversity. Ecosystem health is the public value considered by many to be a useful, perhaps essential, concept in formulating environmental policy; the concept reflects value-based assumptions more than science (Lackey 2001). Thus, broad-based anthropocentric environmentalism may have real influences on conservation of natural resources.

Although there is growing public concern, environmental issues are nearly absent from national political campaigns and rarely shape individual voter preferences because of low issue salience, small perceived differences between candidates, and the tendency of environmental concerns to cut across traditional and more powerful cleavages including political party identification (Guber 2001). Thus, legislature has been scaling back wildlife protection and pollution control since 1994, despite the National Election Study that confirmed environmental values (Guber 2001). Because of low voter interest and low levels of political knowledge and information, most voters fail to perceive party differences, even on important matters of public policy. Bengston et al. (2001) examined 1,500 online media stories and concluded that ecosystem management (and, one presumes, conservation) is on the downside of the attention cycle. Interest rose in the early 1990s, declined in the mid-1990s, and leveled out with 78 percent of all attitudes favorable (in other words, ecosystem management was noncontroversial); but still most people have little or no knowledge of ecosystem management, including the concepts of ecosystem health, conservation of biodiversity, sustainability, complex systems, adaptive management, or

Sidenote 7—Czech et al. (2001) found gender influences conservation attitudes. Women ascribe greater value to nonhuman species than men and exhibit greater concern for species conservation relative to property rights. But like men, they consider ecological importance as the most important factor in prioritizing conservation efforts for individual species. Priority percentages—female/male (N = 643):

- Economic growth—74/76
- Democracy—82/83
- Property rights—75/77
- Ecosystem health—84/79
- **Conservation of species**—80/75
- Resources for the future—88/85

Sidenote 8—Kellert et al. (2000) reported that community forest management is extensively promoted for ecological, social, and economic reasons. The rationale is often compelling, but there is little data on its success. A review of five case studies worldwide revealed serious, widespread deficiencies based on criteria of equity, empowerment, conflict resolution, knowledge and awareness, biodiversity protection, and sustainable resource use. The ideal characteristics of community forest management are:

- Involving community members and local and indigenous institutions in management
- Devolving power and authority from central to more local and indigenous institutions and people
- Reconciling objectives of socioeconomic development, conservation, and environmental protection
- Legitimizing local or indigenous resource and property rights
- Including traditional values and ecological knowledge in modern resource management

collaborative management (Bengston et al. 2001). Television entertainment shows decreasing attention to environmental topics since a peak in 1993–1994, with a virtual absence of the topic on prime time network shows (McComas et al. 2001).

The lack of national public interest, the concentration of forest products manufacturing in fewer multinational corporations controlling larger areas of forest, the lower commitment of absentee owners to community stability, and the lack of commitment of multinational corporations to long-term maintenance of forested ecosystems or mill communities and their employees led Krogman and Beckley (2002) to suggest community forestry and demands for socially and ecologically responsible forest management as alternatives to corporate forestry (sidenote 8). Community forestry is a situation where community benefits are enhanced relative to standard industrial forest models and can be achieved through value-added investments in communities and progressive local hiring policies. A broad spectrum of value-added investment types is possible: school forests, urban forests, county and municipal forests, forestry cooperatives, model forests, and others devoted to local control and local benefit. Buyout of corporate lands can lead to increased community cohesion through maintaining employment and fair and congenial working conditions by the new owner. Heightened sensitivity to ecosystem health and provision of multiple benefits to communities provide greater ecological stewardship of forest land. Alternatively, communities can participate in collaborative management of federal, state, industrial, and private land by using a variety of tools and mechanisms, including tax benefits, conservation easements, forest stewardship certification in the market place, and others.

Within the arena of conservation of forests and rangelands, Callicott et al. (1999) found a plethora of normative concepts including biological diversity, biological integrity, ecological restoration, ecological services, ecological rehabilitation, ecological sustainability, sustainable development, ecosystem health, ecosystem management, adaptive management, and many more. They suggested that these terms, with their various meanings, could be interpreted by reference to two new schools of conservation philosophy: compositionalism and functionalism (table 2). In contrast to previous schools of preservationism and resourcism, which were mutually exclusive, compositionalism and functionalism are complementary, forming a continuum, and could lead to a more unified philosophy of conservation. Although some remain skeptical, Callicott et al. (1999) asserted "these concepts are at large in the world shaping conservation thought and policy."

Compositionalism

Compositionalists perceive nature primarily through population-level and evolutionary ecology and consider humans as separate from nature. Terms in a compositionalist glossary, such as biodiversity, integrity, and restoration, are norms associated with reserves. Compositionalism is essentially an entity-oriented biological approach—beginning with organisms that are aggregated into populations, which interact in biotic communities in maintained reserves. Emphasis is often on identifying areas of high species richness and preserving them (e.g., Ricketts et al. 1999). Protection of hotspots of biodiversity is appealing because it does not require changes in our daily living or the way we behave toward poorer nations and the other 99 percent of the land (Ehrenfeld 2002). Humanly inhabited and exploited areas are relegated to the functionalists. Compositionalists posit all species have equal rights to persist in nature; productivity, stability, resistance, and resilience in nature are partly a function of species diversity, functional redundancy, and niche differentiation; and the consequences of losing any one species or groups of species are not predictable and could be disastrous. They assert that reliance on isolated reserves in a semideveloped matrix is inadequate to stem the tide of an unprecedented wave of extinctions arising from habitat conversion by rapidly expanding human populations. Compositionalists support large, buffered, and connected reserves and deem a return to historical disturbance regimes as vital. Buffer zones are

Table 2—Differences between contemporary conservation philosophies

Philosophy	Compositionalism	Functionalism
Human-nature relationship	▪ Humans are separate from nature; humans defile and destroy nature	▪ Humans are part of and embedded in nature
Branch of ecology	▪ Evolutionary ecology • Organisms • Species • Communities • Ecosystems	▪ Ecosystem ecology • Energy flow • Nutrient cycling • Processes • Function
	Complementary approaches to conservation	
Conservation concepts	▪ Preservation of: • Biological diversity • Ecological integrity ▪ Ecological restoration ▪ Reserves ▪ Ecosystem health	▪ Ecological services ▪ Adaptive management ▪ Ecosystem management ▪ Sustainability

Source: Adapted from Callicott et al. 1999.

necessary because "… it is impossible to secure enough public land to protect all biodiversity" (Soulé and Terborgh 1999).

Functionalism

Functionalists perceive nature primarily by means of ecosystem-level ecology and consider humans as part of nature. Terms in the functionalist glossary are associated with humanly inhabited and exploited areas. Functionalism is a process-oriented approach—beginning with solar energy and the physical system with biotic organisms as moments in interlocked processes of energy transfers and nutrient cycles, indifferent to specific taxonomic identity. Functionalists postulate there is little evidence that a particular number of species is required for any particular ecosystem function or that ecosystems function better with more species than with fewer; if abundance or diversity of a particular functional group changes, it suggests the ecosystem has changed relative to that function; and maintaining ecosystem function through the presence and vitality of functional groups is more practical than attempting to maintain a large number of species without regard to their function (Huston et al. 1999).

A Fusion of Complementary Approaches

Can compositionalism and functionalism be used to form an integrated coherent approach to managing the total landscape? Conservation of biodiversity is more feasible when its goal is not conflated with that of wilderness preservation (Sarkar 1999). Aldo Leopold wrote, "Ability to see the cultural value of wilderness boils down [to] … intellectual humility," and moreover, we need "… a militant minority of wilderness-minded citizens … available for action" to ensure wilderness preservation (Leopold 1949). However, Leopold also believed that healthy ecosystems can incorporate human inhabitants, economic exploitation, and management, and that "there are degrees and kinds of solitude" (Leopold 1949).

The current battle over ecological dogma is distressing (Callicott et al. 1999, Hardin 1969). For example, claims that landscapes unaltered by humans existed in North America at the arrival of Europeans are often (not always) fallacious—the Europeans' diseases preceded their explorations, decimating indigenous populations and obscuring evidence of the aboriginal influence on the landscapes

Annette Wilson hikes along an old-growth forest trail in the Olympic National Forest, near Quinault, Washington. Photo by T. Wilson.

(Krech 1999, Pyne 1997, Reid 1996, Wright 1992). The long history of human interactions with nature reveals that landscapes that have not experienced important human influences are the exception. Wright (1992) described the civilizations of the Iroquois, Cherokee, Aztec, Maya, and Inca in the Americas. The history of agriculture and technological development in agriculture has been documented in Europe, too—e.g., the Ystad Project in Sweden (Malmer 1991). Ystad documents human land use to 6,000 years ago by pre-Neolithic hunters and gatherers, herding and slash-and-burn agriculture 3,000 to 5,000 years ago in the Neolithic Bronze Age, permanent field farms 1,000 to 3,000 years ago in the Iron Age, advanced field farming 500 years ago, and artificial fertilizer farming in the present (Berglund 1991).

Information on aboriginal interactions with the biophysical environments of the Americas now abounds. Aboriginal overkill eliminated 31 genera of North American mammals 11,000 to 17,000 years ago (Martin 1973). Humans in Mesoamerica practiced intensive agriculture well before the Europeans adopted this practice (Wright 1992). The Spanish reintroduced the horse to the Americas 500 years ago, and the horse quickly became widespread and domesticated by indigenous peoples. An estimated 400,000 horses were grazing the prairies of eastern Washington when Lewis and Clark arrived. There was ample evidence of a long history of prescribed burning to maintain prairies, oak woodlands, and shrubland-conifer savannahs in western Washington and Oregon when settlers from the Eastern United States first arrived (Thysell and Carey 2001b). Thus, conservation strategies minimizing human intervention may fail because the objective of maintaining a natural ecosystem may be nonsensical or oxymoronic—excluding human influence is not natural (Reid 1996). Moreover, conservation is almost never the preservation of primeval conditions, but rather a means of maintaining critical functions of the primeval system (Allen et al. 2001) and its capacity to adapt to future change (Holling 1986).

Nevertheless, one cannot simply maintain or restore ecological processes and conserve biodiversity—some such processes are generic and can be performed by weedy species (Soulé 1986). Most conservationists are somewhat in the middle of the compositionalist-functionalist continuum, and many shift back and forth in emphasis depending on circumstances. The keystone species concept provides a nexus of evolutionary and ecosystem ecology (Callicott et al. 1999). The goal of evolutionary ecology is to explain and predict the behavior of individual organisms and populations because natural selection acts exclusively on individuals. The trophic structure of biotic communities, then, should be accounted for by the exclusive application of evolutionary theory. However, evolutionary ecologists studying the dynamics of populations and communities have found foraging behavior and life histories depend on ecosystem characteristics as well as interactions with other species populations. Because ecological processes occur at discrete temporal scales, they create discrete scales in space (landscapes composed of patches composed of microhabitats). For example, the ecological process of competition between northern flying squirrels and Townsend's chipmunks (see appendix for scientific names) for the same truffles occur at very local scales where both species are present. This might be a shrub patch within a forest, or in other words, a microhabitat within a patch within a landscape. Other processes, particularly hydrologic processes like waterflow, may occur at much larger scales, such as landscapes (watersheds) within multiple landscapes. Ecosystem ecologists have found efforts to model and predict some ecosystem functions are foiled because species do matter. Community ecologists must fuse the ecosystem and evolutionary approaches to ecology in order to predict accurately the impact of particular species on particular food webs, key biotic communities, or to predict the outcome of human development projects. Thus, a synthesis already is underway. This synthesis of paradigms is necessary for the development of conservation strategies that integrate reserves and other protected areas with the rest of the biosphere.

Callicott et al. (1999) concluded that emphasis on preservation of biodiversity and ecological restoration is appropriate for wilderness areas, wildlife refuges, national and state parks, world heritage sites, and international biosphere reserves. This list is somewhat problematic in that many wildlife refuges are intensively managed with agricultural crops to provide concentrated food supplies for migratory wildlife, and parks often explicitly were set aside legislatively for human enjoyment and edification, which are not necessarily incompatible with maintenance of biodiversity but are perceived as such by many. Co-opting parks and refuges to meet extreme philosophical tenets would exacerbate divisions among conservationists rather than reconcile differences. Callicott et al. (1999) suggested that the functionalist emphasis on ecosystem health, ecological services, adaptive ecosystem management, and ecological sustainability, is more suited to inhabited and exploited areas than to reserves. They state: "The really innovative idea in contemporary conservation is the functionalist ideal, which conceives of human economics as embedded in the larger and more enduring economy of nature."

The point is to adapt human economics to ecological exigencies in order to achieve a mutually sustaining relationship between humans and the ecosystems they inhabit and on which they clearly depend; however, Wilber (1995) would argue the embedment is in the opposite direction. Of course, the really exciting idea is social evolution with its best end products being lasting institutions, durable friendships, stable communities, accumulated wisdom, and gentle and productive cooperation that promote local conservation with continuity, passed from parent to child and friend to friend (Ehrenfeld 2002).

Conservation, Forest Management, and Sustainability

The science of ecology has had a popular impact unlike that of any other science; it has been ubiquitous, and it has changed the language of politics and philosophy (Worster 1990). Concerns about forest conservation and sustainability are producing ecological forest management systems across the biosphere (e.g., Hunter 1999, Larson and Danell 2001, Mönkkönen 1999, Swedish National Board of Forestry 1990, Virolainen et al. 2001, Wikstrom and Eriksson 2000, Yang 1997). Trees and forests are important to Americans for their ecological contributions and their economic value ($200 billion/year). But the ecological contributions are more valued by a culture concerned with aesthetic qualities, pollution, and sustainability; changing values are reflected in the growing dichotomy between commodity-focus forestry and environmental and restoration management (McDonough 2003). Sustainability is a word that evokes positive associations and that is claimed and shaped by proponents of various conservation philosophies to their own goals. Pacific Northwest neo-conservation biologists argue that achieving sustainability (meeting human needs without compromising the health of the ecosystem) should be the principal goal of conservation, whereas orthodox conservation biologists do not welcome a paradigm shift from wilderness to sustainability (Callicott and Mumford 1997). Ecosystem management is often held as the means to achieve environmental sustainability in managed forests. Ecosystem management asks forest stewards to manage lands for commodities, amenities, and native biological diversity. Ecosystem management, however, can conflict with commodity interests, wilderness advocates, and outdoor recreationists; this term also is co-opted by narrow interests to legitimize narrow goals (Knight 1996).

Forestry and Conservation

Concern about a global biodiversity crisis arose in the late 1970s (Noss and Kranz 2001, Wilson 1999a). By 1993, more than 600 species had been listed as threatened or endangered in the United States. The Endangered Species Act of 1973 has had less effect than expected because remedial action is not triggered until a population is in serious trouble (Orians 1993). And federal agencies, first in a state of "future shock," then "midlife crisis," failed to adapt to rapidly changing societal demands (Bengston 1994, Kennedy and Quigley 1998). R.E. Wolf, a key congressional staff member for important federal conservation legislation (Multiple Use Sustained Yield Act, Wilderness Act, Resources Planning Act, and National Forest Management Act) labeled USDA Forest Service behavior as a "corruption of the Resources Planning Act" (Wolf 1989) (table 3). The new environmental paradigm was environmental sustainability, skepticism of science and technology, finite natural resources, limits to substitution, and public involvement (Bengston 1994). Classic forestry concepts of multiple use and sustained yield were not useful to contemporary, ecologically informed, biocentric conservation (Callicott and Mumford 1997). The Forest Service was a model machine bureaucracy, but complex, challenging, and important policy issues are ill served by command-and-control paradigms (Lackey 2003).

In the Pacific Northwest and Alaska, the diverse high values of forests have intensified conflict, and the public has become more polarized and distrustful; the polarization is manifested in Forest Service alternatives of zoning for different uses and attempting to identify compatibilities between wood production and other values (Peterson and Monserud 2002). Command-and-control paradigms not only polarize the public, but also engender top-down centralized decisionmaking and attendant public resistance, rarely use new scientific and technical information, and reinforce policy and scientific reductionism (Lackey 2003), yet such policies based on these paradigms persist (Mills et al. 2002) (sidenote 9). Kimmins (2002) reported similar future shock in forestry in Canada (sidenote 10).

Perry (1998) defined forestry as the scientific management of forests for continuous production of goods and services, but cited the National Research Council as concluding that existing knowledge was inadequate for sound forest management in 1990. Perry (1998), and many others, concluded that the social sciences, including sociology, aesthetics, ethics, spirituality, economics, history, and so on,

Table 3—Traditional forest management versus ecosystem management

Traditional forest management	Ecosystem management
▪ Maximize commodities	▪ Leopold land ethic and sustainable commodity production
▪ Maximize net present value	▪ Maintain future options
▪ Sustained yield	▪ Long-term ecosystem sustainability, maintaining aesthetics, socially acceptable
▪ Forest management as an applied science	▪ Forest management as a social science
▪ Instrumental values	▪ Instrumental and intrinsic values
▪ Focus on outputs	▪ Focus on inputs and processes
▪ Timber focus	▪ Species focus
▪ Timber in short supply	▪ Loss of biodiversity
▪ Reductionistic view	▪ Systems view
▪ Stand-level focus	▪ Ecosystem-landscape-level focus
▪ Plan and manage by ownership	▪ Plan and manage by ecosystem
▪ Economic efficiency	▪ Cost effectiveness and social acceptability

Source: Adapted from Bengston 1994.

Sidenote 9—Achieving science-based national forest management (Mills et al. 2002):

- Decisionmakers (line officers) and the public fully appreciate the contributions of science to land management.
- Forest Service scientists and professionals provide the science needed for decisions.
- Policy-relevant science is readily available and easy to use.
- Available science is fully used by decisionmakers.
- The consistency of land management with available science is evaluated.
- Science is recognized as important but only as one piece of information considered in a decision.

Sidenote 10—Kimmins (2002) defined future shock as the point at which the rate of change in society exceeds the willingness and ability for institutions to adapt to change.

are critical to forest management. Furthermore, as Kimmins (2002) stated, forestry is about people—their needs and desires—not fundamentally about biophysical issues. At present, North American forestry seems archaic and too narrowly focused to conduct forest ecosystem management.

Technical ecosystem management is broadly interdisciplinary, requiring specialists in forest ecology, plant ecology, silviculture, forest insects and diseases, wildlife, biodiversity, geology, forest engineering, and on and on. The forestry profession is in trouble because of resistance to change and maintaining an archaic forestry dogma including the economic myth of soil rent theory and short rotations (Curtis and Carey 1996, Maser 1994). Soil rent theory has six flawed primary assumptions (Maser 1994): (1) the depth and fertility of soil is constant, (2) the quantity and quality of precipitation is constant, (3) the quality of air is constant, (4) biological and genetic diversity are nonessential, (5) the amount and quality of solar radiation are constant, and (6) climate is constant.

Overarching the technical aspects of ecosystem management is social forestry, the science of sustainable forest management for multiple values—a new environmental management that needs to develop and use credible, ecologically based forest ecosystem management models based on both experience and theoretical models (Kimmins 2002). Administrative and legal challenges to forest management in the United States convinced Jack Ward Thomas (Chief of the U.S. Forest Service, 1993–1996) in 1996 that "… the overriding de facto policy for the management of federal lands is the protection of biodiversity" (MacCleery and Le Master 1999). Huge areas of federal land were allocated to reserves that permit little or no active management under the assumption that natural regulation will maintain a natural balance. Since then, timber sales on national forests have dropped 70 percent (since a 1985 benchmark), and 23 percent of the forests (about 17 million hectares or roughly the size of Washington state) have been set aside. Nationwide, in 1999, only 35 percent of total land holdings (48 percent of productive forest lands) in the National Forest System and 15 percent of land holdings in the Pacific Northwest were available for timber harvests. Rangelands have been subject to the same pressures for conservation, and grazing on federal lands is beginning to decrease (Davis 2001, Samson and Knopf 2001).

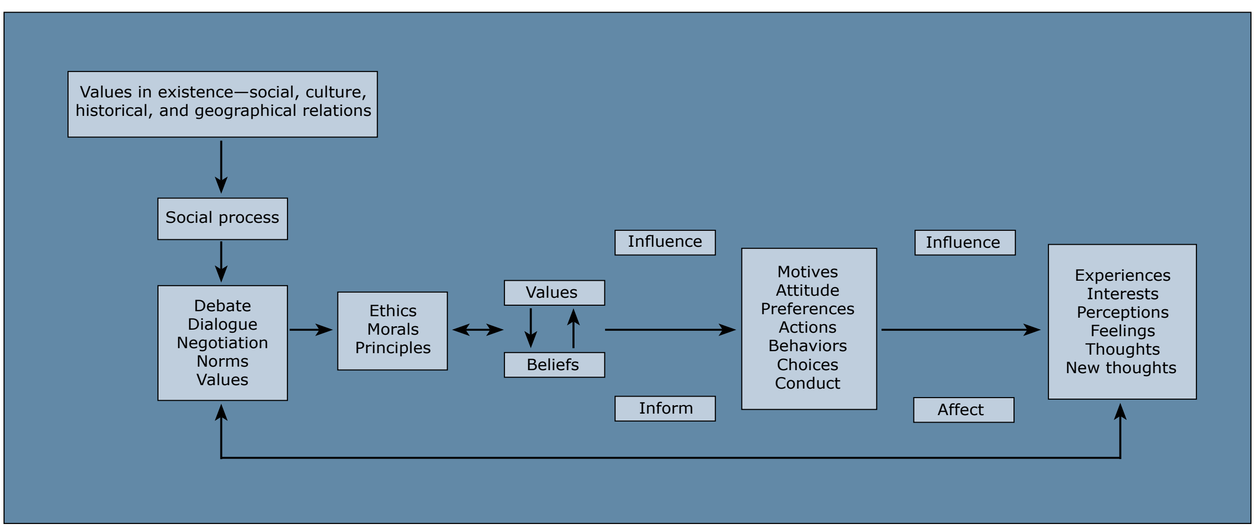
Narrow-focus forestry wrought profound changes on other continents also. For example, forestry in Fennoscandian forests began in the 1700s; numerous species were red-listed in the 20th century. In the 1990s, Nordic countries implemented forest conservation efforts of mimicking natural disturbance regimes, setting aside reserves, and implementing a corridor-and-stepping-stone strategy (Mönkkönen 1999). Now, however, conservation goals are becoming more elusive. O'Brien (2003) assessed people's values and their importance to forestry in England through a review of the literature. He found that the values people hold for the environments are multiple and complex and produce conflicts when not considered by managers. The English public is increasingly interested in having their views heard, being involved, and being consulted on environmental matters. Dominant themes are lack of trust in elected representatives, feelings of powerlessness in the face of globalization, ethical and social impacts of increased technology, and a call for justice in environmental decisionmaking; issues very similar to North American issues. He concluded forests should be managed for multiple values not multiple uses (sidenote 11) (fig. 3). Values, however, must be assessed through mechanisms like citizen juries, focus groups, indepth interviews, and collaborative management. During a tour of restoration projects in Denmark, Sweden, and Germany in 2001, Danish and German foresters defined forestry as a social science, with values assessment and collaborative management beginning with one-on-one tea sessions and culminating in community meetings.

Sidenote 11—Management for Multiple Values (O'Brien 2003): Forests should be managed for multiple values rather than multiple uses. Instead of focusing on the forest as a resource to be used, managing for multiple values posits that respect is given to human and forest communities in order to provide a wide range of benefits. Management for multiple values highlights the ethical dimension of management, incorporates moral judgments, and brings together different interests and expertise. Values are (1) formed out of a social process of dialogue and debate; (2) influenced by social, cultural, historical, and geographic relationships between society and the individual; and (3) informed by ethical and moral judgments.

Reserves and Conservation

Modern conservation philosophy now questions the concept of "protected area" as a throwback to equilibrium ecology. Twenty years of emphasis on protected area systems is now suspect on the bases of minimum viable population analyses demonstrating the

Figure 3—Schematic representation of value formation: Thus, values can shift, be contested, be multiple and renegotiated, be reviewed, and be reinterpreted through discursive processes, or revised meanings and understandings (O'Brien 2003).



inadequacy of many protected areas and of climate change bringing about ecological change (Reid 1996). There is growing consensus that management of nonreserved lands is as important for conservation, if not more so, than maintaining a patchwork of reserves and corridors (Carey et al. 1999c, Hunter 1999, Reid 1996). A concept of "total landscape management" is emerging that incorporates an intentional approach including designating wilderness and parks; protecting fragile areas; promoting ecological forest management; providing tax incentives, conservation easements, and green certification to private landowners; assessing development fees; and growth (of socioeconomic systems) management.

New Conservation Objectives

The very objectives of conservation have become more elusive in recent years (Reid 1996). What should the overarching concern be? The majority of efforts to preserve biodiversity have focused on species, subspecies, and populations. It is fundamentally impossible to deal with more than a small fraction of nature on a single-species basis. A 1997 symposium on global conservation of mammals asked, "Has the panda had its day?" (Entwistle and Dunstone 2000) and concluded that success of single-species approaches has not been great, that one-quarter of all mammals are threatened with extinction, despite the aesthetic, scientific, and economic values people place on mammals. They suggest conservation must rapidly move away from protectionism to integrated wildlife and landscape conservation within the context of human use. Moving beyond reserves and corridors and managing for ecosystems and landscapes is the only comprehensive way to address conservation (Franklin 1993b). Some fundamental concern is needed that guides the relationship between humanity and nature that addresses our acknowledgment that the biosphere's capacity to support life must be maintained (Reid 1996).

Increasingly, that concern is seen as maintaining biotic integrity and ecosystem health (Regier 1993). The notion of ecological integrity is rooted in the integration of ecological concepts with human values. The emergent normative goal of human-environmental relationships, then, is to maintain the integrity of a combined natural-cultural ecosystem through ecological understanding and an ethic that seeks proper relationships. The concept of ecosystem health, however, is more contentious because achieving such an overarching ecological objective may fail because of unpredictability of ecological systems and ignorance of those aspects of system behavior that are predictable (Reid 1996). We clearly want to maintain ecological services important to humanity, and we want to maintain biodiversity to keep options open for future generations (sidenote 12). Reid (1996) suggested that the objective of conservation should not be ecological but social—e.g., maximize human capacity and the capacity of the biosphere to adapt to change.

Of course, all human choices, from designation of reserves to urbanization, serve human objectives. Designating reserves enhances self-esteem through perceived altruism and peer positive reinforcement. Urbanization buffers people from the more unpredictable whims of nature. Perhaps the most practical goal would be to buffer people from the fear of loss of control over one's life promoted by rapid and socially destabilizing technological and environmental developments, while maintaining options for future generations. Maslow's (1987) hierarchy of needs (fig. 4) provides insight into the fundamental bases of conservation-utilization philosophies, ties attitudes to economic or security status and self-actualization, and highlights intragenerational equity. Three major ecologies must be integrated for a sustainable resolution of contemporary conservation concerns and conflicts: (1) an environmental ecology that is sustainable, (2) a social ecology that is satisfying, and (3) a spiritual ecology that is soulful (Elgin and LeDrew 1997).

Sidenote 12—Ecological services are economically valuable, diverse, and marginally marketable. Costanza et al. (1997) listed the value of 17 ecosystem services in 16 biomes around the world at an average of $33 trillion per year. Krieger (2001) estimated the value of forest ecosystem services—climate regulation, waste treatment, and food—to be $64 million per year in the United States alone. De Groot et al. (2002) listed 23 different ecosystem functions—natural processes that provide goods and services that directly or indirectly satisfy human needs. Eight categories of ecosystem services are soil stabilization and erosion control, air quality, climate regulation, carbon sequestration, biodiversity, recreation and tourism, nontimber products, and cultural values (Krieger 2001).

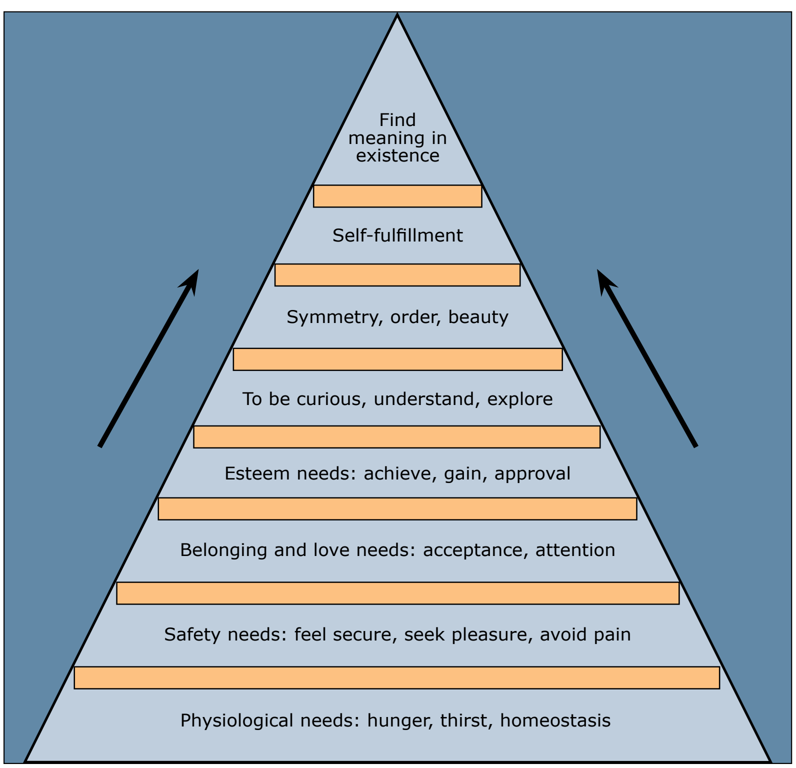


Figure 4—Maslow's hierarchy of human needs (adapted from Maslow 1987).

General Sustainability

It is widely recognized that forests should be managed for sustainability (Daily and Ehrlich 1996, Dasgupta et al. 2000, di Castri 2000). The concept of sustainable forestry dates from 18th-century concerns about soil productivity (Farrell et al. 2000, Hilborn et al. 1995). A broader concept of sustainability derives from John Stuart Mill, Thomas Malthus, Paul Ehrlich, Garrett Hardin, and Herman Daly. In 1981, the International Union for the Conservation of Nature and Natural Resources produced a World Conservation Strategy and called for ecologically sound use of natural resources. In 1987, the World Commission on Environment and Development adopted the idea that economic development and environmental protection are compatible and called for sustainable development of Third-World countries. In 1992, the United Nations Conference on the Environment and Development adopted sustainability and elicited widespread acceptance by governments. After these events, however, sustainability was subordinated to development, supported by economists, and opposed by humanists and ecologists (Clark 1995). The reason for this schism, Nelson (1995) reported, is that economics is not only a science, but also a set of values often at odds with other natural and physical sciences. Economics is a social science concerned about the interactions and welfare of people. Animals, plants, the physical state of the world, and other material conditions do not enter into considerations—only what people do counts. Emphasis on development promoted fears about overexploitation because history demonstrates universal overexploitation in development of natural resources (Hilborn et al. 1995). A new discipline of ecological economics arose to address these concerns. But as in other conservation disciplines, conflicting values implicit in mainstream economics and in ecological economics reflect deep underlying theological differences. And both theoretical economists (Nelson 1995) and theoretical ecologists (Clark 1995) are too abstract-thinking to produce ideas of practical consequence for policy decisions or intellectual generalizations to inform policy well. What is actually delivered is metaphysics, morals, personal convictions, and, in some cases, religion.

The debate over values pertinent to sustainability produced the concept of general sustainability (Goodland 1995). General sustainability has three components: environmental sustainability, social sustainability, and economic sustainability. Environmental sustainability seeks to improve human welfare by protecting sources of raw materials (the natural capital) and ensuring that sinks for human waste are not exceeded. To be sustainable, harvest rates of renewable resources must stay within regeneration rates and not diminish the capacity of the environment as a sink. Conservation of biodiversity is generally accepted as part of environmental sustainability, but there is no agreement on how much and at what cost. In any case, people must live within limitations imposed by the biophysical environment and the finite capacities of the global support system. Social sustainability is achieved by systematic community participation and strong civil society. The cohesion and norms of a civil society are social capital and moral capital. Human capital must be maintained by investments in education, health, and nutrition. Economic sustainability is keeping capital intact. Together these form a general sustainability that maintains the life support systems of the atmosphere, water, soil, and environmental services. General sustainability also has a strong component of both intragenerational and intergenerational equity. Thus, general sustainability includes poverty reduction through qualitative development, redistribution of wealth, sharing of resources, population stability, and community solidarity, but not through increased consumption of materials and energy from the environment, returned to the environment as waste. Morally undesirable gross inequities throughout the world are also biophysically unsustainable. Thus, to perpetuate poverty has deleterious, irreversible impacts on the biophysical component of Earth's life support system. Poverty around the world has long been associated with dense populations, deforestation, unconstrained mining, erosion, desertification, poor farming practices, overgrazing of livestock, and pollution (lack of sanitation systems, polluting factories based on cheap labor, etc.). These inequities also hinder cooperation among parties of different socioeconomic status (Daily and Ehrlich 1996). Thus, in essence, sustainability is a normative paradigm for improving the quality of human life within the carrying capacity of the ecosystem without compromising the ability of future generations to meet their needs. Sustainability is a global concern with enormous social and political ramifications if it is to be achieved. Of course, the ramifications of not achieving sustainability are equally enormous (fig. 5).

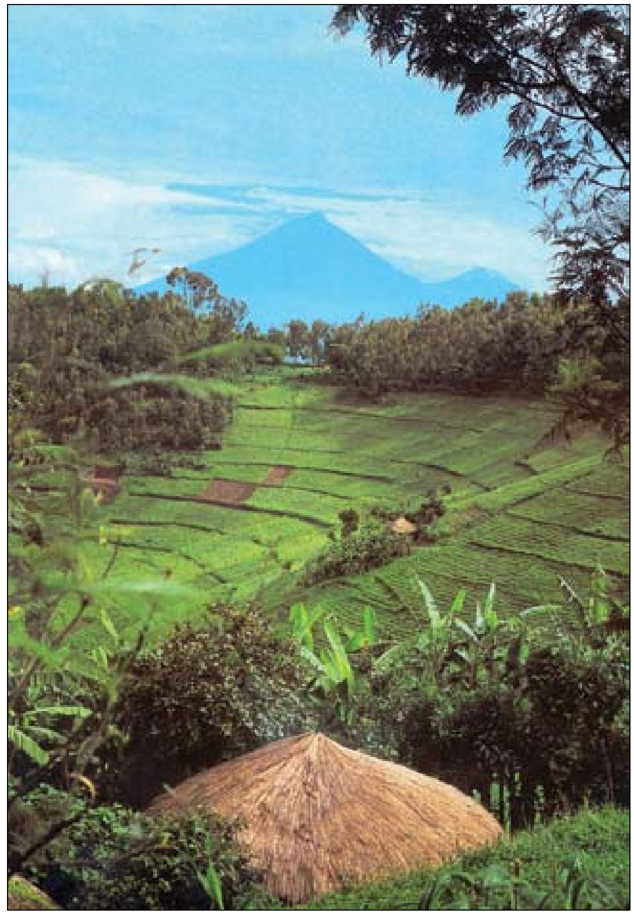


Figure 5—The rich environment of the central African highlands supports a rich flora and fauna. In Rwanda, over 95 percent of the arable land has been developed for agriculture. Strong international efforts have been made to develop economic diversification through ecotourism geared around reserves for mountain gorillas (Parc National des Volcans) and other primates (Forêt de Nyungwe). Large human populations and colonialism induced social inequity between the Hutu and Tutsi ethnic groups and resulted in genocide. Photo courtesy of Rwanda Tourism.

In 1994, Albert A. Bartlett hypothesized that the population of the Earth had exceeded the Earth's carrying capacity for the average standard of living and proposed Bartlett's Laws for Sustainability (Goodland 1995):

- Growth in human populations or in rates of consumption cannot be sustained.
- The larger the population and rates of consumption, the more difficult the transition to sustainability.
- About 50 years are required for populations to respond to a change in total fertility.
- Carrying capacity and sustainable mean standard of living are inversely related.
- Sustainability requires population size be less than carrying capacity for a given standard of living.
- Beneficiaries of growth are few, but costs are borne by all (the tragedy of the commons).
- Growth in consumption of nonrenewables dramatically decreases their life expectancies.
- Increases in efficiency of utilization produces savings wiped out by modest population increases.
- Rates of pollution greater than natural cleansing capacity mean it is easier to pollute than clean up.
- Humans always will depend on agriculture and forestry; land and renewables always will be essential.

Increased population size is the single greatest and most insidious threat to representative democracy, general sustainability, and conservation. Reserving land for nonhuman species limits the amount of land available to support people. And the current production is exhausting natural capital. Depletion of essential resources and degradation of land and atmosphere are seriously damaging the biosphere and its future biophysical carrying capacity for people. Faith in the ability of technology to solve humanity's problems, paralleled by polarization by extreme statements intended to dramatize, make it difficult to "paint a richer picture" and achieve consensus on appropriate courses of action (Costanza et al. 2000). Still, there are guiding principles for managing the environmental portfolio: (1) protect capital, live off interest; (2) hedge investments, do not put all eggs in one basket; (3) do not risk more than you can afford to lose; and (4) buy insurance—do not harvest everywhere and not even close to the sustainable limit.

Policies of diverse organizations, from the USDA Forest Service to the nongovernmental Forest Stewardship Council and Pacific Forest Trust to the professional Ecological Society of America (Christensen et al. 1996) and industrial American Forest and Paper Association (Heissenbuttel 1996), emphasize that sustainable ecosystems are essential to the health and support of human societies and quality of life. Although carefully crafted definitions of sustainability have been offered (Goodland 1995), none have received universal acceptance. The concept, like other conservation concepts, means different things to different people (Clark 1995, Goodland 1995, Gowdy 2000, Hunter 1999, Lindenmayer et al. 2000, Nelson 1995, Reid and Miller 1989, Wilson 1999a). Emphasis varies among sustained yield of wood products, maintenance of long-term site productivity, intergenerational equity, social justice, and conservation of biological diversity (Angermeier and Karr 1994, Christensen et al. 1996, Hunter 1999, Soulé and Terborgh 1999). Disagreements include debates about (1) limits to economic and human population growth (Barrett and Odum 2000, Czech 2000, Davidson 2000), (2) the relationship of biodiversity to ecosystem stability (Tilman 1996, 1999; Wardle et al. 2000), (3) the spatial and organizational scale at which conservation should focus (Folke et al. 1996, Franklin 1993b, Orians 1993), and (4) property rights (Geisler and Daneker 2000, Lee 1993). Polarization extends from sustainable development and resource extraction on the one hand to preservation of genetic diversity through establishment of ecological reserves on the other. Our current debate is counterproductive because it is based on untestable assumptions embedded in deeply held worldviews and ethical beliefs (Costanza et al. 2000, Worster 1994). Nevertheless, the public is beginning to formulate cultural definitions of the term (Ray 1996) and demand sustainability through the market place, political processes, administrative appeal processes, and the courts. Examples include purchase of green-certified wood products, payment of carbon credits, donations to nonprofit organizations for the purchase of conservation easements, state and federal legislation, litigation, and international agreements and treaties (Costanza et al. 2000, Daily and Ellison 2002, Harwell et al. 1999, Kennett 1998).

Ecosystem Management

Ecosystem management is variously asserted as being an evolutionary step in natural resource management, a cooperative solution to resource management problems, a public deliberation on values, and a dispersion of power and authority in the natural resource management arena (Lackey 1998, 2001; MacCleery and Le Master 1999). Ecosystem management grew out of the multiple-use-sustained-yield management of the 1960s during a period of increasing demands on federal lands followed by conflict, legislation, and litigation (table 4). Nonsustainable timber management led to markedly reduced area of forest land and amounts of timber available for harvest. Rather than encompassing theoretical developments in ecology and philosophical developments in conservation, ecosystem management remains a pragmatic tool—a means to an end in meeting human needs while maintaining the health and productivity of ecosystems. Ecosystem management expands the range of values considered by multiple use-sustained yield management and requires consideration of social, economic, and environmental interactions at a variety of spatial scales (MacCleery and Le Master 1999). Different groups use it with different meanings; such ambiguity promotes debate and limits acceptance. Debates over the utility and purpose of ecosystem management bring to light fundamental (and historical) differences in values and beliefs and highlight where the scientific basis of ecosystem management may be lacking. Thus, ecosystem management provides an opportunity for values clarification, expressing beliefs, identifying scientific uncertainties, and convening diverse interests into collaborative management groups, and, finally, creating opportunities for novel and creative solutions to persistent problems at local scales.

Ecosystem management is not a technical exercise of structuring decisionmaking around self-defining ecosystems to promote absolute preservation; rather, it is a set of normative principles and operational guides for managing human activities so that they coexist with ecological processes deemed worthy of protection over

Table 4—A comparison of multiple-use-sustained-yield management and ecosystem management

Multiple-use-sustained-yield	Ecosystem management	Both
▪ Featured species	▪ Biological diversity	▪ Sustainability
▪ Resource productivity	▪ Ecosystem health	▪ Meet the needs of the people in the long term with a sustained yield of goods and services
▪ Multiresource management	▪ Integrated management	
▪ Multiple use, site by site	▪ Systems, integrated, holistic	
▪ Site-specific management	▪ Landscape management	
▪ Stand-level focus	▪ Multiple-scale focus	
▪ Efficient production	▪ Range of natural variability	
▪ Line-staff organization	▪ Public-private partnerships	
▪ Planning by function	▪ Multidisciplinary planning	
▪ Respond to research findings	▪ Adaptive management	

Source: Adapted from MacCleery and Le Master 1999.

the long term (Kennett 1998). Some proponents claim ecosystem management is founded on five global precepts: (1) equity between human and nonhuman communities; (2) moral consideration for both humans and other species; (3) respect for cultural diversity and biological diversity; (4) inclusion of women and minorities; (5) inclusion of nonhuman nature in a code of ethics; and (6) ecologically sound management consistent with continued health of both humans and the environment (Lackey 1998, 2001). Each of these precepts can be contested—e.g., (1) not equity among species, but interdependence; (2) moral consideration for human intra- and intergenerational equity requires wise use, but does not require a precept of equity among species; (3) all management (not just ecosystem management) in contemporary democratic societies is bedded in systems that incorporate pluralism and diverse cultures; (4) better to focus on intra- and intergenerational equity and sustainability in a code of ethics; and (5) better to recognize limits to system capacity.

In addition, ecosystem management is based on four major assertions that also are contested (Lackey 1998). First is the assertion that ecosystems are real and, thus, ecosystems can and should be managed. Some assert that ecosystems lack clear spatial definition and are imbedded systems, with management practical only at certain scales, with different approaches at each scale. Thus, given that humans are limited cognitively, management cannot be fully successful. Nevertheless, ecosystems are as real and tangible as anything in life, and cognitive limitations and uncertainty can be addressed with intentional systems management (Carey et al. 1999c).

The second assertion is that natural, undisturbed ecosystems are inherently preferential to disturbed ecosystems. Additionally, native species are more important than exotic species and, therefore, biological diversity should not be reduced. In reality, few ecosystems have not been historically altered or influenced by people, exotic species include some of our most aesthetically and commercially valued ornamental and food plants (fig. 6), and native diversity often can be enhanced by intentional management (e.g., Carey 2003a, 2003c; Carey and Curtis 1996; Thysell and Carey 2001a).

The third assertion is that everything is connected to everything else (callout 1). Thus, ecosystem management would be

(continued on page 44)

Figure 6—A highly diverse, cultivated landscape unit: Regine Carey's Olympia, Washington, 0.4-hectare garden and surrounding 1.5-hectare managed woods contains over 140 species of cultivated and wild plants and 35 species of indigenous birds and has been highlighted in regional tours of natural gardens. Photo by A. Carey.

Callout 1—A. Carey's *Science Findings* July 2003, page 1

PNW
Pacific Northwest Research Station

Science
FINDINGS

INSIDE

issue fifty-four / july 2003

"Science affects the way we think together."
Lewis Thomas

THE TROUBLE WITH CONNECTEDNESS: DISTURBANCE AND ECOSYSTEM CRASHES

Credit: A.Bristol

Biocomplexity encompasses both the abundance and diversity of species and how communities are structured. It then considers how diversity factors structure the community both physically and compositionally.

"You may drive out nature with a pitchfork, yet she'll be constantly running back."

Horace 65–8 B.C.

The patchwork quilt covering the forest lands of the Pacific Northwest has come to represent the logical outcome of heavy logging patterns and the particular policies of federal landowners during the latter part of the last century. On the one hand, the patches symbolize fragmentation and all its negative connotations: the break between wildlife and habitat, the loss of connectivity. On the other hand, numerous biodiversity studies are beginning to compile a case for the value of heterogeneity—or dissimilarity—at various levels of ecological organization from ecological communities within a forest to differences among communities within different forest types across a landscape.

Current federal land management in the Pacific Northwest, under the Northwest Forest Plan, is based on the idea of reserves to leave things be, corridors as connectors, and "matrix" lands to be managed for multiple values—the only place where timber

IN SUMMARY

How do we promote resistance to disturbance, resilience when disturbance does occur, and forest health in general when forests and landscapes are actively managed for a variety of values? How do we manage for sustainability when humans and their consumption patterns are munching up the earth at alarming rates? How do we move beyond the now-controversial ideas of reserves and connecting corridors, the centerpiece of the Northwest Forest Plan?

New theories about how ecosystems renew themselves suggest some possible pathways from here to there. The development of panarchy theory, for example, and research into the ecological foundations of biodiversity are being synthesized into practical guidance for promoting forest health and sustainability. Old ideas about the importance of corridors are giving way to recognition of the importance of connectivity maintained by high permeability, varied dynamic landscapes, and ecologically high-quality patches; the patches are naturally and continually in states of rebirth, growth, and dissolution. Reduced connectedness and enhanced permeability, it seems, can increase resistance to agents of catastrophe and enhance resilience after catastrophes.

In order to preserve ecosystem health, therefore, we must consider the whole cycle of an ecosystem's development, including the value of both crash and recovery.

Callout 1—A. Carey's *Science Findings* July 2003, page 2

can be harvested. But behind this kind of management, according to Andy Carey, research biologist with the Pacific Northwest Research Station, is a deeply held belief in the value of connectedness (everything is connected to everything else), equilibrium (static forest structures), and the "balance of nature." This belief does not allow us to design ecosystems that can adapt to long-term trends such as climate change.

What, then, are we to think of connectedness? Is it a good thing or a bad thing?

First, a definition. Despite all we learned about the values of sound connections between ecosystem components—a good thing—in the 1970s and 1980s, it is important now to recognize that too much connectedness between simplified ecosystems can render them highly vulnerable to catastrophic disturbance, Carey says. Not such a good thing.

In this sense, connectedness refers to tight coupling through homogeneity. Consider plantation monoculture an extreme case. Across a commercial private forest plantation, the likelihood of disease spreading, for example, is far higher than across a diverse, patchy landscape. A less extreme example is a nonplantation landscape where fire has been suppressed, where biodiversity is potentially undermined by the dominance of fewer species and the ecosystem is at high risk owing to large, connected fuel loads.

KEY FINDINGS

- The forest ecosystem study demonstrates that managing for ecologically appropriate spatial heterogeneity at a variety of scales promotes diversity in vascular plants, fungi, invertebrates, birds, small mammals, and carnivores.
- That study and others collectively demonstrate that spatial heterogeneity and compositional diversity reduce overall connectedness of ecosystems across a landscape. This increases both resistance to agents of catastrophe and ability to recover after disturbance.
- Reduced connectedness allows competing species to exist on a fine scale, prevents single predators from extirpating prey, inhibits the spread of diseases such as root rot and Swiss needle cast, reduces susceptibility to windthrow, inhibits the establishment and spread of invasive exotic plants and animals, and allows quick system recovery after ice and windstorms.

A certain degree of connectedness, Carey suggests, is healthy. As adaptation occurs, all the parts of a system can then bend and move as needed. But in an overly connected system, a kind of rigidity between the parts can occur, rendering the whole much more vulnerable to the dramatic shifts of catastrophic disturbance.

"You only have to look to epidemiology to see what happens if everything is too closely connected," says Carey. "The value of happy-and-peaceful-everything-is-connected-to-everything-else made a nice little story back in the sixties and seventies but in truth it's just a disaster waiting to happen."

The recent international spread of severe acute respiratory syndrome, exacerbated by the connection of continents by airplanes, is a chilling example.

What do we get when we turn the idea of connections on its head, throw in the complex roles of disturbance and effects of human activity, the truth of Nature's lack of a plan, and time? One possible scenario is described by panarchy theory.

PANARCHY THEORY AND STABILITY

Simply put, panarchy theory, developed by Gunderson and Holling (2002), addresses ideas of stability. How do ecosystems absorb, buffer, or generate change?

The two widely accepted phases of ecosystem dynamics are exploitation, in which rapid colonization of recently disturbed areas occurs, and conservation, the slow accumulation and storage of energy and material. Panarchy theory adds two more stages. The first is release, or "creative destruction," in which accumulations of biomass and nutrients become increasingly susceptible to disturbance and are suddenly released by such agents as forest fire, insect pests, or intense grazing. The second is reorganization, which brings processes into play that work toward preparing the system for the next phase of exploitation in a potentially different setting of climate and disturbances.

Panarchy theory is constructive for considering some of our remaining land management options today and can help change them profoundly, Carey believes.

"Our traditional forest management approach has emphasized homogeneity and low diversity, engineering efficiencies with single species in which you predictably plant, fertilize, spray herbicides, harvest, and in effect, keep everything highly connected. Under such a system, any loss by disturbance becomes catastrophic, and the ability to recover less likely."

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Several philosophies on forest management currently prevail. The more recent conservation biology approach looks to an elusive past for guidance about what we should be producing from any given ecosystem, he says, and bases its approach on protecting as many individual species as possible. By contrast, disturbance ecology sees each biotic site as resulting from whatever disturbance has hit that site plus a random drawing from the species pool for the exploitation and conservation phases. Historical range of variability offers sideboards between which we try to steer our forests.

"Whatever the guiding philosophy, what most of these approaches miss is the idea that ecosystem development is not entirely based on random chance, nor on a very specific set of circumstances that once existed in the past," Carey says. "The past may not be reproducible, and I believe we'd be better off looking to produce the phenomena we want at a time that's right for them. Self-organizing, or adaptive, systems offer us this opportunity, a chance to look to the future rather than trying to restore an elusive or ill-defined past."

LAND MANAGEMENT IMPLICATIONS

- Systems not managed with ecologically appropriate spatial heterogeneity and compositional diversity are at greater risk of catastrophic disturbance owing to low resistance and resilience. They would thus require more external inputs (site preparation, herbicides, pesticides, fertilizers, protective barriers) to ensure narrow goals are achieved.
- Variable-density thinnings to promote compositional diversity and heterogeneity across the landscape contribute to forest health, and are increasingly being used on the ground by federal, state, and private land managers.
- Wood production is compatible with conservation of biodiveristy and can be used to promote forest health. Conversely, narrow-focus silviculture can induce risk factors for various forest health issues.

BIOCOMPLEXITY AND RESTORING BIODIVERSITY

So how do the tenets of panarchy theory relate to biodiversity and sustainability?

To most scientists, single-species conservation and natural reserves seem insufficient for protecting biodiversity, and to much of the public, conventional forestry seems suspect in sustainability, according to Carey.

"In the Pacific Northwest, comparisons of natural and managed coniferous forests support the idea that both single-species conservation and conventional forestry are unlikely to be successful. The reason is that biocomplexity is more important than individual habitat elements in maintaining the diversity of forest ecosystems and their capacity to produce useful goods and services."

Biocomplexity?

Biocomplexity goes beyond the genes, species, and populations of biological diversity, beyond the communities, ecosystems, processes, and economic and ecological goods and services of biodiversity. Biocomplexity encompasses how communities are structured—their collection of species—and looks at diversity at certain levels of organization. It also takes into account how those diversity factors structure the community both physically and compositionally.

In natural forests, biocomplexity is a given: many ecosystem elements are patchily distributed, including live trees from the preceding stand, large fallen trees, trees with cavities used for denning and nesting, berry-bearing shrubs, shade-tolerant trees in the midstory, forbs, mosses, and fruiting bodies of fungi, among others. Groups of these elements can form distinct patches.

"Thus we have biotic legacies from preceding forests, propagules from adjacent stands, forest structuring processes, and development of heterogeneity across the forest ecosystem interacting to produce both overall compositional diversity and patch diversity, or what we call habitat breadth," Carey explains. At the landscape scale, a similar phenomenon can be brought about. We need, he says, to manage in ways that promote such biocomplexity.

Generic model	Timber-wildlife	(duration, years)	Natural development	Active management:	simple	complex
Stand initiation	Grass-forb	(2–5)	Disturbance and legacy	Ecosystem reinitiation creation	x	x
	Shrub	(3–10)				
	Open sapling pole	(8–20)	Cohort establishment			
Stem exclusion	Closed sapling-pole-sawtimber	(40–100)	Canopy closure	Canopy closure	x	x
			Biomass accumulation/ competitive exclusion	Competitive exclusion	x	
				Biomass accumulation	x	
Understory reinitiation	Large sawtimber	(10–100)	Maturation	Understory reinitiation	x	x
			Vertical diversification	Canopy stratification	x	x
				Niche diversification		x
Old growth	Old growth	(700)	Horizontal diversification	Natural old growth		x
	Climax		Pioneer cohort loss	Natural climax		x

Stages of forest development based on ecological processes. Stages used in a generic model of forest development contrasted with structure-based timber classes used in a wildlife habitat relationship model, a model of Douglas-fir forest development under natural conditions, and a model for active ecosystem management.

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FOREST MANAGEMENT AS JUGGLING ACT

Northwest forests are asked to provide a potentially impossible array of values: commodities; revenues for landowners, schools, and roads; economic support to local communities; habitat for forest wildlife and plants; recreational and spiritual experiences; and clean air and water. A single-focus history of timber management, however, has simplified forest ecosystems, enabled invasion by exotic species, unbalanced biotic communities, reduced prey biomass for predators, and hindered functioning of food webs.

Controversy over the utility of the Northwest Forest Plan and its reserve/corridor/single-species and matrix "sacrifice zone" approach has raised questions for Carey about better ways of managing landscapes in the Pacific Northwest and elsewhere around the world.

To address these questions, he took on a broad-scale investigation called the forest ecosystem study. Several decades of quantitative studies by Forest Service researchers around the Northwest uncovered geographically stratified data on plant, reptile, amphibian, bird, and mammal communities in old-growth, mature, and young forests. Similar studies on the spotted owl, including its prey base, habitat use, and demography, followed. Finally, comparative studies of natural and managed forests in the Northwest region helped researchers design treatments to restore lost biodiversity to managed stands. The treatments were then tested experimentally and by simulation modeling.

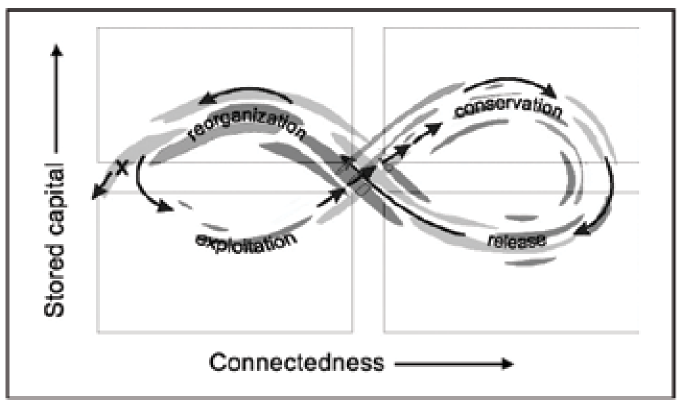
By using published and established models, Carey formulated five ecological indices to track landscape function and evaluate the ecological tradeoffs of alternative silvicultural systems and landscape management scenarios. They included the ability to support wide-ranging threatened species, capacity for vertebrate diversity, forest-floor function, ecological productivity, and production of deer and elk populations.

All management constraints selected included a relatively even flow of outputs on a decadal basis, Carey explains. Under the Northwest Forest Plan, 40 percent of the land base was withdrawn from management because of riparian constraints alone, and significant parts of the remaining landscape were so fragmented and overdispersed as to become economically infeasible to manage. Other alternatives took a more flexible approach to types of harvest and regeneration, rotation ages, riparian management, and tree species diversity, and came up with only 18 percent of the land base removed from management.

MANAGING FOR MULTIPLE VALUES

Based on results from 20 years of research, Carey believes it is absolutely possible to manage for multiple values.

The research findings show strong support for the idea that connectedness can actually counteract forest resilience, and suggest that panarchy theory has value in explaining the dynamic phases of ecosystem development. Maintaining heterogeneity across ecological scales can bolster a variety of elements central to forest health, Carey explains. These include the diversity and structure (biotic integrity) of various ecological communities; the integrity of such keystone complexes as the Douglas-fir/truffle/flying squirrel/spotted owl complex; resistance to wind and ice storms and invasion by exotics; and resilience after disturbance from wind and ice storms, wildfire, root disease, or mechanical disruption during harvest.



According to panarchy theory (Hollings 1992), adaptive systems go through four phases: exploitation, conservation, release, and reorganization. The stages of the cycle represent changes in connectivity and stored capital in the system.

"Our research demonstrates the potential for reconciliation of interest in wood production, sustainable human communities, recovery of threatened species, maintaining forest health, and promotion of general sustainability when compared to narrow-focus approaches," he says. "Narrow-focus approaches maximize the net present value of wood, set aside reserves for threatened species and maintaining biodiversity, and magnify concerns over ecosystem health due to past management and prior disturbance events that have led to simplified and over-connected ecosystems."

Management methods to alleviate narrow-focus outcomes are all based in part on inducing spatial heterogeneity through variable-retention harvest systems and also on variable-density thinning. They include retaining legacies of individual live trees, dead trees, coarse woody debris, or even patches of uneven-aged forest, and actively restoring missing key elements of biocomplexity. Observing that natural young forests

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can exhibit many of the attributes of old-growth forests, Carey believes the emphasis on conserving legacies within managed forests is central, a lesson he learned from guru Jerry Franklin (professor, ecosystem sciences, University of Washington, College of Forest Resources).

"Thinning influences all structuring processes, including decadence and development of heterogeneity across the landscape. Thinning with underplanting restores tree species diversity and accelerates canopy stratification and understory development. Retaining decadent trees, wounding trees, and inoculating trees with top-rot fungi, all promote decadence essential to ecosystem development," says Carey.

Carey notes that conservation biologists once argued the relative merits of single, large reserves versus multiple, small reserves; the need for conserving genetic diversity, and the need to restrict active management. At the same time, forest managers focused on plantation management, transportation networks, and watershed restoration.

"Now it is becoming recognized by both groups that extensive active management for biodiversity is needed to restore degraded ecosystems and to produce fully functional forests outside of reserves," he says. "Research has shown that reserve systems could become self-fulfilling prophecies of highly isolated diverse forests separated by impoverished second-growth forests and developed areas."

Carey's research suggests that the dynamic mosaics produced by intentional management have high biocomplexity at multiple scales and high biodiversity. Thus, he supposes that these landscapes should be resistant to disturbance and resilient when disturbance does occur.

PANARCHY THEORY AND MANAGEMENT

Panarchy theory's foundations of adaptive cycles, both social and ecological, have profound implications for management, according to Carey.

Take, for example, the immeasurable ecological and social values of old-growth forests. "Once lost, it is unlikely that any particular old growth could be reproduced either through natural succession or through intentional management simply because the biophysical conditions of its development are not subject to unvaried natural repetition, or to human control," he says. "Furthermore, the complete species composition of old growth has not been determined, so it is impossible to demonstrate its successful re-creation."

Attempts to harvest old growth will be contentious and lead to litigation. "The awe-inspiring size of old-growth structures induces values associated with its existence that can never be addressed by the scientific method alone," Carey explains. "It would also be useful for us to remember that, try as we might to mimic nature, nature has no plan." Thus, he notes, our improved knowledge of old growth and its importance to people for its ecological, scientific, and spiritual values, suggests that it might best be reserved rather than harvested.

Patches symbolize fragmentation and all its negative connotations, but numerous biodiversity studies are beginning to compile a case for the value of heterogeneity within certain complex forest types.

Taking the remaining small percentage of old growth out of management would contribute to rather than detract from the adaptive cycle of death and renewal. Its legacies to the landscape around it and to society far outweigh its removal from timber production, Carey says.

Just as old-growth forest will pass in its own, albeit long, timeframe, so ecosystems have a natural rhythm of change, through disturbances that can produce "crashes" for differing periods. Recovery follows, in a huge variety of forms. Restricting this rhythm will produce surprises, few of them pleasant. "Reduced variability means reduced resiliency. When you add in homogenization of forests to produce increased connectedness, the result is increased numbers of surprises," he explains.

The recurrence of surprises leads Carey to suggest another alteration to management approaches: "In an age of computer modeling, developing predictive tools should have a lower priority than designing systems that are flexible enough to undergo renewal after unexpected events." Translation: reduce unnatural levels of connectedness within the ecosystems we manage. The future of biological diversity, biodiversity, and biocomplexity may just depend on it.

"Life, like a dome of many-coloured glass, stains the white radiance of Eternity, until Death tramples it to fragments."

Percy Bysshe Shelley, 1792–1822

FOR FURTHER READING

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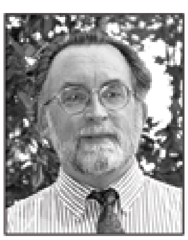

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done best across large geographical areas. In reality, landscape character is conditioned by climatic, geomorphic, and biogeographic factors rarely modified by ecosystem management and determined by the array of biotic communities that compose the biotic landscape. The spatiotemporal arrangement of these communities determines the quality of the landscape for any particular purpose or sets of purposes through time (Carey et al. 1999c), and management at both stand and landscape levels is appropriate (Carey 2003a, 2003c).

The fourth and final assertion is that there is a moral imperative for ecosystem management—the benefits and costs of management are accruable to all ecosystem components, not solely to people. This crucial assertion requires global action. An equally crucial assertion is that people have a moral requirement for intra- and intergenerational equity (Goodland 1995) that requires even stronger action.

Ecological worldviews are in contest with profound implications for ecosystem management (MacCleery and Le Master 1999, Partridge 2000, Reid 1996). For most of history, people had direct and personal connections to the land as their source of sustenance. In developed nations, personal connections between resource consumption and production have been severed for most people. Linkages between "food and fields, forests and hearth, and home" are nonexistent. A common view assumes that natural ecosystems have a natural balance or equilibrium not found in managed ecosystems, that pristine nature is sacred, and that landscapes should be separated into those substantively modified by people and those not. Paleobiology belies this view (Reid 1996). An emerging view challenges assumptions of natural equilibrium and classification of landscapes as natural or humanized. This view argues that the natural world is dynamic, and holistic management is needed to sustain natural and cultural systems. Huge areas of federal land are allocated to reserves under the worldview of natural balance. This belief in an "order of nature" characterized by integrity, stability, equilibrium, and self-regulating mechanisms has led to a library of national and international policies, laws, and regulations (Partridge 2000).

Ecologists and philosophers have challenged each of these beliefs, which pose important questions. Are romantic images of nature and reserves a sufficient basis to assume reserves and wilderness can be maintained as envisioned? Will human intervention be needed to maintain the health and biodiversity of reserves? If there is no natural equilibrium, stability, or self-regulation, are extinction, loss of biodiversity, limits to growth, and sustainability important? Can a fundamentally noninterventionist policy achieve the goal of maintenance of biodiversity? What emerging knowledge will give insight into holistic integration of humans and nature? What are the ramifications of not exploring new ways of thinking about active resource management? These questions call for a better articulated form of ecosystem management. It is past time to rethink ecosystem management (Reid 1996).

There is another unfinished agenda for ecosystem management (MacCleery and Le Master 1999). This agenda includes problems of fragmentation of wild and cultivated lands by residential subdivision and urban development; degradation and loss of forest and grassland communities once maintained by frequent, low-intensity fires; loss and fragmentation of late-seral forest by timber harvesting and narrow-focus forestry; degradation and loss of riparian and wetland communities; damaging effects of air pollution on forests and wetlands; displacement of native species by exotics; loss of rare and unique types of ecosystems; and deforestation in developing nations. This is the agenda of total landscape management and global cooperation. United States federal agencies manage over 120 million hectares of public land (approximately a half million square miles or twice the combined area of Washington, Oregon, and Idaho). Many of these agencies are in varying stages of crisis because of unclear or contradictory agency missions, internal malfunctions, and lack of responsiveness to foreseeable problems (Samson and Knopf 2001).

Ecosystem management requires some measures of effectiveness. Ecosystem health is the most commonly referenced measure of ecosystem management effectiveness (Lackey 2001). There is, however, no universal conception of ecosystem health. Some find the concept too value laden, too abstract, and too contentious. Many perceive health concepts to be relegated to individuals and not appropriate to populations, communities, and systems. Such a perception shows a lack of knowledge in the fields and institutions of epidemiology, disease prevention through environmental management, public health, and occupational safety and health and in the fact that the roots of landscape ecology lie in landscape epidemiology (Carey and McLean 1983; Carey et al. 1978, 1980a, 1980b). Many conclude that because there is no consensus, the concept is not useful—conclusions all too similar to those drawn for almost all conservation concepts. Nevertheless, ecosystem health can be defined as the preferred state of ecosystems modified by human activity (Karr and Chu 1999). The concept of ecosystem integrity (the unimpaired condition of ecosystems not influenced by people) can be used to set benchmarks by which management effectiveness can be measured. The biotic integrity of key communities and keystone complexes are especially useful when benchmarks are defined by natural ecosystems that exhibit longevity, resistance to disturbance, resilience in recovering from disturbance, and capacity to provide valued goods and services, including conservation of biodiversity (Carey et al. 1999c) (table 5). The utility of ecosystem health includes comparing alternative desired future states, comparing alternative pathways to that state, and measuring progress from a past state toward the future state.

With no consensus on process management or total quality management that incorporates natural benchmarks (Rummler and Brache 1995, Schein 1994), effective measures of change, and carefully defined management goals, conservation biologists suggest using a natural variability concept (Landres et al. 1999, Lindenmayer et al. 2000, McIntyre and Hobbs 1999). This approach asserts that the range in natural variation in past conditions and processes provides adequate context and guidance for managing ecological systems today and in the future, and disturbance-driven spatial and temporal variability is a vital attribute of ecological systems. The use of natural variability began out of a search for a legally defensible strategy for maintaining biodiversity and threatened, endangered, and sensitive species. It is also used where maintaining biotic integrity is the primary goal. However, the proposition that natural variation provides for the maintenance of biotic communities is oxymoronic. Natural variation emphasizes random processes that result in random or haphazard assemblages of the regional species pool, unlike biotic communities that are assemblages based on interactions among species conditioned by the environment. Either an assemblage is a random collection, or it is a biotic community developing from interactions among species in the context of the immediate or nearby environment. The nonequilibrium-stochasticity paradigm imposes no particular value on any species or any set of species, nor any mechanistic basis for biotic integrity (Landres et al. 1999). Thus, further examination of the natural variability concept is in order. The concept has seven premises:

- Human activities diminish the viability of many species.
- History implies that a "coarse filter," or an array of vegetative conditions mimicking historical conditions, could maintain biological diversity.
- A coarse-filter strategy requires few external subsidies and is more cost effective than other strategies.
- Natural variability is a useful reference for evaluation of the environmental impacts of people.

Table 5—A comparison of unique species and ecosystem health under two management approaches, timber focus and biodiversity focus

	Management focus	
Ecological measure	**Timber**[a]	**Biodiversity**[a]
Unique species[b]	0	14
Ecosystem health[c]	32	98
Vertebrate diversity	64	100
Forest-floor function	12	100
Ecological productivity	19	94

[a] Both pathways include an even flow of timber from a landscape maintained as a shifting, steady-state mosaic.
[b] Unique species is the total number of species of wildlife unique to the particular management focus.
[c] Ecosystem health is a percentage of the maximum possible in a fully regulated forested landscape. Ecosystem health was calculated as the average of the modal percentages of maximum potential vertebrate diversity, forest-floor function, and ecological productivity (measures functional groups) summed from stand values.

Source: Adapted from Carey et al. 1999c.

- Natural variability provides context that is important to understanding driving factors.
- Environmental factors and disturbances are strong, lasting, and key structuring factors.
- Spatial heterogeneity itself is an important component of ecological systems.

Problems associated with these premises are many and profound. First, the premise that a retrospective view will focus on the set of factors ultimately responsible for biodiversity is questionable. Cursory retrospective investigations have produced mixed results at best. Nor does this approach identify key variables that can be monitored to determine if biodiversity goals are being met. At best, monitoring implementation of the strategy is possible (e.g., hectares cut per year, number of watershed analyses completed, or number of reserves set aside on paper). Research can help identify key factors and their function, but then this new knowledge abrogates the need for relying on a coarse filter. Second, the premise that there exist areas with ecological conditions relatively unaffected by people and that the range of natural variation in these areas is appropriate to other areas with more substantial human influence is tenuous at best. Some of the most pristine forests in the world, however, are Pacific Northwest old-growth forests, which might well produce useful benchmarks for management to conserve biodiversity. Extrapolating beyond the sampling universe is always risky. Pristine environments, when they exist at all, generally are harsher (steeper, higher, drier, wetter, colder) than managed environments. Third, the premise that the biodiversity of a large area is a product of the full range of natural variation there as opposed to a more limited set of conditions is unsupported. Stochastic disturbances by definition are unlikely to uniformly maximize or maintain diversity; some conditions produced will be very conducive to native diversity, some may be quite inimical. Fourth, the range of natural variability, when imposed on a managed landscape may fail to produce desirable future conditions or produce the goods and services desired from that landscape. More intentional ecosystem management may have a better chance of accomplishing human goals, including maintenance of biodiversity. Fifth, the natural variability concept assumes a consensus can be reached on managing for stochastic disturbance, when such a consensus is likely to become increasingly improbable with increasing human demands on a landscape. Sixth, given increasing human populations, increasing demands on natural resources, and decreasing areas of wild and quasi-wildlands broken into much smaller areas than existed prior to European settlement of North America, it may be neither possible nor prudent to try to re-create the disturbance regimes of more than 300 years ago (Carey et al. 1999c, Reid 1996). McCool and Kruger (2003) described this approach as "management that proceeds with little scientific understanding of consequences and uses assumptions about the 'intrinsic goodness' of the management activity."

More complex, diverse, and integrated organic management models than range in natural variation are necessary to understand and adapt ecosystem management to a globalized environmental and sociopolitical world (Kennedy and Dombeck 1999). The 20th-century agency-machine bureaucracy approach that could implement range-of-natural-variation ecosystem management is no longer appropriate. General sustainability, complex systems management, social values, stewardship, and collaborative management hold sway (table 6). There is considerable public skepticism about government, science, and technology. Still, public acceptance is essential to every resource management decision of public agencies (Shindler et al. 2002). The conflicting roles that management agencies have been directed to play in the past—resource protection and provision of commodities—have made them vulnerable to social criticism. Past commodity production without understanding what was necessary to maintain biodiversity produced violations of the public trust. These violations have ranged from breach of the social and psychological contracts with individuals and communities that depended on renewable resources for economic activity and management that violated the spirit and intent of federal legislation such as the Multiple Use-Sustained Yield Act and Endangered Species Act to failures of regulatory agencies to enforce laws and regulations (judged "capricious" by federal courts). Range-of-natural-variation ecosystem management potentially has significant, perhaps irreversible, consequences to the environment and to human communities that depend on the environment for sustenance, security, shelter, spirituality, and leisure. It increases the anxiety of long-term rural residents who feel increasingly alienated by an apparently remote and insensitive federal government, overwhelmed by growing global economic complexity, antagonized by an enlarging environmental elite, and alarmed by vacillating land management policy (McCool and Kruger 2003). At best, public judgments are always provisional, never absolute or final because social acceptance is a process, not and end product. Acceptable practices and policies must be biologically and physically feasible, economically efficient, equitable, culturally acceptable, and operationally practical (Shindler et al. 2002). If management for the range of natural variation is attempted, lost trust may never return.

Total Landscape Management

The myth of untouched nature works against protection of the real world that is shaped jointly by human activities and nature. Two-thirds of terrestrial Earth is covered by agriculture, grazing, and

Table 6—The 20th-century machine model vs. the 21st-century organic model of natural resource management

20th-century machine model	21st-century organic model
▪ Sustained yield/economic efficiency	▪ Sustainable healthy ecosystems
▪ Resource inventory	▪ Systems monitoring
▪ Intensively managed plantations	▪ Multifaceted, multivalued forests
▪ Omnipotent foresters	▪ Interdisciplinary teams, public participation
▪ Focus on a stand	▪ Focus on hierarchy of scales, stand-region
▪ Anti-entropy imperative	▪ Open, accepting, adaptive organization
▪ Science illuminates the path	▪ Science as one of a set of values
▪ Top-down goal setting	▪ Bottom-up field and community planning
▪ Implementation of complex law	▪ Simplify, humanize, facilitating regulation
▪ Local-regional focus	▪ Local community within national and global context

Source: Adapted from Kennedy and Dombeck 1999.

managed forests (Farina 2000). Economic globalization is producing new disturbance regimes and new driving forces. The market economy is one of the oldest human adaptations to the unpredictability of local environments and to high spatial variability in the distribution of resources (di Castri 2000). Recognition of market economies is essential to the integration of economics and ecology. Human activity is now the predominant evolutionary force (Palumbi 2001).

Both natural and human disturbance affects the fragility and resilience of cultural landscapes. The susceptibility of an ecosystem to undergo changes in composition and structure because of perturbation (fragility) and its ability to recover to its prior state after disturbance (resilience) is as important in managed landscapes as in natural landscapes. Biological diversity may be higher in cultural landscapes than in remnants of natural landscapes, depending on landscape heterogeneity and purpose of cultivation (see fig. 6). If land is properly managed and zoned, humanity can use biological resources without diminishing the biota's capacity to meet future generation's needs (Reid and Miller 1989). Intentional management can produce highly diversified ecological systems that are sustainable (Carey et al. 1999c) (fig. 7). The resilience of cultural landscapes is often enhanced by reduction in vulnerability to natural environmental stresses such as flooding and fire by regulating waterflow and by removal of dry biomass. The challenge is to maintain cultivated

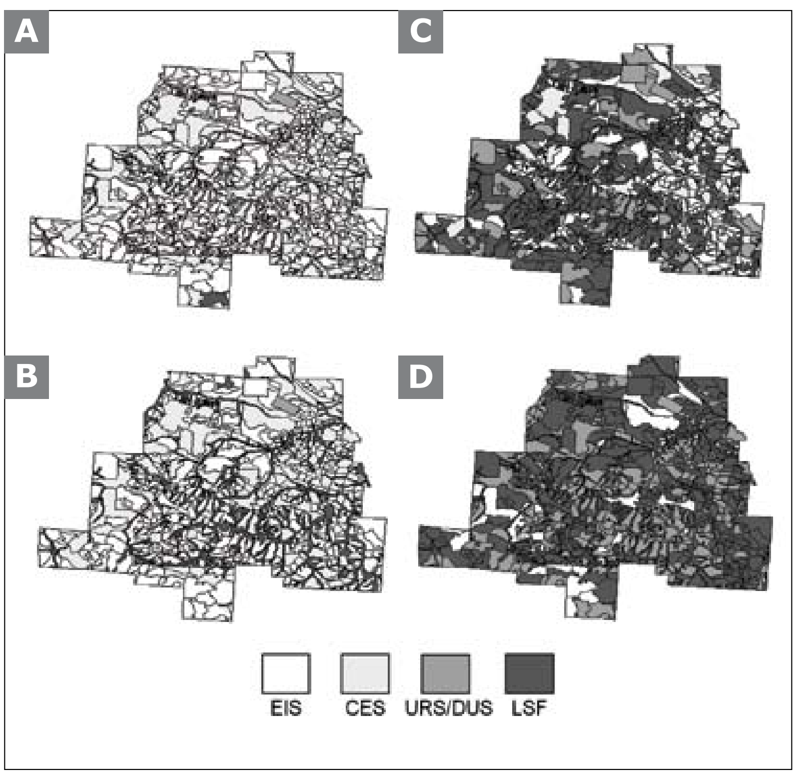

Figure 7—Seral-stage arrangement and composition of the Clallam River Planning Area after regulation and 300 years of simulated management for (A) timber production with minimal riparian protection; (B) timber production with wide buffers emphasizing small streams; (C) biodiversity with a 30 percent late-seral forest goal, by using a mix of timber management and biodiversity management and variable riparian management zones; (D) maximum biodiversity by using a mix of 70- and 130-year rotations with biodiversity management and variable riparian management zones. Seral-stage categories are ecosystem initiation (EIS), competitive exclusion (CES), understory reinitiation and development (URS/DUS), and late-seral forest (LSF: niche diversification and managerially fully functional forest) (Carey et al. 1999c).

landscapes with human co-adaptation within the global economic landscape (Farina 2000). Unconstrained growth and development bodes poorly for sustainability (see fig. 2D). Throughout Europe and North America, major aquatic, forest, grassland, and cultural ecosystems have been degraded (Farrell et al. 2000, Regier and Baskerville 1986). Redevelopment (restoration) of degraded landscapes requires global thinking and local action. The transition from development to redevelopment (exploitation to husbandry) necessarily involves substantial tension among governments, industries, and publics that is heightened by a mutual lack of trust. Redevelopment requires geographic control in implementation of management—plans must specify where local events will take place in order to achieve the desired regional effect.

Culture and Contemporary Players in Conservation

Human societies and the Earth form a complex system that is subject to abrupt shifts from one pattern of behavior to another. The Earth and its people may well be at the crux of social transformation. Which world lies ahead? The 2050 project (Hammond 1998) visualized three scenarios: Market World, Fortress World, and Transformed World. In Market World, economic reform and technological innovation produces rapid economic growth, and the global economy delivers modern technologies and products to all countries resulting in prosperity, peace, and stability. In the Fortress World, market growth fails to redress social wrongs and prevent environmental disasters; large portions of humanity are left out of prosperity; the economy stagnates and fragments producing enclaves of wealth and prosperity within misery, desperation, violence, and conflict. In the Transformed World, fundamental social and political change produces market forces that lead to power sharing and social coalitions that produce local community-based decisionmaking. Which scenario will come about? Each has profound implications for conservation of biodiversity and the knowledge needed to inform it.

Cultural Streams in the United States

American culture is distinct from other cultures of the world but is still internally heterogeneous (Ray 1996). American culture can be characterized by two primary variables: socioeconomic status and cultural change. This cultural variable can be divided into three subcultures—the traditionalists, modernists, and cultural creatives—each contemporary, but each reflecting an era-specific dominant worldview (past, present, and potential future). Traditionalists include conservative, religious, low-income and low-educated elderly people as well as upper middle class cultural and economic conservatives; together these two groups constitute 30 percent of the adult population of the United States. Their numbers are generally in decline (an aging population), but are being bolstered by intense recruitment by the religious right. The traditionalists are particularly interested in family values, have a low regard for civil liberties, and differ internally among socioeconomic classes in support for big business. The modernists are the current cultural mainstream. The media emphasizes their malaise about what the modern world has come to be. They make up 47 percent of the population. They have a wide range of incomes but average almost twice the income of the traditionalists. They include factory and office workers, engineers, doctors, and business people. One in eight in this group are free-market conservatives with a materialist focus on status and success with a heavy work ethic. They are likely to be opposed to ecological sustainability. The cultural creatives (24 percent of the total population) are primarily upper-middle income and middle aged; a majority (60 percent) are women. They can be subdivided into two groups, the greens and the core cultural creatives. The core holds both person-centered and green values. They are concerned with spirituality, self-actualization, self-expression, and new ideas. Core cultural creatives are leading-edge thinkers; women outnumber men 2:1. Greens (13 percent of the total population) have values centered on the environment and social concerns. Certain values cut across all the major subcultures. More than 50 percent of each group believes in financial materialism, rebuilding communities, eliminating violence against women and children, xenophilism (attraction to foreign peoples and cultures), and voluntary simplicity. Moreover, these more universal values include nature as sacred, general green values, and ecological sustainability (table 7). More than 80 percent of cultural creatives are concerned with rebuilding communities, treating nature as sacred, general green values, and ecological sustainability (Ray and Anderson 2000). To summarize these findings in different words, American culture overall is characterized by beliefs in social, economic, and environmental sustainability.

Leadership by Nongovernmental Organizations

Conservation organizations have long been active lobbyists and litigants for their causes, but now have moved more directly into the research, technology transfer, and management arena. The Nature Conservancy, Forest Stewardship Council, Northwest Ecosystem Alliance, Pacific Forest Trust, and many others have wrested land management and conservation leadership from both state and federal agencies. The Nature Conservancy received $37 million in federal funding in 2000. Coalitions, such as The Nature Conservancy and the Malpai Borderlands Group as well as The Nature Conservancy and Red Canyon Ranch, have achieved credibility outside, above, and beyond the traditional ranching-range science-federal and state agencies community (Jensen 2001). It seems these and other (Daily and Ellison 2002, Johnson et al. 1999) coalitions can effectively resolve conservation issues that are not simply conservation questions but ultimately questions of cultural values—such as whether or not ranching should continue. Coalitions of nongovernmental organizations are driving conservation policies and conservation activities internationally. In Central America, a coalition of The Nature Conservancy, The World Resources Institute, the World Bank, and

Table 7—Values of American subcultures expressed as percentages of each of the three main cultural streams ascribing to major values (percentages greater than or equal to 65 percent are in bold type)

Values	Traditionalists	Modernists	Cultural creatives
Religious	**70**	36	31
Traditional relationships	55	25	26
Financial materialism	61	**82**	51
Cynicism about politics	29	48	19
Secular	15	42	29
Success is high priority	11	36	12
Hedonism	5	12	4
Rebuild communities	**86**	**84**	**92**
Fear violence	**84**	**75**	**87**
Xenophilism	**69**	63	**85**
Nature as sacred	**65**	**72**	**85**
Green values	58	59	**83**
Ecological sustainability	52	56	**83**
Voluntary simplicity	**65**	53	**79**
Relationships important	**65**	49	**76**
Feminism in work	45	56	**69**
Altruism	55	32	58
Idealism	36	32	55

Source: Adapted from Ray and Anderson 2000.

others along with the United Nations, Netherlands, and Germany have begun a 40-year project to establish a system of reserves and corridors that transcends eight countries—"one of the largest, most ambitious conservation initiatives in the world" (Kaiser 2001). The Central America project is a leap beyond the past sustainable development-conservation initiatives in the Third World (Food and Agriculture Organization of the United Nations 1990). Forest Stewardship Council certification confers a credibility and stature that also transcends any associated with state or federal management or research; thus, in the last 2 years, the Washington Department of Natural Resources, the Fort Lewis U.S. Army installation, and a number of private land and forest products marketing groups in the Pacific Northwest have sought certification. The Pacific Forest Trust has pursued paying landowners for conservation easements and the practicality of trading in carbon credits (see also Daily and Ellison 2002). The Northwest Ecosystem Alliance, with contributions from the general public and "Microsoft millionaires," purchased key, ecologically significant timber rights on the Loomis State Forest from the Washington Department of Natural Resources. The alliance, with a coalition of environmental groups, is now attempting to build local coalitions of all stakeholders to promote watershed restoration and ecological forestry through collaborative management.

Charity is a new force in environmental issues (Jehl 2001). The Pew Charitable Trust, a $4.8 billion foundation, is the largest grantmaker to environmental causes focusing on forest protection, global warming, and marine conservation. The trust spent $52 million in 2001, compared to a USDA Forest Service investment in research of $242 million (U.S. Department of Agriculture 2003). Other foundations—David and Lucille Packard Foundation, Ford Foundation, Robert W. Woodruff Foundation, and W. Alton Jones Foundation—allocate more than $700 million per year to grants related to the environment and animals.

Professional and scientific societies (American Fisheries Society, Ecological Society of America, Society of American Foresters, Society for Conservation Biology, The Wildlife Society, and others) now routinely issue white papers, policy statements, editorials, and testimony to legislative bodies and urge their members to lobby actively on conservation issues. "Deep ecologists" claimed the moral high ground by asserting the spiritual value of wilderness and wilderness for its own sake (Reid 1996). However, a more transcendent cultural trend now incorporates the spiritual value of the oneness of self, family, community, and nature (Maser 1994, Ray 1996, Wilber 1995).

Managing Public Lands

The federal government has lost its historical grip on the West that began with the imperialism of Manifest Destiny under Thomas Jefferson and Teddy Roosevelt and that was perhaps irreparably diminished by declining budgets under Ronald Reagan (Behan 2001, Kemmis 2001). The USDA Forest Service received fewer and fewer resources with which to assert its jurisdiction or fulfill its obligations. The adherents of exploitive philosophies, in some cases the actual descendants and in other cases the ideological descendants of the homesteaders, cattle barons, lumber pirates, and mining interests that initially settled the West following the Homestead Act of 1862, the Timber Culture Act of 1873, and the Desert Land Act of 1877, are pitted against the descendants of the environmentalist heirs of the preservation philosophy underlying the creation of Yellowstone National Park in 1872, the "midnight reserves" of 1907, the National Environmental Policy Act of 1969, and the Wilderness Act of 1964. Even with the National Forest Management Act of 1976, which sought to maintain a natural resource and conservation posture, federal land managers have found themselves increasingly paralyzed by appeals and litigation.

Towering Douglas-fir giants in Olympic National Forest, near Quinault, Washington. Photo by T. Wilson.

There seems to be a growing consensus across political lines that centralized authority for natural resource decisionmaking must be replaced with decentralized collaborative stewardship (Behan 2001, Kemmis 2001, Kennett 1998, Lewis 2001, Prugh et al. 2000, Rey 2000). Our common goals for conservation of natural resources include a society that works for our descendants and us ecologically, economically, morally, culturally, and politically (Prugh et al. 2000). What sustainability is really about is the scope, quantity, richness, and benignity of human culture, the biosphere and the economic life we make from it, and the distribution of those economic and social benefits now and over time. Communities are the primary locus of responsibility for creating a sustainable world, and a sustainable society must be built on a foundation of local communities. Thus, we need a politics of engagement, not consignment. Strong democracy makes communities stronger and more reflective. Communities, then, must create the vision, broad stakeholder base, wide citizen engagement, tolerance for pluralism, and adaptability to changing circumstances that governmental agencies have not been able to create alone. Amenity migrants (rock climbers, hunters, fly fishers, skiers, and others) to the New West define themselves avocationally, in contrast to the wave of immigrants that became the cowboys, loggers, and miners of the Old West. Both are tied to the land. The Secure Rural Schools and Community Self Determination Act recoupled local citizens with federal lands by establishing local advisory groups for each national forest and Bureau of Land Management unit, with financial support for stewardship investments on federal lands where local consensus can be achieved (Rey 2000). Rey (2000) posited some guiding principles for this stewardship: (1) continuous process improvement in reducing impacts of commodity production on the land; (2) a change from the doctrine of "the infallibility of nature left to its own devices" to a philosophy of "man as part of a dynamic environment with changing ecosystems;" (3) policies that favor people and ecosystems, not one or the other; (4) change from a doctrine of primacy of national interest groups with decisionmakers selected from national organizations to a doctrine of local community control.

Managing Private Lands

Both governmental and nongovernmental organizations are more and more influencing management on private lands through regulation, incentives, conservation easements, and outright purchases to place the lands in trusts or public ownership. Even industrial forest-land managers are finding themselves being held accountable to public values (Loehle et al. 2002). Nearly 175 million hectares of privately owned forest land (58 percent of all forest land) in the United States is increasingly threatened by population growth, urbanization, and development (Best and Wayburn 2001). For example, in the Pacific Northwest, the Pacific Forest Trust has implemented conservation easements worth $80 million on about 12,000 hectares of land and provides conservation advisory services on an additional 500,000 hectares (Pacific Forest Trust 2001).

Property Ownership and Conservation

Land ownership in the United States is a mosaic of legal interests that are conditional rather than absolute (Geisler and Daneker 2000). Our public lands are a great reservoir of pride, mystique, and national identity. Federal, state, and local governments own about 42 percent of all U.S. land. Most federal lands, however, are split estates where permittees have acquired ownership rights. In the United States, there exists an "almost defiant conceit" that private ownerships are the highest and best use of land and the center of American civil liberties, lifestyle, and individualism." But the federal government has secured rights to 1.2 million hectares of private land through leases, agreements, and easements. Achieving conservation through government regulations, thus raises issues of (1) the constitutionality of property regulation without restriction in terms of "uncompensated takings," (2) privatization, and (3) ethics of ownerships, social justice, land tenure, stewardship, equity, and fairness. In other words, the overriding issue is the fundamental balance between rights of individuals and those of society. Most private lands, however, have a perpetual social mortgage. For example, the U.S. Department of Agriculture subsidizes conservation on private lands with about $1 billion per year. Even more alternatives to private and public property have emerged, are evolving, and are rapidly growing. In third-sector property, ownership is neither public nor private; property serves to meet broadly defined social needs as well as individual needs, not merely to increase wealth. The locus of control is local and management is decentralized. Third-sector property is social property, with value generated by public action, not by an individual property owner. Third-sector properties include a variety of community land trusts, limited equity cooperatives, conservation easements, and many other innovative schemes.

One alternative theory of public ownership, the General Land Ordinance of 1785, created 60 million hectares of state school trust lands in 22 states compared to 30 million hectares eventually allocated to national parks, 40 million hectares to wildlife refuges, 75 million hectares to national forests, and 115 million hectares to the Bureau of Land Management (Souder and Fairfax 2000). About 5 million hectares are in tribal trusts; 175 million hectares of forest land are privately owned (Best and Wayburn 2001). An unknown amount of land is held in trusts or easements by pension funds, conservation organizations, and other groups. Such trusts separate title, benefit, and management control. The obligations that bind the trustor, settler, trustee, and beneficiary are called fiduciary relationships. The principles of trusts are clarity, accountability, enforceability, perpetuity, and prudence. Trustees must meet exacting requirements of fairness, openness, honesty, and full disclosure. Intergenerational equity is mandatory requiring that the productive capacity of the trust be maintained in perpetuity—the framework for sustainability. In contrast, federal lands are not trust lands, there is limited accountability, oversight is congressional, and both agencies and legislators seek benefits for their constituents and conceal the extent to which different user groups are subsidized. Public mistrust and dissatisfaction with federal land managers may lead to placing more federal lands into trusts (Behan 2001, Kemmis 2001, Rey 2000). Other trusts include public trust (the sovereign's duty to protect public values in tidelands and waterways), land trusts with the focus to protect land from development, and charitable trusts. It seems the concept of land ownership in the United States is almost as dynamic as other parts of U.S. society. As pressures from growing populations increase demands and expectations from forests, one emerging mechanism for conservation seems to be creation of trust lands (and community forests) as replacements for public and industrial lands.