Conservation Biology & U.S. Forest Service Views of Ecosystem Management and What They Imply About Policies Needed to Achieve Sustainability of Biodiversity

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DAVID W. CRUMPACKER, CONSERVATION BIOLOGY AND U.S. FOREST SERVICE VIEWS OF ECOSYSTEM MANAGEMENT AND WHAT THEY IMPLY ABOUT POLICIES NEEDED TO ACHIEVE SUSTAINABILITY OF BIODIVERSITY (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 1996).

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NRLC Public Land Policy
Discussion Paper Series
(PL03)

Natural Resources Law Center
1996
This publication is a product of the Natural Resources Law Center, a research and public education program at the University of Colorado School of Law. The Center’s primary goal is to promote a sustainable society through improved public understanding of environmental and natural resources issues.

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Introduction

Federal agencies in the United States are implementing a new approach to management of natural resources in the 1990's: ecosystem management. The term has been defined and viewed in various ways. Most traditional ecosystem scientists would probably consider ecosystem management to be biogeochemical management. Here the interest would focus on how ecosystems absorb and process solar energy, how they move or "cycle" materials such as carbon and nitrogen, and how they provide a life-support system for organisms which, in turn, affect ecosystem processes. Ecosystem ecologists might define a sustainable ecosystem as one which uses energy or materials in amounts less than or equal to the amounts entering the system. Seastedt makes the critically important point that, while this type of ecosystem management is potentially compatible with species preservation, one can imagine major ecosystems managed for energy acquisition that are relatively depauperate in native species. Put another way, efforts to enhance biodiversity are likely to maintain high quality biotic...
support systems but the reverse may not be true. Tree plantations, "improved" rangelands, and reservoirs might provide a healthy mix of ecosystems that contain little native biodiversity.

An alternative definition of ecosystem management has developed in response to the pending or worsening biodiversity crisis.\(^5\) It stems from a conservation biology view that has traditionally emphasized the biotic components of an ecosystem, the latter being typically defined as a biotic community of species interacting with one another and with their abiotic or "physical" environment. This sort of ecosystem management aspires to maintenance of the natural integrity of ecosystems, including native species as well as natural biochemical processes. A healthy ecosystem in this case is one which sustains native species in naturally occurring, self-regulating, and naturally evolving communities. In this sense, "sustains" refers to maintaining species over time until they become extinct from nonhuman-related causes, during which period they may be joined or replaced by newly-evolved, naturally-occurring species. An important human value judgment is included here, that future environments should sustain (i.e., maintain or even increase, when possible) natural biodiversity as well as human and economic health. This view of ecosystem management, which is common among conservation biologists, includes the concept of restoring all or parts of ecosystems in order to enhance as well as maintain natural biodiversity.\(^6\)

Although the federal agency approach to ecosystem management (another viewpoint) grew out of concerns for loss of biodiversity from protected areas, it is now visualized as a

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\(^5\) Whether there is a pending or worsening biodiversity crisis is argued among conservation biologists; e.g., see Smith Fraser, D.M., et al., "How Much Do We Know About Current Extinction Rates?" Trends in Ecology and Evolution, volume 8, pp. 375-378 (1993). Biological diversity or more simply, biodiversity, is the variety and variability among living organisms and the ecological complexes in which they occur; biodiversity is commonly used to refer to differences among ecosystems, species, and genes, and among their relative abundances; see Office of Technology Assessment, Technologies to Maintain Biological Diversity (Congress of the United States, OTA-F-330, Washington, D.C., 1987).

proactive method for ensuring a healthy, sustainable environment and economy. The Forest Service has been the most prominent promoter and developer of this federal initiative. It views ecosystem management as a means of changing from a traditional emphasis on multiple uses such as timber, grazing, water, recreation, and wildlife to a primary goal of sustaining ecosystem integrity. Multiple uses would continue to be of much importance but would usually be provided within ecological limits imposed by the need to maintain ecosystem integrity.

There is general consensus among all of the above parties that ecosystem management involves the need for long-term management of whole ecosystems and so across political boundaries as necessary, in order to sustain ecosystem integrity. There is less agreement on the priority that should be given to management of human activities within ecosystems. Furthermore, the terms "ecosystem integrity" and "ecosystem health" have different implications for the maintenance of natural ecosystems and native species, depending on the perspective of the manager. The present report will 1) provide a brief account of the development of conservation biology and Forest Service views and plans concerning ecosystem management, 2) discuss the implications of these viewpoints for maintenance of biodiversity, 3) mention some of the political resistance to implementation of ecosystem management and its potential consequences, and (4) consider ways in which public guidelines and local community action might interact to sustain reasonable, and possibly essential, amounts of natural biodiversity on the U.S. landscape.

Concepts and Definitions

A Prevailing View of Ecosystem Management among Conservation Biologists

Grumbine surveyed papers published on ecosystem management in peer-reviewed journals through June, 1993, as well as various books, environmental publications, and agency

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Ten dominant themes were identified, leading to the following "working" definition: Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term. He then listed five specific goals related to sustaining ecological integrity:

1) Maintain viable populations of all native species in situ;

2) Represent, within protected areas, all native ecosystem types across their natural range of variation;

3) Maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.);

4) Manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems; and

5) Accommodate human use and occupancy within these constraints.

The first four of the above goals were apparently derived from Clark and Zaunbrecher, Grumbine, and Noss. Noss and Cooperrider described them in more detail and considered them to be "comprehensive and idealistic so that conservation programs have a vision toward which to strive over centuries." They are value statements aimed at alleviation of the biodiversity crisis. These goals are closely related to certain ethical principles, most of which are probably shared by the majority of conservation biologists, i.e., diversity of organisms is good, untimely extinction of populations and species is bad, ecological complexity

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(interactions among species and between species and their physical environment) *is good,* evolution (in natural environments) *is good,* and *biodiversity has intrinsic value* (regardless of its value to human society).\[11\]

Wilcove and Blair have argued that the first four goals listed by Grumbine appear to be in order of their importance. This is not because a particular species is more important than, e.g., a hydrological process or a nutrient cycle, but because species protection offers a more easily understood, practical way to maintain the other values. Furthermore, "no amount of emoting about the beauty of a carbon cycle will make it more appealing to the public than a sea otter or giant panda, and public support is critical to the success of land protection."\[12\]

Grumbine's fifth goal (also a value) acknowledges the "vital (if problematic)" role of humans in natural ecosystems but is clearly made subsidiary to the maintenance of native biodiversity. Noss and Cooperriider have argued in this regard that biology is a better "bottom line" for making land use decisions than socioeconomic criteria because human cultural systems can adjust much more rapidly to new conditions than can other species and ecosystems.\[13\]

The biological basis for this argument has been presented more explicitly by Pickett, Parker, and Fiedler. They noted that the evolution and dispersal of species over geologic time has kept pace with extensive environmental changes that have occurred on earth. However, today's global biota cannot be expected to adjust to the extensive anthropogenic environmental changes that are occurring on a scale of decades or even a few years. There are physiological limits to what species and ecosystems can tolerate, and previous long-term, evolutionary processes may not have produced enough naturally occurring species in the right locations to meet the new stresses in a compensatory fashion. Conservation biologists must, therefore, help to devise management systems that will protect native species and the processes that maintain them, while simultaneously educating the public about the need to limit large-scale

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\[13\] See Noss, Reed F., and Allen Y. Cooperriider, *supra* note 10.
changes in naturally occurring ecosystems. Examples of the latter are extensive conversions of natural forests to other land uses, global warming, and widespread environmental toxification.

Grumbine's definition of ecosystem management and the associated goals have been referred to as an "academic consensus" by Alpert and as a "shift from anthropocentric values towards biocentric values" by Stanley. They are described in this report as "a prevailing view" among conservation biologists because of their emphasis on native species, native ecosystem types, and native ecosystem integrity. This is consistent with the emphasis on maintenance of native species diversity in naturally occurring, changing, and evolving ecosystems that underlies the notion of conservation biology as a crisis discipline. The degree to which a biocentric concern is adhered to by conservation biologists will obviously vary among individuals and cannot be ascertained precisely without a survey of several thousand practicing professionals.

The Forest Service View of Ecosystem Management

The Forest Service concept of ecosystem management grew out of the "New Perspectives" initiative launched in 1990 by Chief F. Dale Robertson. New Perspectives proposed "a different way of thinking about managing the national forests and national grasslands, emphasizing ecological principles, to sustain their many values and uses." The


four guiding principles of New Perspectives were to sustain healthy ecosystems, involve people as partners, strengthen the scientific basis for management, and use collaborative problem-solving. This led to a 1992 policy change in the way multiple uses would be managed, i.e., ecosystem management, which was described by then Deputy Chief James C. Overbay as follows: ¹⁸

The Forest Service has managed ecosystems since its inception. But, beyond the protection of about 20 percent of the National Forest System in wilderness, research natural areas, and wild rivers, that management often focused more on selected parts of ecosystems than on the wholes or on the processes that keep ecosystems healthy, diverse, and productive. Our knowledge has evolved. Our thinking has evolved. It is time to embrace the concept of managing ecosystems to sustain both their diversity and productivity and to chart a course for making this concept the foundation for sound multiple-use, sustained-yield management.

Overbay then pointed out that goals are not obvious from definitions and that ecosystem management goals will come from laws that govern the Forest Service, the RPA (Forest and Rangeland Renewable Resources Planning Act) program, forest plans, and project decision documents. A little later he stated that desired resource values, uses, products, and services will not be treated as by-products to be derived from the preservation of intrinsic values or natural conditions of ecosystems. Rather, the Forest Service will consider that ecosystem management means to produce desired resource values, uses, products, or services in ways that also sustain the diversity and productivity of ecosystems. Important differences between this original Forest Service version of ecosystem management and that described by Grumbine are the lack of detail about what is meant by "diversity," the reference to multiple-use and sustained-yield concepts that will not be subordinate to natural conditions of ecosystems, and the lack of specific references to native ecosystems and native species. Sustained yield, as used by Overbay, refers to achievement and maintenance in perpetuity of a high level of annual or regular output of the various renewable resources of the national

forests without impairment of the productivity of the land. Renewable resources include multiple uses such as timber, grazing, water, wildlife, recreation, and wilderness.

The Forest Service has traditionally considered most multiple uses as secondary to the dominant use on a particular site, e.g., timber on productive forest land, big game on winter range, winter sports on ski areas, or wilderness on areas so designated. The practical effect of this has been to emphasize commodity production at the expense of uses more closely related to biodiversity. Ecosystem management seemed in 1992 to represent a change in Forest Service philosophy from optimization of yield levels among competing resources to sustaining resource yields that are compatible with the overall ecological condition of the land. As stated by Kessler, et al., in the context of New Perspectives, "the new paradigm must not diminish the importance of products and services, but instead treat them within a broader ecological and social context." 20

It is now clear that the Forest Service is beginning to implement, through ecosystem management, a new land management ethic. In his first report to the U.S. Congress as Chief of the Forest Service in 1994, Jack Ward Thomas said: 21

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21Thomas, Jack W., Concerning "New Directions for the Forest Service" (Testimony before the Committee on Natural Resources, U.S. House of Representatives, Feb. 3, 1994). Despite the officially stated desire of the Forest Service to make ecosystem integrity the highest priority of ecosystem management, a U.S. General Accounting Office (GAO) report in August, 1994 noted that "neither the administration's fiscal year 1995 budget document nor the task force's draft "Ecosystem Management Initiative Overview" [author's note: a 1993 product of the White House Office on Environmental Policy] clearly identifies the priority to be given to the health of ecosystems relative to human activities when the two conflict;" see United States General Accounting Office, Ecosystem Management — Additional Actions Needed to Adequately Test a Promising Approach (Washington, D.C.: U.S. General Accounting Office, Report to Congressional Requesters, GAO/RCED-94-111, 1994). The GAO analysis does not, however, mention that there has been an approximate two-thirds decrease in Forest Service timber offer volume between 1990 and 1994. The Forest Service has also proposed a decrease of $23 million in timber sales management for fiscal year 1996 that is combined with proposed increases for rangeland restoration, heritage resources, and wildlife and fish habitat management; see documents related to fiscal year 1996 entitled "FY 1996 Budget — Key Messages, Budget Reality, Priority Budget Increases, and Budget Decreases," prepared by the Program Development and Budget Staff of the Washington Office of the U.S. Forest Service for presentation at the National Leadership Team Meeting of the U.S. Forest Service on January 22-24, 1996. These budget proposals are consistent with the Forest Service’s
I believe in a land ethic that is based on an acceptance of constraints on human treatment of land in the short term to ensure long-term preservation of the integrity, stability, and beauty of the biotic community. Human activity that is consistent with this ethic is properly within the realm of resource management options. That which would violate this ethic should be resisted for all but the most compelling reasons. Having said that, I also recognize that people are inseparable from ecosystems and their varied needs must be accommodated if we are to reach consensus about how our forests are to be managed.

Recent Forest Service documents provide additional indications of what the agency means by ecosystem management. Volume II of the Forest Service's Eastside Forest Ecosystem Health Assessment states that the primary objective of ecosystem management is "to sustain the integrity of ecosystems (i.e., their function, composition, and structure) for future generations while providing immediate goods and services to an increasingly diverse public."22 "The Forest Service Ethics and Course to the Future" document defines ecosystem management as "the integration of ecological, economic, and social factors in order to maintain and enhance the quality of the environment to best meet current and future needs."23

The Forest Service's 1994 publication entitled "A National Framework for Ecosystem Management" provides a description of what the Forest Service means, and intends to maintain, with respect to biodiversity. It states that the Forest Service will "care for the national forests and grasslands in ways that sustain populations of all native plants and animals; provide habitat for healthy populations of game animals and fish for recreation, subsistence, and commercial use; and protect threatened, endangered, and sensitive species."
Sustainability is defined as the maintenance of desired ecological conditions or flows of benefits over time.  

Although the "National Framework" document does refer to sustaining native species of plants and animals, the differences mentioned earlier between conservation biology and Forest Service views of ecosystem management still appear to hold. The former is largely biocentric, i.e., places primary emphasis on native species and the integrity of natural ecosystems, whereas the latter attempts at best to balance biocentric and anthropocentric concerns. However, the Forest Service's use of phrases such as "to best meet current and future needs" and its lack of a clear legislative mandate for implementation of ecosystem management certainly leaves the door open for less biocentric emphasis in the future.

Uncertainty in future determination of the role of human activities within the framework of ecosystem management is illustrated further by a discussion which the Keystone Center sponsored in 1993. A large, diverse group of federal, state, and local agency personnel, representatives from environmental and commodity-based organizations, and others tended to agree that ecosystem management should include ecological (biodiversity, ecological processes), social, and economic objectives but disagreed about their relative importance.

Concepts of Integrity, Health, Natural, and Native as They Apply to Ecosystems, Species, and Ecosystem Management

Some definitions of integrity are closely tied to the concept of naturalness. Karr and Dudley defined biological integrity as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition,


25 See USDA Forest Service, _supra_ note 23.


diversity, and functional organization comparable to that of natural habitat of the region. Angermeier and Karr stated that "biological integrity refers to a system’s wholeness, including presence of all appropriate elements and occurrence of all processes at appropriate rates," and that biological integrity is generally defined as "a system’s ability to generate and maintain adaptive biotic elements through natural evolutionary processes." They considered a biota with high integrity to reflect natural biogeographic, as well as evolutionary processes and that the loss of biological integrity includes loss of natural diversity components such as species and communities, in addition to breakdown of the processes needed to generate future natural diversity.

Angermeier and Karr’s concept of the interrelatedness of integrity and naturalness is based on the arguments of Ehrlich and Mooney that 1) exotic (non-native) species rarely perform ecosystem services like energy flow and mineral cycling as effectively as the native species for which they were substituted, and that 2) exotic species, which are often broadly adapted, weedy generalists, may also undergo rapid range expansion, with a concomitant loss of native species, thereby lowering the potential for future adaptive evolutionary change. As Ehrlich and Mooney also noted, simple loss of a native "controller" species such as an important herbivore can have a dramatic effect on the diversity of a natural plant community. Alternatively, human modification of a community to favor a predominately native species monoculture, such as a loblolly pine plantation in the southeastern United States, may not cause important losses in ecosystem services, at least over the short term. (But it may require relatively large expenditures of energy and nutrient subsidies to keep the system productive.) It is possible that a general loss of species due to 1) substituting a few generalist-type exotics for many native species, or 2) producing a native species monoculture, may have little effect on basic ecosystem processes, as long as no keystone species have been


lost.\textsuperscript{31} Even so, the lowering of future evolutionary capability remains a potentially serious, longer-term problem.

Other definitions of integrity are not so closely related to the concept of naturalness. For example, Cairns defined biological integrity as "the maintenance of the community structure and function characteristic of a particular locale or deemed satisfactory to society."\textsuperscript{32} Regier argues more explicitly that:\textsuperscript{33}

The notion of ecosystem integrity is rooted in certain ecological concepts combined with certain sets of human values. \ldots A living system exhibits integrity, if, when subjected to disturbance, it sustains an organizing, self-correcting ability to recover toward an end-state that is normal and "good" for that system. End-states other than the pristine or naturally whole may be taken to be "normal and good."

It is clear from the above discussion that the ecosystem management goal of the Forest Service to emphasize ecosystem integrity, accompanied by production of timber, livestock, forage, recreational opportunities, and other multiple-use benefits within this constraint, uses a concept of integrity similar to that of Cairns and Regier. That is, the managed ecosystems may have varying degrees of naturalness, based on public preference. Alternatively, the conservation biology goal is more biocentric. It aims to maintain natural ecosystem integrity.

Ecosystem health appears to be a less useful concept than integrity for purposes of this report because it has been defined and applied in various ways. Kay considers ecosystem

\textsuperscript{31}See Rundel, Philip W., "The Role of Species in Ecosystems," \textit{Conservation Biology}, volume 9, pp. 467-469 (1995); Schulze, Ernst-Detlef, and Harold A. Mooney, eds., \textit{Biodiversity and Ecosystem Function} (New York: Springer-Verlag, 1993). A keystone species is one which has a large effect on the persistence of other species in an ecosystem, e.g., by means of mutualistic or predatory interactions with other species.


\textsuperscript{33}Regier, Henry A., "The Notion of Natural and Cultural Integrity," in Woodley, Stephen, et al., eds., \textit{Ecological Integrity and the Management of Ecosystems}, pp. 3-18 (Delray Beach, Fla.: St. Lucie Press, 1993). A part of Regier's definition of integrity is very similar to the concept of resilience as defined by Holling, viz., the ability of an ecosystem to absorb shocks and to maintain its integrity even if the shocks are so great that the system shifts to a new mode. See Holling, C.S., "Resilience and Stability of Ecological Systems," \textit{Annual Review of Ecology and Systematics}, volume 4, pp. 1-23 (1973).
health to be a component of ecosystem integrity; i.e., ecosystem integrity includes 1) ecosystem health (the ability to maintain an optimal operating point under normal environmental conditions), 2) the ability to cope with stress (i.e., changes in environmental conditions), and 3) the ability to continue evolving and developing (i.e., to continue the process of self-organization on a continuing basis). On the other hand, Rapport considers ecosystem integrity to be a component of ecosystem health and that "the primary requirements for a healthy ecosystem are those of system integrity and sustainability." Ecosystem integrity, in turn, "depends on a small number of critical functions and structures, including maintaining efficiency in energy transfer and nutrient cycling, and maintaining a diverse species assemblage in which the longer-lived and larger life-forms are dominant in the mature phase of ecosystem development." Rapport also considers that an ecosystem does not need to be pristine in order to be healthy. A final example of the inconsistency associated with use of the term "health" involves the Western Forest Health Initiative of the Forest Service, which defines forest health as "a condition where biotic and abiotic influences do not threaten resource management objectives now or in the future." Examples of poor forest health that are cited include large wildfires and pest outbreaks that are considered to be indicative of previously undesirable types of management.

The concepts of "natural" and "native" are also important because of their relationship to differences between conservation biology and Forest Service views of how to accomplish ecosystem management, i.e., whether or not to place major a priori emphasis on managing for natural (or native) ecosystem integrity. As used by conservation biologists, "natural" generally refers to a condition or situation that is largely unaffected by humans. This is the meaning that is most applicable to the present report. What people perceive as natural is not always obvious. Human perceptions of naturalness are affected by their cultural biases and

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the concept of naturalness varies in its closeness to reality.37 A remnant of annual grassland in coastal California may be desired as a nature reserve, even though it was dominated by native perennial grasses several hundred years ago. Similarly, a relatively large hammock in northern Florida, dominated by native hardwood tree species and highly valued by a state conservation agency, may have been largely native pines several hundred years ago, prior to the modern period of active fire suppression.

Naturalness can be used in the context of aboriginal, as well as modern human environments. Thus, the suspected "Pleistocene overkill" of large vertebrates that followed the arrival of humans in the New World could be considered "unnatural".38 In Great Britain and Europe, where there is no condition prior to a major-land use change that is generally accepted as a description of naturalness, uncultivated lands containing native species, that have not been subjected to chemical treatments such as fertilization, may be considered natural or seminatural.39 Margules and Usher have suggested that a natural ecosystem might be considered one in which the size of the human population is limited by its environment (no import of food, building materials, etc.) and products of the ecosystem are used locally (no export of biological material). An approximation to this might be the conditions in Australia at the time of European settlement.40

It is easy from the practical standpoint to identify relatively natural and unnatural ecosystems such as Everglades National Park and New York City. Pre-Columbian humans quite likely caused significant changes in the Greater Yellowstone Ecosystem but there is no


40Id.
mistaking the roads, villages, mines, lumbering, and ranches produced by post-Columbian humans over the last 200 years. Anderson has proposed three indices to describe the amount of naturalness in an ecosystem, as follows: 1) the degree to which the system would change if humans were removed, 2) the amount of cultural energy required to maintain the functioning of the system as it currently exists, and 3) the complement of native species currently in an area compared with the suite of species in the area prior to settlement. Indices 2 and 3 can be quantified. If a presettlement inventory is not available, the proportion of native species in the current system can be used as an alternate.

While the term "native" is sometimes used interchangeably with natural, it is most commonly used to describe a species that has not been introduced into an area from somewhere else by humans. A native species will usually be one that is adapted to its environment, rather than one that arrived recently and may or may not be undergoing adaptation. An exception would be a native species that is no longer well adapted to its environment and is characterized by one or more declining populations. An exotic species is one that has come to an area as a result of deliberate or accidental introduction by humans. This could have been through direct transport by humans or as a result of indirect human activities such as habitat alteration. In all of these cases, some sort of human activity has permitted the invading species to overcome a natural barrier to dispersal. Exotic species which have become adapted to their new environment over time are sometimes referred to as "naturalized."

Under natural conditions, species gradually disperse and colonize new areas, thereby causing long-term changes in the biota of a region. Human augmentation of this process has greatly increased the rate of these natural invasions since the Pleistocene and has caused well

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42 See Anderson, Jay E., supra note 38.

43 See Noss, Reed F., and Allen Y. Cooperrider, supra note 10.

44 Id.
documented, destabilizing influences on some of the invaded ecosystems.\textsuperscript{45} All exotic species do not have equally disruptive effects on their recipient ecosystems and some may even be highly valued by segments of society.\textsuperscript{46} The major concern of conservation biologists is that well adapted native communities of species are usually associated with high ecosystem integrity, whereas exotic species may lower ecosystem integrity by interfering with natural ecosystem services and also by driving some native species to local extinction. If the latter are endemics (i.e., species found only in a particular geographic area), global as well as local biodiversity will be lowered.

Aside from the contribution of native species to ecosystem integrity and to many commodities that humans value for commercial and recreational purposes, natural ecosystems with predominately native species have great aesthetic and spiritual importance to many people. This is notwithstanding the fact that the "natural" condition may be partly a result of human activities several generations earlier. For these reasons, conservation agencies and organizations often have a goal of protecting ecosystems with a desired "historic" condition or of restoring them to such a condition. A complementary goal is to protect or restore the natural processes, including the natural disturbance regimes, that produced the historic condition.\textsuperscript{47}

**Plans for Implementation of Ecosystem Management**

**An Approach Suggested by Conservation Biologists**

Noss and Cooperrider have outlined a national strategy for maintaining natural biodiversity in perpetuity. It involves meeting the following goals.\textsuperscript{48}


\textsuperscript{46}Id.


\textsuperscript{48}See Noss, Reed F., and Allen Y. Cooperrider, *supra* note 10.
1) Represent, in a system of protected areas, all native ecosystem types and seral stages across their natural range of variation.

2) Maintain viable populations of all native species in natural patterns of abundance and distribution.

3) Maintain ecological and evolutionary processes, such as disturbance regimes, hydrologic processes, nutrient cycles, and biotic interactions.

4) Manage landscapes and communities to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of the biota.

These goals are very similar to, but more explicit than, the first four goals listed by Grumbine for sustaining ecological integrity, in relation to his definition of ecosystem management. The Noss and Cooperrider goals are, therefore, referred to in the present paper as a "conservation biology" approach for implementing ecosystem management. The phrase "in natural patterns of abundance and distribution" in Noss and Cooperrider's goal 2 implies maintenance or restoration of a relatively natural historic condition in important segments of the landscape. This condition might be one thought to typify the U.S. landscape just prior to the major land use changes that began with European settlement, although that is not explicitly stated. Goal 2 is potentially rather different from the Forest Service's goal to "sustain populations of all native plants and animals" on the national forests and grasslands. The Forest Service goal might conceivably be met by maintaining just enough reasonably viable populations of special-interest species over a reasonably long period of time, but in an overall regional landscape that has considerable unnaturalness. On the other hand, there would seem to be no way that the Forest Service could avoid maintaining large amounts of relatively natural habitat in some regions, if it is to meet a goal of sustaining viable populations of large vertebrates such as grizzly bears and gray wolves.

49 See Grumbine, R. Edward, supra note 8.

50 See USDA Forest Service, supra note 24.
The strategy outlined by Noss and Cooperrider is based on the concept of "regional reserve networks," which is derived primarily from earlier suggestions by Noss and Harris.1 "Regional" refers to a large landscape differing from other such types in factors such as climate, soils, physiography, and species assemblages; e.g., a bioregion or ecoregion. The North Cascades, Great Basin, Southern Appalachians, and Florida would be U. S. examples. A "network" would consist of core reserves, surrounded by buffer zones, and linked by connectors. A core reserve is an area that would be maintained in its natural state and within which natural disturbance events would be allowed to proceed spontaneously or be mimicked by active management. Existing protected areas such as national parks, wilderness areas, national wildlife refuges, BLM areas of critical environmental concern, and Nature Conservancy reserves might qualify as core reserves.

A buffer zone would surround a core area and permit a wider range of human uses than the core but still be managed with native biodiversity as a preeminent concern. Although a buffer zone would be a multiple-use area, it might differ from a typical multiple-use area in a national forest, if the latter did not have maintenance of native biodiversity as a primary concern. Ideally, a buffer zone would enlarge the effective size of its core reserve, at least for some species, as well as provide external protection for the core. It might also serve as a substitute core area, if disturbance should render the core habitat temporarily unsuitable. A major intent of the buffers would be to reduce regional activities harmful to biodiversity, such as certain types of logging, mining, livestock grazing, and off-road vehicle use, in national forest and BLM lands surrounding core reserves. The core reserve-buffer zone idea is very similar to the concept of conservation networks proposed by Salwasser, et al.2 Noss and


Cooperrider believe that large changes in national leadership and agency organization would be required to create, e.g., a national forest buffer zone around a national park core reserve.

Connectivity of core-buffer complexes would be achieved, for at least some species, by corridors of adequate width, designed also with respect to factors such as movement behavior of species, distance between the complexes, and nature of intervening habitat. Connectivity for species that tend to disperse randomly might depend on having a suitable, overall landscape matrix rather than on a linear type of corridor. Connectivity or "landscape linkage" could serve multiple purposes such as permanent habitat; temporary habitat for movement related to home range, dispersal out of parental home range, and seasonal migration; and habitat for long-range shift of species in response to climate change.

Noss and Cooperrider noted that, while most species and processes would probably persist in well managed buffer zones, a conservative approach would be to represent each regional ecosystem type at least once in a core reserve and to create a secure network of reserves for large carnivores and other species particularly sensitive to human activities. The level of detail at which ecosystems might be classified (i.e., identified and described) for the purpose of determining representation would depend on the extent and complexity of the region under consideration. One example of a useful classification might be The Nature Conservancy's series level vegetation types for the western United States; ideally, this type of classification would also represent the full array of physical habitats and environmental gradients that underlie the biodiversity of a region.53

Area requirements for maintaining large and/or far-ranging carnivorous species might necessitate several interconnected regions such as the entire southeastern United States for the Florida panther and the Northern Rocky Mountains for the grizzly bear. In order to accommodate natural disturbance patterns that would maintain adequate seral stages of major

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regional ecosystem types, some core reserves might have to be many times larger than the average disturbance patch of, say, a fire or pest outbreak.

Based on a review of several admittedly very crude estimates of the total amount of natural habitat needed to meet the conservation goals of the reserve network strategy, Noss and Cooperrider suggested most regions of the United States would require that 25% to 75% of their total land area be in core reserves and inner (more highly regulated for conservation) buffer zones. Extensive amounts of public and private lands would need to be involved. These percentages also assume that the core-buffer complexes would be well connected both within and, when necessary, between regions. The proposed area requirements are an order of magnitude greater than the amount of land currently protected in most of the regions (i.e., protected in a reasonably satisfactory fashion that would serve the reserve network purpose). Many of the cores and buffers would not need to be "locked up" because a variety of human uses could be accommodated, as long as they were compatible with conservation objectives. Nevertheless, accomplishment of this strategy would require many years of cooperative action among agencies, landowners, citizens, and scientists.54

A continental-scale effort for developing a collection of regional reserve networks in North America has been initiated. It is called The Wildlands Project. It involves local groups of people in each of several regions who are utilizing conservation biology principles to devise regional reserve network proposals. The latter will be used to educate government agencies, environmental organizations, the general public, and others about the importance of biodiversity and requirements for protecting it.55

Approaches Suggested by Forest Service Personnel

It is important to consider how the Forest Service might translate its new ethic of ecosystem management into land management prescriptions and how this might affect biodiversity. One aspect of the technical part of this question has been summarized preliminarily in a report produced by the Forest Service’s Eastside Forest Ecosystem Health

54See Noss, Reed F., and Allen Y. Cooperrider, supra note 10.
55See Noss, Reed F. (1992), supra note 9.
This report is largely concerned with multiple-use lands, as opposed to those national forest lands set aside for wilderness, research natural areas, and other types of special protection. The authors contributing to this document believe ecosystem management can be implemented with current scientific knowledge and land management experience but that it will have to be continually assessed and revised, as new experience and knowledge accumulate. This is to be accomplished by considering each of the many attempts to implement ecosystem management as an experiment with pre-quantified objectives. Such objectives can then be evaluated as each experiment proceeds. They can also be modified, if necessary, based on what happens, as well as on new information related to changes in scientific theories and human values. This process is called adaptive ecosystem management.

**Management of Disturbance Patterns and Vegetation**

The Forest Service intends to put special emphasis on regional, landscape-level analyses across vegetation types (ponderosa pine forest, spruce-fir forest, sagebrush steppe, etc.) which, in turn, will be considered at several spatial and temporal scales. Vegetation types are especially useful representations of ecosystems because of their importance to harvestable timber and wildlife habitat suitability, and because vegetation can be manipulated through commercial harvests and other practices to mimic important natural disturbance regimes. The major goal will be to recreate the natural or "historic" range of variability that occurred on the landscape before its extensive modification by European settlers. This approach assumes "that native species have adapted to and, in part, evolved with the natural disturbance events of the Holocene (past 10,000 year) environment. Accordingly, the

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56Jensen, Mark E., and Patrick S. Bourgeron, tech. eds., *supra* note 19.


potential for survival of native species is reduced if their environment is pushed outside the range of its natural variability.\textsuperscript{59} Closely tied to this assumption is the additional assumption that the historic vegetation pattern in terms of different types and developmental or "seral" stages (shrub seedling, young forest, old growth, etc.) across the landscape can be approximated by management practices of varying type, intensity, and duration. To reemphasize, if this can be accomplished, it is assumed that most native biodiversity can be maintained — and perhaps in some cases increased — at all levels from landscapes (characteristic groupings of ecosystems) through ecosystems to species and individual populations (which maintain genetic variability within species). Adaptive ecosystem management will be used to test these basic assumptions.

There are important practical problems with the idea of maintaining historic variability patterns of vegetation by mimicking historic disturbance patterns of fire, wind, flood, pests, etc.\textsuperscript{60} Examples include 1) the difficulty of determining past disturbance patterns, 2) the extent to which present or future environments may be forced outside of their historic range by other factors such as climate, exotic species, and human structures (roads, dams, mines, mountain resorts, etc.), and 3) whether or not society will permit the type of management that is needed (e.g., restricting the harvest of old growth forests on public lands in areas where old growth was historically common but is now rare on private lands\textsuperscript{61} or encouraging old growth harvest in areas that were historically dominated by fire and younger seral stages\textsuperscript{62}).

One example of potential compromises would be to use prescribed fire to maintain certain

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\textsuperscript{59}Swanson, Frederick J., et al., "Natural Variability - Implications for Ecosystem Management," in Jensen, Mark E., and Patrick S. Bourgeron, tech. eds., supra note 19, at pp. 80-94.

\textsuperscript{60}Id.


species populations at individual sites, and timber harvests to replace natural fire as important
determinants of landscape vegetation patterns.63

Swanson et al. believe that the above suggestions for management of disturbance and
vegetation are consistent with productive use of the Pacific Northwest landscape, including
timber harvest and fishing. They do point out that near-term costs might be increased and
that "The socially acceptable balance between ecological and commodity objectives will be
determined by the public."64 Thus it is possible, perhaps probable, that historic variability
patterns of biodiversity cannot be well simulated because of political roadblocks, unless there
are fundamental changes in the way that environmental policies are developed and
implemented.65

Need for Additional Emphasis on Populations of Special-Interest Species and Protected
Areas

Complete dependence by the Forest Service on historic vegetation patterns to maintain
all levels of biodiversity would place too much emphasis on the "coarse-filter" approach.
That approach assumes that maintenance of landscape and ecosystem diversity would
simultaneously maintain most of the component species and population (i.e., within species)
diversity. The coarse-filter method will not, however, suffice for protection of rare species
such as those that are threatened or endangered, or those for which habitat is not the limiting
factor. Populations of these species need to be maintained by the "fine-filter" approach;66
i.e., a number of populations of each such species, if possible, will have to be protected, and
each of these populations should be maintained with a large enough size and/or other special

63 See Swanson, Frederick J., et al., supra note 59.

64 Id.


support that it has a reasonable chance for survival over a reasonable period of time. Special support might have to include one or more activities such as protection from excessive competition and predation, assurance of adequate food and water, provision of habitat connectors, and artificial supplementation with immigrants to replenish dangerously low genetic variability.

One can imagine that it may be feasible to protect critical populations of certain rare plant species by setting aside a relatively small portion of critical habitat but metapopulations (systems of semi-isolated subpopulations of a species that fluctuate in size over time) of a plant or small animal species may require a considerably larger area. A reserve system for such a species, which has subpopulations that are subject to periodic catastrophic, environmental disturbances such as large-scale fire, flooding, or windstorms, riparian ice flows, and massive pest outbreaks, will need to protect a range of colonizable sites in addition to those currently occupied. Twenty-two percent of U.S. vascular plant species (e.g., trees, shrubs, vines, and grasses) are presently of special concern with respect to survival, and the number of plants listed, or being considered for listing, under the Endangered Species Act is greater than the number being delisted. The above are all problems that the coarse-filter approach cannot solve and which the Forest Service must address in ways other than landscape-level manipulation of vegetation. Larger threatened or endangered animals with longer generation times, lower abilities to increase their numbers when environmental conditions are favorable, and low or high rates of habitat specificity (e.g., the federally listed grizzly bear and northern spotted owl, respectively) present very serious large-area requirements that also have to be considered by public land managers.


68 See Menges, Eric S., supra note 67.


The need for a fine-filter strategy to ensure the survival of special-interest species means that the Forest Service will have to consider development of a protected area network to supplement its proposed management of vegetation and disturbance patterns at the landscape level. This could presumably be done by extending its present complex of research natural areas, wilderness, and other specially-protected areas. Not only are more protected areas needed, but there are also extensive gaps in the ecosystem coverage of the existing systems. In fact, this is the case for all of the federal agency protected area systems.\(^7^1\) The core reserves of the regional reserve network described by Noss and Cooperrider provide a useful model for a coordinated expansion of all agency protected area systems. An expanded federal protected area system would also provide additional benchmark or "control" areas against which the results of adaptive management "experiments" could be compared.

A Forest Service system of core reserves and buffers would fit well with the first and last of three major forest uses described by Salwasser: "Most affluent cultures acknowledge that some forests should be protected for their spiritual and environmental values; some should be managed intensively to produce the wood products that people need and desire; and others should be managed to balance the protection of environmental values with the production of desired products."\(^7^2\)


Development of an expanded fine-filter system for special-interest species by the Forest Service would require extensive changes in the management of some of their multiple-use lands. Increased effort would also be required to develop models that help to estimate the habitat needed to provide reasonable assurance of viability for such species. These actions would appear to be necessary even if the Forest Service goal to "sustain populations of all native plants and animals" should have to be accomplished within a landscape matrix that contains relatively large amounts of unnaturalness.

Prospects for Ecosystem Management

Political Resistance

Many members of the 104th U.S Congress elected in November of 1994 are unlikely to favor implementation of ecosystem management by the Forest Service and other federal land management agencies. An indication of this can be obtained from the statement of Congressman James V. Hansen of Utah at a joint oversight hearing on ecosystem management conducted by the House of Representatives of the 103rd Congress on September 20, 1994.

Some excerpts from Mr. Hansen's statement are as follows:

Mr. Chairman, I fully concur with your decision to hold a congressional hearing on "ecosystem management," a term that is now in common usage in the environmentalist vernacular and particularly since the Administration is proposing to spend $610 million for the undefined purpose of "ecosystem management" in fiscal year 1995. . . . We may also hear about a so-called "Majority Staff Report" on this same subject. That report was prepared at a cost of thousands of dollars of limited Committee funds, (sic) is based largely on the opinions of a handful of persons on this topic from the farthest left perspective. . . . We need to move toward less Federal intervention and regulation of non-Federal lands, as well as less Federal

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land ownership over time. . . . Ecosystem management, the latest environmentalist code word for expanded Federal land use control, is the wrong solution for the conservation of this country's natural resources.

George T. Frampton, Jr., Assistant Secretary of the Interior for Fish and Wildlife and Parks, also testified at the joint oversight hearing on September 20, 1994. His statement provided a good description of contrasting public views of ecosystem management and emphasized its procedural rather than substantive aspects. Most relevant federal agencies have prepared documents explaining the procedures they plan to use for implementation of ecosystem management (provide opportunities for extensive public input, use the best available science, promote cooperation among managing agencies, promote sustainable economies in human communities, pursue adaptive management etc.), whereas there has been much less discussion of exactly what aspects of the environment are to be managed and how (the Forest Service's 1994 General Technical Report is an exception). This may be an important reason why Congressman Hansen and perhaps others are able to refer to the "undefined purpose" of ecosystem management.

Senator Frank H. Murkowski, Chairman of the U.S. Senate Committee on Energy and Natural Resources, submitted a statement to a public lands conference on Oct. 13, 1995 at the University of Colorado in which he said:

Past administrations, without exception, have extended the already too long arm of the federal government in the name of environmental protection. Examples from the Bush Administration are expanded federal roles in the areas of wetlands protection, endangered species, and the rewrite of the Clean Air Act. The Clinton Administration has continued this surge in federal authority in it's (sic) pursuit of "ecosystem management," a "National Biological Survey," the desire to

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76 Frampton, George T., Jr., (Testimony before the Joint Oversight Hearing on Ecosystem Management, U.S. House of Representatives, Sept. 20, 1994).


78 See Jensen, Mark E., and Patrick S. Bourgeron, tech. eds., *supra* note 19.

create a new and more expansive federal mining law, and a Btu tax.
The message the voters delivered at the polls has been heard in Congress, it’s time to turn the tide of federal encroachment.

In other parts of his statement at the University of Colorado conference Senator Murkowski remarked that:

A new public land ethic is developing around the principles of reduced Federal regulation and control and increased reliance on local governments and private markets to efficiently manage land resources. It is time the Federal government stopped subsidizing resource development and got out of the business of commodity production. This could be accomplished by privatizing resources dedicated to commodity uses. Lands retained in federal ownership should be reserved for appropriate federal purposes like the preservation of valuable natural areas that are part of the heritage of all Americans. Lands more appropriately meeting state or local government needs like protection of water supplies or fish and game management should become the responsibility of state or local governments. . . . The public lands that our forefathers walked across are no more — fires that once swept across the lands removing the old and making way for the new are now aggressively suppressed — the buffalo herds that grazed the nations (sic) grasslands are in reserves — rivers have been turned to many additional purposes beyond their natural flows. We cannot go back — we should not go back. I urge you to consider the complexities that must be factored into planning the nations (sic) land ethic for the coming century.

Senator Murkowski’s comments clearly favor a reduced federal role in management of the present public lands, which is the opposite of what would be needed if the Forest Service and other federal agencies were to participate in development of the kinds of regional reserve systems needed to maintain U.S. biodiversity. Although he does favor using "lands retained in federal ownership" for the preservation of valuable natural areas, he clearly argues for transfer from federal authority of much of the multiple-use lands that would be needed to form the critical buffer zones and connectors in regional reserve networks. It also seems clear from the concluding part of the above quotations that he would not favor a Forest Service plan to maintain or restore historic vegetation and disturbance patterns on the landscape.
Potential for Survival of the Ecosystem Management Philosophy

Because the federal ecosystem management initiative is based primarily on executive branch directives and lacks a government-wide legal mandate, it could be easily reversed by another federal administration. One of the purposes of the Endangered Species Act is, however, to provide a means by which the ecosystems upon which endangered and threatened species depend may be conserved and this provision has been strengthened by a recent U.S. Supreme Court decision. In addition, Secretary of the Interior Bruce Babbitt has been using the Act to promote management of ecosystems so as to avoid the need for future federal listing of species whose populations are currently a matter of concern. Provision of adequate critical habitat for endangered or threatened species with large metabolic and space requirements also offers a statute-based approach to implementing ecosystem management. However, the Act itself is being considered for revision in the 104th Congress, including a possible moratorium on listing of new species. It now appears that further consideration of these changes will not occur until after the federal elections of 1996.

Survival of the ecosystem management philosophy is a much different matter than survival of the present executive branch initiative. Shepard has argued in this regard that ecosystem management should not be viewed as "a haphazard or frenetic attempt to find management answers or a public relations cover; ecosystem management should not be viewed as the latest flavor-of-the-month. Rather, these terms capture a clear evolution of thinking and on-the-ground management as the silvicultural implications of 20 years of scientific findings are joined with emerging appreciation of changed sociological, political, and economic circumstances."


Examples: ecosystem management, new forestry, new perspectives, adaptive forest management.
In fact, ecosystem management is the second major response of the federal government in this century to large-scale social and political controversy surrounding the use of American forests. The first resulted in the creation of the Forest Service in the Gifford Pinchot era. This followed the close of the American frontier, and the greatly increased industrialization, urbanization, and forest exploitation of the late 19th Century. As described by Kennedy and Quigley:

National Forests were to be an insurance policy or alternative to free enterprise values and methods of forest management. ... The Forest Service led the American people and politicians into the conservation era. It was a lean, righteous, radical, organization confronting frontier era and laissez-faire natural resource values that were no longer appropriate for a modern, industrializing America.

World War II and the post-war economic boom of the mid-20th Century created an enormous demand for timber products and the Forest Service shifted from its custodial and protective role to that of timber supplier. As a result, timber harvest rose almost 800 percent between 1941 and 1971, i.e., from 1.5 to 11.5 billion board feet per year. Ecosystem management is a clear and understandable response by the Forest Service to the desires of the American public in the late 20th Century to control these harvests of natural resources and attendant pollution, the loss of biodiversity, and the rapidly decreasing naturalness of the national landscape. The way had actually been indicated almost a half-century earlier by the Forest Service's second (first?) most influential member, Aldo Leopold. Leopold began as a Pinchot disciple and later argued in some of the most moving prose in environmental

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84See Shepard, W. Bruce, supra note 82.


86Id.

literature that the primary goal of land management should be to maintain the health of natural systems and ecological processes.\footnote{Leopold, Aldo, \textit{A Sand County Almanac, and Sketches Here and There} (New York: Oxford University Press, 1949).}

The Forest Service’s present intent to place primary management emphasis on ecosystem integrity, to provide traditional multiple uses within that constraint, and to let the public decide the extent to which naturalness will characterize the landscape may be the most appropriate way to proceed. Along with outer space, Antarctica, the atmosphere, and the oceans, global biodiversity can be viewed as global common property. Most wildlife species are certainly considered to be common property in the United States. It therefore seems reasonable that the U.S. public should make this decision about the extent to which its publicly held biodiversity should be returned to its natural state of variability through ecosystem management.

As Senator Murkowski made clear in his Oct. 13, 1995 statement,\footnote{See Murkowski, Frank H., \textit{supra} note 79.} there is more than one kind of land ethic to be considered. Ecosystem management is an environmental ethic that lies between the extremes of 1) steady-state economics\footnote{Daly, Herman E., \textit{Steady-state Economics - 2nd ed. with New Essays} (Washington, D.C.: Island Press, 1991).} and 2) maintaining the status quo or reducing the emphasis on environmental quality as it is understood through much of the federal and state environmental legislation that has been enacted in the United States since the 1960s. The steady-state approach would take immediate steps to halt economic growth; shift major wealth from developed to developing countries, stop global human population growth, curtail consumption of energy and materials in the developed world and raise it above poverty levels in the developing world, and put quotas on the use of nonrenewable resources until they can be replaced with renewable resources. Maintenance of the status quo or reducing the emphasis on environmental quality would probably differ only in the speed with which biodiversity continues to be lost and the natural environment is converted to a largely artificial, exotic condition. The evidence on which this prediction is
based represents one of the most important contributions to date of the science of conservation biology.

Consequences for Biodiversity of Not Implementing Ecosystem Management

Insight from Conservation Biology

Conservation biologists are actively producing population viability models for use in helping to design management and recovery plans for individual species listed or considered for listing under the Endangered Species Act.\(^1\) Models of this sort usually involve working closely with biologists who are knowledgeable about species life histories, and the iterative process of simulation modeling can lead to a great deal of insight on how to manage individual species in certain habitat situations. But these kinds of studies, along with earlier ones that attempted to apply island biogeography theory to the design of specific nature reserve systems, have led some scientists to suggest that conservation biology is essentially an empirical science, with little to offer in the way of powerful generalizations and guidelines.\(^2\)

Part of the problem associated with individual-species studies stems from the fact that the area needed to maintain a particular species population is not easy to infer from ecological studies of individuals; i.e., information obtained from one geographical and/or temporal scale is not easily transferable to another.\(^3\)

It is instructive to consider some previous work in conservation biology that has led to valuable guidelines with respect to the amount of land needed to maintain biodiversity. The most important thing about these earlier studies is that they inform policymakers and managers, in a very general way, about the magnitude of the land area needed to protect all biodiversity. This helps to illustrate that many of our present policies are simply incapable of preventing a decline in biodiversity and a denaturalizing of the landscape.

\(^1\) See all citations supra note 73.


Localized Species Extinctions in National Parks

An important concept that follows from island biogeography theory is based on the study of land-bridge islands that were formerly connected to a continental mainland and which have become insularized over the past 10,000 to 20,000 years by sea-level rise following the melting of glaciers and thermal expansion of oceans. Newly-formed, land-bridge islands are supersaturated with species; i.e., they contain more species at first than they can maintain over time, because they are no longer an integral part of the mainland. A relentless biotic decay process follows that is dominated for some period of time by species extinction. The rate of species loss is expected to be larger on the smaller islands.

Although continental protected areas are not as isolated from one another as oceanic land-bridge islands, they are surrounded by a habitat matrix that has been modified in many ways by human activities. Newmark used this analogy to test the hypothesis that, for a subset of all mammals in national parks or closely associated groups of such parks in western North America, 1) mammalian extinctions (as evidenced by natural disappearance from a park at some time following the park’s establishment) would exceed natural recolonizations, 2) the extinction rates would be higher for smaller parks such as Bryce Canyon and Crater Lake than for larger ones such as Grand Canyon and Yellowstone-Grand Teton, and 3) given approximately equal sized parks, species loss would be higher for older than for younger parks (the oldest individual park is Yellowstone, which was established in 1872). Each of these predictions was verified, although it was later suggested that at least a part of the data might be better interpreted as having resulted from subpopulation extinctions within a metapopulation framework. Newmark also showed that initial species population size (i.e.,

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96Newmark, William D., "Extinction of Mammal Populations in Western North American Parks," Conservation Biology, volume 9, pp. 512-526 (1995). Newmark is apparently suggesting that national parks in western North America can be viewed as subpopulations of a regional metapopulation. A park could then undergo a species extinction, followed at some later date by a recolonization of the lost species from the surrounding matrix of partially
at the time of park establishment) was a good predictor of a species’ survival time, with initially smaller mammalian species populations going extinct more rapidly. Only the largest park group, Kootenay-Banff-Jasper-Yoho (20,736 km²), in Canada, which was established on average in 1899, has had no natural mammalian species extinctions. These findings, along with surprisingly high post-Pleistocene mammalian extinction rates on true land-bridge islands such as Borneo⁹⁷ (much of which remained relatively unmodified by human activity until recently), provide strong evidence that no park in the world is large enough to prevent non-human related, local extinction of at least some mammalian species. This provides a compelling argument for careful management of mammalian species (and probably many others), to prevent human- and non-human-related extinctions both within parks and in the less-protected-matrix of multiple-use and private lands surrounding parks.

Newmark estimated the biotic boundaries necessary to maintain minimum viable populations (MVPs) of the largest terrestrial, non-flying, mammalian species in eight of the largest western North American parks or closely-associated park groups.⁹⁸ He did this by using 1) 50 individuals as a very crude estimate of the minimum viable population size needed to prevent short-term, nonhuman-related loss of an isolated species population due to inbreeding depression, and 2) 500 as a crudely-estimated minimum size for preventing an isolated population’s nonhuman-related loss of ability to adapt to environmental change over the longer term,⁹⁹ and then combining these MVP values with 3) the estimated home range (total area utilized by an individual organism during its life) of each mammalian species in the analysis, and 4) the areal extent of the entire watershed of each park or park group. The

protected, multiple-use lands. This reemphasizes the importance of multiple-use public lands in future regional reserve networks.

⁹⁷ See Wilcox, Bruce A., supra note 94.


⁹⁹ For derivation of these estimates, see Franklin, Ian R., "Evolutionary Change in Small Populations," in Soulé, Michael E., and Bruce A. Wilcox, eds., supra note 94, at pp. 135-149; Soulé, Michael E., "Thresholds for Survival: Maintaining Fitness and Evolutionary Potential," in Soulé, Michael E., and Bruce A. Wilcox, eds., supra note 94, at pp. 151-169.
biotic boundaries for seven of the eight parks or park groups were found to be 1.2 to 9.6 times greater than their legal boundaries for an MVP of 50 and 6.0 to 96.0 times greater than their legal boundaries for an MVP of 500. Species used for these estimates, depending on the park or park group, were grizzly bear, mountain lion, and wolverine.

Other, and some more recent theoretical and experimental studies indicate that the actual census population sizes needed to maintain isolated viable natural populations for many species over the longer term may need to be on the order of 10,000 or more individuals, rather than 50 to 500. Although this would greatly increase the area requirements for the mammalian species used by Newmark to estimate biotic boundaries, his original conclusions remain unaltered:

There are probably no remaining regions in western North America where there are expanses of wildlands of sufficient size in which it will be possible to design national parks so that the legal and biotic boundaries of a park are congruent. In addition, because of the enormous potential size of the biotic boundaries, it may be both politically and economically impractical to purchase the necessary lands. Cooperative forms of land management between the national parks and adjoining public and private lands will be necessary.

Lest these results seem too gloomy, it is important to note that enlightened, professional management of populations and habitats, across political boundaries as necessary, should be able to compensate for (and has, at least in the short term) some of the large areal requirements embodied in Newmark’s projections.

Relationship of Species Population Size to Park Size

Schonewald-Cox estimated the relationship between park area and census population size for a wide range of mammalian species in temperate and tropical regions of North America, South America, Europe, and Africa. Surprisingly large, relatively


\[101\] See Newmark, William D., supra note 98.

homogeneous, and highly statistically significant correlations were found for large carnivores (bears, canids, and large cats), as well as for large herbivores (deer, elk, wildebeest, elephant, etc.) and small herbivores (certain rodents, rabbits, etc.). The analysis indicated that, at least for the short term, parks greater than the following sizes would be needed to maintain 1,000 individuals of the following types of mammals: small herbivores — 1 km$^2$; large herbivores — 100 km$^2$; and large carnivores — 10,000 km$^2$. (Note that the Yellowstone-Grand Teton park group is approximately 10,000 km$^2$ and it is still not large enough to accommodate over the long term an isolated population of grizzly bears, according to Newmark’s analysis.)

A much more extensive investigation involving the relationship between study site area and census population size of medium to large carnivores was subsequently conducted by Schonewald-Cox and associates.\textsuperscript{103} Results supported the earlier suggested need for more than 10,000 km$^2$ to maintain 1,000 individuals; in fact, areas of at least 20,000 to 40,000 km$^2$ were indicated for some large carnivore species. Future increases of habitat fragmentation within parks would generally be expected to increase these area requirements.\textsuperscript{104}

\textit{Conservation Networks}

The very general and admittedly crude area values for large carnivores obtained from Schonewald-Cox’s 1983 analysis were used by Salwasser, et al. to estimate the size of U.S. conservation networks needed to maintain populations of large carnivores over at least the short term.\textsuperscript{105} Salwasser et al. considered a conservation network to be the sum of the major land management agency units, including other units than federal in some cases, surrounding an existing higher-protection core that consists, e.g., of one or more national parks. They found that eight of the nine national park core areas included in their analysis were not large enough to protect large carnivores whereas all but one of the conservation

\begin{footnotesize}
\begin{enumerate}
\item See Salwasser, et al., \textit{supra} note 52.
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networks might be. To give some idea of relative sizes, the Yellowstone Conservation Network, consisting of eight national forests and two national refuges surrounding the Yellowstone-Grand Teton National Park core, is 55,580 km$^2$ compared to the core area of 10,240 km$^2$. The Southern Appalachian Highland Conservation Network, consisting of five national forests surrounding the Great Smokies National Park core, is 23,990 km$^2$ compared to the core area of 2,080 km$^2$. This very preliminary analysis was intended primarily to demonstrate the concept of conservation networks; it used only National Park Service lands for cores (excluding, e.g., wilderness areas in national forests) and assumed that "ideal" cooperation would be obtained among all of the land managers in a network. Ideal cooperation might require modification of certain activities such as clear-cutting, road building, mining, grazing, water development, or high density recreation in certain parts of the national forests surrounding a core. The intent of the authors was to "begin to view networks of lands under different ownerships and management policies as being able to sustain the structural and functional diversity of entire ecosystems while providing a steady flow of resources to local and regional economies."

**Policy Implications and the Future of Biodiversity**

Analyses such as those conducted by Newmark, Salwasser et al., and others, together with detailed ecological studies on grizzly bears in the Yellowstone National Park region, provide a powerful argument for ecosystem management, especially with respect to the idea of managing over time and space and across political boundaries to maintain biodiversity. The type of very crude modeling and prediction accomplished by Newmark and Salwasser et al. does not produce risk estimates in terms of probability for survival of a species population over a specified period of time, nor does it attempt to provide detailed area requirements for specific habitat types. Instead, it contributes to a desirable goal suggested by

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106 *See supra* notes 52 and 94-98.

Fitch,\textsuperscript{108} i.e., to warn policymakers when there is reason to believe that policies under consideration are likely to be unsustainable. In this instance, the unsustainable policies consist of many individual, sometimes poorly coordinated, land management efforts, confined within the political boundaries of, e.g., national forests, BLM resources areas, national parks, and national wildlife refuges, that are expected to result in continuing losses of biodiversity. As Fitch points out, in a different context, "in order to serve this kind of function we do not need fancy theoretical models — Brundtland optimality — or the ability to make precise predictions about the future consequences of alternative investments in reducing ozone depletion, as long as we can recognize that ozone depletion is unsustainable behavior."\textsuperscript{109}

Those who argue against the implementation of ecosystem management may believe that environmental quality will be better served by less government restraint on how individuals and corporations use environmental resources. The more likely result will be a "tragedy of the biodiversity commons." Garrett Hardin has argued in this regard that "Each man is locked into a system that compels him to increase his herd without limit — in a world that is limited. . . . Ruin is the destination toward which all such men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all."\textsuperscript{110} Native species are a unique type of global commons in that once they are lost they cannot be expected to occur again; in fact they cannot reasonably be expected to be replaced by new native species within a time frame that has any meaning for humans. Dependence on the marketplace to signal that a particular, naturally occurring species has become rare, and therefore valuable enough to warrant protection, runs the high risk that its population or populations will no longer be minimally viable. This already appears to be one of the main weaknesses of the Endangered Species Act, which is not even supposedly driven by market factors. By the time most threatened or endangered species are brought under protection through listing, their actual census population sizes are on the order

\textsuperscript{108}Fitch, John S., Department of Political Science, University of Colorado, Boulder, Colo., personal communication, June 9, 1995.

\textsuperscript{109}Id.

of 100 for plants and 1000 for animals. These numbers now appear to be well or far below sizes that would be expected to be minimally viable under natural conditions (i.e., without special human support) for reasonable periods of time (e.g., hundreds to thousands of generations involving hundreds to thousands of years for various kinds of species). From the standpoint of natural environmental quality, de-emphasis of ecosystem management can be expected to interact in a negative and synergistic fashion with increased human population growth in the United States. It is very likely in this situation that the per capita amount of forests and woodlands of all kinds, public and private and natural and non-natural, will continue to decrease. Assuming 10 million persons in the United States in 1700 A.D., the per capita area of these kinds of ecosystems has decreased from 45 hectares in 1700, to 1.2 hectares at present (i.e. from 111 acres to 3 acres). This compares with a global per capita decline from 30 hectares to 0.75 hectares (from 74 acres to 2 acres) over the same period of time. The United States has also experienced large decreases in other major types of terrestrial and wetland ecosystems such as grasslands, shrublands, and marshes.

Possible Effects on Ecosystem Services

If something like ecosystem management is not increasingly practiced in the United States and elsewhere, the ability of the natural environment to maintain air and water quality, soil stability and fertility, flood control, pest control, a moderate climate, and other ecosystem services is very likely to decrease. The amount of decrease will depend on how much natural environment is lost, and on how adequately and rapidly human ingenuity can provide native

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112 See Lande, Russell, *supra* note 100.


species monocultures, exotic species, and abiotic technologies to replace the native species and natural processes. An extremely negative case could be unbelievably expensive, thereby providing a general warning about the costs associated with less extreme situations.

Loss of natural ecosystem services is a major concern of ecological economists who believe that slowly changing ecological systems will be unable to maintain their integrity (e.g., adequate functional capabilities and resilience) if the natural world is depleted too rapidly. They view "sustainability" as the amount of human consumption that can be continued indefinitely without degrading capital stocks or, in an important sense, justice with respect to future generations. Even though some mainstream economists believe that human knowledge and technology can substitute for loss of natural capital, ecological economists would question if this could be done rapidly enough to prevent serious environmental degradation in the interim.

Ecologist George Woodwell predicts that a combination of deforestation, climate change, increased organic matter decomposition, and human population increase would lead to serious world impoverishment. In his words:

Could an impoverished world support people? The speculation is not constructive. No one would want to live in such a world, I think, but the world would go on, life would exist, and people would survive, albeit in smaller numbers and with far fewer opportunities. The

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115 Avise, John C., "The Real Message from Biosphere 2," Conservation Biology, volume 8, pp. 327-329 (1994). Avise notes that it cost about $9 million per person per year to support eight Biospherians over two years, with large electrical energy subsidies from outside Biosphere 2.


essential cycles of the major elements for life, carbon, nitrogen, phosphorus, sulphur, oxygen, would continue, driven as they are by microbial processes that are probably sufficiently resilient in the face of chronic disturbance to survive. But the loss of forests would be but the prelude to the loss of higher plants, the impoverishment of agriculture, and the further impoverishment of the earth’s residual populations of higher animals.

Such an earth might support people, but it would not support civilization and the density of human population now present. Nor would it be a pleasant life by most standards.

If the integrity of the global environment is not maintained while using it for human life and activities, impoverishment is likely to be very serious in many parts of the world. People working together to sustain the quality of life in their communities, in concert with and aided by environmental quality regulations, offers a possibility for avoiding this situation.

A Potential Solution: Integration of Ecosystem Management Into Human Communities

Implementation of ecosystem management in the United States will require a willingness to live in a more sustainable fashion and also, for conservation biologists, a much closer concern for the effects of conservation measures on human communities. Jon Roush, a rancher, environmentalist, former member of The (U.S.) Nature Conservancy’s Board of Directors, and president of The Wilderness Society, has said:121

We have seen that problem in the West, where states and counties have asserted local control over federal lands. Legally, their claim is frivolous; psychologically, it is an important expression of frustration. We cannot have local people making unilateral demands on resources of national importance. Yet we also cannot have national policies forced down the throats of local people. We will not escape the dilemma until we create new institutional contexts for decisions about natural resources.

Keiter has noted that because the impetus for ecosystem management is dependent on scientific insight from disciplines such as ecology and conservation biology, some proponents

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121 See Roush, Jon, supra note 65.
believe that scientific experts should tell the public what to do. Yet the concept of ecosystem management is value based and owes much of its currency to societal values concerning biological diversity and species preservation. The most important problem will be to integrate scientific data with public values. As long as humans are part of ecosystems, meaningful participatory decisionmaking must be an essential part of ecosystem management. Serafin and Steedman have even argued that the concept of ecological integrity does not exist outside of human value judgments, unlike, e.g., the concepts of gravity and general relativity.

Community Action Groups

The best chance for implementing the Forest Service type of ecosystem management, i.e., management with a priority to sustain the integrity of ecosystems while producing desired goods and services, may lie with community groups that represent commodity and development as well as preservation interests but which share some ethical values related to biodiversity and the "land." This fits well with the current situation in which the Forest Service has no clear legal mandate to implement ecosystem management and therefore needs to find a socially accepted balance between ecological and commodity objectives. It also fits with the approach of local groups who are using conservation biology principles to promote maintenance of biodiversity through development of regional reserve network plans.


123 Gerlach, Luther P., and David N. Bengston, "If Ecosystem Management is the Solution, What's the Problem?," Journal of Forestry, volume 92, pp. 18-21 (1994).


125 See both articles by Keiter, Robert B., supra note 26.

126 See Swanson, Frederick J., et al., supra note 59.
for The Wildlands Project. For them, the priority of ecosystem management is to maintain natural ecosystem integrity while producing desired goods and services. It may be possible for the commodity-development and natural biodiversity interests to find some common ground in a shared land ethic.

Chapman has described the "place-based" emphasis of community and regional consensus groups that are beginning to spring up in the western United States. Instead of wise use, property rights, and many environmental organizations that promote special interests, the purpose of these consensus groups is to identify and pursue solutions that are in the best interest of their communities. This will usually require compromises because "Nobody expects to get everything they want. Everybody hopes to get more than they would had they not participated. And they hope whatever they get will be more long-lasting." The goal would be for local economies to continue to use the public land resources, so long as their uses are sustainable or restorative. This will require a better understanding by everyone of environmental limits and carrying capacity. Consensus groups suffer from various problems related to lack of authority and funding, including the tendency of the present public land management planning system to encourage individual rather than community responses to environmental issues. Consensus groups, therefore, usually favor decentralization of public agency decisionmaking authority.

To an important extent, the major, shared justification for protecting natural biodiversity among all interest groups is likely to be perceived as ethical and cultural rather than ecological (e.g., ecosystem services) and economic (e.g., commodities). The pleasure of being able to experience a better quality of life, including opportunities to interact with reasonably natural environments, is a major force behind current immigration to the interior.

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127 See Noss, Reed F. (1992), supra note 9.

west of the United States. It is also likely to be an important reason why many "natives" don't want to leave. If the main, commonly shared justification for protecting natural biodiversity is actually ethical and cultural, then management to sustain the integrity of natural ecosystems may well be achieved only by integrating scientific data with human values.

The Man and the Biosphere Program (MAB) of the United Nations Scientific, Educational, and Cultural Organization (UNESCO) represents one of the earliest attempts in the modern environmental age to emphasize the community approach to maintenance of biodiversity. Since its inception in 1971, MAB has promoted the idea that it is possible to achieve a sustainable balance among the conservation of biological diversity, economic development, and cultural values. The main vehicle for demonstrating, refining, and implementing this concept is MAB's international network of biosphere reserves. A biosphere reserve is an internationally recognized area within which the biodiversity characteristic of the ecosystem(s) of a region is preserved and opportunities are also provided for environmental research and education, and for sustainable types of economic development (i.e., development which sustains both the economy and the natural environment).

The biosphere reserve concept has served as a model for innovative attempts by the U.S. Nature Conservancy to protect entire ecosystems from environmental degradation. Protected areas are established within which the most highly-valued biodiversity of a region is concentrated and around or within which people live in "buffer" and/or "transition" zones, where sustainable types of economic activities are encouraged. U.S. examples include the Virginia Coast Reserve on the Atlantic Ocean near the mouth of Chesapeake Bay, a tallgrass prairie in Northeastern Oklahoma, the San Pedro River and Animas Mountains areas of southeastern Arizona and southwestern New Mexico, and the hill country of central


\[^{130}\) U.S. Man and the Biosphere Program, Strategic Plan for the U.S. Biosphere Program (Biosphere Reserve Directorate, U.S. Man and the Biosphere Program, Department of State Publication 10186; available from the National Technical Information Service, Springfield Va., as No. NTIS PB95-101226-1994, 1994).
In all instances, these programs involve working with local citizens, local governments, and often, as well, with corporate and environmental group stakeholders. These efforts are building constituencies of economic and conservation interests through long-term, intensive involvement at the community level.

The Forest Service began to change the way it deals with community issues in the early 1990s. This has evolved from emphasizing "community stability," as linked to sustained commodity yields, to promoting a "rural development" approach. The latter includes working with rural people and communities to develop resource-based ventures that contribute to their economic and social well being. As noted by Bates, this type of planning focuses on enhancing the productive capacity of rural America over the long term and emphasizing that, e.g., "maintaining timber-related employment should be a less important goal than diversifying a local economy and building alternative sources of income and employment."

Bates described initiatives of this sort in Kremmling, Colorado and Dubois, Wyoming, as well as community-based efforts that have been stimulated by nongovernmental organizations, such as the Grand Canyon Trust's involvement on the Colorado Plateau and that of the Wilderness Society in Oregon and Washington.

An initiative begun in 1989 by The Keystone Center of Keystone, Colorado brought a wide array of public and private interests together to consider the problem of conserving, protecting, and restoring biological diversity on U.S. federal lands. The participants in this dialogue concluded that biological diversity is necessary for the continued health and development of humans; current positive, public and private efforts to conserve biological diversity are not completely adequate; federal lands can play a significant role in conservation


132 Bates, Sarah, Discussion Paper: Public Lands Communities (Boulder, Colo.: Natural Resources Law Center, University of Colorado School of Law, Western Lands Report No. 5, 1993). An expanded version of this paper appeared in the Spring 1993 issue of the Public Land Law Review, University of Montana School of Law.

133 Id.

of biological diversity; and the changes needed to sustain biodiversity can be accomplished while allowing significant human use of natural resources on federal lands.

A more recent Keystone initiative is considering how to develop community-based efforts that promote ecosystem management. Meetings in 1995 have been held in Tucson, Arizona (April 21-23); Bangor and Castine, Maine (May 31 - June 2); Seattle, Washington (June 11-13); and San Diego, California (June 27-30). Core members of the Keystone "Dialogue" attended each meeting, during which they usually toured key sites in the region and met with community-based stakeholder organizations. Examples of such organizations include:

1) The Malpai Borderlands group in southern Arizona, which consists of a small number of ranchers and environmentalists who are concerned about landscape fragmentation, declining productivity, and loss of biological diversity associated with encroachment of woody species on grasslands. They meet periodically with personnel from public agencies, The University of Arizona, The Nature Conservancy, and The Animas Foundation.

2) The Yakima Resource Management Cooperative Group, consisting of schools, utilities, agricultural producers, public and private corporations, the Yakima Indian Nation, environmental groups, and governmental representatives. This group is interested in sustainable development, environmental health, and community values in the Upper Yakima River Basin of central Washington.

3) The Natural Communities Conservation Planning Program, involving federal-state-local agencies, developers, environmental organizations, and private citizens. This group is developing habitat conservation plans for a range of species in southern California.

The Keystone Dialogue Group actually met with individuals involved in approximately 30 initiatives in 1995 that were similar to, and included most of, those mentioned above. Examples of important points raised at these meetings are:

- redefining the role of government to give community stakeholders an incentive to launch processes;

- definition of a stakeholder (e.g., a person or group who must be included for a solution to be viable, endure, and persist);

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• the concept of internal stakeholders (dependent on cohesion) and external stakeholders (encouraged to buy into the process);

• support and latitude from superiors for agency personnel who want to be intimately involved in the process;

• the appropriate role for scientists (e.g., less time should be spent on the technical "what is" part of the process and more on "what ought to be," which is not resolvable by science);

• the need for more financial incentives and less legislative disincentives with respect to local ideas that have the potential to improve the environment;

• the use of stakeholders to help in monitoring the results of management activities; and

• the potential value of more professional risk taking within federal bureaucracies on behalf of innovations.

Examples of products considered by the Keystone Dialogue Group as a result of their deliberations are:

1) a report to the U.S. Congress suggesting changes in some federal statutes (e.g., the Federal Advisory Committee Act and the Sherman Antitrust Act) that would facilitate community-agency joint planning; and

2) a report on the potential role of the marketplace in ecosystem management.

Some Policy and Economic Considerations

The recent increase in community-based groups interested in better integration of human values in public land management appears to offer an important means by which federal agencies can obtain guidance with respect to ecosystem management, especially in regard to the balance between managing for natural ecosystem integrity and human needs. This has led some persons to suggest that ecosystem stewardship might be a more appropriate name than ecosystem management, as the former connotes the idea of people having responsibility.\(^{136}\)

\(^{136}\)From a presentation by Gary McVicker to the Colorado Rockies Regional Cooperative in Boulder, Colo., February 23, 1996.
Many locally-dominated decisions of the sort desired by most community action groups would undoubtedly vary in the extent to which they advance natural ecosystem integrity. The approach is risky from that standpoint because it could simply result in a tragedy of the biodiversity commons on a higher spatial scale, e.g., adjoining national forests or BLM resource areas might end up being managed in different ways that would not promote the broad-scale natural or even seminatural integrity of ecosystems. Alternatively, the more successful of these activities on certain land management units might serve as prototypes that would influence their adoption in other units. A somewhat similar approach to managing something as complex as ecosystems has been suggested by Brunner with respect to the U.S Global Change Research Program and its ability to provide useful information for federal policy formation.137 He argued that decentralized policy teams might make the most efficient contributions in this regard. Each team could simplify the national problem by focusing on those scientific projections and sociopolitical considerations that are most important in its own locality over the next few years. Progress would not then depend on reducing scientific uncertainty on a national or global scale but rather on a series of "parallel local actions designed in part to clarify expectations, preferences, and political realities through experience." Whether this would work with natural resources and biodiversity is, of course, unknown but the adaptive management process could serve as a guide.

It is important to note that an underlying philosophy of conservation biology is prudence; i.e., due to uncertainty about the behavior of ecosystems, it is best to err on the side of preservation.138 This is one reason why it would be preferable to have a clear legal mandate for protection of biodiversity as a central requirement of public land management.139 Such legislation would need to accommodate the constitutional rights of

137Brunner, Ronald D., Policy and Global Change Research: A Modest Proposal (Boulder, Colo.: Center for Public Policy Research, University of Colorado at Boulder, Discussion Paper No. 75, 1993); see also discussion on "Creating a Culture of Creativity and Risk-taking" in Yaffee, Steven L., supra note 65.


private property owners. This is a complicated area that concerns the degree to which property owners should be able to use their property without causing harm to other people and the environment. But within those limits, compensation should be provided to landowners who are affected by the need to maintain regional ecosystem integrity and they should not be required to open their lands to public use by people.

A promising way to proceed, then, would be to obtain some broad legislative guidance concerning the importance of biodiversity to the public welfare, within which local community decisionmaking could play a major role. As Noss and Cooperrider have suggested, top-down guidance would provide context, while bottom-up involvement would provide care and local knowledge. Ultimately, the new legislation would need to incorporate a federal endorsement of biodiversity conservation as a major objective of federal land management; i.e., there would need to be a tilt from federal agency anthropocentrism toward a somewhat more biocentric goal for ecosystem management. The legislation could be implemented as broad guidelines rather than strict rules. This would allow managers to deviate from the guidelines if justified by, e.g., compelling local community circumstances.

A method for addressing the negative effect of some current federal statutes on community-agency planning and the potential positive effect of market-based incentives on ecosystem management — priorities identified by the Keystone Dialogue Group — has been proposed by Lippke and Oliver. It would involve a different legislative approach.
that would create an economic tradeoff system. Public and private land managers within a
landscape unit would make competitive bids to a public body charged with using public funds
to protect ecosystem values. A typical bid might be to produce certain forest "structures"
(e.g., stands of certain vegetation types and seral stages) in order to promote both market
(timber) and nonmarket ("ecosystem") values.

Advantages of a competitive bidding process, compared to a strictly regulatory or a
"guidelines" approach, might include:

- removing the need for land managers to cooperate in violation of federal trade laws
  and other statutes;

- encouraging land owners to do things of public value that would not otherwise be
  personally beneficial;

- ensuring that public funds would be spent as efficiently as possible, using a market
  approach to determine the costs involved in producing ecosystem values; and

- producing both market and nonmarket outputs, without substitutions from
  competing suppliers that would contribute to an overall loss of global
  environmental quality (e.g., by stimulating tropical deforestation, oil drilling in the
  Gulf of Mexico and the arctic, and mining of minerals in South America and
  Africa).

A hypothetical example of the above type of market-based ecosystem management for
15,000 acres of existing forest stand structures on nonfederal lands in eastern Washington was
investigated. The analytical results indicated that biodiversity and general forest health
could be increased while incurring management costs that were not much higher than the cost
savings related to creation of new jobs and reduction of unemployment compensation in the
local communities.

Conclusion

Ecosystem management from the perspective of conservation biology is biocentric in
that it tends to place primary emphasis on sustaining the integrity of natural ecosystems. The
U.S. Forest Service view of ecosystem management also places primary emphasis on sustaining ecosystem integrity but favors an anthropocentric approach in which an array of public preferences will determine the extent to which utilitarian (commodities, recreation, etc.) and natural values will be favored.

One important suggestion for implementing ecosystem management is the creation of regional reserve networks for biodiversity, which is popular among many conservation biologists. Another is the U.S. Forest Service’s suggestion for using timber management and other forest practices to mimic historic patterns of disturbance and vegetation on the landscape, in order to help maintain biodiversity while simultaneously providing for traditional multiple uses such as timber, grazing, recreation, and wildlife. These ideas are not mutually exclusive, could potentially be complementary, and are viewed as long-term, very challenging efforts.

Some important political interests do not presently appear to favor either of the above strategies. Nevertheless, compelling scientific evidence from conservation biology argues that failure to apply some sort of ecosystem management type of approach to the remaining natural and seminatural parts of the U.S. landscape will result in the continued loss of natural biodiversity. Even failure to maintain the status quo, which includes only the beginnings of management to sustain natural ecosystem integrity, is likely to cause additional loss of naturalness and result eventually in a "tragedy of the biodiversity commons."

To discontinue implementation of the present Forest Service and other agency goals of producing publicly desired resources within the constraint of sustaining ecosystem integrity is likely to have important ecological effects, regardless of the emphasis placed on naturalness. That is, services such as maintenance of air and water quality provided by the remaining mix of natural, seminatural, and exotic ecosystems are likely to be disrupted. The effect on U.S. welfare would depend in part on the success and cost of the human fixes that would presumably be attempted.

Creation of broad legislative guidelines for maintenance of biodiversity, within which the concern and knowledge of local communities can play a much greater role than previously in determining local and regional land management, offers a potential means of sustaining both ecosystem integrity and local economies. Even this approach is risky with respect to
sustaining natural ecosystem integrity but can, perhaps, be guided by knowledge obtained from the practice of adaptive ecosystem management. The degree to which a meaningful amount of natural biodiversity survives would probably still depend on the degree to which stakeholders in a community share ethical and cultural values related to maintenance of the natural environment. Prospects for success would be strengthened by the extent to which financial incentives could be offered for natural biodiversity maintenance, and by respect for private property rights, so long as the exercise of those rights does not involve loss of natural environmental sustainability.

Whether or not the U.S. public wants to manage ecosystems to maintain their natural integrity, i.e., practice the conservation biology type of ecosystem management, is one of the most important "quality of life" questions that we need to consider. Put slightly differently, we might ask, "Do we want to live in a largely exotic and artificial environment during much of the 21st Century, or in an environment that allows reasonably easy access to native plants and animals in reasonably natural ecosystems and landscapes?" This question needs to be debated openly and actively now, in order that the decision can be made knowingly and intelligently. If this is not done, it seems very likely that, as mentioned previously in this paper, the tragedy of the commons will provide the default answer and it will be "exotic and artificial."

Holmes Rolston has said:

We need wild nature in much the same way that we need the other things in life which we appreciate for their intrinsic rather than their instrumental worth, somewhat like we need music or art, philosophy or religion, literature or drama. But these are human activities, and our encounter with nature has the additional feature of being our sole contact with worth and beauty independent of human activity. . . . Wild nature has a kind of integrity, and we are the poorer if we do not recognize it and enjoy it.

The United States is one of only a few industrialized nations that still retains a large biodiversity commons, and the extent of this diversity, from alpine and arctic to tropical

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biomes, and from forests, grasslands, and deserts to wetland and aquatic habitats, is unsurpassed by any nation in the world. In an important way, this is our last nation frontier. Ecosystem management, as presently visualized by many conservation biologists, offers a rational means of attempting to sustain this national heritage. The following quotation from E.O. Wilson provides an impetus for doing so:  

"The stewardship of environment is a domain on the near side of metaphysics where all reflective persons can surely find common ground. . . . An enduring environmental ethic will aim to preserve not only the health and freedom of our species, but access to the world in which the human spirit was born."