Policy Analysis

Cato Institute Policy Analysis No. 217: Federal Ecosystem Management: A "Train Wreck" in the Making

October 26, 1994

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Executive Summary

The Ecosystem Management Initiative, launched by President Clinton as part of his effort to "reinvent" government, signals a radical departure from past environmental policy. The idea is to avoid what the administration aptly terms policy "train wrecks"--collisions of economic enterprise and environmental preservation--before they occur. The administration seeks to reach that goal by having the federal government manage and protect ecosystems throughout the country.

Analysis shows that the assumptions behind the policy are incorrect. The nation is not facing serious environmental perils requiring drastic new federal policies. The ecosystem concept, while quite useful within the realm of science from which it was borrowed, is inappropriate for use as a geographic guide for public policies. Instead of introducing science into public policy, use of the ecosystem concept interjects uncertainty, imprecision, and arbitrariness.

Federal management of ecosystems would significantly expand federal control of the use of privately owned land and lead to increased restrictions on the use of the nation's public lands for economic purposes. Economic activity and private property rights would be subordinated to ecosystem protection.

The key to minimizing "train wrecks" is the abandonment of existing policies that elevate environmental protection above the pursuit of human welfare. Restoration of policy equilibrium and greater reliance on market forces, rather than further movement toward coercive federal regulations and additional intrusions of the government into land-use decisions, should guide federal actions.

Introduction

As federal actions to protect the environment impose greater and greater economic and social costs on society, a growing number of analysts are searching for ways to amelio- rate the collision of economic and environmental policy goals. Many people have been persuaded that, instead of acting after such a collision has occurred, government would be best advised to act before the fact to ensure that, to the extent possible, conflicts between environmental protection and economic activity are mediated before high economic or environmental costs must be paid. Only by adopting such an approach, proponents argue, can we hope to head off the acceleration of environmental crises that are believed by some to threaten the very future of the planet. Thus, the Clinton administration, intending in part to avoid costly economic and environmental "train wrecks," determined that, as part of its National Performance Review, federal management and protection of ecosystems would henceforth be a cornerstone of American environmental and natural

resource policy.[1]

There can be little doubt about the ambitiousness of the administration's effort, for it aims at nothing less than "reinventing the way the federal government uses and cares for the environment."[2] Ecosystem management is an effort to centrally manage land-use decisions and commercial activity in order to protect and restore the function, structure, and species composition of ecosystems that blanket the entire United States.

The Ecosystem Management Initiative has thus been established by the White House along with the Interagency Ecosystem Management Coordinating Group of 20 federal agencies.[3] Although Congress has yet to pass legislation authorizing creation of the National Biological Survey (NBS), Secretary of the Interior Bruce Babbitt has reorganized the Department of the Interior to create the NBS as a major first step in putting administration policies into practice. President Clinton's budget reflects his seriousness about the matter: the administration requested $610 million for "ecosystem management and biodiversity" in fiscal year 1995, while only $56 million was expended on such activities in FY93. Federal agencies have been directed to interpret "existing authorities as broadly as possible to implement the ecosystem management policy and process."[4]

Ecosystem management, however, is predicated on a number of dubious assumptions that promise to cripple the application of the concept in public policy. The environ mental health of the nation is not in serious jeopardy, and ecosystem management is not a particularly useful tool for addressing environmental stresses that do occur. Nor will the NBS deliver the kind of information necessary to avoid the sort of political "train wrecks" decried by the administration.

Indeed, careful analysis shows that the federal government is incapable of managing and protecting ecosystems throughout the United States and that implementation of such a policy would only exacerbate, not alleviate, the policy "train wrecks" so common under current regulatory practices.

The NBS: Legitimizing Ecosystem Management

The creation of the NBS is the cornerstone of the administration's federal ecosystem management program and is Bruce Babbitt's top priority as secretary of the interior.[5] The NBS is to provide resource managers with the best possible biological science on which to base decisions and to be the "biological underpinning" for ecosystem management.[6] According to the secretary, the information the NBS produces will permit the identification of "biological trends before they become white hot crises" and yield a definitive ecosystem map for the country that can serve the needs of all levels of government and the private sector when faced with economic-environmental conflicts.[7]

The entire United States, including the 70 percent of the nation that is privately owned, would be subject to the NBS and federal ecosystem protection. As noted by Secretary Babbitt, "ecosystems do not recognize political or bureaucratic boundaries."[8]

Neither what is to be surveyed nor the scale at which surveys are to be conducted is clear. Babbitt envisions examination of the status and trends of individual species as well as whole ecosystems in a "systematic biological inventory of the entire nation at an appropriate scale and feasible level of detail."[9] John Sawhill, chief executive officer of the Nature Conservancy, told Congress that mapping should be conducted from the species level (including all vertebrate, invertebrate, and plant species) up through "natural communities and ecosystems" and that the survey should be sufficiently detailed to help with land-use decisions.[10] Other environmental organizations, including the National Audubon Society and the Sierra Club Legal Defense Fund, recommend mapping down to the subspecies level.[11] Scientific societies have further urged that biological surveys include microorganisms.[12] The National Research Council called for study of "terrestrial, freshwater, and marine invertebrates (all classes); plants (bryophytes and vascular plants); macrofungi; and selected fresh-water, marine, and terrestrial invertebrates (mollusks, crustaceans, mosquitoes, beetles, butterflies, moths, spiders, and ticks)."[13]

Yet definitive estimates of the total number of species resident in the United States do not exist, which should give some idea of the challenge presented by the NBS. For instance, Peter Raven, director of the Missouri Botanical Garden, suggested to Congress that perhaps 250,000 species reside in the United States, of which only some 150,000

have been identified.[14] Therefore, even one of the most basic tasks of the NBS--to identify ecosystems--is problematic if for no other reason than the fact that scientists are not even close to a firm count of plant and animal species.

Although the administration has thus far been unable to secure legislation authorizing the NBS, Babbitt has used his authority to establish the survey administratively within Interior.[15] The organization is staffed by some 1,700 personnel shifted from other Interior bureaus, including some 1,180 research scientists from the U.S. Fish and Wildlife Service.[16] The administration requested $179 million for the NBS for FY94 (Congress appropriated $164 million) and $177 million for FY95.[17]

The Assumptions of Ecosystem Management

The charge of the NBS is largely dictated by fundamental assumptions about ecosystem health and environmental management. Many proponents of the NBS, for example, believe that there are critical problems with the U.S. environment that the survey is uniquely positioned to address. Secretary Babbitt, for instance, wrote to Interior staff that the NBS "is designed to save the West," which he views as suffering from a "history of . . . destruction" produced by human use of the land and natural resources.[18] Tom Lovejoy, who served as the secretary's science adviser, chiefly for the purpose of establishing the NBS, believes that "the planet is in the process of falling apart biologically."[19] Environmental groups, including the Sierra Club Legal Defense Fund, the National Audubon Society, the Sierra Club, the Wilderness Society, and Greenpeace, have all written or testified in support of NBS legislation, and their views on environmental conditions are well known.[20] For example, the executive director of the Sierra Club Legal Defense Fund wrote, "Our world is drowning in filth. Garbage covers the land and . . . our cities sprawl beneath skies awash with a brown haze." Each day, he said, brings "new environmental atrocities" leading to "humanity's reckless slide toward environmental suicide."[21] The National Wildlife Federation recently concluded that virtually all aspects of the U.S. environment were getting "worse," and the new executive director of the Sierra Club views the planet as being in such environmental danger that "aspects of the American way of life . . . cannot be sustained." He further singled out the automobile and the single-family suburban home as the most harmful features of the American lifestyle.[22] Only dramatic new policy approaches, such as the NBS and the Ecosystem Management Initiative, are alleged by proponents to provide the government with the information and authority necessary to undertake the environmental rescue mission deemed so necessary.

A second assumption is that general federal management and protection of ecosystems offer the necessary new approach to ensure proper protection of the environment. Ecosystems are envisioned as the on-the-ground organizing principle for the management of federal lands as well as for the application of federal environmental and natural resource regulations that affect privately owned lands (e.g., requirements stemming from the Endangered Species Act or section 404 of the Clean Water Act). Babbitt consistently emphasizes the need for ecosystem-based policies, which he judges to be the "most effective and efficient natural resource management strategy."[23] That approach is part of what he terms a "new land ethic" that calls for a relentless "search for levels and methods of human activity that [are] compatible with the ecosystem."[24]

An inescapable corollary to the assumption that ecosystems offer a sound spatial basis for the application of federal policies is the presumption that ecosystems are discrete entities on the landscape awaiting discovery by the application of science and technology. Ecosystems are assumed to have distinct and identifiable boundaries offering the geographic precision and stability necessary to guide on-the-ground federal actions.

The third assumption behind the NBS is Babbitt's belief that the NBS "will provide the map we need to avoid the economic and environmental train wrecks we see scattered across the country."[25] Because it is held out as a means of avoiding economic-environmental conflicts, the creation of that map is a major lure to attract supporters to the NBS.

A fourth basic assumption underpinning the NBS is that additional information is the key to preventing "train wrecks." According to Babbitt, "The National Biological Survey will unlock information about how we protect ecosystems and plan for the future."[26] He argues that NBS data would be of particular value in sidestepping problems associated with administration of the Endangered Species Act because the survey could identify troubled species before they were listed under the act, and management actions could then be taken before such listing.[27] Presumably, such actions

would be less antithetical to considerations of economic growth and private-property rights than those required under the Endangered Species Act. Many in the scientific community share the view that information is the linchpin of resolving conflicts. For example, Norman Christensen, dean of Duke University's School of the Environment, argues that "we are woefully ignorant of the processes we influence . . . the 'environmental train wrecks' cited by Secretary Babbitt are mostly a tribute to that ignorance."[28]

Analysis reveals, however, that no matter how reasonable those assumptions appear on their face, there is precious little scientific or policy justification for their acceptance.

Our Dying Ecosystems?

It is difficult to sustain the argument that a major new federal environmental initiative like the management and protection of ecosystems throughout the country is justifiable on the grounds that the American environment is either poor or degenerating. There are no national environmental crises gripping the United States or poised to overtake us.[29] On balance, the record shows that the U.S. environment is generally in good shape and getting better.

It would be remarkable if that were not the case, given our nation's vast public and private expenditures (no matter how inefficient those expenditures may have been) on environmental protection and cleanup. The Environmental Protection Agency estimated pollution-control costs for 1993 to exceed $120 billion (1986 dollars), and total costs from 1972 through 1993 were thought to be approximately $1.5 trillion (1986 dollars).[30] The EPA calculated expenditures for pollution control at approximately 0.9 percent of gross national product in 1972 and some 2.5 percent in 1993, an increase of over 175 percent.[31] The EPA analysis is not intended to be all-inclusive. For example, it did not estimate costs stemming from compliance with statutes such as the Endangered Species Act or the National Environmental Policy Act, state or local environmental regulation, or the failure to develop domestic natural resources such as offshore oil and natural gas or the energy resources of the Arctic National Wildlife Refuge.[32] An analysis by Management Information Services, Inc., found that environmental expenditures totaled $170 billion (1992 dollars) in 1992, or 2.8 percent of gross domestic product.[33] According to MISI, spending on environmental protection will exceed the na- tion's total spending on national defense by the year 2000.[34]

Neither the EPA, MISI, nor other regulatory analysts, however, have attempted to calculate secondary environmental regulatory costs such as rent-seeking investments or the myriad opportunity costs associated with regulatory compliance. Studies suggest that those social costs may nearly double conventional regulatory expenditures.[35]

Examination of national environmental conditions from several perspectives reveals that, contrary to the rhetoric of the environmental lobby, environmental quality has been dramatically increasing, not decreasing, over the past 20 years. According to the EPA, the 1990 national ambient air pollutant concentration of each criteria pollutant was below the standards established to protect human health.[36] Moreover, trends in concentrations of those pollutants are all downward for the 1975-90 period. That is not surprising because total emissions dropped by one-third--from nearly 192 million metric tons in 1970 to approximately 127 million metric tons in 1990.[37] That translates into continuing improvements in urban air quality. The EPA reported a decline of more than 50 percent in the cumulative number of days that selected major urban areas experienced air quality that was "unhealthy or worse" between 1981 and 1990.[38] In the Los Angeles area, for example, the number of people exposed to unhealthy levels of ozone has decreased by about 50 percent over the last decade, even though the total population has increased by some 25 percent.[39]

The terrestrial environment, like the air above it, shows no signs of crisis. For example, consider our forests. As a nation, we are long past the time when the clearing of forests was the order of the day, largely because (1) improved agricultural technologies radically reduced the amount of land necessary to produce a given amount of foodstuffs; (2) the advent of the automobile eliminated the need for draft-animal feed, which actually accounted for about a quarter of the agricultural production of American farms; and (3) fossil fuels replaced wood as the chief source of energy.[40] In the contiguous 48 states, the amount of land in forests in 1987 was some 558 million acres (not including forests in parks, wilderness, or wildlife refuges) compared with 578 million acres in 1900.[41] Changes in management policies and the application of technology have yielded increasingly healthy forests. In 1920 almost twice as much wood was removed as was replaced by forest growth. By 1952 growth exceeded removals by 2 billion cubic feet per year, and it has continued to outpace removals.[42] In 1987 the nation's timber volume was some 23 percent greater than in 1952,

with the greatest increases in hardwoods.[43] During the same period, the annual growth rate for softwoods increased by nearly 75 percent and by nearly 65 percent for hardwoods.[44]

Available data suggest that our rangelands are not endangered and that their condition is improving.[45] The Bureau of Land Management within Interior manages most federal rangeland, some 167 million acres in 1992. Approximately 39 percent of BLM rangeland was categorized as in "good" or "excellent" condition in 1992 compared with 17 percent in 1975--nearly a 130 percent increase in the amount of land so rated.[46] While more rangeland was moving into the top two condition categories, less was being found in the bottom classification, "poor." In 1975, 33 percent of BLM rangeland was estimated to be in "poor" condition compared with 13 percent in 1992.[47] The condition of nonfederal rangelands has also improved markedly. Some 33 percent were deemed "excellent" or "good" in 1987 compared with 20 percent in 1963.[48] In 1963 some 40 percent of nonfederal rangeland was thought to be in "poor" condition as opposed to 14 percent in 1987.[49]

The nation also retains a rich biological foundation. On balance, human actions have had little overall impact on species diversity. Peter Raven estimated the number of species of "plants, animals, fungi, and microorganisms" at 250,000.[50] James Williams and Ronald Nowak suggested that the number of vertebrate species that had become extinct in the 50 states since 1492 was 87.[51] The number of species currently listed by the U.S. Fish and Wildlife Service as threatened or endangered is 822, with approximately 300 additional candidate species in category one (meaning there is probably sufficient information available to justify their being proposed for listing as threatened or endangered).[52] Taken together, the number of extinct species plus those listed as threatened or endangered plus those in FWS category one is approximately 1,200, or 0.5 percent of the total number of species estimated by Raven to reside in the United States.

By contrast, the Office of Technology Assessment recently estimated that human actions have resulted in "at least 4,500 species of foreign origin establishing resident populations in this country."[53] Some of those species have been introduced deliberately, and others arrived accidentally. Many clearly benefit society--virtually all our food crops are introduced species--whereas others appear to have little redeeming societal value (e.g., Melaleuca and zebra mussels). All, however, add to the diversity of life in the United States.

Maintenance of our biological diversity should not surprise, given land-use patterns in the United States. In 1987 (the most recent year for which data are available) only about 4 percent of the country--89 million acres--was part of the built landscape, a landscape that includes all cities and towns with at least 2,500 population; all highways, roads, airports, and rights-of-way; and other miscellaneous man-made components of the environment.[54] Croplands, on the other hand, were found to occupy over 20 percent of the country.[55] Yet another 10 percent of America--225 million acres--was permanently protected as parks, wilderness, and wildlife refuges.[56] Finally, there were 648 million acres of forest; 591 million acres of grassland and range; and 247 million acres of desert, tundra, marshes, and other undeveloped land.[57]

Put another way, about 75 percent of America's land base was found to be forests, rangelands, grasslands, parks, wilderness, deserts, marshes, and so forth--broad landscapes widely available for use by other species. Another 20 percent of the United States is cropland, which is available to other species on a more restricted basis. Less than 5 percent of the country is devoted to human construction, which requires other species to adapt to a drastically changed environment in order to survive.

Ecosystems--The Pretense of Knowledge

The ecosystem concept is a research tool intended to aid scientists in better understanding the world of living organisms.[58] It serves that purpose very well, in part because the ecosystem concept is geographically amorphous--a useful attribute in the realm of research but a fatal flaw in the world of people, property, policy, and regulation. Ecosystems in reality are mental constructs fashioned by researchers to forward some particular analysis. A pond can be an ecosystem; so can the territory shared by two species of trees or the space that forms the habitat of an insect or an eagle. Rather than discrete entities, ecosystems are devices of analytic convenience and reflect all the vagaries of research (e.g., project purpose, budget, data availability and quality, and time constraints).

The National Research Council points out that (1) there is no agreed-upon classification system for ecosystems; (2) no

accepted list of core ecosystem attributes exists; (3) protocols for the sampling, measuring, and recording of data are not defined; and (4) scientists cannot predict which species and which interactions are key to determining the makeup and location of assemblages of living things.[59]

The ecosystem concept is unavoidably characterized by geographic fog when actually applied on the ground and should not be used to garb policies in the cloak of science. For example,

1. the location of ecosystems on the landscape is inherently arbitrary, imprecise, and variable over time;

2. ecosystems can vary in size from a back yard to the drainage basin of the Mississippi River;

3. ecosystem boundaries are normally little more than geographic best guesses;

4. ecosystem boundaries are always based on only a tiny fraction of the ecological information about the area they outline;

5. the nation contains a virtually unlimited number of ecosystems and ecosystem patterns;

6. there are no protocols available for selecting any one ecosystem pattern as the "best" for the purpose of guiding federal policies;

7. a given portion of the landscape may simultaneously be in hundreds of different ecosystems, each designated using different criteria; and

8. a given portion of the landscape may be crisscrossed by hundreds of different ecosystem boundaries at the same time.[60]

Those characteristics do not reduce the value of the ecosystem concept as a research tool, but they do render it unsuitable as a guide to federal policies.

It is instructive to examine the characteristics of ecosystems listed above in the light of policy pronouncements and past actions. In a joint hearing on the National Biological Survey Act of 1993, Rep. Jay Dickey (R-Ark.) asked Babbitt about ecosystems.

Mr. Dickey--Good morning, Mr. Secretary. In your mind, what is an ecosystem, how will one be defined, and how will you differentiate one from another?

Secretary Babbitt--Mr. Congressman, to some degree, an ecosystem is in the eye of the beholder.

Mr. Dickey--Is that your answer? Would you like to elaborate?

Secretary Babbitt--I think I would be willing to elaborate, sir. I can put it in specific context. The timber problem and the salmon problem drives you to an ecosystem which essentially runs from the crest of the Cascades to the Pacific Ocean from approximately Puget Sound to the beginning of the Sierra Nevada in California. It is characterized by a lot of the commonalities. Stream drainage is certainly a big one.

Climate. The weather from the Pacific creates a lot of precipitation until it hits the tops of the Cascades and then you are off into the desert. So that is an ecosystem. River basins are a pretty good starting point.

In the case of the Edwards Aquifer in Texas, we were looking at an ecosystem defined by ground water recharge in the limestone hill country of west Texas. In other cases, the dominant thing will be the vegetation communities. Some would say the Colorado Plateau is an ecosystem. Others would vigorously dissent.

I think the essential thing you are looking for is common natural and geographic features that generate a particular set of resources or a particular set of problems or opportunities.[61]

The secretary's statement partially illustrates the geographic chaos associated with trying to depict ecosystems but fails to acknowledge the policy significance. Babbitt refers in general terms to characteristics such as climate, vegetation, and drainage as major factors in determining the location of ecosystems.[62] He gives rough boundaries for an ecosystem that extends from Puget Sound in the north to the northernmost portions of the Sierra Nevada in the south and from the Pacific Ocean in the west to the peaks of the Cascades in the east. In that area there are at least 6 distinct natural vegetation regions (based only on the distributions of selected species of trees) in addition to some 50 separate hydrologic accounting units.[63] Secretary Babbitt did not discuss how the various boundaries of those individual factors were blended into the boundary of the single ecosystem he described. References to a "timber problem and the salmon problem" are not geographically enlightening in anything but broad terms unsuited for directing the placing of lines on maps to determine the spatial extent of an ecosystem.

The secretary's general reference to defining ecosystems by identifying "common natural and geographic features that generate a particular set of resources or a particular set of problems or opportunities" is the usual approach taken by those who create general ecosystem maps. Two widely known maps of ecoregions of the United States have been made, each seeking to identify areas with common characteristics such as those described by the secretary. Tellingly, the pattern of ecosystems they show are noticeably different. Robert Bailey's Ecoregions of the United States divides the coterminous states into 57 regions.[64] James Omernik divides the same 48 states into 103 regions.[65] Their respective ecoregions are dramatically different in size, shape, and location, and both maps have several thousand miles of ecosystem boundaries with little congruency between them.

Not surprisingly, neither Bailey nor Omernik shows an ecosystem running from Puget Sound into northern California and extending from the crest of the Cascades to the Pacific Ocean. On the Bailey map, that area is part of at least four different ecosystems, and Omernik places the area in six separate ecosystems. There is no way to determine if the Babbitt, Bailey, or Omernik map--or any one of the hundreds of other possible ways to divvy up the region into ecosystems--is the "best" way to portray the area for purposes of federal ecosystem management and protection.

The Great Plains Initiative provides a glimpse into the quandaries of ecosystem identification. Conceived by former Kansas governor Mike Hayden, the initiative is a geographically expansive effort at ecosystem management covering all or part of some dozen states from Texas to North Dakota and Iowa to Wyoming. Just where the Great Plains begin or end, however, is a problem that has eluded precise solution for decades, largely because the eastern boundary is notoriously inexact.[66]

Various proposals have been advanced to mark the eastern boundary of the ecosystem to be covered by the initiative, including, "the 94th, 97th, 98th or 100th meridian; . . . the 20-inch or 25-inch precipitation line; the 1,500- foot elevation contour; the former extent of the short-grass or tall-grass prairies; or even I-35."[67] Yet meridians are totally artificial lines having nothing whatsoever to do with the distribution of biota. The 20- and 25-inch precipitation lines (isoheyets) are equally artificial, representing substantial cartographic compromises that transform point data that change yearly into fixed lines on a map. Such lines have little to do with the distribution of living things. Neither does the 1,500-foot contour. The past extent of the short- or tall-grass prairies can only be estimated in general terms, and cartographic renderings of those distributions would be replete with guesswork.

When ecosystem boundaries are drawn for the purpose of dictating land use, their location is of enormous importance. For example, if the 94th meridian were selected as the eastern boundary of the Great Plains ecosystem, all of Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota would be included within the ecosystem, and all their residents would be directly affected by any policies aimed at its management. If the 100th meridian were chosen, the ecosystem boundary would be shifted nearly 340 miles westward, and most of the area (and the overwhelming majority of the population) of those states would lie outside the Great Plains ecosystem so that the land and the people would not be subject to ecosystem management and protection policies.[68]

The Limitations of Ecosystem Maps

It is impossible to create a meaningful ecosystem map for the nation that will permit the avoidance of economic and environmental "train wrecks," given the limitations of maps in general and the weaknesses of ecosystem maps in particular. Integrating the sheer volume of ecological data that proponents of the NBS wish to map as a coherent

whole is a cartographic impossibility. Trying to include vital nonecologic information critical to informed decisionmaking on the train-wreck-avoidance map is an exercise in futility.

Geographers and cartographers have long recognized the limitations of maps, but many others have not, which sometimes results in false hopes for the ability of maps to solve problems. Denis Wood, associate professor of geography at North Carolina State University, notes that by many, "the objectivity of maps . . . is so taken for granted that they serve as powerful metaphors for other sciences, on occasion even for scientific objectivity itself."[69] He writes that "viewers should become better educated about what maps can and cannot do."[70] Mark Monmonier, professor of geography at Syracuse University, proclaims that to combat what he terms the "unhealthy and widespread naivete" of map users, nonspecialists must be made aware that "a single map is but one of an indefinitely large number of maps that might be produced for the same situation or from the same data."[71]

All maps share the following characteristics: they are subjective and biased; they portray only a tiny fraction of the information about the areas they represent; and they are generalizations.[72] The practical needs of cartography dictate that only a small number of variables be illustrated on the map lest it become indecipherable. It is a cartographic impossibility to show every plant in a region, let alone every plant, animal, insect, road, house, factory, field, and so on. Choices must be made about which variables to put on the map and which to leave off. Those choices are subjective and influenced by the bias of the researcher and the biases imposed by the project at hand. More information about the area represented on the map is left off than is ultimately included--by several orders of magnitude. Even the variables that are represented on the map are generalizations (e.g., a housing map of the Los Angeles metropolitan area will not show each house; rather, the map may depict such variables as housing densities, predominant housing types, age, or value).

Ecosystem maps carry additional burdens. Whereas the location of features shown on some maps may be well known--cities, state and county boundaries, highways, and buildings--the location of ecosystem boundaries is often little more than a guess in even the best of circumstances. That is true even if the ecosystem is defined in its simplest terms; that is, by the distribution of a single species.

Consider the case of the grizzly bear population centered in Yellowstone National Park. Estimates of the grizzlies' range are constructed from numerous sources including sightings, radio-collar data, and evidence from the landscape. Those data are of different quality and gathered at different times, yet they must be amalgamated to identify a single ecosystem. As Monmonier cautioned, a very large number of different maps could be constructed from the same data. In nearly all cases, the lines on the map depicting the Yellowstone grizzly ecosystem would be wholly imaginary in that they would have no counterpart on the landscape.

Ecosystem maps are further burdened by the fact that many of the things they seek to depict are in constant spatial flux over time so that an ecosystem map may be out of date before it is printed. A case in point is the northern spotted owl. Few species have attracted so much effort to determine an ecosystem based on their range. The location of northern spotted owls has been dealt with by interagency task forces, the subject of numerous scientific studies and field investigations, examined in environmental impact statements, and addressed in multiple public hearings and voluminous public comments.[73] Yet in spite of that massive effort, the boundaries of what might be called the northern spotted owl ecosystem continue to shift. Previously thought to exist only in old-growth forests, the owl has now been found in substantial numbers in areas that have been logged. Indeed, 600 northern spotted owls have recently been banded on timberlands in northern California that were logged about 70 years ago.[74]

The ecosystem map envisioned by proponents of the NBS will have to be a composite of many factors. Consider, for example, Babbitt's aforementioned desire to include considerations of climate, vegetation, and drainage as well as individual species. There is also, as noted earlier, a widespread desire to map what would ultimately be thousands of species of vertebrates, invertebrates, plants, fungi, and microorganisms. It is reasonable, therefore, to ask how many maps would have to be integrated into the single anti- train-wreck map and whether that could be done in a meaningful way.

Wetland mapping offers insights into the volume of maps associated with the NBS. Wetland ecosystems account for about 5 percent of the land in the conterminous states.[75] They are defined and mapped by considering dominant

species of vegetation as well as soils and hydrology.[76] The distributions of vertebrates, invertebrates, fungi, and microganisms are not considered when delineating the boundaries of wetland ecosystems. Similarly, the distributions of special kinds of biota, such as threatened or endangered species, play no role in identifying wetlands. There is no information concerning the interrelations of biota portrayed on those maps; there are no data on population trends of individual species or on a wide variety of other ecologically valuable factors.

Even with all those informational deficiencies, the administration recently rejected calls for categorizing wetlands by value on the grounds that "simply mapping [wetlands in] the lower 48 States at a scale suitable for . . . regulatory use would involve a mammoth undertaking yielding nearly 14 million maps and costing in excess of $500 million."[77] If 14 million maps are needed to give what is at best a very incomplete ecological picture of only 5 percent of the land in the conterminous states, the number of maps required to cover the entire country in the comprehensive manner envisioned by supporters of the NBS can be expected to be several times greater. The idea that such an enormous collection of maps could then be reduced to a single national "map we need to avoid the economic and environmental train wrecks we see scattered across the country" is without foundation.

As ecologically limited as ecosystem maps are, they are even more constrained in their ability to show the socioeconomic information necessary to reach knowledgeable and balanced public policy decisions. They do not show economic activity, jobs, tax revenues, land ownership and productivity, or numerous other factors that must be considered by policymakers. Many important considerations are not even mappable, for example, the rights of property owners or the wide range of societal benefits that are associated with economic activity.

The Anatomy of a Train Wreck

More science and better information will not ameliorate economic and environmental "train wrecks" as long as the policy playing field remains tilted against fulfillment of legitimate societal aspirations tied to economic growth and private-property rights whenever there is a conflict with environmental goals.[78] The protection of northern spotted owls and wetland ecosystems, as currently required by the Endangered Species Act and section 404 of the Clean Water Act, respectively, provides illuminating case histories of why more science will not prevent future collisions between economic and environmental aims.

Assume that the science concerning the northern spotted owl was perfect. Assume that we knew where every owl could be found at all times, what every owl ate, all about the health of each owl, what was required for each owl to make a maximum contribution to the continuation of the species, the status and condition of future generations of northern spotted owls, and so forth. That knowledge could not have prevented the "train wreck" in the Pacific Northwest because of the policy playing field on which it would have been used.

The Endangered Species Act as currently written requires that activities benefiting humans or aiding in the realization of human aspirations and goals give way to protecting threatened and endangered species.[79] Efforts to protect the northern spotted owl will have significant adverse human consequences. Estimates of job losses vary; however, Benjamin Stevens of the Regional Science Research Institute concludes that more than 80,000 jobs would be lost through implementation of owl-protection measures.[80] Lost jobs translate into lost wages, which annually run into hundreds of millions of dollars, as well as declines in income for local communities.[81] Studies indicate that over 100 communities and counties in Washington, Oregon, and northern California would be severely affected.[82]

Economic harm is only one measure of the human costs imposed by the Endangered Species Act. In its discussion of the social costs of measures to protect the northern spotted owl, the Department of the Interior noted,

Sociological research shows the social costs in timber dependent communities may be heightened by the stereotyping and stigmatizing methods that some groups advocating preservation of owl habitat have employed . . . particularly against loggers. . . . The combination of economic stress and stigmatization can lead to . . . depression and passivity, drug and alcohol abuse, violence and family dysfunction. . . . Sociologists regard such situations as life-threatening traumas that can cause maladaptive behavior patterns that can be transmitted through families for generations.[83]

Ecosystem management, then, would have done precious little to alter the fundamental legal dynamic that has led to the economic "train wreck" about to occur in the timber communities in the Pacific Northwest. Whether the

government acted sooner or later to protect the spotted owl, those jobs would be affected and those communities would be devastated under the Endangered Species Act.

"Train wrecks" in wetlands would not be avoided by better science. Suppose we knew exactly where wetlands were located and had complete understanding of the innumerable interactions among all wetland biota and their physical environment.[84] Absent changes in present policy, that information would not resolve existing conflicts about the use of wetland areas.

Section 404 of the Clean Water Act, the chief legislative vehicle providing for federal regulation of wetlands, requires those who wish to place material in wetlands to obtain a permit from the U.S. Army Corps of Engineers. Within the 404 program, the process known as "sequencing" requires that regulators presume that the preservation of existing wetlands is the highest and best use of land, without regard to the societal benefits that could accrue from its use for other purposes or the costs imposed by permit denial.[85] The act also provides that the EPA may veto any Army Corps permit if, in the sole opinion of the EPA, a veto is necessary to protect the environment. The EPA does not have to consider the human consequences of its action. By design, then, sequencing and the EPA veto establish an unbalanced policy-regulatory playing field responsible for many wetland-related "train wrecks" that cannot be overcome by additional scientific knowledge.

James City County's (Virginia) efforts to provide an adequate supply of water for its residents illustrates the anti-human bias of section 404. The county is located in low-lying coastal Virginia and contains a substantial amount of wetlands. Facing a serious potential water shortage, the county embarked on an extensive effort to develop a replacement for its wells, the levels of which were falling as was the quality of water they yielded. After a decade of scientific studies and millions of dollars in expenditures, the county overcame the sequencing hurdle to the satisfaction of the Army Corp of Engineers, and a 404 permit was issued to proceed with construction of a reservoir. The EPA, however, vetoed the permit, arguing that not all non-wetland-impacting options had been considered--including towing icebergs to the county--and that the reservoir would have too great an adverse impact on the environment.[86]

The county initially prevailed in a court challenge to the veto, but on December 30, 1993, the Fourth Circuit Court of Appeals held that the EPA could use its veto authority without having to consider human costs or the public interest.[87] Even though the court agreed with the county's (and the Army Corps of Engineers') contention that no "practicable alternatives" to the project had been shown to exist, it wrote that under section 404, the EPA's "authority to veto to protect the environment is practically unadorned."[88] Because of the bureaucratic obstacles, cost estimates for the project went from $43.2 million in 1987 to $90.1 million in 1993.[89] So even if the county successfully appeals the EPA decision, the taxpayers of James City County will pay a heavy cost directly attributable to an unbalanced political playing field and regulation run amok.

Not surprisingly, the EPA veto of the James City County reservoir was strongly endorsed by the National Wildlife Federation.[90] It and other national environmental groups in favor of the NBS and federal protection of ecosystems advocate strengthening section 404's restrictions on the human use of wetlands to further tilt the unbalanced playing field against economic activity, the rights of property owners, and human needs.[91]

Ecosystem Management or Federal Land Grab?

Providing the federal government with the authority to centrally manage ecosystems would entail a massive transfer of power from the individual to the state. Federal regulators and third-party activists would inevitably be involved in land-use decisions throughout the nation; since most "ecosystems" are in the hands of private landowners, one could not hope to seriously "manage" ecosystems without "managing" private land use. That would probably occur through the application of a greatly expanded regulatory framework and virtually unlimited opportunities to use or threaten to use litigation if government demands regarding private land-use decisions were not met. Absent capitulation by those favoring economic use of the land and adherence to principles of property rights, the possibility for "train wrecks" is enhanced rather than diminished by embracing the NBS and federal management and protection of ecosystems.

A plethora of federal environmental and resource management legislation already covers the landscape of the United States, albeit in a nonsystematic manner. The Endangered Species Act, for example, applies to publicly and privately owned land but only to the habitat of threatened and endangered species.[92] Section 404 of the Clean Water Act

likewise applies to publicly and privately owned land but only to wetlands. The Coastal Zone Management Act applies only to the coastal zone, the geographic extent of which is determined on a state-by-state basis.

Geographic disjointedness is a major impediment to using federal authority to control land use in a comprehensive manner. Adoption of a policy for federal protection and management of ecosystems overcomes that perceived deficiency because all of the nation's land and water--regardless of ownership, amount or kind of existing or proposed activity, or environmental characteristics--can be placed within something labeled an ecosystem and thus be subjected to an all-embracing regulatory regime.

Ecosystem management has another major appeal for those seeking to use the power of the federal government to influence land-use decisions on private property. Federal landuse dictates are currently constrained by the takings provision of the Fifth Amendment to the Constitution that requires just compensation for land owners.[93] Federal protection of ecosystems, however, offers a way to circumvent the takings problem by invoking the public trust doctrine to protect ecosystems as entities.[94] That doctrine provides that there are certain public trust responsibilities vested in government that cannot be relinquished; that is, there is an affirmative government responsibility to protect the people's common interest in certain resources. For example, David Hunter, a proponent of increased federal controls, wrote recently in the Harvard Environmental Law Review,

The public trust doctrine permits the states to avoid traditional takings inquiries when they are merely fulfilling their obligations as trustees of the public's interest in private lands. The doctrine is important because it empowers states to place onerous regulations on certain lands . . . while successfully avoiding the takings problem. It has a great potential for interjecting [Leopold's] land ethic into property law.[95]

The recent case of a Rhode Island farmer, Bill Stamp, provides a glimpse of the federal-protection-of-ecosystemsas-a-public-trust approach.[96] The land in question had been in the family for four generations. It was a wetland ecosystem and therefore subject to federal protection under section 404 of the Clean Water Act. Taxes on the land had increased from $4,000 to $72,000 annually to reflect the increase in property values associated with the evolution of land use in the area from agriculture to industry. The increased tax burden, however, made farming uneconomic, so the landowner sought to use the land as it was taxed--as a site for industrial development. The federal government refused to grant a permit, leaving the landowner "stuck with the land and the taxes." He felt he should be compensated as provided for by the takings clause of the Fifth Amendment. Jay Hair, president of the National Wildlife Federa tion, disagreed. He commented that "there are certain benefits that accrued to the public at large that transcends [sic] the individual rights" of property owners so that landowners have a "stewardship responsibility" to protect resources "for the public good" without compensation.[97]

The geographic application of the public trust doctrine is currently linked with the notion of navigable waters (including wetlands).[98] However, a case is being built for border-to-border application of the public trust doctrine. Greg Meyers, adjunct professor at Northwestern University's School of Law, writes that the doctrine should apply to "wildlife, and by necessity the habitat it depends upon."[99] David Hunter goes further, arguing that "the public trust doctrine should be . . . expanded to all ecologically important lands [because] our growing understanding of ecology should lead to certain obligations on all landowners in order to protect the public's interest."[100] Justice Stevens, in his dissent in Lucas v. South Carolina Coastal Council (1992), lent support to that view; he wrote that "new learning" and "self-education [produce] . . . changes in the rights of property owners." He found that "new appreciation of the significance of endangered species, the importance of wetlands, and the vulnerability of coastal lands shapes our evolving understandings of property rights."[101] Ecosystem management, then, threatens to radically alter the nature of the relationship between governmental agents and private-property owners by expanding the "public trust" doctrine to justify centrally managed land-use planning.

Conclusion

The administration has wholeheartedly embraced a policy of federal management and protection of ecosystems as the foundation for its environmental and natural resource policies in spite of the fact that the assumptions behind the policy do not stand close inspection. The evidence strongly indicates that the overall quality of the nation's environment is neither bad nor declining; indeed, it is good and getting better. America is simply not in need of environmental

salvation. We particularly do not require excessive new policies that may greatly expand federal intrusion into land-use decisions about private property and increase limitations on the use of federal lands for economic purposes.

Supporters of the administration's policy suppose that because the ecosystem concept comes from science it provides a scientific foundation for the policy itself. In a most unscientific way, however, advocates fail to acknowledge that ecosystems are but shifting, unfocused, and incomplete images of fragments of the landscape. Ecosystems are not concrete features of the environment. Rather, they are mental constructs that appear as a crazy quilt of overlapping and geographically fuzzy areas, the location, size, and shape of which are in constant flux. They do not provide a rational on-the-ground basis for federal land management policies throughout the nation. After all, how can one justify telling a landowner or a land user that some activity will be prohibited because it would occur on the "wrong" side of an ecosystem boundary, when the location of the boundary is geographic guesswork and the ecosystem it delimits is but one of hundreds that could include all or various portions of the area in question?

No amount of new information (however scientifically useful it may be) provided by the NBS can overcome that fatal policy flaw inherent in the ecosystem concept. The latent danger of the NBS is that it can be used to provide an undeserved mantle of science to federal ecosystem management and protection policies. The interactions of thousands of species of living things with all the various components of the physical environment is extremely complex and not well understood. To imagine, as proponents of federal ecosystem management and protection must, that the federal government has the wisdom and knowledge to determine a single set of ecosystems for the nation and precisely locate potentially tens of thousands of miles of ecosystem boundaries, establish agreed-upon and measurable goals for the performance and desired condition of each of those ecosystems in all its complexity, and manage the intricacies of all the natural and human forces that affect the living and nonliving things on the landscape to reach those goals is to credit the federal government with an omniscience that simply does not exist in the real world.

New federal environmental policies must address specific and clearly formulated problems. The NBS mission to help save the West, for example, is not a concise statement of a public policy issue. What is the West to be saved from? What is the West to be saved for? Where is the West? Is all of the West at risk? Is all of the West threatened by the same thing? Numerous such fundamental questions are unanswered. Unfocused policy goals can yield unfocused policy responses that create confusion and undue burdens for those directly affected as well as impose significant economic and other costs on society at large.

The avoidance of economic and environmental "train wrecks" is an admirable goal. The administration--through the NBS and federal management and protection of ecosystems--would attain that goal by placing the economic and property-rights trains on sidings to allow the "Environmental Express" to highball down the track at top speed. However, the real cause of "train wrecks" is inflexible federal statutes that create uneven playing fields whereon the legitimate pursuit of human aspirations is subordinated to environmental protection. "Train wrecks" will be effectively avoided only when economic and environmental goals are harmonized on an even policy playing field that maximizes the use of noncoercive market processes.[102]

Notes

[1] Al Gore, Reinventing Environmental Management, Accompa nying Report of the National Performance Review (Washington: Government Printing Office, September 1993), p. 11. The phrase "economic-environmental train wrecks" has been used extensively by Secretary of the Interior Bruce Babbitt in conjunction with establishment of the National Biological Survey.

[2] Budget of the United States Government, Fiscal Year 1995 (Washington: Government Printing Office, 1994), p. 143.

[3] Agencies include the Environmental Protection Agency, the U.S. Forest Service, the Bureau of Land Management, the U.S. Department of Defense, the U.S. Fish and Wildlife Service, the National Park Service, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Federal Highway Administration, the Bureau of Mines, the Bureau of Reclamation, the Bureau of Indian Affairs, the Minerals Management Service, the National Biological Survey, the Federal Energy Regulatory Commission, the U.S. Depart ment of Energy, the National Science Foundation, the Soil Conservation Service, the Office of Surface Mining, and the National Aeronautics and Space

Administration.

[4] Gore, p. 14.

[5] Bruce Babbitt, testimony, in Hearing on H.R. 1845, the National Biological Survey Act of 1993, before the Subcom mittee on Technology, Environment and Aviation and the Subcommittee on Investigations and Oversight of the House Committee on Science, Space, and Technology, 103rd Cong., 1st sess., September 14, 1993 (Washington: Government Print ing Office, 1993), p. 12.

[6] Ibid., p. 13; and Bruce Babbitt, "Re: Creation of the National Biological Survey," memorandum of March 17, 1993, to cabinet secretaries, White House officials, the president of the National Academy of Sciences, and the director of the Smithsonian Institution.

[7] Ibid.

[8] Babbitt, testimony, in Hearing on H.R. 1845, the Na tional Biological Survey Act of 1993, p. 13.

[9] Bruce Babbitt, statement, in Joint Hearing on the National Biological Survey Act of 1993 before the Subcommit tee on Environment and Natural Resources of the House Com mittee on Merchant Marine and Fisheries and the Subcommittee on National Parks, Forests, and Public Land of the House Committee on Natural Resources, 103rd Cong., 1st sess., July 15, 1993 (Washington: Government Printing Office, 1993), p. 42.

[10] John Sawhill, statement, in ibid., p. 54.

[11] Mark Shaffer, statement, in ibid., p. 71.

[12] American Association for the Advancement of Science, "Resolution in Support of a National Center for Biodi versity," February 18, 1991, p. 177; and American Society for Microbiology, letter to Rep. James H. Scheuer (D-N.Y.) in support of national biological diversity legislation, May 23, 1991, in Hearing on H.R. 585 and H.R. 2082, National Biological Diversity Conservation, before the Subcommittee on Environment of the House Committee on Science, Space, and Technology, 102d Cong., 1st sess., May 23, 1991 (Washington: Government Printing Office, 1991), p. 165.

[13] National Research Council, A Biological Survey for the Nation (Washington: National Academy Press, 1993), p. 70.

[14] Peter Raven, testimony, in Hearing on H.R. 585 and H.R. 2082, National Biological Diversity Conservation, p. 37.

[15] Secretarial Order no. 3173, September 29, 1993.

[16] Staffing of the NBS was laid out in U.S. Department of the Interior, "The National Biological Survey: Integrating Biological Science at the Department of Interior," June 8, 1993.

[17] Bill Clinton, letter to the Speaker of the House of Representatives, April 26, 1994; and Budget of the United States Government, Fiscal Year 1995, Appendix, p. 544.

[18] Bruce Babbitt, "Dear Interior Colleague," letter dated April 1, 1993; "Interior Views--Interview with Secretary Babbitt," Audubon, May-June 1993; and Tom Kenworthy, "The Lord of the Land," Washington Post, January 23, 1994, p. F1.

[19] U.S. Department of the Interior, "Secretary Babbitt Announces Appointment of Tom Lovejoy as Science Advisor," Department of the Interior press release, March 13, 1993; and Chris Smith, "The Natural," New York, April 8, 1991, p. 30.

[20] Mark Shaffer, representing the Wilderness Society, the Natural Resources Defense Council, the Sierra Club, the Environmental Defense Fund, and Greenpeace, testimony, in Joint Hearing on the National Biological Survey Act of

1993. [21] Vawter "Buck" Parker, Sierra Club Legal Defense Fund, fundraising letter, Fall 1992.

[22] "26th Environmental Quality Index: It's the Ecosystem, Stupid," National Wildlife, February-March 1994, pp. 38-45; and "Want to Climb a Mountain?" Sierra, March-April 1993, p. 22. See also J. Michael McCloskey and Carl Pope, "To gether in Time," Sierra, May-June 1992, pp. 96-99, 124-25.

[23] Babbitt, testimony, in Hearing on H.R. 1845, the Na tional Biological Survey Act of 1993, p. 13.

[24] "Bruce Babbitt: Is He Tough Enough to Save the Environ ment?" Rolling Stone, July 8-22, 1993, p. 52.

[25] U.S. Department of the Interior, "The National Biologi cal Survey."

[26] Quoted in House Committee on Merchant Marine and Fish eries, National Biological Survey Act of 1993, Report to Accompany H.R. 1845, 103d Cong., 1st sess., July 27, 1993, Report 105-198, committee print, p. 4.

[27] Babbitt, testimony, in Hearing on H.R. 1845, the Na tional Biological Survey Act of 1993, p. 17.

[28] Norman Christensen, Jr., in ibid., p. 52.

[29] Critics of the arguments presented in this section can point out that looking at the condition of the American environment in the broad strokes used here masks trouble spots and that more can be done to improve the quality of our environment. Although that is true, the presence of environmental trouble spots is not what is driving efforts to legitimize generic federal management and protection of ecosystems. Rather, that ambitious approach is justified on the grounds that major environmental problems national in scope exist and that they cannot be resolved using existing policy tools.

[30] Environmental Protection Agency, Environmental Invest ments: The Costs of a Clean Environment (Washington: EPA, December 1990), table 2-1. The statutes considered in the EPA analysis were the Clean Air Act; the Radon Gas and Indoor Air Quality Research Act of 1986; the Radon Pollution Control Act of 1988 (and earlier, unspecified acts relating to air pollution); the Clean Water Act; the Marine Protec tion, Sanctuaries, and Research Act; the Safe Drinking Water Act; the Resource Conservation and Recovery Act; the Compre hensive Environmental Response, Compensation, and Liability Act; the Toxic Substances Control Act; the Federal Insec ticide, Fungicide, and Rodenticide Act; the Energy Security Act; and title III of the Superfund Amendments and Reauthor ization Act.

[31] Ibid.

[32] Other analysts have found that total hard environmental expenditures are 67 percent higher than the EPA's estimates. See "Environmental Clean-Up Spending May Help Boost Econo my," Journal of Environmental Health 55, no. 3 (April 1993): 55-56.

[33] Although Management Information Services, Inc., calcu lates that direct pollution and abatement control expendi tures were actually $139 billion in 1992 (1992 dollars), MISI accounts for other environment-related expenditures such as global warming research; clean energy technology; utility conservation; demand-side management; and similar federal, state, and local programs not considered by the EPA (excluding, however, government spending on parks, recre ation, and natural resource functions). MISI's figures are particularly striking, given that the firm applauds environ mental regulation as a means of stimulating economic activi ty, so there is no incentive on the part of the firm to "inflate" cost totals to discredit environmental regulation. See Management Information Services, Inc., "U.S. 1992 Envi ronmental Spending Totals 170 Billion and Creates 4 Million Jobs," Washington, December 1992.

[34] Ibid.

[35] Michael Hazilla and Raymond Kopp, "Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis," Journal of Political Economy 98, no. 4 (1990): 853-73.

[36] Environmental Protection Agency, National Air Quality and Emissions Trends Report, annual. The criteria pollut

ants are carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, total suspended particulates, and lead.

[37] Environmental Protection Agency, National Air Pollutant Emission Estimates, 1940-1990 (Research Triangle Park, N.C.: EPA, 1991), p. 2.

[38] Ibid. Cities included are Atlanta, Boston, Chicago, Dallas, Denver, Detroit, Houston, Kansas City, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, Seattle, and Washington, D.C.

[39] James Lents and William Kelly, "Clearing the Air in Los Angeles," Scientific American, October 1993, p. 32.

[40] See generally Indur Goklany, "Sustaining Development and Biodiversity: Productivity, Efficiency, and Conserva tion," Cato Institute Policy Analysis no. 175, August 6, 1992.

[41] U.S. Department of Agriculture, Major Land Uses Data Base; and John Fedkiw, The Evolution of Use and Management of the Nation's Forests, Grasslands, Croplands, and Related Resources, General Technical Report RM-175 (Washington: USDA, Forest Service, 1989), p. 7.

[42] U.S. Department of Agriculture, Agriculture Statistics 1991 (Washington: Government Printing Office, 1991), p. 467; and Douglas MacCleery, American Forests, FS-540 (Washington: USDA, 1992), p. 47.

[43] Ibid.

[44] Ibid.

[45] Data on rangelands are less comprehensive than those on air quality or forests. Rangeland data are subject to some controversy, but the trends they show are supported by the judgments of many rangeland experts and individual empirical studies. The issue is reviewed by B. Delworth Gardiner, "Rangeland Resources: Changing Uses and Productivity," in America's Renewable Resources, ed. Kenneth Frederick and Roger Sedjo (Washington: Resources for the Future, 1992), pp. 123-66. The National Research Council recently termed data on rangelands inadequate in Rangeland Health (Washing ton: National Academy Press, 1994).

[46] Bureau of Land Management, Public Land Statistics--1992 (Washington: BLM, 1993), p. 28; and Council on Environmental Quality, Environmental Quality--22nd Annual Report (Wash ington: Government Printing Office, 1992), p. 299. In 1992 the condition of 11 percent of BLM rangeland was classified as "unknown." For 1992 the categories of "excellent," "good," "fair," and "poor" were relabeled "community," "po tential natural seral," "late seral," and "mild seral," respectively. The definitions behind the category labels, however, remained unchanged so that range judged to be in "excellent" condition in 1991 would have had an ecological status of "community" in 1992.

[47] Ibid.

[48] U.S. Department of Agriculture, Soil Conservation Service, "Summary Report: 1987 National Resources Invento ry," Statistical Bulletin no. 790, December 1989, p. 37. Nonfederal rangeland was estimated at approximately 401 million acres in 1987. In 1987 the condition of 6 percent of nonfederal rangelands was "unknown." Survey methods differ for federal and nonfederal lands so data are not strictly comparable.

[49] Council on Environmental Quality, p. 299.

[50] Raven, p. 37.

[51] James Williams and Ronald Nowak, "Vanishing Species in Our Own Backyard: Extinct Fish and Wildlife of the United States and Canada," in Last Extinctions, ed. Les Kaufman and Kenneth Mallory (Cambridge, Mass.: MIT Press, 1986), pp. 133-37.

[52] As of January 28, 1994. The adequacy of data used for listing species is the subject of controversy; see Robert E. Gordon Jr., "When the 'Best Available Data' is B.A.D.: The Data Error Plague," Resources (Summer 1993): 3.

[53] U.S. Congress, Office of Technology Assessment, "Harm ful Non-indigenous Species in the United States," September 1993, p. 3.

[54] U.S. Department of Agriculture, Major Land Uses Data Base.

[55] Ibid.

[56] Ibid.

[57] Ibid.

[58] A. G. Tansley, a British botanist, is generally credit ed with coining the term "ecosystems" over 50 years ago. Definitions of the term include "dynamic and interrelating complex of plant and animal communities and their associated non-living environment" (U.S. Fish and Wildlife Service, An Ecosystem Approach to Fish and Wildlife Management [Wash ington: U.S. Fish and Wildlife Service, 1994], p. 4); "an interesting collection of organisms and the abiotic [non- living] factors that affect them" (Eldon Enger, Concepts in Biology, 6th ed. [Dubuque, Iowa: William C. Broea, 1991], p. 516); and "a self-sustaining and self-regulating communi ty of organisms interacting with one another and with their environment" (G. Tyler Miller, Living in the Environment, 4th ed. [Belmont, Calif.: Wadsworth, 1985], p. A33).

[59] National Research Council, A Biological Survey for the Nation (Washington: National Academy Press, 1993), pp. 75-77.

[60] These points are discussed in detail in Allan K. Fitz- simmons, testimony, in Hearing on H.R. 1845, the National Biological Survey Act of 1993, pp. 72-95, and in a statement in Joint Hearing on the National Biological Survey Act of 1993, pp. 104-12.

[61] Babbitt, statement, in ibid., pp. 15-16.

[62] Drainage basins are not generally regarded as causal factors in the distribution of biota and are therefore of little value in determining ecosystem boundaries. See James Omernik, "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, March 1987, p. 119.

[63] A. W. Kuchler, "Potential Natural Vegetation--Revised 1985," in National Atlas of the United States of America (Reston, Va.: U.S. Department of the Interior, U.S. Geologi cal Survey, 1985); and Paul Seasber et al., Hydrologic Unit Maps--U.S. Geological Survey, Water-Supply Paper 2294 (Wash ington: Government Printing Office, 1987), pp. 55-58.

[64] Robert Bailey, Ecoregions of the United States (Ogden, Utah: U.S. Forest Service, 1976); and Robert Bailey, De scriptions of the Ecoregions of the United States, Miscella neous Publication 1391 (Washington: U.S. Department of Agriculture, 1980). Bailey melded maps of climate, eleva tion, potential natural vegetation, and soils to determine ecoregions.

[65] Omernik, pp. 118-25. Omernik blended considerations of land surface form, soils, land use, and potential natural vegetation in formulating his ecoregions.

[66] C. Langdon White, Edwin Foscue, and Tom McKnight, Regional Geography of Anglo-America, 5th ed. (Englewood Cliffs, N.J.: Prentice Hall, 1979), pp. 94-95.

[67] Scott Pendleton, "Great Plains Initiative's Twin Goals Aim at Regional Survival Strategies," Christian Science Monitor, May 18, 1993, p. 10.

[68] The approximately 340-mile shift would occur in Kansas; in North America, the distance between meridians decreases as you move toward the north pole and increases as you move toward the equator.

[69] Denis Wood, "The Power of Maps," Scientific American, May 1993, p. 89.

[70] Ibid., p. 93.

[71] Mark Monmonier, How to Lie with Maps (Chicago: Univer sity of Chicago Press, 1991), p. 2. Emphasis in original.

[72] For good discussions of maps and their characteristics, see Wood and Monmonier.

[73] See Draft Recovery Plan for the Northern Spotted Owl (Washington: U.S. Department of the Interior, April 1992).

[74] NBC Nightly News, September 17, 1993.

[75] T. E. Dahl and C. E. Johnson, Wetlands Status and Trends in the Conterminous United States: Mid-1970s to Mid-1980s (Washington: U.S. Department of the Interior, 1991), p. 8.

[76] U.S. Army Corps of Engineers, Wetlands Delineation Manual, Technical Report Y-87-1 (Washington: U.S. Army Corps of Engineers, January 1987).

[77] White House, "Protecting America's Wetlands: A Fair, Flexible, and Effective Approach," August 24, 1993, p. 12.

[78] Folding better science and good data into decision making should be encouraged while recognizing that more information will not ensure good policymaking. For example, concerns about the impacts of the NBS on other governmental programs and responsibilities are highlighted in the testi mony of Bill Horn (Wildlife Legislative Fund of America), Max Peterson (International Association of Fish and Wildlife Agencies), and Rollin Sparrowe (Wildlife Management Insti tute) in Joint Hearing on the National Biological Survey Act of 1993.

[79] The literature on the Endangered Species Act is volumi nous. For a recent synopsis of the act and its consequenc es, see Thomas Lambert and Robert J. Smith, "The Endangered Species Act: Time for a Change," Policy Study no. 119, Center for the Study of American Business, St. Louis, March 1994; Rob Gordon Jr. and James Streeter, "Salamander the Great," Policy Review (Winter 1994): 56-61; Charles Mann and Mark Plummer, "The Butterfly Problem," Atlantic Monthly, January 1992, pp. 47-70; and Brian Mannix, "The Origin of Endangered Species and the Descent of Man," American Enter prise, November-December 1992, pp. 56-63. A concise legal review is provided by Robert Meltz, "CRS Report to Con- gress--The Endangered Species Act and Private Property: A Legal Primer," Congressional Research Service, March 7, 1993.

[80] Benjamin Stevens, Final Report on the Comparative Evaluation of Two Major Studies on the Employment Impacts of the ISC Northern Spotted Owl Conservation Strategy of Wash ington, Oregon, and California (Washington: Regional Science Research Institute for the American Forest Resource Alli ance, 1991), p. 20.

[81] U.S. Department of the Interior, Recovery Plan for the Northern Spotted Owl--Draft (Washington: U.S. Department of the Interior, April 1992), pp. 544-46.

[82] Ibid., pp. 556-57.

[83] Ibid., p. 549.

[84] There is substantial controversy regarding federal wetland policies. They have been the subject of White House task forces in both the Bush and Clinton administrations, numerous congressional hearings, and widespread public debate. The Clinton administration's views are outlined in White House, "Protecting America's Wetlands." For a general review of applicable federal policies, see General Account ing Office, "Wetlands Overview," General Accounting Office RCED-92-79FS, November 1991.

[85] "Sequencing" as applied to the 404 process provides first for the avoidance of wetlands; second, if wetlands cannot be avoided, then impacts must be minimized; third, after minimization, mitigation may be required for

remaining impacts. Steps in sequencing are set out by the Council of Environmental Quality at 40 CFR 1508.20, and their appli cation to the issuance of individual 404 permits is dis cussed in Federal Register, February 15, 1990, p. 5510.

[86] William Ellis, testimony before the Domestic Policy Council's Interagency Wetlands Task Force, Providence, Rhode Island, September 17, 1990, pp. 28-36.

[87] James City County v. EPA (no. 92-2294) (4th Cir., Dec. 30, 1993).

[88] James City County v. EPA, 955 F.2d 254 (4th Cir., 1992), quoted in National Wetlands Coalition, Washington Update, December 1993-January 1994, p. 5; and Randolph Goode, "Need for Water Ruled Not Sufficient for Approval," Richmond Times-Dispatch, January 1, 1994, p. B-5.

[89] "Final Environmental Impact Statement--Ware Creek Reservoir," 1987, p. 2-12, table 12; and James City County, "Capital Improvement Request Form," January 1, 1993.

[90] National Wildlife, June-July 1992, p. 28.

[91] Douglas Inkley, National Wildlife Federation, testimo ny, in Hearing on S. 1114, Reauthorization of the Clean Water Act, before the Subcommittee on Clean Water, Fish eries, and Wildlife of the Senate Committee on Environment and Public Works, 103d Cong., 1st sess., September 15, 1993, S. Hrg 103328 (Washington: Government Printing Office, 1993), pp. 1283-99.

On June 4, 1991, a letter from 101 conservation and other organizations, "Re: Strengthening and Improving Sec tion 404 of the Clean Water Act," was hand delivered to members of the Senate.

[92] The reach of the Endangered Species Act on private lands could be substantially restricted if a March 11, 1994, decision by the U.S. Court of Appeals for the District of Columbia is upheld. In Sweet Home v. Babbitt (no. 92-5255), the court found that FWS regulation defining the word "harm," as found in the statute, to include the modification of habitat (ecosystems) to be invalid.

[93] "[N]or shall private property be taken for public use, without compensation."

[94] See James Huffman, "Avoiding the Takings Clause through the Myth of Public Rights: The Public Trust and Reserved Rights Doctrines at Work," Journal of Land Use and Environ mental Law 3 (1987): 171-212.

[95] David Hunter, "An Ecological Perspective on Property: A Call for Judicial Protection of the Public's Interest in Environmentally Critical Resources," Harvard Environmental Law Review 12 (1988): 316. Also see Alison Rieser, "Ecolog ical Preservation as a Public Property Right: An Emerging Doctrine in Search of a Theory," Harvard Environmental Law Review 15 (1991): 393-434; and James Huffman, "A Fish Out of Water: The Public Trust Doctrine in a Constitutional Democ racy," Environmental Law 19 (1989): 527-71.

[96] MacNeil/Lehrer Newshour, December 17, 1991.

[97] Ibid.

[98] William Rodgers Jr., Environmental Law (St. Paul: West, 1986), vol. 1, p. 158.

[99] Gary Meyers, "Variations on a Theme: Expanding the Public Trust Doctrine to Include Protection of Wildlife," Environmental Law 19 (1989): 728,

[100] Hunter, p. 377.

[101] 505 U.S., ___, 12 S. Ct. 2886 (1992).

[102] See generally Terry Anderson and Donald Leal, Free Market Environmentalism (San Francisco: Pacific

Research Institute, 1989); Taking the Environment Seriously, ed. Roger Meiners and Bruce Yandle (Lanham, Md.: Rowman & Littlefield, 1993); and Economics and the Environment: A Reconciliation, ed. Walter Block (Vancouver: Fraser Institute, 1990).