A Science Agenda and Strategy for the United States National Biological Survey

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Secretary of the Interior Bruce Babbitt clearly described his vision of a modern National Biological Survey in early 1993 when he said:

The National Biological Survey will produce the map we need to avoid the economic and environmental ‘train wrecks’ we see scattered across the country. NBS will provide the scientific knowledge America needs to balance the compatible goals of ecosystem protection and economic progress. Just as the U.S. Geological Survey gave us an understanding of America’s geography in 1879, the National Biological Survey will unlock information about how we protect ecosystems and plan for the future.

In order to produce the information needed to avoid these catastrophic natural-resource-based clashes, the National Biological Survey will have to prepare inventories of the nation’s biological resources to document where we’ve been, monitor dynamic living systems to identify current trends, and conduct biological research to predict future ecosystem behavior. All of this information must be transferred effectively to governmental agencies, the scientific community, and the public if it is to be useful in influencing public and private policies. Decomposing this complex task into its constituent components requires that we predict those trends in biological systems that will conflict with economic development.

Biotic trends

The rapidly increasing human population in the United States, along with evolving national attitudes toward natural resources, drive several major trends in biotic resources, such as those described below. The pervasive unsustainable consumption of “renewable” resources; fragmentation of habitats; human alterations of air, water and soil; and the spread of alien species require immediate attention to avert economic, social, and environmental catastrophe. The National Biological Survey must address these issues and use them to frame an agenda to define the next generation of biological inventories, monitoring programs, and research on ecosystem behavior.

The unsustainable consumption of “renewable” resources drives populations and communities to failure. For ex-
ample, serial depletion of coastal fishery stocks and harvest of ancient forests in the 19th and 20th centuries supported economic development, but seriously eroded the biological productivity on which continued economic productivity depends. California's red sea urchin fishery, currently the state's largest coastal fishery, provides a graphic example. In southern California, commercial and recreational divers sequentially exhausted a series of five abalone species from 1950 to 1980. In the early 1970s, the commercial fishery shifted to a new resource base, red sea urchins, but was forced to expand into new territory in northern California after less than a decade when stocks began to decline in the mid-1980s. Today, the urchin industry must develop new markets for yet another species, purple sea urchins, to "sustain" the fishery. Ironically, it takes 20,000 metric tons of urchins to provide the same economic return as 2,000 tons of abalone, so even greater biological productivity is required to support the economic status quo. Now, with few new forests or fish populations to exploit, we must learn either to restore ecosystem integrity and productivity, or live within the limits of reduced biological productivity.

Land-use practices that fragment habitats erode society's productive resource base when populations and communities collapse from lack of appropriate space, i.e., critical habitat. Habitat fragmentation threatens not only tropical rain forests; throughout North America native ecosystems are being carved into smaller and smaller remnants. Florida's Everglades, the great midwestern prairies, California's Mediterranean ecosystems, dammed river basins, and intensively developed coastal zones are but a few examples of the seriously fragmented habitats in the United States. Habitat alterations threaten migratory birds and fisheries with the loss of critical marshes and estuaries. The loss of wide-ranging predators that require large expanses of continuous habitat alters ecological community structure and function, thereby precipitating and accelerating loss of biodiversity.

Human alterations of air, water, and soil drive ecosystems toward unstable and less-productive states. Pollution can simplify systems either by reducing species outright or the resources available to various populations. Productivity of individuals and ecosystems may be reduced due to contamination of food and water sources. Pollution stress added to variations in natural stresses, such as weather or parasite levels, may bring communities to crisis conditions.

The spread of alien species causes loss of biodiversity and disrupts ecosystem structure and function. The virtual extinction of native birds on Guam caused by introduced brown tree snakes provides a sobering example of the serious ecological consequences of alien species. Alien species introduced by human activities, both intentional and accidental, are wrecking havoc on native Hawaiian flora and fauna, Floridian aquatic systems, and plant communities across the entire nation.

The NBS science agenda

The National Biological Survey's scientific agenda needs to address the trends described above with directed programs, not simply collections of re-
lated projects. Predicting future conditions of biological systems and determining cause-effect relationships to prevent "train wrecks" requires forecasting, based on past trends, information regarding potential conditions (e.g., reproductive efforts, recruitment, and population age structures), and experimental manipulations (research). Putting an astronaut on the moon 30 years ago was relatively easy compared with the task of predicting the future health and conditions of biological resources in America and predicting potential conflicts between their health and human activities. Managing the deterministic physics and engineering processes for space flight is straightforward compared with accurately anticipating the behavior of complex biological systems that are fundamentally probabilistic functions.

Resources and time frames of NBS endeavors need to reflect the magnitude and complexity of its mission. Even though significant national biological inventories and monitoring programs exist, such as the NWI, BEST, and NAWQA, it is not reasonable to assume that all of the required information about biological resources in the United States is currently being collected and only needs requires organizing by NBS so as to be useful. In fact, the methods for collecting much of the necessary information do not yet exist and must be developed by original research on ecosystems and population biology. NBS needs to lead the exploration of ecological restoration, develop ecosystem monitoring protocols, improve understanding of population viability, invent ways to predict ecosystem behavior, and explore adaptive ecosystem management, as well as coordinate the myriad sources of information already in place.

NBS must develop ecological restoration techniques, because we are well beyond the point of merely managing the remaining system fragments to extract the last sustainable yields, or simply reducing impacts, and hoping systems will self-heal. We must learn to restore ecosystem productivity through creative development of original concepts, such as designating marine wilderness to replenish fisheries, achieving better fire prescriptions, and beginning innovative landscape alterations and watershed manipulations. NBS must develop better measures of ecosystem dynamics and processes, i.e., institutionalize techniques to monitor the ways in which populations change over long time intervals and at large geographic scales. NBS must develop a better understanding of population viability to know how populations are maintained and what they require to survive. NBS must develop the ability to predict ecosystem behavior and understand the relationships among environmental conditions and population dynamics. Techniques for making measurements and modeling processes are well-developed for small scales (site or field measurements, plants, small populations, small community models), and very large scales (satellite remote sensing of plant cover, global climate models). However, because many issues require landscape-scale understanding, NBS must develop the means for transferring information among scales. Finally, NBS must develop adaptive management approaches that recognize the experi-
mental nature of ecosystem management.

**National focus**

As Machiavelli warned his prince, a new organization that seeks to change established ways of conducting business has few allies. To overcome this potential handicap, the NBS could use the National Park, Wildlife Refuge, and Wilderness Systems to expand national attention from these highly regarded components of the national heritage to the nationwide plight of biotic resources. Using these exceptional public lands as examples of NBS efforts to emphasize cooperation among agencies and to achieve balanced environmental protection and economic progress will also enhance NBS credibility and relevance with the public. National park managers have long sought to adopt an ecosystem management approach, but rarely have they achieved success until recently. NBS-led research in the parks and refuges, applied to ecosystem management by on-site managers, could effectively demonstrate the advantages of using ecosystem-level research and monitoring to assure sustainable development and avoid environmental "train wrecks" by providing real-life examples of ecosystem management.

The National Park, Wildlife Refuge, and Wilderness Systems are integral parts of American society and its natural resource base. These areas are rapidly becoming islands of quasi-natural habitat in a sea of development. The contrast in resource conditions across park and refuge boundaries intensifies conflict over often-painful local resource allocations. The parks, refuges, and wilderness are environmental microcosms at the leading edge of society. As we learn to "save" the "crown jewels" of our natural heritage, we can learn to sustain development and assure economic prosperity based on long-term environmental stability.

Today, national parks are more than the pleasuring grounds envisioned by their 19th-century American creators. In addition to providing opportunities for outdoor recreation, sources of inspiration, and emotional retreats from stressful modern life, they are also repositories of the nation's heritage of biological diversity. They protect diversity of everything from genotypes and populations to ecosystems and landscapes. America's wilderness areas are remnants of native ecosystems that may serve as measures of environmental and economic soundness that help set societal goals for sustainable development. National parks are also focal points for public and scientific concerns, and have historically supported scientific activities with their existing infrastructure.

If the pioneers of the National Biological Survey focus on the National Park, Wildlife Refuge, and Wilderness Systems as they chart a course to help the nation balance environmental protection with economic progress, they will not only resolve critical issues for these special areas, they will also help realize the potential of wildlands to resolve society's broader environmental issues and produce truly sustainable economic development.