Biological Diversity on Federal Lands

Report of a Keystone Policy Dialogue

KEYSTONE CENTER

United States Department of the Interior

NATIONAL PARK SERVICE
P.O. BOX 37127
WASHINGTON, D.C. 20013-7127

IN REPLY REFER TO

N2623(490)

2 1 JUN 1991

Memorandum

To: Directorate, Field Directorate, and Superintendents

From: ACTING Director

Subject: Keystone Policy Dialogue on Biological Diversity

After 2 years of deliberations, the Keystone Policy Dialogue on Biological Diversity on Federal Lands has been completed with formal release of a final consensus report. I strongly urge you to read the attached report, consider its findings, and examine your own programs with respect to the report's recommendations.

You will find the report provides many ideas regarding conservation of biological diversity in the United States. It:

- gives us a definition:
  biological diversity is the variety of life and its processes, including the variety of living organisms, genetic differences among them, and communities and ecosystems where they occur.
- identifies the problem facing biological diversity:
  actual and threatened extinctions of genotypes, populations, and entire species; loss of plant and animal habitats; spread of exotic species; and loss of natural biological communities.
- suggests a national goal:
  to conserve, protect, and restore biological diversity on federal lands to sustain the health of the ecological systems, to provide for human well-being, and because of the intrinsic value of biological diversity.
- encourages federal agencies to coordinate and cooperate:
  in conducting program evaluation, inventory, monitoring, research, data management, information transfer, planning, and budgeting activities that respond to the recommended goal.

As you assess the applicability of the report to your individual management situations, I encourage you especially to consider Chapter IV and Appendix C. I believe these two sections are especially relevant to park management decisionmaking.

The National Park Service co-sponsored, and actively participated in, the dialogue that led to this report. I have asked Associate Director Gene Hester to review the report and to take into account any comments received from throughout the Service. I would appreciate your providing comments directly to Gene so he can develop a draft action plan for review by August 1, 1991.

Attachment

United States Department of the Interior

NATIONAL PARK SERVICE
P.O. BOX 37127
WASHINGTON, D.C. 20013-7127

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

N16(490)

SEP 8 1989

Memorandum

To: Regional Directors
WASO Directorate

From: Associate Director, Natural Resources

Subject: Update on Service Participation in the Keystone Center Dialogue on Biological Diversity

On April 14, I sent you information on the initiation of the Keystone Dialogue on Biological Diversity and on the Service's participation in that Dialogue. Since then, the Dialogue has sponsored an additional plenary session and two working group meetings, the results of which I am summarizing here for your information.

The first of the working group meetings was the May 22 meeting of the Policy and Coordination Work Group, which was held to exchange information about those existing policies, programs, and activities of the Dialogue's member organizations which are supportive of the protection and maintenance of biological diversity. As background for this meeting, the Service submitted Chapter IV of the Management Policies, a staff paper discussing the Service's mandate with respect to biological diversity, and a summary of existing Service activities that relate to four objectives established by the Dialogue (see attachment).

The second of the working group meetings was the June 5-6 meeting of the Data and Research Work Group, which was held to continue the development of the group's work plan regarding inventory, monitoring, and research aspects of protection of biological diversity. The group took advantage of its Denver meeting site to engage in a half day field trip to Rocky Mountain National Park to meet with park research staff, to observe some examples of research on biological diversity preservation concerns that is being conducted by Service and cooperator scientists, and to learn first hand the reality of some of the constraints that may limit the practical application in the field of concepts that the Dialogue may be developing in the abstract.

The second plenary session, held July 10-12, carried out the following steps. It received reports on each of the previous work group meetings. It split the Policy and Coordination Work Group into an Agency Policy Work Group and a Coordination Work Group, and conducted sessions of all of the work groups. It reexamined the scope of the Dialogue in response to concerns raised as a result of the various work group discussions and reaffirmed that the Dialogue purpose is to focus initially on programs and

activities of major federal land management agencies on federal lands as they affect biological diversity, with an added recognition that federal agencies will need a broad perspective. It scheduled a separate meeting of each work group in September and the next plenary session for November.

At this stage of its development, the Dialogue has passed through the phase of introductions of what the various agencies are doing and now is actively generating ideas and new ways of viewing biological management situations. I expect this brainstorming phase to extend through several more sets of meetings.

F. Eugene Hester

Attachment

KEYSTONE CENTER NATIONAL POLICY DIALOGUE ON BIOLOGICAL DIVERSITY

THE NATIONAL PARK SERVICE ROLE

Baseline information report prepared by William Gregg and John Dennis
Wildlife and Vegetation Division
15 May 1989

I. OBJECTIVE: MANAGE ECOSYSTEMS AND SPECIES TO SUSTAIN VIABLE POPULATIONS OF NATIVE PLANTS AND ANIMALS THROUGHOUT THEIR GEOGRAPHIC RANGE

Internal Policies: The National Park Service relies on natural ecological and evolutionary processes to regulate species populations to the greatest extent possible. Specific policies, approved in 1988, are in effect for management of migratory animals, fisheries, threatened or endangered species, and exotic species; pest management; restoration of species populations and ecosystems; harvesting of species; and use of fire as a management tool.

Regulations: Maintaining viable populations of native species is one purpose of regulations promulgated for controlling resource uses and human activities within parks. Regulations are based on NPS generic enabling legislation, other legislation relating to specific influences (e.g., mining), and legislation establishing purposes and allowable uses for individual NPS areas.

Planning Process: Each park has a Resource Management Plan which identifies influences affecting park biota as well as inventory, monitoring, research, protection and management needs. These plans provide the basis for programming all park natural resource projects. A Servicewide assessment, updated periodically, identifies national priorities based on Resource Management Plan needs and special studies of issues of Servicewide importance.

Activities: Research and management programs for maintaining ecosystems and their genetic resources are implemented to carry out the provisions of park Resource Management Plans.

Data Bases: National data bases exist for park flora (NPFlora) and endangered and threatened species (TEX) occurring in NPS areas. A national data base on park fauna (NPFauna) is being developed beginning with vertebrates. An ethnobotanical data base is operational at Great Smoky Mountains National Park and a protocol for developing a national data base is being developed. A cumulative effects model is used to assess potential impacts to the Greater Yellowstone Area grizzly bear population. Most parks individually have checklists, biological collections, and data bases on biological diversity.

Cooperative Arrangements: The NPS participates in interagency cooperative agreements or programs to coordinate management of endangered and threatened species (e.g., grizzly bear, Florida panther, spotted owl), to control exotic species (e.g., weeds in south Florida, gypsy moth in Virginia and West Virginia, exotic plants in Hawaii), and develop species data bases (e.g., with The Nature Conservancy). Many research projects

are conducted through cooperative agreements with universities. Of the 20 natural resource oriented Cooperative Park Studies Units now existing, 13 have permanent NPS staff, and most have senior university scientists as designated contacts. Cooperative programs with state natural resource agencies also provide coordinated research on, and management of, selected fish and wildlife populations.

Policies for Non-Federal Lands: Existing policy requires that all available authorities be used to ensure that lands within park boundaries are protected. Each park must have a Land Protection Plan that identifies the minimum interests required to protect park resources, including natural ecosystems and native species, and to provide for ecologically compatible visitor activities. Available land protection tools include acquisition of either fee interests or less-than-fee interests, and cooperative approaches, such as agreements, regulations, zoning, and other measures short of acquisition. NPS has no authority to directly regulate uses outside park boundaries, and so relies on cooperative approaches to achieve management objectives related to biological diversity.

Resources Allocated: The FY 1989 budget for all park-oriented natural resource programs is $59.7 million and 953 FTE, and includes inventory, monitoring, research, protection, restoration, and management activities for individual species, ecosystems, and air, water, and geological components of these ecosystems.

II. OBJECTIVE: MANAGE DISTINCT BIOLOGICAL COMMUNITIES, ECOSYSTEMS AND THEIR PROCESSES TO MAINTAIN REPRESENTATIVE EXAMPLES OF ALL HABITATS AND LINKAGES OF SPECIES AND COMMUNITIES ACROSS REGIONAL LANDSCAPES

Internal Policies: See I above. NPS policy is to maintain natural processes responsible for the continuing evolution of natural ecosystems and to restore elements that have been lost as a result of previous human activities. NPS generally does not seek to maintain successional communities in natural zones of parks as a biological diversity conservation purpose, but may seek to maintain successional communities in cultural zones of parks as an historic scene conservation purpose. Development of new policies for the purpose of maintaining representative examples of ecosystems at various successional stages is being discussed, in part as a response to the effects of increasing regional (e.g., habitat fragmentation, pollution) and global (e.g., climate change) influences.

NPS policy also encourages the use of special designations in parks to encourage protection, monitoring, research, and cooperation in conserving outstanding examples of selected ecosystems (i.e., World Heritage Sites, RAMSAR sites, natural landmarks, research natural areas, wilderness areas, NPS portions of biosphere reserves).

Regulations: See I.

Planning Process: Each park has a General Management Plan that provides the strategy for integrating the park into its regional context, and for developing appropriate cooperative programs relating to conservation and use of park ecosystems and their genetic resources. The Man and the Biosphere Program (MAB) provides a powerful tool for stimulating voluntary cooperation on scientific, educational, and demonstration activities at the regional landscape level. NPS is cosponsoring several studies to determine the feasibility of developing bioregional interagency MAB programs. Integration of biosphere reserve concepts within a park General Management Plan is being tested in a pilot project now underway at Organ Pipe Cactus National Monument.

Activities: Cooperative programs that support conservation of plant and animal communities in regional landscapes and that integrate NPS areas into their surrounding biogeographical landscapes are being implemented in several areas, including the Greater Yellowstone Area, the Virgin Islands, and the Southern Appalachians. The NPS-administered National Natural Landmarks Program identifies biological communities of national significance and obtains periodic assessments of their protection status.

Data Bases: Regional and subregional data bases that can support application of concepts of conservation science to design of cooperative monitoring, research, management, and educational programs are being developed in cooperation with other agencies. Examples include a regional data base for the Flathead River watershed including parts of Glacier National Park and adjacent British Columbia to assess impacts of proposed coal mine development; a regional inventory of St. John and adjacent British Virgin Islands to provide a basis for monitoring of coral reef communities; a regional geographic information system (GIS) in the southern Appalachians to assess the status of ecosystem conservation in protected areas; and a GIS to assess boundary effects at Organ Pipe Cactus National Monument. Park-based GISes now being developed or planned will routinely include ecological community classifications that frequently will extend slightly beyond park boundaries.

Cooperative Arrangements: Interagency agreements have been used to establish cooperative regional arrangements to carry out several programs mentioned above (Greater Yellowstone Coordinating Committee, Southern Appalachian Man and Biosphere Cooperative, and Virgin Islands Resource Management Cooperative).

Policies for Non-Federal Lands: Emphasis is on developing cooperative regional programs, with MAB as a potentially promising aegis, and on increasing the role of national natural landmark designation as a biological diversity conservation tool.

Resources Allocated: See I. Additionally, the National Natural Landmark Program is allocated $168,000 and 4 FTE.

III. OBJECTIVE: MANAGE THE GENETIC RESOURCES AND DEMOGRAPHICS OF DESIRED SPECIES TO SUSTAIN HUMAN WELL-BEING

Internal Policies: NPS policy is to maintain genetic resources in naturally evolving ecosystems for their intrinsic value rather than for utilitarian purposes. Park management emphasizes non-consumptive uses except where consumptive uses are allowed by law. NPS policy discourages active manipulation of genetic resources, except to mitigate adverse effects of prior human activities (e.g., genetic manipulation to maintain the genetic viability of artificially small populations). Introduction of nonnative genetic resources into natural ecosystems is normally prohibited, except in certain carefully designed integrated pest management programs for controlling nonnative pests, in restoration programs involving nearest genetic relatives of extirpated species, in cases of improved varieties of native species when the native varieties cannot survive under current, human-impacted environmental conditions, or when the introduction is legally mandated. NPS policy on revegetation of disturbed areas requires the use of locally derived native species to the greatest degree practicable. Collection of park genetic resources for research and development, including ex situ propagation, is restricted to purposes that identifiably depend on park genetic resources for their success.

Regulations: Specific regulations govern the collection of park genetic resources for research and ex situ applications. Subsistence uses, when allowed by law, are regulated to minimize effects on ecosystem processes while maintaining benefits to indigenous people.

Planning Process: Park Resource Management Plans identify research and management needs for projects involving park genetic resources.

Activities: A process for coordinating collection of park genetic resources with ex situ facilities will be included in an ongoing collections management plan for Great Smoky Mountains National Park as a pilot biosphere reserve demonstration project. An ongoing Servicewide inventory of cultivars in NPS orchards may identify potentially economic plant genetic resources. Ethnobotanical surveys in several parks will provide information useful for identifying species having potential economic or cultural significance. Research to support cooperative management of subsistence uses is underway in several parks. Genetic characterization of a few selected species is being developed to provide information for research and management purposes.

Data Bases: Park ethnobotanical data bases (see I), national data base on cultivars of orchard species found in parks.

Cooperative Arrangements: A memorandum of understanding with the Soil Conservation Service on mutual development of native plant materials for use in revegetation. The Cooperative Park Studies Unit at the University of California at Davis has a program on the biology of small populations.

Policies for Non-Federal Lands: N/A

Resources Allocated: Limited. Less than $200,000 annually.

IV. OBJECTIVE: MANAGE HUMAN ACTIVITIES AND PROMOTE AWARENESS TO SUSTAIN BIOLOGICAL DIVERSITY AND ITS USES AND TO SUPPORT POLICIES AND PROGRAMS FOR ITS CONSERVATION

Internal Policies: Visitors are encouraged to pursue inspirational, educational, and recreational activities related to park resources and significant values in ways that do not harm or degrade such resources or values except as authorized by law. In keeping with this policy, NPS seeks to foster understanding and appreciation of the biological diversity values of parks and to develop public understanding of park programs for preserving park resources through in-park interpretive programs and outreach educational efforts with local communities and constituencies.

Regulations: Human uses of park lands are regulated in accordance with the above policy.

Planning Process: Strategies for providing compatible uses of parks and identification of major interpretive themes and infrastructure requirements are included in the park's General Management Plan, and specified in detail as needed in specific action plans. Existing issue-oriented programs include public education on atmospheric pollution (field program initiated in 1988) and biological diversity (being implemented this year). Future programs may include wetlands and global change issues.

Activities: The NPS Biodiversity Education Program has conducted Servicewide training on biodiversity issues, has produced an annotated bibliography of references and available media, and has prepared a comprehensive manual for park interpreters that includes background papers, fact sheets, and sample educational programs. In progress are a brochure, a biodiversity slide repository, various audiovisuals, curriculum modules for schools, and cooperative educational programs on international linkages involving migratory shorebirds and neotropical song birds.

Data Bases: Annotated bibliography on references and media.

Cooperative Arrangements: Cooperating National Park Associations publish and distribute written and other media on park biological resources and biological diversity. An NPS - Ohio State University cooperative agreement provides for joint development of educational media and programs.

Policies for Non-Federal Lands: N/A

Resources Allocated: The total current budget for all interpretive activities in park units is approximately $48 million and 2100 FTE. An additional $13.5 million and 235 FTE are alloted for development of interpretive media. About $50,000 is currently allocated for development of specific materials for the Servicewide Biological Diversity Interpretation Initiative. About 16,000 volunteers assist in NPS interpretive programs. Substantial park resources are used to promote public awareness of biological diversity issues as part of of the overall NPS interpretive program.

Briefing Statement
April 26, 1991

Subject: Consensus Report on the Keystone Dialogue on Biological Diversity on Federal Lands

Background: The Keystone Center recently published the results of a two year multi-disciplinary dialogue on biological diversity on federal lands. Membership in this dialogue included personnel from federal agencies, Congressional staffs, environmental organizations, commodity organizations, private industry, and academia. Although supported by their parent organizations, members of the dialogue acted individually, not as representatives of their organizations.

Content of the Report: The report argues that conservation of biological diversity is an important issue which requires comprehensive, coordinated interagency approaches to management programs. It suggests that these programs should include identified indicators of success that can help people understand what is desired and when the desired conditions are being achieved. It recommends that the objective of maintaining biological diversity should be applied to all federal lands. It recognizes that the achieving of its recommendations may require additional funding and personnel.

More specifically, the report recommends that each federal land management agency and each agency conducting activities on federal lands should pursue strategies cumulatively to meet all of seven related objectives. These objectives include:

- Maintain viable populations of the nation's native plants and animals well distributed throughout their geographic range.
- Maintain natural genetic variability within and among populations of native species.
- Maintain representative examples of the full spectrum of ecosystems, biological communities, habitats and their ecological processes.
- Implement management solutions at the landscape level which integrate human activities with the conservation of biological diversity.
- Increase scientific understanding of biological diversity and conservation.
- Achieve public awareness and understanding of biological diversity.
- Enable and encourage the private sector to develop and apply innovative approaches to the conservation of biological diversity.

In addition, the report recommends that agencies should develop and implement mechanisms for coordination, including forming a Federal Biological Diversity Policy and Coordination Committee.

The report provides specific discussion and recommendations on such program topics as maintaining viable populations of native species; maintaining genetic variability; maintaining ecosystems, biological communities, habitats, and ecological processes; integrating conservation of biological diversity with other human needs; increasing scientific understanding; achieving public awareness and understanding; and encouraging private sector involvement. The report also provides information about the five federal land managing organizations, including the National Park Service, that are responsible for managing most of the federal land holdings.

To establish the basis and urgency of its recommendations, the report also provides information on the importance of biological diversity, the problems that impede conservation of biological diversity, the criticality of federal lands to maintaining the nation's biological diversity, and the imperativeness of recognizing the role of humans in efforts to conserve biological diversity.

The naturalist Aldo Leopold spoke of conservation as a state of harmony between humans and the land; a harmony that recognizes that people depend on the wealth of a healthy land community and that they have an ethical obligation to be wise stewards of that natural wealth. Leopold also spoke of people as members of the land community rather than as masters or conquerors of nature.

Final Consensus Report of the Keystone Policy Dialogue on Biological Diversity on Federal Lands

April 1991

The Keystone Center is a private, non-profit organization providing services in two programmatic areas: 1) the Keystone Science and Public Policy program which facilitates the resolution of national public policy conflicts through the use of a consensus dialogue approach and, 2) the Keystone Science School which provides residential natural science education programs for students of all ages with emphasis on sound scientific understanding of nature and our relationship to the environment.

Additional copies of this report may be obtained for $20.00 from:

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Executive Summary

■ Introduction

Biological diversity is a key part of a healthy land. The ultimate challenge facing a growing human population is to meet its material needs while maintaining a diverse, productive, and resilient living environment. This challenge will force a shift in the attitude that one must decide between people and nature, and instead calls for solutions that blend people with nature. Such solutions will draw upon the entire landscape. Both lands and management practices are key elements in meeting the goal of a biologically diverse world that sustains human well-being.

Beginning in the spring of 1989, about sixty individuals from a diverse cross section of groups and organizations concerned about the conservation of biological diversity on the nation's federal lands came together to formulate consensus recommendations. Their efforts focused on the biological diversity programs of the major federal land management agencies (Bureau of Land Management, Department of Defense, Fish and Wildlife Service, USDA Forest Service, and National Park Service). Among the Dialogue participants were individuals from federal agencies, Congressional committee staffs, environmental organizations, commodity groups, professional associations, and academia.

The Dialogue participants found that:

1. **Biological diversity is necessary** for the continued health and development of humans because it supports the integrity and resilience of ecological systems and for its intrinsic value.

2. **In spite of the numerous positive federal, state and private efforts underway, present efforts to conserve biological diversity are not completely adequate.** Loss of biological diversity, nationally and internationally, continues and the rate of loss of components of biological diversity is increasing. This loss can have direct, significant adverse impacts on humanity.

3. **Federal lands can play a significant role in conservation of biological diversity in the United States.** Biological diversity in the U.S. cannot be totally or adequately conserved just on federal lands; for example, some ecosystems are not represented in federal holdings. However, changes in federal land policies and practices can have a significant positive impact.

4. **The changes necessary to achieve biological diversity goals and objectives can be accomplished while allowing significant human use of natural resources on federal lands.** A variety of uses, many frequently competing among each other, occur on federal lands. These uses must continue to sustain human well-being, although the degree, extent, frequency, timing, magnitude, or location of these uses may change as a result of efforts to conserve biological diversity.

It should be a national goal to conserve, protect, and restore biological diversity on federal lands:

- **to sustain the health of ecological systems;**
- **to provide for human well-being; and**
- **because of its intrinsic value**

The Dialogue group believes that in order to conserve, protect, and restore biological diversity on federal lands, biological diversity needs to become an important issue on agency agendas.

The Dialogue group did not reach consensus on how to ensure that biological diversity is an important consideration for federal agencies. Some believe that sufficient legislative authority and administrative direction already exist and that conservation of biological diversity has already become or is in the process of becoming an important consideration in federal agency planning. Others believe that federal agencies need a clear signal from elected officials, through either an executive order or legislation, that maintaining biological diversity is an important public policy objective that should be vigorously pursued.

The Dialogue group agreed that coordination among federal agencies that manage federal lands as well as with and between those federal agencies whose activities affect biological diversity on federal lands is critically important. The Dialogue group determined early in its deliberations that the organizational and procedural elements in support of coordination need to be as simple and straightforward as possible.

Bearing this in mind and given the need to signify the importance of the biological diversity issue, the Dialogue group developed the following recommendations regarding policy and coordination on biological diversity for federal agencies.

■ Recommendations

It should be a national goal to conserve, protect and restore* biological diversity on federal lands:

— to sustain the health of ecological systems;
— to provide for human well-being; and
— because of its intrinsic value.

* (Note. The Dialogue group does not think that biological diversity can or should be restored in every instance or in every place where it has been depleted. However, there are site specific instances where restoration of depleted biological diversity is feasible and appropriate.)

To implement this goal:

1. Federal agencies responsible for managing federal lands should conserve biological diversity within the context of their mission.

2. Federal agencies should recognize that conservation of biological diversity is an important, integral element of wise land stewardship.

3. Each federal land management agency should evaluate how its programs address biological diversity and determine what steps are needed to minimize impacts and maintain and restore biological diversity on its lands.

   Agency evaluations should include at least the following programs as they relate to biological diversity:

a. inventory, monitoring, research, data management and information transfer;

b. training and public information;

c. management activities;

d. agency accountability and public involvement; and

e. budget development and allocation.

4. Each federal agency conducting research or other activities affecting lands managed by federal agencies should review such activities and evaluate how such activities further the maintenance of biological diversity on federal lands.

5. Each federal land management agency and each agency conducting research or other activities on federal lands should pursue strategies aimed at accomplishing the following objectives and, as necessary, develop or modify its policies, programs, and/or regulations to meet the objectives. These objectives are cumulative in the sense that achieving one alone, or achieving one at the expense of another, is not enough. The objectives are:

To the greatest extent practicable, through wise stewardship:

a. Maintain viable populations of the nation's native plants and animals well distributed throughout their geographic range.

b. Maintain natural genetic variability within and among populations of native species.

c. Maintain representative examples of the full spectrum of ecosystems, biological communities, habitats and their ecological processes.

d. Implement management solutions at the landscape level which integrate human activities with the conservation of biological diversity.

e. Increase scientific understanding of biological diversity and conservation.

f. Achieve public awareness and understanding of biological diversity.

g. Enable and encourage the private sector to develop and apply innovative approaches to the conservation of biological diversity.

6. Coordination/Cooperation: Agencies should develop and implement mechanisms to ensure coordination and cooperation in:

a. evaluation of agency programs;

b. completion of a comprehensive inventory of biological diversity on the federal lands within ten years using available and appropriate inventory methodology;

c. monitoring, research, data management, and information transfer;

d. land and related resource planning and regional ecosystem management;

e. reporting and program accountability;

f. budget and program development; and

g. developing a strategic plan and priorities for action.

7. A Federal Biological Diversity Policy and Coordination Committee should be appointed by the President to provide guidelines and coordination for the agencies as they pursue this national goal.

The Federal Biological Diversity Policy and Coordination Committee should be appointed by the President and the following should be members:

— Chairman, Council on Environmental Quality (CEQ)

— The Secretary of the Interior

— The Secretary of Agriculture

— The Administrator of the Environmental Protection Agency

— The Secretary of Defense

— The President's Science Advisor

— The Secretary of Commerce

8. The Committee should:

a. Review laws[1] regulations, policies and land management programs which encourage or promote activities and uses on public lands that are inconsistent with national policy on biological diversity;

b. Coordinate appropriate inventories of biological diversity, ensuring that agencies initiate a national assessment of what major elements of biological diversity on federal lands are and are not protected. (This should take full advantage of the Nature Conservancy's Heritage Program, the National Wetlands Inventory, Resources Planning Act Assessment, Resources Conservation Act Appraisal, and Environmental Assessment and Monitoring Program, and allow for full implementation of the U.S. Fish and Wildlife Service's Gap Analysis Project.) The Committee should report to the President on the findings within five years after the Committee is established.

c. Evaluate ways to encourage and facilitate direct citizen participation in the preservation of biological diversity, including:

— incentives to enlist the private sector as partners in national policy on biological diversity;

— market strategies that channel economic interests in the direction of national policy on biological diversity; and

[1] The Dialogue group did not discuss any particular laws.

— opportunities for citizens to implement activities and uses on public lands which contribute to national policy on biological diversity.

d. Seek outside scientific expertise in evaluating and developing agency programs and actions with respect to biological diversity.

9. This Committee, one year from the date of its establishment and annually thereafter, should prepare a report to the President on the state of biological diversity on federal lands, the summary of which should be published in the annual report of the CEQ. The first report should set forth the evaluations and reviews performed by affected federal agencies, the administration and should detail proposed actions to address deficiencies. The Committee should also provide opportunities for citizen input and inquiry in conjunction with the release of each annual report.

I. Purpose and Scope for the Dialogue

Conservation of biological diversity has emerged in the last few years as a significant issue on the national environmental agenda. Concerns about biological diversity have generated a great deal of discussion about the nature and extent of the problem domestically and about potential solutions. The Keystone Center was asked by many of the interests involved to provide a forum where a diverse cross section of groups and organizations actively concerned with the biological diversity issue could come together to 1) formulate consensus recommendations, 2) clarify areas of disagreement, and 3) produce a final report summarizing the group's deliberations. The Keystone Center organized the Keystone National Policy Dialogue on Biological Diversity to provide such a forum. As a neutral, third-party convener, The Keystone Center's role in the Dialogue was to identify participants for inclusion in the process, work with the participants to develop the Dialogue agenda, convene and facilitate the Dialogue sessions, and produce the final report.

The Dialogue group focused on programs and activities of major federal land management agencies as they affect biological diversity on federal lands. The decision to focus on the federal land management agencies evolved from the fact that federal lands encompass one-third of the nation's land area and that federal lands and their wealth of resources comprise a major network of public areas to sustain much of the biological diversity of the nation while meeting needs for natural resources. Specifically, the Dialogue was oriented toward the Bureau of Land Management, the Department of Defense, the U.S. Fish and Wildlife Service, the U.S.D.A. Forest Service, and the National Park Service.

The Dialogue participants recognized that many other agencies and landowners play a significant role in conservation of biological diversity. They also acknowledged that while the federal government can address the issue of biological diversity most directly on the public lands,

The Dialogue Scope:

Programs and activities of major federal land management activities as they affect biological diversity on federal lands.

The Dialogue Participants:

- **federal agencies**
- **Congressional committees**
- **environmental organizations**
- **commodity groups**
- **professional associations**
- **academia**

documentation of the magnitude and distribution of the features of biological diversity cannot be achieved without inventory and monitoring of natural biological communities and ecosystems on a national scale.

The Dialogue participants included individuals from federal agencies, Congressional committees, environmental organizations, commodity groups, professional associations, and academia. The list of participants is included in Appendix A. Participants attended as individuals, not as formal representatives of their respective organizations. The consensus process was one in which all participants agreed to strive toward the development of recommendations that, taken as a whole, addressed everyone's respective interests. The significance of their names on this final report is that they, as individuals, agreed that they could support the package of recommendations outlined in the report. Support of the report does not signify that each and every recommendation was the first choice of every participant.

The audience for this report includes Congress, the federal land management agencies, the administration, and other groups, both private and public, that have a stake and interest in the biological diversity issue.

II. Introduction

■ What is Biological Diversity?

Biological Diversity is the variety of life and its processes . . . it includes the variety of living organisms and the genetic differences among them and the communities and ecosystems in which they occur.

— In the simplest of terms, biological diversity is the variety of life, and its processes; and

— It includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.

Because biological diversity is so complex, and much of it is hidden from our view, unknown, or both, it is necessary to establish means of addressing its distinct and measurable parts. (See Figure 1). Most basic of these is genetic variation. Genetic variation within and between populations of species affects their physical characteristics, viability, productivity, resilience to stress, and adaptability to change.

A second, more easily recognized aspect of biological diversity is distinct species. Some species, such as American elk, rainbow trout, and ponderosa pine are plentiful. Others such as the red cockaded woodpecker, Siler's pincushion cactus, or grizzly bear, have populations that are much reduced or may even face extinction. Conserving biological diversity includes perpetuating native species in numbers and distributions that provide a high likelihood of continued existence.

Associations of species are a third element of biological diversity. These associations are often called biological communities, usually recognized as distinct stands, patches, or sites, such as old-growth forests, riparian areas, or wetlands. Communities form the biotic parts of ecosystems. The variety of species in an ecosystem is a function of its structural and functional characteristics and the diversity of its ecological processes, and the physical environment.

Figure 1

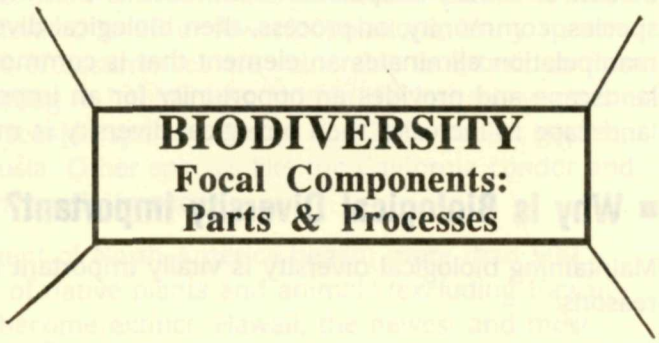
Biodiversity Focal Components: Parts & Processes

GENETIC DIVERSITY

- **Diversity within & among populations**

SPECIES POPULATIONS

- **Recovery**
- **Visibility**
- **Productivity**
- **Sustainability**



COMMUNITIES - ECOSYSTEMS

- **Richness**
- **Structure**
- **Composition**
- **Function**

LANDSCAPES - REGIONS

- **Variety**
- **Pattern**
- **Connectedness**
- **Resilience**
- **Integrity**

Finally, at large geographic scales — from watersheds to the entire biosphere — biological diversity includes variety in the kinds of ecosystems, their patterns, and linkages across regional landscapes. It is from these large, regional landscapes, such as the Southern Appalachian Highlands, Sierra Nevada, and Northern Continental Divide, that people must derive sustainable yields of resources while perpetuating multiple intact examples of biologically diverse ecosystems.

This hierarchy of the parts and processes of biological diversity is admittedly artificial, and it has a distinct human context. However, it provides a focus for a concept that is infinitely varied and dynamic and that must be addressed in light of the full spectrum of human needs and aspirations.

Because different species of plants and animals utilize different stages of biological community succession, maximizing the number of successional stages can increase the number of species within a given tract of land. Any habitat manipulation involves a trade-off between species that benefit from the change and those that do not. Whether this increase in local species richness represents an increase in overall biological diversity is a question of geographic scale. Understanding the importance of scale is critical to accurately assessing the impacts of various activities on biological diversity. If the species that are harmed by a given management action are rare or more imperiled than the ones that benefit or if the manipulation eliminates one of the few occurrences of a species, community, or process, then biological diversity is reduced. If the manipulation eliminates an element that is common elsewhere in the landscape and provides an opportunity for an imperiled element in the landscape to increase, then biological diversity is more secure.

■ Why is Biological Diversity Important?

Biological Diversity is Important For:

- **integrity and resilience of ecological systems**
- **critically needed medicines**
- **improved resistance of our food, fiber and ornamental species**
- **intrinsic value**
- **variety and interest**

Maintaining biological diversity is vitally important for the following reasons:

— It supports the integrity and resilience of ecological systems on which humans depend; it provides the genetic variation necessary for the continued evolution of new forms of life, for life's response to climatic changes, agricultural and silvicultural changes, desertification, etc.;

— It is the source of many critically needed medicines; about one-half of all prescription medicines are derived from living biota, yet only a small percent of species have been screened for medically useful properties;

— It makes possible, through the use of wild relatives and genetic engineering, the improved resistance of our food, fiber, and ornamental species to pests, disease, drought and other threats, increased productivity, and discovery of new food crops;

— Its intrinsic value; and

— It adds variety and interest in our daily lives, thereby enhancing our appreciation and aesthetic enjoyment of nature.

■ What is the Problem?

Conservation of biological diversity has become an environmental issue because of the actual and threatened extinction of many species of plants and animals, and disappearance of habitats. Currently, there is a large and growing number of species recognized to be in danger of extinction. The increased number of threatened and endangered species indicates a loss of genetic variability and a decline of natural communities.

Species extinction is only the most extreme manifestation of the loss of biological diversity. Biological diversity declines with the loss of genotypes or populations, reductions in the distribution and abundance of species, and the elimination or degradation of natural communities. Some populations of wild species have already vanished. Natural communities that once covered immense areas have been largely reduced to fragments with questionable futures. For example, the tallgrass prairie once covered 400,000 square miles in the midwestern United States. Less than one percent remains.

In recent years, media attention has primarily focused on the loss of biological diversity in tropical rain forests. Nevertheless, a number of populations and native habitats in the United States have disappeared or are in danger of disappearing. Data collected by state Natural Heritage Programs across the U.S. show that some 3,000 vascular plants and 350 vertebrate animals are limited to 20 or fewer populations. Many species with these low numbers of occurrences are vulnerable to extinction from landscape changes resulting in habitat loss. Within the last ten years, the U.S. has lost the dusky seaside sparrow, Kauai o'o, Goff's pocket gopher, and the Amistad gambusia. Other species like the California condor and black footed ferret survive only in zoos.

Since European settlement of North America began, more than 500 species and subspecies of native plants and animals (excluding Hawaii and Puerto Rico) have become extinct. Hawaii, the newest and most imperiled state, has lost half of its endemic birds and hundreds of plants and invertebrate species. The number of U.S. species on the federal endangered species list has reached almost 600; another 4000 are considered at risk. Both the absolute number and rate of extinctions are rising, largely because of the growing demand by people for natural resources. Moreover, extinction is only the most extreme manifestation of the loss of biological diversity — for every species that vanishes, countless populations and unique gene pools are also extinguished. Both the number and rate of extinctions are rising.

There are many threats to biological diversity. Foremost among them are the rapidly growing human population, the increasing demand of this population for natural resources, and the conversion and degradation of natural habitats to meet human demand. Biological diversity is also threatened by over exploitation of species, pollution, and toxic chemicals, habitat fragmentation, desertification, the spread of exotic species, potential climate change, and the simplification of ecosystems and gene pools.

In many instances, individual action or government policy has resulted in habitat loss. In other instances, biological diversity has been diminished

The Problem:

- **actual and threatened extinctions**
- **disappearance of habitats**
- **loss of genetic variability**
- **decline of natural communities**

by human actions taken without considering long-term consequences. In specific instances natural phenomena can lead to extinction. Natural and human caused disturbances can act together, worsening each other's effect on biological resources. For example, human interference with natural hydrological processes can exacerbate the biological impact of a drought; air pollution can intensify the impact of a disease outbreak; and fragmentation of habitat can divide populations of species so that they are vulnerable to extinction from otherwise normal fluctuations in their populations.

The loss and deterioration of native habitats in the U.S. presages an increase in the number of species and populations that will be threatened in coming years. It is estimated in *The Parade of Passing Species: A Survey of Exterminations in the U.S.* (Opler, 1976) that during the Ice Age, North American bird and mammal species were lost at the rate of about three per century. Now, worldwide, about one species is lost per hour, according to E.O. Wilson in *Biodiversity* (1988). One prediction (Norman Meyers in *Tropical Forests and Their Species*, 1984) is that by early in the twenty-first century, several hundred species will be lost per day worldwide. According to the U.S. Fish and Wildlife Service, more than half of the wetlands ecosystems originally found in the U.S. have been lost or converted. Prior to colonization, 221 million acres of wetlands are estimated to have been found in the contiguous U.S.; less than 106 million acres remain. Many other ecosystems in North America are threatened by habitat conversion. For example, as noted in a 1986 Office of Technology Assessment Report entitled *Status and Trends of Natural Ecosystems in the U.S.*, long leaf pine wire-grass communities have declined by as much as 98 percent since presettlement times, from about 40 percent of the southeast coastal plain region to about 0.7 percent of the region today.

■ Why are Federal Lands Important to Biological Diversity?

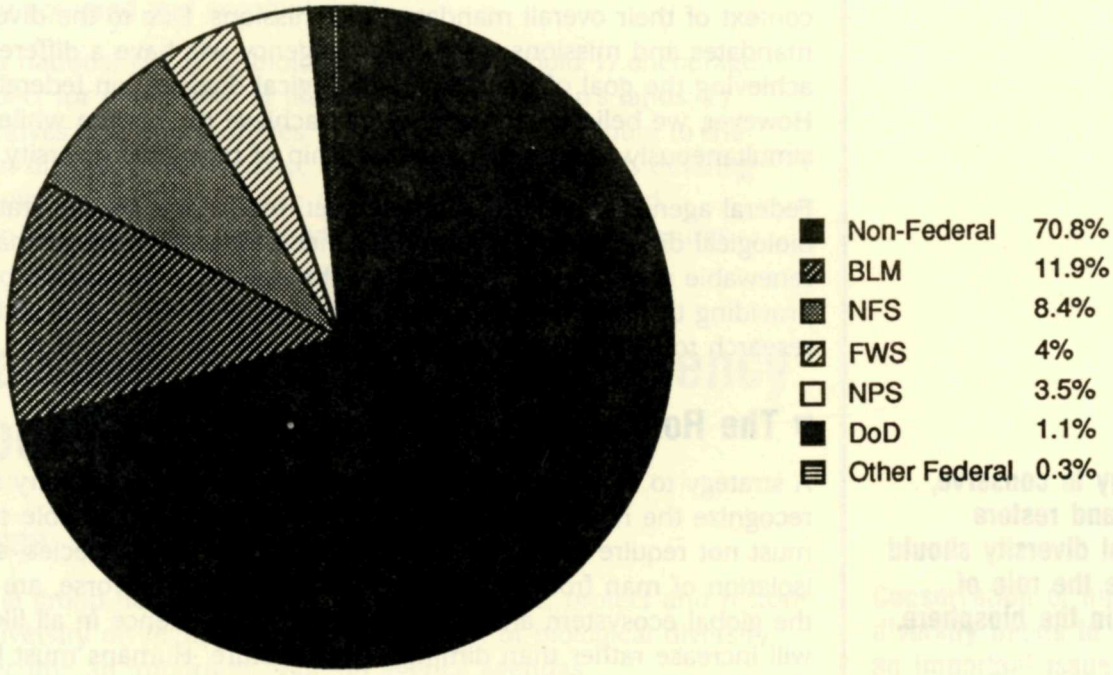
Federal lands comprise one-third of the nation's land area.

Federal lands comprise one-third of the nation's land area. (See Figure 2.) They contain more than half of all the wildlands, deserts, alpine areas, and shrublands in the country and more than one-third of all federally listed endangered or threatened species. In addition, they contain about one-third of the nation's commercial forest land. The diversity of habitats and species on federal lands places federal land management agencies in a key role for the future of such elements of biological diversity as genetic variation in commercially valued tree and fish species, threatened or endangered species, old-growth forests, alpine and tundra ecosystems and contiguous habitats for migratory birds and mammals.

The federal lands and their wealth of resources comprise a major network of public areas which contribute to and sustain much of the biological diversity of this nation while meeting our people's needs for natural resources. While the federal government can address the issue of biological diversity most directly on the public lands, it is acknowledged that inventory and monitoring of natural biological communities and ecosystems must be completed on a national scale. And while the focus of this Dialogue was on the federal land management agencies, the

Figure 2

Land Ownership in the 50 States



	million acres	*% of 50 States*	*% of Federal lands*
Non-Federal	1609	70.8%	n/a
BLM	270	11.9%	40.8%
NFS	191	8.4%	28.8%
FWS	90	4.0%	13.6%
NPS	80	3.5%	12.1%
DoD	25	1.1%	3.8%
Other Federal	6	0.3%	0.9%

Dialogue participants recognized that the conservation of biological diversity will ultimately involve many other entities besides those agencies.

The policies and programs of federal land managers are dictated by a wide array of statutes, regulations, executive orders, and demands of the user public. These influences are constantly changing. The land management agencies must balance the varied demands for natural resources in a manner consistent with the particular agency's mandates as well as the mandates that apply to all agencies.

Conservation of biological diversity should be appropriately integrated into the full array of federal agency management programs within the context of their overall mandates and missions. Due to the diverse mandates and missions, each federal agency will have a different focus in achieving the goal of maintaining biological diversity on federal lands. However, we believe each agency can achieve its mission while simultaneously improving its stewardship of biological diversity.

Federal agencies can also help interpret, teach, and demonstrate biological diversity concepts and the need for sustainable management of renewable resources. This can occur through field demonstrations, providing technical assistance to the private sector, and conducting research to fill gaps in knowledge.

■ The Role of Humans In the Solution

A strategy to conserve, protect, and restore biological diversity should recognize the role of humans in the biosphere.

A strategy to conserve, protect, and restore biological diversity should recognize the role of humans in the biosphere. An acceptable strategy must not require the separation of people from other species, or the isolation of man from nature. Humans, for better or worse, are a part of the global ecosystem and their presence and influence in all likelihood will increase rather than diminish in the future. Humans must be part of the solution.

Economists are predicting that demand for wood products in the United States will increase by 50 percent over the next five decades. During the same period, world demand is expected to double. Our situation regarding petroleum is equally significant. We are currently importing about eight million barrels of oil per day or about 50 percent of our domestic consumption at a cost of 50 billion dollars annually. Imports are projected to worsen with domestic consumption increasing at one to two percent per year while domestic production falls at three to five percent per year. These trends are being fueled by global human population growth approaching two percent per year.

Improved conservation of raw materials and integration of commodity production techniques with other biological values provide reasonable and necessary solutions.

An ecologically sound strategy for conserving, protecting and restoring biological diversity must begin at all levels of our society. Conservation of biological diversity, if it is to succeed as a national policy on federal lands, must begin and end in the wise stewardship of the nation's lands.

While people will continue to need and to enjoy the use of natural resources, social and economic policies, plans, and actions will be needed to reconcile that fact with the imperative of conserving biological

diversity. Those policies, plans, and actions may in some instances entail "preservation." However, an acceptable strategy to maintain biological diversity has to include consumptive use of the resources. Indeed, in some instances, human uses will serve to promote biological diversity. The challenge, therefore, is to find strategies that serve these dual purposes.

The immediate challenge is to include a constructive role for humans in a national policy dedicated to maintaining biological diversity on the nation's lands. Such integration is necessary and must be recognized if the long-term goals and objectives of conserving biological diversity are to be widely accepted and accomplished.

Therefore, a national policy of biological diversity should 1) encourage human respect for the variety of life forms on the nation's lands; 2) create incentives and opportunities for all people to contribute to the conservation of biological diversity; and 3) allow people with differing values and visions to play a role in the use, management, and conservation of the nation's lands and their rich biological treasures.

III. National Policy and Inter-Agency Coordination

■ The Issue

The Dialogue group believes that in order to conserve, protect and restore biological diversity on federal lands, conservation of biological diversity needs to become an important issue on agency agendas.

Conservation of biological diversity needs to become an important issue on agency agendas.

The Dialogue group did not reach consensus on how to ensure that biological diversity is an important consideration for federal agencies. Some believe that sufficient legislative authority and administrative direction already exist and that conservation of biological diversity has already become, or is in the process of becoming, an important consideration in federal agency planning. While recognizing that this is true others believe that federal agencies need a clear signal from elected officials through either an Executive Order or legislation that maintaining biological diversity is an important public policy objective that should be vigorously pursued.

The Dialogue group agreed that coordination among federal agencies that manage federal lands as well as with and between those federal agencies whose activities affect biological diversity on federal lands is critically important. The Dialogue group determined early in its deliberations that the organizational and procedural elements in support of coordination need to be as simple and straightforward as possible.

Bearing this in mind and given the need to signal the importance of the biological diversity issue, the Dialogue group developed the following recommendations regarding policy and coordination on biological diversity for federal agencies.

It should be a national goal to conserve, protect, and restore biological diversity on federal lands:

- **to sustain the health of the ecological systems;**
- **to provide for human well being; and**
- **because of its intrinsic value.**

■ Recommendations

It should be a national goal to conserve, protect, and restore* biological diversity on federal lands:

— to sustain the health of ecological systems;

— to provide for human well-being; and

— because of its intrinsic value.

* (Note. The Dialogue group does not think that biological diversity can or should be restored in every instance or in every place where it has been depleted. However, there are site specific instances where restoration of depleted biological diversity is feasible and appropriate.)

To implement this goal:

1. Federal agencies responsible for managing federal lands should conserve biological diversity within the context of their mission.

2. Federal agencies should recognize that conservation of biological diversity is an important, integral element of wise land stewardship.

3. Each federal land management agency should evaluate how its programs address biological diversity and determine what steps are needed to minimize impacts and maintain and restore biological diversity on its lands.

   Agency evaluations should include at least the following programs as they relate to biological diversity:

   a. inventory, monitoring, research, data management, and information transfer;

   b. training and public information;

   c. management activities;

   d. agency accountability and public involvement; and

   e. budget development and allocation.

4. Each federal agency conducting research or other activities affecting lands managed by federal agencies should review such activities and evaluate how such activities further the maintenance of biological diversity on federal lands.

5. Each federal land management agency and each agency conducting research or other activities on federal lands should pursue strategies aimed at accomplishing the following objectives and, as necessary, develop or modify its policies, programs, and/or regulations to meet the objectives. The objectives are:

   To the greatest extent practicable, through wise stewardship:

   a. Maintain viable populations of the nation's native plants and animals well distributed throughout their geographic range.

   b. Maintain natural genetic variability within and among populations of native species.

c. Maintain representative examples of the full spectrum of ecosystems, biological communities, habitats and their ecological processes.

d. Implement management solutions at the landscape level that integrate human activities with the conservation of biological diversity.

e. Increase scientific understanding of biological diversity and conservation.

f. Achieve public awareness and understanding of biological diversity.

g. Enable and encourage the private sector to develop and apply innovative approaches to the conservation of biological diversity.

Because these objectives are very broad, they need to be translated into specific guidance for managers working 'on the ground.' To that end, for several of the objectives described above, the Dialogue group developed more specifically focused "field objectives." The group also developed a set of management strategies to achieve each objective. The recommended field objectives and management strategies are detailed in subsequent sections of this report.

The objectives are cumulative in the sense that achieving one objective alone will not suffice; they should be pursued in combination. Achieving one alone, or achieving one at the expense of another, is not enough. This is true for the field objectives as well as for the more generalized objectives listed above.

6. Coordination/Cooperation: Agencies should develop and implement mechanisms to ensure coordination and cooperation in:

   a. evaluation of agency programs;

   b. completion of a comprehensive inventory of biological diversity on the federal lands within ten years using available and appropriate inventory methodology;

   c. monitoring, research, data management, and information transfer;

   d. land and related resource planning and regional ecosystem management;

   e. reporting and program accountability;

   f. budget and program development; and

   g. developing a strategic plan and priorities for action.

7. A Federal Biological Diversity Policy and Coordination Committee should be appointed by the President to provide guidelines and coordination for the agencies as they pursue this national goal.

   The Federal Biological Diversity Policy and Coordination Committee should be appointed by the President and the following should be members:

Objectives:

- **Viable populations**
- **Genetic variability**
- **Ecosystems, communities, habitats, and ecological processes**
- **Integrate human activities**
- **Scientific understanding**
- **Public awareness and understanding**
- **Private sector involvement**

— Chairman, Council on Environmental Quality (CEQ)

— The Secretary of the Interior

— The Secretary of Agriculture

— The Administrator of the Environmental Protection Agency

— The Secretary of Defense

— The President's Science Advisor

— The Secretary of Commerce

8. The Committee should:

   a. Review laws[1] regulations, policies, and land management programs which encourage or promote activities and uses on public lands that are inconsistent with national policy on biological diversity;

   b. Coordinate appropriate inventories of biological diversity, ensuring that agencies initiate a national assessment of what major elements of biological diversity on federal lands are protected. (This should take full advantage of the Nature Conservancy's Heritage Program Act, the National Wetlands Inventory, Resources Planning Act Assessment, Resources Conservation Act Appraisal, and Environmental Assessment and Monitoring Program, and allow for full implementation of the U.S. Fish and Wildlife Service's Gap Analysis Project.) The Committee should report to the President on the findings within five years after the Committee is established.

   c. Evaluate ways to encourage and facilitate direct citizen participation in the preservation of biological diversity, including:

      — incentives to enlist the private sector as partners in national policy on biological diversity;

      — market strategies that channel economic interests in the direction of national policy on biological diversity; and

      — opportunities for citizens to implement activities and uses on public lands which contribute to national policy on biological diversity.

   d. Seek outside scientific expertise in evaluating and developing agency programs and actions with respect to biological diversity.

9. This Committee, one year from the date of its establishment and annually thereafter, should prepare a report to the President on the state of biological diversity on federal lands, the summary of which should be published in the annual report of the CEQ. The first report should set forth the evaluations and reviews performed by affected federal agencies and should detail proposed actions to address deficiencies. The Committee should also provide opportunities for citizen input and inquiry in conjunction with the release of each annual report.

[1] The Dialogue group did not discuss any particular laws.

IV. Biological Diversity on the Federal Lands

A. The Issue

It is the consensus of the Dialogue group that many very positive initiatives and programs exist (and it should be acknowledged that many relevant initiatives and programs do not carry the "biodiversity" label). However, the federal land management agencies' current approaches for conserving biological diversity are not completely adequate. (See Appendix C for an overview of existing biological diversity policies, programs, and activities in the federal land management agencies. While these overviews mention problems of data collection and management, weaknesses in other programs have not been as systematically defined.)

The reasons for the inadequacy of current approaches are several. First, some programs are administered by federal land management agencies to serve other objectives altogether, and these sometimes adversely affect biological diversity. Second, those programs that are primarily intended to conserve biological diversity often do not do all that they might. In part, this is due to insufficient resources. It is also due to the expanding scope of biological diversity concerns; programs that were conceived at a time when the nearly exclusive focus of conservation concern was on the relatively few species valued for recreational or commercial use may continue to emphasize these despite more recent concerns with a much broader array of species. Even those programs that potentially encompass the whole panoply of plant and animal species may not fully address other important aspects of biological diversity, such as genetic and landscape diversity. Agencies have been grappling with the concept of biological diversity, yet there has been a lack of an agreed upon definition and guidance about how to insert it into agencies' ongoing programs and activities.

Finally, the conservation programs of federal land management agencies can be undermined by events largely beyond the control of federal land managers, such as air pollution, invasion by exotic organisms, the insularization of federal land units as a result of land use changes outside those units, and so forth. The current federal agency policies and practices represent only part of the effort needed to conserve and protect biological diversity. The agencies need the active, voluntary cooperation of non-federal neighbors to achieve biological diversity goals. The agencies need to adopt comprehensive management strategies to meet biological diversity objectives and still accommodate the human use of natural resources on most lands.

In summary, the participants in the Keystone Dialogue find that:

1. **Biological diversity is necessary** for the continued health and development of humans because it supports the integrity and resilience of ecological systems and for its intrinsic value.

2. **In spite of the numerous positive federal, state, and private efforts underway, present efforts to conserve biological diversity**

are not completely adequate. Loss of biological diversity, nationally and internationally, continues and the rate of loss of components of biological diversity is increasing. This loss can have direct, significant adverse impacts on humans.

3. **Federal lands can play a significant role in conservation of biological diversity in the United States.** Biological diversity in the U.S. cannot be totally or adequately conserved just on federal lands. For example, some ecosystems are not represented in federal holdings. However, changes in federal land policies and practices can have a significant positive impact.

4. **The changes necessary to achieve the identified goals and objectives can be accomplished while allowing significant human use of natural resources on federal lands.** A variety of uses, many frequently competing among each other, occur on those federal lands. These uses must continue to sustain human well-being, although the degree, extent, frequency, timing, magnitude, or location of these uses may change as a result of efforts to conserve biological diversity.

B. Taking a Comprehensive Approach

Comprehensive, interagency approaches should be developed and appropriately integrated into the full array of management programs within the context of the agencies' overall missions and mandates.

While recognizing that each federal land management agency is a unique institution, with its own statutory mission and land management objectives, culture, and bureaucratic organization, the Dialogue group believes that all agencies should work to conserve biological diversity. In order for the agencies to play their appropriate role in the conservation of biological diversity in the United States, comprehensive, interagency approaches should be developed and appropriately integrated into the full array of management programs within the context of the agencies' overall missions and mandates. Biological diversity activities should not be compartmentalized add-ons.

Effective conservation of biological diversity will require that actions be taken at the international, national, regional and local levels. Many migratory species are critically dependent upon habitats in the U.S. for only a portion of their annual life cycle. Other species range widely within and between large regional ecosystems. Still others are confined to more localized biological communities. The federal land manager will be an important player at all these levels.

■ Recommendations

- Each federal land management agency should undertake a thorough review and evaluation of current compliance with existing legislation and policies related to biological diversity.
- Each federal land management agency, within the context of its mission and goals, should incorporate the following elements into its programs and activities:
  - specific strategies to achieve each of the biological diversity objectives contained in this report;

— means for evaluating whether the strategies are working, i.e., indicators of success;

— a commitment to adjust management if monitoring reveals a problem or modifies our picture of the pattern and amount of diversity;

— integration of biological diversity considerations in land management planning;

— program accountability for achieving biological diversity objectives;

— training in biological diversity concepts for managers; and,

— an assessment of the human and financial resources needed to fulfill the preceding elements.

Indicators of Success

Recognizing that biological diversity is extraordinarily complex, that much of it is hidden from easy view, and that it is always changing over time and across geographic scales, the question arises — how will we know when we are conserving biological diversity and when we are not — i.e., how will we determine when the objectives are being achieved? We must identify indicators of success for the biological diversity objectives to help guide conservation strategies, plans, programs, and projects toward ensuring biologically diverse ecosystems with viable populations of species.

The indicators of success should be thought of as focal points that can help guide conservation actions to sustain not only the desired elements of diversity, but also a large portion of the associated variety of life that we may never see or understand. The indicators of success should be cumulative in the same way that the biological diversity objectives are. The presence of just one indicator does not indicate overall success; only when all of the indicators of success are realized should the manager believe that the agency's efforts to conserve biological diversity are effective.

■ Recommendations — Indicators of Success

The federal land management agencies should develop indicators of the success of their biological diversity conservation efforts. The indicators should have the following characteristics:

— They are readily recognizable and understood by a majority of people who form public opinions and policies.

— They allow managers, citizens, and policy makers to know when strategies, plans, programs, and projects are effective in meeting the biological diversity objectives.

— They can lead to explicit and quantitative standards by which actions can be planned, expectations evaluated, and accomplishments measured.

We must identify indicators of success for the biological diversity objectives.

Planning

In many cases the institutionalization and implementation of the elements of biological diversity management will occur in agency planning processes and through other organizational strategies.

The first step in many federal agency land-use planning processes (e.g., in Forest Service Forest Plans and Bureau of Land Management Resource Management Plans) is identification of issues. Integration of biological diversity into agency planning processes can be most directly accomplished through consideration of biological diversity in each relevant step in the planning process.

A key step in many agency land use planning processes is formulation of alternatives. Several plan alternatives are usually identified, ranging from a commodity production or human use emphasis to emphasis on protecting the natural environment. Biological diversity should be explicitly considered in planning analysis and documentation. The environmental analysis contained in agency land use plans could either incorporate or cross reference the traditional discussions on the topics of vegetation and special status (i.e., threatened and endangered, sensitive) species. It would be awkward, however, for it to attempt to incorporate all traditional discussion on wildlife. Wildlife discussions, more appropriately, should cross reference the biological diversity discussion.

Integration of biological diversity into agency planning processes in a comprehensive fashion should assure that planning decisions are made with reasonably effective public and decisionmaker understanding of the impacts on biological diversity. It will be a challenge for the agencies, however, to identify scientifically and publicly acceptable measures of biological diversity in varying environments, for use both in formulating plan alternatives and comparing consequences for those alternatives.

When actions are guided by well-prepared plans, done in advance of taking actions, protection of biological diversity can be made an integral part of the plan and implementing programs. Because biological diversity was not an issue of significant public concern in the past, many old plans fail to explicitly consider biological diversity. Even when plans do consider biological diversity, unanticipated events such as fires, floods, and development can make such plans obsolete.

In many cases the institutionalization and implementation of the elements of biological diversity management will occur in agency planning processes.

■ Recommendations — Planning

— Biological diversity should be considered in comprehensive planning efforts. Project level actions should provide for those aspects of biological diversity relevant to the area, as set forth in the land management plan.

— For land management plans in which a range of alternatives is required, one alternative should emphasize restoring biological diversity (recognizing that all alternatives will consider biological diversity). The biological diversity alternative should reference the seven objectives described in this report and emphasize restoration of rare and vulnerable elements of biological diversity.

— Biological diversity should be explicitly considered in environmental analysis and documentation.

— In the case of actions for which there is no land management plan that considers biological diversity, or when plans have become out-of-date due to unanticipated events, managers should take into consideration the biological diversity consequences of these actions prior to implementation.

Program Accountability

As used in this report, the term "program accountability" means management systems to ensure that agencies are carrying out and evaluating biological diversity programs. The Dialogue group agreed that accountability systems would be a critical element in the accomplishment of biological diversity objectives. While the agencies have a variety of approaches for program accountability already in place, none of those approaches is geared specifically toward conservation of biological diversity. Existing approaches should be expanded or modified to include biological diversity.

Accountability systems will be a critical element in the accomplishment of biological diversity objectives.

■ Recommendations — Accountability

— Building on existing accountability systems, each agency should develop an internal accountability process for biological diversity. The respective agency processes should reflect each agency's particular culture and organizational structure. The agencies have several systems from which an accountability mechanism could be built. These include the periodic inventories for status, conditions, and trends of federally listed threatened and endangered species, wetlands, forests, and rangelands (Resources Planning Act Assessment), and The Nature Conservancy Heritage Programs for rare elements that all agencies are increasingly using. Agencies should build from these, not create new accountability systems.

— The accountability process for each agency should consider whether the biological diversity objectives are being implemented.

— Where reward programs exist, they should include rewards for managers who are making notable progress toward achieving the biological diversity objectives.

— Agencies should include biological diversity as a topic in their annual reports.

— There needs to be enough consistency among the agencies' accountability systems so that information about progress can be assembled and integrated into an overall assessment of how the federal land management agencies are progressing in the achievement of biological diversity objectives.

Land Designations and Acquisition Authorities

The Dialogue group agreed that, in general, the objective of maintaining biological diversity should apply on all federal land. In some areas, selected aspects of biological diversity will be featured over other uses. On multiple-use lands, even where conservation of biological diversity is not the primary featured purpose, biological diversity will be an important consideration in the development of management plans and

The objective of maintaining biological diversity should apply on all federal land.

- **In some areas, selected aspects of biological diversity will be featured over other uses.**
- **On multiple-use lands, even where conservation of biological diversity is not the primary featured purpose, biological diversity will be an important consideration.**

activities. Intensive management of some lands for commodity uses, using selected and modified trees, range species, or domestic animals, may free other acreage for protection of more sensitive elements of biological diversity. Thus, all acres contribute to the solution, including areas being managed for fiber, water, recreation, and other multiple uses.

The Dialogue group also agreed that biological diversity should be a key consideration in existing special management units (e.g., research natural areas (RNAs), areas of critical environmental concern (ACECs), national natural landmarks, special interest areas (SIAs), and wilderness areas).

There was a divergence of opinion among Dialogue participants, however, on the issue of new land designations and acquisitions. Some Dialogue participants believed that additional designations and acquisitions are neither necessary to achieve biological diversity objectives nor in the public interest. Other participants supported designation of additional special management areas and land acquisitions when necessary to achieve biological diversity objectives.

■ Perspective In Favor of New Land Designations and Acquisitions:

The rationale among those Dialogue participants who supported the use of designation and land acquisition was that, in many places, the ownership pattern of public land does not lend itself to effective biological diversity management; existing designation programs have proven to be effective tools for agencies to recognize and manage lands with exceptional biological diversity values; and biological diversity protection will have to be implemented at the landscape level.

Our native flora and fauna, and the biological communities in which they live, evolved in an era of minimal or no human impact, or very different impacts than those that occur today. The most endangered portions of biological diversity are often those most sensitive to human activities. Therefore, some portions of the landscape will need to be reserved for evolutionary processes to continue with minimal human impact if significant components of biological diversity are to survive and continue to meet our needs.

Some components of biological diversity will require the establishment of large protected units, such as national parks or wilderness areas while others will need the designation of special management units within existing federal lands. In the larger landscape, these "nature reserves" should be buffered by public and private land uses which are compatible with their long-term viability. Land uses in this buffer may range from minimum impact resource development and recreation areas to cities and villages. The core reserve may also have compatible recreation and other resource management activities. Major biological diversity values which are compatible with resource development will also be maintained in the buffer. This often will not be a series of concentric rings around a single core reserve, but rather a patchwork of well-designed landownerships and activities. This mosaic may have large and small reserves utilizing a range of protective designations. The surrounding landscape will need to be managed under guidelines designed to meet

essential human needs for production, to maintain viable local and regional economies, to maintain the biological diversity that tolerates some level of human activity, and to provide corridors for genetic and species dispersal through and among core reserves.

Rarely do existing landownerships and resource utilization patterns match this scenario, but frequently, some major pieces are in place from which to plan and build. The application of tools such as landowner agreements, conservation easements, land exchanges, and land acquisition are essential for finding the compatible balance between maintaining and restoring biological diversity and providing for other human needs. All landowners are critical players in protecting biological diversity in an economically viable landscape or region.

■ Perspective Against New Land Designations or Acquisitions:

The rationale among those participants who believe that new land designations and acquisitions are unnecessary and undesirable is that conservation of biological diversity will be successful only if land managers utilize innovative approaches to protect biological diversity while providing for human needs within existing landownership patterns and designations. Effective conservation of biological diversity does not mean simply withdrawing land from multiple use management and attempting to prevent all changes.

Set-asides such as wilderness, special management areas, buffer zones, and greenways do not necessarily translate to gains in biological diversity. In fact, set-asides may be a contributing factor in the loss of biological diversity by increasing the type and number of competing uses on a smaller land base.

Private landowners and commodity users have long demonstrated their willingness to cooperate with federal land management agencies, State Natural Heritage Programs, The Nature Conservancy, and other organizations to identify opportunities for enhancing protection of special resource values. This cooperation has resulted in meaningful land use plans, agreements on areas which are deserving of protection, and most importantly, development of reasonable solutions to complex resource issues. This spirit of cooperation would be dampened considerably if landowners and commodity users believed they were being coerced by the threat of land acquisition and additional land withdrawals.

Beyond wholesale federal acquisition of private lands being bad public policy, it is also a fiscal impossibility. Land managers responsible for conservation of biological diversity must recognize that scarce federal funds should be invested in improving management techniques on existing federal lands. Utilizing existing programs such as the Extension Service, the State and Private Stewardship Program, and Forestry Incentives Program to educate and encourage private landowner cooperation in efforts to improve conservation of biological diversity is fiscally responsible.

There is a need to include the concept of biological diversity in agency training efforts.

Training

An important aspect of the human resource issue is the need for appropriately trained personnel. The subject of biological diversity is complex and difficult to define. In many instances, agencies' seeming failure to provide for biological diversity or to consciously manage for biological diversity is a matter of being unaware of what is meant and how it can be incorporated within current management systems and programs. There is a continuing need to define biological diversity to agency personnel so they can recognize when it is being conserved. This understanding of biological diversity is necessary in order to communicate among agency employees whose work affects biological diversity, and to employees who interpret agency biological diversity efforts to visitors and others. Therefore, there is a need to include the concept of biological diversity in agency training efforts.

■ Recommendations — Training

— The land management agencies should conduct a strong and continuing program of training to develop awareness of needs and problems of biological diversity through in-house publications, seminars, short-courses, segments of longer courses, videotapes, brochures, and other media.

— Federal agencies should play a role in cooperation with universities to ensure that both undergraduate and graduate curricula better address biological diversity.

Full realization of the biological diversity goals may require dedication of additional resources to the effort.

Human and Financial Resources

While many of the recommendations of the Dialogue can and should be carried out with the agencies' available staffs and budgets, full realization of the biological diversity goals may require dedication of additional resources to the effort.

■ Recommendation — Resources

— The federal land management agencies should clarify their roles and responsibilities with regard to conserving biological diversity on the federal lands and assess changes in their programs which may be required to meet those new responsibilities.

The assessment should include 1) an evaluation of staffing and funding needed to carry out specific roles and 2) review of options for generating additional resources, e.g., user fees, private sector funding, cooperative research projects, federal appropriations, etc.

C. Strategies to Maintain Viable Populations of Native Plants and Animals Well Distributed Throughout Their Geographic Range

Sensitive, Candidate, and Listed Species

Conservation of biological diversity requires actions to maintain viable populations of individual species. The concept of population viability

provides a relative standard for judging the expected future for native plant and animal species. Viability, the likelihood of continued existence in an area for some specified period of time, is a direct function of the degree to which population number, genetic variation, demographics, and geographic distribution provide security from the many factors, such as catastrophe, extreme environmental variation, inbreeding, or loss of habitat, that can eliminate a species from an area.

Viability is not a scientific absolute. In general, viability is higher in direct proportion to population number, breadth of geographic distribution, redundance of kinds and numbers of locations occupied by the species, and overall species resilience and tolerance to toxic chemicals, exotic competitors, and human influences in the environment. Conditions or trends that reduce population number; fragment populations into small, isolated sub-populations; or increase unnatural stresses can threaten viability.

Because viability is an inferred concept (that is, it cannot be directly measured, only estimated or inferred from analysis of empirical data), it necessarily involves subjective human judgments. Better understanding of population viability would be extremely helpful in management decisionmaking.

Nearly six hundred native species have been officially recognized as being in danger of extinction nationwide. Populations of these species are, by definition, not viable. For these species which are listed as threatened or endangered, federal agencies have initiated, or will initiate, programs that are intended to effect their eventual recovery.

Conservation of biological diversity requires actions to maintain viable populations of individual species.

In addition, there are nearly four thousand other native species nationwide whose population trends and changes in geographic distribution put them at risk of extinction. Many of these species are already candidates for federal listing. Many of these occur on federal lands. Others have been identified as "sensitive" and in need of special management attention. It is important to consider candidate and sensitive species as focal elements of programs to conserve biological diversity.

At the same time, it is inappropriate or unwise to ignore the vast majority of native plants and animals that are neither listed, candidate, or sensitive species. Management strategies which identify and ameliorate factors that contribute to loss of viability in populations of these species will prevent the population declines that ultimately lead to costly and often ineffective corrective actions.

■ Field Objectives — Sensitive Species

Recommended field objectives for managing sensitive, candidate and listed species are that:

1. **"Sensitive and candidate species are maintained in numbers and distributions that provide high likelihood of continued existence"**, and
2. **"The numbers and distribution of listed species are increased to the point where they are capable of being delisted; that is, they**

are judged to be recovered and conserved under the Endangered Species Act."

■ Recommendations — Sensitive Species

The federal land management agencies should:

— Ensure that management of lands, waters, biota, and people provide environmental conditions and trends that contribute to the long-term viability of all native species.

— Agree on common criteria for determining whether a species or population is "sensitive."

— Take actions to ensure that viable populations occur throughout the geographic range of listed, candidate, and sensitive species. Where such species occur on lands of two or more federal agencies, or on two or more units of the same agency, the managers of those units should closely coordinate their efforts. The Dialogue group recognized that it will not always be possible to restore biological diversity to levels that previously existed throughout the entire geographic range of every listed, candidate and sensitive species.

— Enhance the predictive understanding of population viability.

— Further the conservation of listed, candidate, and sensitive species by the appropriate use of existing administrative designations on their lands (e.g., Areas of Critical Environmental Concern, Research Natural Areas).

— Further the conservation of listed, candidate, and sensitive species by the appropriate use of active management tools (e.g., prescribed fire, vegetation manipulation, water management, and grazing).

— Regularly monitor the status of listed, candidate, sensitive, and other representative species on their lands to ensure that land management decisions are based upon accurate and current assessments of the status of such species.

— Implement the actions appropriate under established recovery plans or equivalent management plans for listed or Category 1 candidate species, establish measurable criteria for determining the success of those actions, and monitor the results of those actions to ascertain whether the criteria are being met.

— Where a recovery or equivalent management plan does not yet exist for a listed or Category 1 species that occurs in whole or in part on lands of any federal land management agency, the agency should contribute actively to the development of such a plan and should identify and implement interim actions for the conservation of the species pending completion of the plan.

— Design actions taken to recover federally listed, threatened, or endangered species to be compatible with the broad goal of conserving biological diversity generally.

— Endeavor to carry out the restoration of listed predator species in a manner that minimizes adverse socioeconomic impacts.

— Take steps to protect staging, resting, and feeding areas for migratory species, the loss of which could contribute to the endangerment of the species.

Exotic Species

Exotic species are species which occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans, which introduction has permitted the species to cross a natural barrier to dispersal. Many exotics were deliberately introduced with the intent of providing some benefit to society. Some established exotics provide recreational and economic value (for example, pheasants). Also, some exotics play a useful role in reclamation efforts as an interim solution until native species can be reestablished.

Exotic species often occur in ecosystems having no co-evolved biological checks or balances on the population growth capabilities of the exotics.

The problem is that exotic species often occur in ecosystems having no co-evolved biological checks or balances on the population growth capabilities of the exotics. As a result, the potential exists for exotics to become aggressively invasive to the detriment of native species and natural processes. Instances of impact of the aggressive spread of an exotic species are found throughout the country. Examples include the decline of ground nesting native birds in Hawaii due to predation, habitat destruction, and/or transmission of disease caused by exotic mongooses and pigs; the elimination of habitat for native plant species in Florida because of the rapid and extensive spread of single-species stands of Melaleuca; the diminution of water seeps and springs in the Southwest due to high rates of evaporation associated with the exotic tree tamarix; the decline of native brook trout populations in eastern streams due to competition from rainbow trout introduced from the western states and brown trout introduced from Europe; the near elimination from the eastern deciduous forest of the once dominant chestnut tree due to introduction of the chestnut blight from Asia; and the reduction of forage production of native plants caused by the aggressive spread of such exotic weeds as cheat grass or leafy spurge.

Management of exotic species often is difficult because of the growth characteristics of both individual organisms and populations of the exotic. For example, because Melaleuca resprouts abundantly and rapidly after such disturbances as cutting or fire; because each individual plant produces thousands of windblown seeds each year; and because these seeds germinate readily in any type of disturbed condition, traditional methods of management are ineffective in controlling it. The key management concern regarding exotic species is that they are living, reproducing organisms suddenly transposed into habitats having no natural checks or balances on their growth potentials.

■ Field Objective — Exotic Species

The recommended field objective for exotic species is that:

"Exotic species are managed to avoid threats to the diversity of native species, natural biological communities, or natural processes."

■ Recommendations — Exotic Species

The federal land management agencies should:

— Prohibit the release into the wild of any species outside of its natural range unless it can be shown through scientific evidence that it will not spread invasively, threaten the viability or limit the range of any native species, significantly reduce the diversity or cover of native species within communities, or significantly alter natural ecological structure or processes. The only exception should be in scientifically valid, carefully controlled situations where host-specific predators, parasites, or diseases of already established exotic species are released for the sole purpose of establishing biological control of previously established exotic species.

— Prohibit any uncontrolled release of exotic species on federal land to control native species.

— Immediately eliminate any known exotic species that is newly found on a federal land management unit, to prevent it from becoming a problem in the future. In some circumstances, exotic species may perform a critical ecological role of a native species that has become extirpated. In such cases, the exotic population should not be removed as long as it does not threaten the viability of any native species until the extirpated native species that it has replaced can, if possible, be restored.

— Identify all the established exotic species that occur on the lands managed by each agency. For those exotics that have the potential to spread invasively, threaten the viability, or limit the range of any native species, significantly reduce the diversity or cover of native species within communities, or significantly alter natural ecological structure or processes, the agencies should establish monitoring programs to determine when action becomes necessary.

— When an exotic species is found to diminish native species or other elements of native biological diversity, implement control methods that are both feasible and minimally impact the native elements of biological diversity as soon as possible to reduce the population of the exotic species to below the level at which it impacts native biological diversity. Complete eradication, where feasible, should be the goal for the more invasive and harmful exotic species. For established exotics, including domestic livestock, that are legislatively or administratively required or authorized to be maintained on federal lands, populations should be controlled to levels that maintain the exotics without jeopardizing native biological diversity.

— Maintain exotic species (e.g., chukar and pheasants) that have important economic and recreation values except in those specific cases where they jeopardize native biological diversity.

— Undertake research on how to replace exotic species with native species.

— Expand federal noxious weed programs to include species that threaten native biological diversity.

D. Strategies to Maintain Natural Genetic Variability Within and Among Populations of Species

Genetic diversity provides the raw materials by which species evolve and adapt to changing conditions.

Genetic diversity produces the raw materials by which species evolve and adapt to changing conditions. Genetic diversity is critical in governing the range of species, the range of habitats, and community associations in which they find themselves, their resistance to stress, their short- and long- term evolutionary potential, and their productivity or availability to fill human needs.

For most species, there is no precise information on the levels or distribution of genetic diversity. In the absence of such information, we should presume that populations are, more or less, genetically distinct. Populations that are ecologically and geographically extreme may be unique, and even within the main body of the species, the forces of selection and dispersal may have established genetic differences that parallel environmental gradients.

However, we presume the conservation of genetic diversity can be accomplished largely by maintaining representative communities and their component species without tracking the genetic material itself. In a few special cases, genetic diversity must be addressed at the gene level. These special cases include species that are extremely rare and declining as well as intensively managed species where genetic variability is being reduced through the selection of limited parent stock to emphasize one or a few beneficial attributes.

It will not be easy to conserve and manage genetic diversity solely in natural reserves because we cannot freeze natural selection and evolution of species in time. When added to the dimensions of spatial diversity, the dimension of time increases management complexity manyfold. Environments change, and eventually, species must evolve to survive. Evolution means genetic change. The potential widespread threats of global warming; increased levels of ultraviolet radiation; ozone and other atmospheric pollutants; and the leaching of soils and alteration of their microflora by acidification are examples of the kind of changes that make it necessary for populations to evolve if anything like present levels of biological diversity are to be maintained.

Because some environmental stresses will almost certainly increase, some natural reserves may be lost. Conserving genetic diversity also means that we must be able to restore diversity in the wake of large scale natural disturbance, such as wildfires, or planned activities such as timber harvest. If the building blocks are lost, reconstruction will be difficult and any restoration will lack authenticity. This is an argument for the establishment and maintenance of gene banks (in the form of seed banks, zoos, etc.) as a back-up to natural reserves.

Managing for genetic diversity should not include techniques that generate unnatural levels of diversity or change the inherent characteristics of a population. For example, neither of the only two extant populations of Torrey pine has maintained any genetic diversity,

but the two differ at an estimated 8.5 percent of their genes. Genetic diversity within populations could be increased and a more variable array of individuals generated by hybridizing trees from the two separate populations and allowing the hybrids to interbreed in future generations. However, this proposal would destroy the "authenticity" of the native populations, replacing them with an engineered construct. The differences between populations that have attracted so many observers would be lost; spatial diversity would be sacrificed for diversity within the local populations. Followed to their conclusion, such approaches would eventually lead to a homogenized world. Hybridization or contamination of local gene pools should be used as a management tool only if necessary to prevent extinction. This should not be taken to preclude hybridization and breeding as tools in tree, range, or fisheries improvement programs on areas devoted to commodity production. (See Appendix H for additional information on genetic diversity.)

■ Field Objective — Genetic Variability

The recommended field objective for genetic variability is:

"Characteristic levels of genetic diversity are maintained in representative and extreme populations of all species, and geographic patterns of genetic diversity and the genetic integrity of representative native populations are protected."

■ Recommendations — Genetic Variability

The federal land management agencies should:

- Maintain genetically representative examples and unique populations of native species throughout their ranges.
- Monitor genetic diversity of species heavily utilized by humans and ensure that natural levels of genetic diversity are not lost.
- Monitor the effectiveness of the management strategy utilizing quantifiable indicators of genetic diversity, such as the new biochemical markers or traditional measurements in test environments.
- Determine the genetic diversity of populations of extremely rare and declining species to insure that recovery activities maintain natural genetic variability.
- Maintain genetic integrity of selected distinct populations, races, and subspecies to ensure that the gene pools that they represent do not become extinct.
- Develop a coordinated national system of gene banks, at least for species heavily utilized by humans, rare species, and long-lived species most vulnerable to disturbance.

E. Strategies to Maintain Representative Examples of Ecosystems, Biological Communities, Habitats, and Their Ecological Processes

Regional Ecosystems

Regional ecosystems are large areas that encompass many biological communities and land management regimes and are identifiable by climate, landform, soils, and landscape patterns. The term "regional ecosystems," as used here, is intended to provide a foundation for coordinated efforts by federal land management agencies to conserve biological diversity. Examples of regional ecosystems range in size, from the Everglades — Big Cypress to the Great Basin. Within such ecosystems, there are likely to be varying mixes of private, state, and federal lands, including lands of several different federal agencies. They may extend across international boundaries. The opportunity for species dispersal and other ecological processes will thus be a function of both federal and non-federal landuse decisions.

Regional ecosystems are large areas that encompass many biological communities and land management regimes and are identifiable by climate, landform, soils, and landscape patterns.

Fragmentation of regional ecosystems into partially or wholly isolated habitats contributes to loss of biological diversity. The effects of fragmentation are cumulative. Human-caused barriers, such as highways, dams, urban and suburban development, intensively cultivated lands, and other areas cleared of natural vegetation often make it difficult for organisms to move safely between patches of suitable habitat.

Further, human-caused barriers may effectively isolate populations on habitats too small to support viable populations of native species. This is particularly true for species that normally occur in low densities or have expansive individual home ranges. Isolated sub-populations, because of their smaller numbers and more restricted ranges, are more vulnerable to extirpation as a result of chance events like floods, fires, randomness in births and deaths, and extreme heat or cold. Also, small patches of habitat may not have adequate area to support species that are sensitive to edge effects, such as increased rates of predation. Once populations are extirpated from isolated habitats, they may not be readily re-populated because the same human-caused barriers that created them now prevent recolonization from nearby sub-populations. Even when such sub populations persist, the small number of individuals within them may lead to loss of genetic variability, and therefore, of long term fitness and evolutionary potential. Finally, habitat fragmentation will limit the ability of many species to migrate and track shifting habitat conditions as climate changes.

A principal means of accomplishing the conservation of biological diversity "on the ground" is through cooperative landuse planning and management on an ecosystem basis involving the responsible administrators of all land units in the regional ecosystem. The primary statutory missions and near-term management issues and objectives of each agency, administrative unit, and landowner may vary, but the base maps and adopted plans should be shared and available to all parties. The influences of proposed, alternative resource management actions on the biological diversity within a unit and on all other units within the ecosystem should be evaluated. A consensus decision should be sought that will achieve both the proposing agency's primary objective and the

biological diversity conservation objective. Public involvement, agency expert staff, and external scientific review should contribute to this decision.

Federal land management agencies need to be sensitive to the potential barrier creating effects of landuse decisions, not only within their own agency, but also those made by other landowners. Thus, land management decisions must be considered in a larger regional context. The adverse effects of habitat fragmentation can be minimized by policies and actions that seek to assure the ability of plants and animals to migrate, disperse, and exchange genetic material across the regional landscape.

The conservation of many species may require more than the establishment of large, contiguous areas of protected land because preservation of selected tracts of land, even at the largest scale possible, will not by itself achieve the desired goal of maintaining Earth's biological diversity. It will also be important to assure that areas of habitat suitable for native species are connected by means of "greenways," wildlife linkages, riparian buffer strips, and overall habitat condition of the landscape that allows for natural movement of all species. By providing opportunities for natural movement of all species, the dual goals of maintaining biological diversity and managing landscapes to meet other human needs can be served. Such linkages also provide a measure of insurance against the possible effects of climate change.

Though our concerns in this section are framed with references to regional ecosystems, providing opportunities for species dispersal and avoiding habitat fragmentation can be important in smaller areas as well. Thus, within a single federal land management unit, many decisions can either serve or thwart dispersal opportunities for species within that very unit. At this scale, providing for hedgerows, windbreaks, wooded visual screens, highway underpasses, and streamside buffers can facilitate local biological diversity by providing opportunities for dispersal and genetic exchange among local plant and animal populations. At the same time, managers must be wary of facilitating dispersal of opportunistic, "weedy" species (including exotic plants and nest predators of birds) that thrive in narrow, edge-dominated corridors.

■ Field Objective — Regional Ecosystems

The recommended field objective for regional ecosystems is that:

"The fundamental patterns and processes (e.g., connectivity and dispersion of habitats, disturbance-recovery processes, and movement of individuals) that operate within each regional ecosystem are maintained."

■ Recommendations — Regional Ecosystems

The federal land management agencies should:

— Cooperate in identifying regional ecosystems that are of sufficient area and physical diversity to be capable of sustaining their distinctive biological diversity.

— Coordinate agency plans to ensure natural opportunities for movement between adjacent land units.

— Be attentive to changes or anticipated changes in land uses elsewhere that may create barriers to movement of native species and adapt management practices as needed to offset, wherever possible, such barrier creating changes.

— Coordinate planning and management at a regional scale to assure that biological communities are maintained in a pattern across the region that approximates their natural dispersion and proportions. Federal agencies with land management responsibilities within regional ecosystems should harmonize their land management policies as necessary to achieve this objective within their mission.

— Encourage non-federal entities to participate in federal regional planning efforts.

Communities

Apart from considerations of landscape connectivity, management of regional ecosystems must include concern for maintenance of biological communities, well distributed through the region in something approaching their natural dispersion and proportions.

Especially important are those biological communities that occur only in remnants of their historical distribution and require special protection and management to be perpetuated. Examples of these are biological communities associated with old-growth forests, wetlands, prairies, riparian areas, and fire-dependent successional stages. It is also important that high quality examples of the full range of biological communities be maintained. The number and size of the areas to be managed should be determined using risk analysis and population viability assessment techniques.

Management of regional ecosystems must include concern for maintenance of biological communities, well distributed through the region in something approaching their natural dispersion and proportions.

■ Field Objective — Communities

The recommended field objective for communities is that:

"Biological communities occur in ecological conditions, frequency, amounts, area, and geographic distributions that, taken together, perpetuate their full range of diversity, ecological processes, species, and populations."

■ Recommendations — Communities

The federal land management agencies should:

— Develop a common and consistent scheme to classify communities. (This should not delay needed actions to protect communities.)

— Identify distinct biological communities. A coordinated effort should be undertaken involving agencies and non agency scientists to identify community types within the United States, and describe where they occur naturally, within present day climate regimes, on federal lands.

— Inventory and evaluate where communities may already be protected and identify gaps in representation of community types in systems of protected areas. This inventory should also identify biological communities that have either experienced declines that threaten their viability or that have lost significant elements of biological diversity. This inventory should build on existing state, federal, and private efforts.

— Augment existing protection of biological communities to maintain well distributed, high quality examples of all natural communities occurring on federal lands within each regional ecosystem. Whenever possible, the examples should be sufficiently large and numerous to sustain viable populations of native species and to assure that extreme events such as fires and windstorms do not eliminate the communities from regional ecosystems. The number, size, and distribution of the areas should be determined using risk analysis and population viability analysis techniques.

— Develop explicit standards and guidelines in agency plans for ecological conditions, number of areas, distribution of areas, size of each area, and appropriate management practices. There should be consistency between agencies in the standards and guidelines.

— Undertake management strategies to ensure the viability of these biological communities with their constituent ecological processes, species, and populations.

— Undertake activities to restore the biological diversity of biological communities that have lost significant elements of diversity or that have experienced declines that threaten their continued viability.

Elements of structural diversity include such features as:

- **snags and large fallen trees**
- **canopy structure**
- **plant age diversity**
- **pools, riffles, and reefs**

Elements of Structural Diversity

Elements of structural diversity include such features as snags and large fallen trees; canopy structure; plant age diversity; and pools, riffles, and reefs in aquatic systems. They make unique or inordinately productive contributions to the species richness or general ecological function of an area.

Structural diversity is especially important in ecosystems that are being managed for production of natural resources. For example, the presence of large snags affects the diversity of cavity-dwelling vertebrates. It is generally estimated that snags and fallen trees directly support up to twenty percent of the vertebrate species in a typical temperate forest — without the snags those species would not be present. Many of these species, e.g., woodpeckers, may be important in maintaining the health of the ecosystems in which they occur.

Structural diversity is also important for numerous poorly known elements of diversity, such as invertebrate and fungal species, by virtue of the array of habitats and niches that structural features provide.

■ Field Objective — Structural Diversity

The recommended field objective for structural diversity is that:

"Elements of structural diversity occur in conditions, amounts, and geographic patterns that contribute to natural species-richness, ecological functions, and overall biological diversity of the area."

■ Recommendations — Structural Diversity

The federal land management agencies should:

— Identify elements of structural diversity and the ecological processes that maintain those elements. The federal land management agencies should develop a classification of elements of structural diversity for each regional ecosystem and describe the major elements of diversity they provide or support.

— Initiate studies on the roles of elements of structural diversity. The federal land management agencies should carry out studies, surveys, inventories, or monitoring needed to refine special elements of structural diversity as indicators of parts of the area's biological diversity.

— Establish and apply standards and guidelines for elements of structural diversity. Federal land management agencies should describe in their plans standards for conditions, amounts, and geographic patterns of elements of structural diversity to be provided in the landscape.

F. Strategies to Integrate the Conservation of Biological Diversity and Other Human Needs

The biological diversity found on federal lands is a significant resource for maintaining current and future human well-being. The most direct use of that resource includes consumption of food for humans and their domestic animals, consumption of wood products for construction and industry, and consumptive and non consumptive uses for recreational, spiritual, and aesthetic purposes. A second category is use of genetic material for development of medicinal products and agricultural and horticultural varieties. A third category is human reliance on the ecosystem services such as watershed protection, nutrient cycling, soil formation, and maintenance of the atmospheric gas balance that are provided by the total mix of species and the communities they constitute. A fourth category of use is the disruption of biological communities associated with development of non-biological resources such as minerals, energy, building sites, and transportation corridors, and the restoration of such sites once they are abandoned. The plants, animals, communities, and processes that contribute to human well-being are also integral parts of regional biological diversity. The future productivity of species and communities that are utilzed to meet human needs as well as the other species and communities that constitute the total biological diversity of the region is dependent on the sustainability of total ecosystem health.

Federal programs to conserve biological diversity should attempt to meet societal resource needs ... and work to assure sustainability of both economic and ecological systems.

Sustaining the needs of society requires that resource development continues to occur on federal lands. Socially responsible federal programs to conserve biological diversity should attempt to meet societal resource needs on a regional ecosystem basis and work to assure sustainability of both economic and ecological systems.

■ Field Objective — Integrating Human Needs

The recommended field objective for integrating conservation of biological diversity and other human needs is that:

"Consumptive and non-consumptive resources are produced in an environmentally sensitive manner at levels which ensure a high probability that long-term human and economic well being can be maintained."

■ Recommendations — Integrating Human Needs

Federal land management agencies should:

— Maintain inventories, conduct assessments, and carry out monitoring to assure that human activities to meet societal resource needs are consistent with long-term sustainability of both the resources and the ecosystem of which they are a part.

— Where other societal resource needs conflict with societies' needs for biological diversity, federal agency decision- makers should weigh both short- and long- term costs and benefits — market and non-market — of options for meeting these societal needs and providing for biological diversity. Taking public comment into consideration, the agencies should consider alternatives for meeting societal resource needs while meeting societal biological diversity goals.

G. Strategies to Increase Scientific Understanding of Biological Diversity and Conservation

The ideal technical information program has well-defined objectives and is statistically and methodologically sound. It seeks to achieve five goals:

— to acquire the data necessary to determine distribution and status of elements of biological diversity (inventory);

— to acquire the data necessary to determine if objectives are being met (monitoring);

— to acquire new information about function and viability of elements of biological diversity, including their response to management (research).

— to ensure that data are acquired, documented, and stored systematically so they can be used efficiently and shared within an agency, between agencies, now and in the future (data management); and

— to ensure that new information is communicated to managers in ways and time frames that permit it to be understood and incorporated into programs for achieving objectives (information transfer).

All of the agencies have technical information programs, but there are significant differences among those programs. As a result, no agency by itself, nor all agencies taken together, currently conduct technical information programs suitable for providing all the information needed to ensure that objectives are achieved. Major cross-cutting problems with existing agency efforts are summarized below, followed by recommendations to alleviate the problems. Appendix C includes a summary of technical information problems and recommendations specific to individual land management agencies.

■ Limitations of Existing Efforts

— Only a small fraction of agency lands are being inventoried for elements of biological diversity.

— Existing inventories have been limited primarily to vegetation and vertebrate communities and species. Few inventories have been conducted on invertebrates or non-vascular plants.

— Very few inventory, monitoring, or research efforts have focused upon obtaining data to assist in conservation of biological diversity at the landscape level.

— Current inventory, monitoring, and research efforts are hampered by lack of adequate funding.

— Very few efforts have been made to sample genetic variation within species.

— No national standards are being used by the agencies for monitoring and no system exists for tracking the amount, purpose, or characteristics of existing monitoring efforts, or (except in limited instances) for determining where management thresholds have been exceeded.

— In many cases, monitoring studies have been set up without reference to thresholds which when approached indicate a need for better management.

— The combination of a wide variety of natural ecosystems and managed landscapes contained in federal lands, the great diversity of land management missions, and the broad range of human activities developed to gather information about those ecosystems, landscapes, and missions has produced an equally large, but poorly communicated, diversity of data management and information transfer systems. As a result there is a significant inability for agencies to communicate technically across common land management boundaries or with respect to common ecosystems or landscapes.

— The agencies lack adequate numbers of trained personnel such as invertebrate zoologists, botanists, and theoretical ecologists.

Limitations to our Scientific Understanding:

- **Only a small fraction of agency land inventoried.**
- **Few inventories on invertebrates or non-vascular plants.**
- **Lack of funding.**
- **Few efforts to sample genetic variation.**
- **No national standards for monitoring.**
- **Lack of thresholds indicating a need for better management.**
- **Inability to communicate technically across common land management boundaries.**
- **Lack of trained personnel.**

■ Recommendations — Inventory

Federal land management agencies should initiate a comprehensive, coordinated inventory that serves to document all levels of biological diversity on the federal lands.

Federal land management agencies (in conjunction with U.S. Fish and Wildlife Service gap analysis, The Nature Conservancy and State Heritage Programs, and other organizations with useful data bases) should initiate a comprehensive, coordinated inventory that serves to document all levels of biological diversity on the federal lands. Such inventory should include the following elements and characteristics:

— The inventory should be hierarchical and "top-down" in the sense that landscape level assessments such as the Fish and Wildlife Service's "gap analyses" are used to identify priorities for inventory at the local level, and local level assessments are used to identify priorities at the site level (Heritage Program).

— The inventory should make maximum use of existing data management systems such as the Bureau of Land Management's Integrated Habitat Inventory and Classification System (IHICS) and Riparian/Aquatic Information Data Summary System (RAIDS); the National Park Service's NP Flora; the U.S. Fish and Wildlife Service's gap analysis program; the Nature Conservancy's Heritage data bases, procedures, and technology; the National Wetlands Inventory; standard mapping procedures; the Forest Service's Ecological Classification System and others, expanded or modified as appropriate.

— The inventory should be landscape-based in the sense that abundance and distribution of plant and animal species are correlated with soils, vegetation, plant and animal community characteristics, and landscape features. This will require that description and mapping of plant communities use "cover" as a minimum standard. Other ecological measures of vegetation may also be required for particular situations.

— The inventory at a minimum should include natural vegetation, all vertebrate and vascular plant species, and at least some indicator species of non-vascular plants and invertebrates, and some indicators of other elements of biological diversity, such as sensitive communities or human-influenced processes and elements of structural diversity.

— Provision should be made for systematic inventories of all candidate, threatened, endangered, and sensitive species and for all other biotic elements that are imperiled due to human activities or natural events.

— Inventories should be guided by an interagency master plan that coordinates acquisition of aerial photography, soil survey, vegetation survey, and vertebrate inventory, and that ensures compatibility of data within and among agencies.

— The above mentioned master plan should be implemented for all regional ecosystems, and vegetation mapping and inventory of vertebrates should be completed within the next ten years.

— The inventory should be compatible with, and feed information directly into, development and implementation of Geographic

Information System (GIS) methodology, monitoring programs, and research activities.

- The inventory should provide the basis for determining species (including genetic level assessment), species groups, populations, guilds, habitats, landscapes, or processes that require more intensive studies.
- Inventories should be coordinated with and make maximum use of the fifty state Heritage Program data bases, procedures, and technology.
- The inventory process should identify levels or intensities of inventory that are appropriate for each level of planning, type of management activity or impact, type of land classification, or degree of rarity or sensitivity of the element being inventoried.
- The inventory should have a strong element of quality control and assurance, including setting specific standards of accuracy and precision, timing the inventory to encompass the life-cycles of the target elements, standardizing methods and data bases to the extent possible, and using trained personnel to conduct the inventories.

■ Recommendations — Monitoring

Federal land management agencies should strengthen their monitoring programs.

Federal land management agencies in conjunction with the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) should strengthen their monitoring programs by taking the following actions to focus on the objectives contained in this report:

- Develop a system for tracking monitoring efforts that is coordinated both within and among agencies.
- Provide an adequate and stable funding commitment to continuous monitoring efforts to ensure that management objectives are being met; ensure that monitoring is conducted on schedule in all types of land classification; and ensure the incorporation of the monitoring efforts into the land management plan of each management unit.
- Avoid duplicating ongoing efforts of other groups.
- Develop a quality control and assurance process for their monitoring programs to ensure that:
  - resource management objectives are stated explicitly in ways that are measurable and thus able to be monitored;
  - appropriate measurement techniques, procedures, and data management practices are being used to achieve specifically stated levels of accuracy, precision and reliability;
  - measurable management thresholds (conditions requiring existing management practices to be changed) are identified; and

— monitoring activities are compatible across agency boundaries.

— Use the inventory information to guide selection of the species groups, guilds, habitats, vegetation, or processes that are to be monitored.

— Ensure that monitoring programs include vegetation types, vertebrates, vascular plants, non-vascular plants, and invertebrates.

— Develop systematic monitoring of all rare, endangered, or sensitive elements.

— Use available biological knowledge to ensure that timing of monitoring encompasses key aspects of the life-cycles of target elements as much as possible.

— Collaborate in developing and implementing common, ecologically standardized monitoring procedures that contribute to both agency and interagency needs.

— Incorporate monitoring programs and their results into compatible GIS and other information transfer systems.

■ Recommendations — Research

Federal land management and environmental agencies should work together to implement a coordinated cooperative program of scientific research on biological diversity.

Federal land management and environmental agencies should work together to implement a coordinated cooperative program of scientific research on biological diversity in order to provide information necessary for conservation of biological diversity on federal lands. This coordinated program should:

— Systematically identify and support an increased number of projects and programs of research on biological diversity processes, genetic assessments, landscape assessments and other topics of mutual concern in cooperation with regulatory, university, private and non-profit organizations and federal laboratories through use of employee exchange appointments (e.g., using the Intergovernmental Personnel Act (IPA), other formal cooperative arrangements, joint funding of research projects, and shared funding of research laboratories.

— Strengthen in-house capability in the biological sciences that apply to conservation issues through upgrading the interdisciplinary skills of current employees with appropriate scientific training or experience in the conservation of biological diversity and hiring new employees with appropriate scientific training and experience.

— Increase cooperative interagency research on the contributing roles of individual land management units for perpetuating biological diversity at the landscape and regional scales.

— Identify factors responsible for losses of biological diversity and techniques to minimize the impacts of these factors.

— Develop effective and reliable methods for restoring the biological diversity of damaged and degraded biotic communities, ecosystems, and landscapes. First priority should be given to

communities and ecosystems (e.g., tall grass prairie) that have experienced declines that threaten their continued existence.

- Ensure that results of scientific research are actively communicated to, and accessible by, other scientists, managers, and the public through reports, refereed journal articles, articles in popular journals, training sessions, and workshops.
- Ensure that research conducted in one land management unit is designed to be applicable to other similar units.
- Include research on threatened/endangered/sensitive species and their genetic structure, habitats, and ecosystems; genetic, species, population, and ecosystem responses to landscape manipulation; long-term viability of key elements of biological diversity; and new technologies for inventorying, recovering, and monitoring elements of biological diversity.

■ Recommendations — Data Management

Federal agencies should maximize the efficiency and effectiveness of their inventory, monitoring, and research activities by adopting consistent, compatible, and technically rigorous standards and protocols for obtaining, managing, and reporting data. The program to manage data should:

Federal agencies should adopt consistent, compatible, and technically rigorous standards and protocols for obtaining, managing, and reporting data.

- Provide for interagency adoption and application for each regional ecosystem of a common set of sampling procedures, data units, land scales, and graphic symbols for selected core elements of that regional ecosystem to ensure cross boundary compatibility in data acquisition, analysis, and display.
- Develop and apply within each agency data management practices that provide systematic documentation and archiving of all data from inventory, monitoring, and research; easy retrieval of data at all appropriate organizational levels; and user-friendly methods for data analysis and predictive modeling.

■ Recommendations — Information Transfer

Federal land management agencies should develop a strong program to incorporate information from inventory, monitoring, and research into land use plans and programs. Such a program should:

Federal land management agencies should develop a strong program to incorporate information from inventory, monitoring, and research into land use plans and programs.

- Incorporate regional or landscape level information into regional interagency plans that specify roles and responsibilities of each agency and administrative unit.
- Ensure that technical expertise is available to help design local programs (district, area, forest, park) that meet commitments and needs identified at higher management levels.
- Establish a system of quality control and assurance which ensures that:
  - all available information from inventory, monitoring, and research is used in land use decisions, is incorporated into

individual land management plans and programs, and is used in developing environmental compliance documents.

— the full range of land classification and management tools for perpetuating biological diversity (including but not limited to ACECs, RNAs, "multiple use modules," biosphere reserve cooperatives, and restoration of missing elements) are being used where appropriate. Risk analysis and population viability assessments should be used to determine if managed areas are large enough to meet objectives of perpetuating biological diversity for a specified period of time.

— commitments are being met and objectives are being attained.

H. Strategies to Achieve Public Awareness and Understanding of Biological Diversity

Managers of public land have a duty to develop understanding of the conservation of biological diversity.

While protection of biological diversity on federal lands will produce substantial benefits to the long-term ecological health of the planet, greater benefits are likely by sharing lessons learned, as examples, with the visitors, neighbors, and private users of federal lands, other federal, state, and local government agencies, non-governmental organizations, and with peoples throughout the world.

By reaching out to the public to explain biological diversity programs, comment can be solicited to improve programs and to gain public understanding and support for federal efforts. Managers of public land have a duty to develop understanding of the conservation of biological diversity.

■ Recommendations — Public Awareness

The federal land management agencies, with the cooperation and assistance of other agencies and organizations having expertise in biological diversity, should:

— Improve the quality of interpretation programs by:

— Developing and using interpretive handbooks (e.g., the National Park Service "Interpreting Biological Diversity" handbook);

— Employing professionals in biological sciences for interpretation duties in order to facilitate development and presentation of accurate and appropriate programs;

— Using professional outside expertise to develop interpretation programs about biological diversity conservation efforts upon federal agency land for use with visitors and for general public dissemination;

— Augmenting on-hand staff with people from universities, conservation groups, and other non-governmental organizations;

- Publishing reports on biological diversity programs to disseminate knowledge throughout the professional community.

- Show examples of successful biological diversity conservation efforts in interpretative programs by:
  - Using appropriate examples of private industry efforts (some may be very extensive) to conserve biological diversity and to mitigate/compensate for adverse efforts caused by industry actions;
  - Emphasizing how local biological diversity programs are necessary and integral to other programs which are likewise necessary and integral to global biological diversity.
- Develop and disseminate education materials by:
  - Preparing, with outside help as necessary, professional level video programs about biological diversity principles and programs for airing on public and commercial television and for general educational purposes;
  - Preparing high quality panel displays for visitor centers, public buildings, and for sale;
  - Preparing time- and place-relevant brochures and slide shows for in-house and outside use;
  - Cooperating with local school districts to develop curricula for school programs either wholly at schools or partly on federal land.
- Spread the word about agency programs by:
  - Providing lectures at colleges, universities, professional organizations, and other outside groups to explain biological diversity programs underway on federal lands;
  - Conducting press conferences and developing media interest in biological diversity programs.

I. Strategies to Enable and Encourage the Private Sector to Develop and Apply Innovative Approaches to the Conservation of Biological Diversity

A major element of national policy on biological diversity on federal lands should be the creation of opportunities, partnerships, and incentives to encourage private sector involvement.

Federal land agencies are obviously major players in the implementation of a national policy on biological diversity. They are the custodians of an immense public estate and have the responsibility to care for and carefully manage the resources which have been placed in their hands. However, federal agencies are only part of the federal land picture. Millions of Americans, ranging from those who carve out a living from federal lands to those who seek recreation and spiritual meaning in the beauty and diversity of those lands, are also major players. An effective national policy on biological diversity needs to involve them all. Indeed, maintaining and protecting biological diversity on federal lands demands the support and participation of the private sector. Enlisting the private

sector in a national effort to maintain and conserve biological diversity begins with education. Knowledge provides citizens with a better understanding of what the problem of biological diversity is and increases their sensitivity toward future management and use of federal lands. But education alone is only part of the answer. Understanding a problem means very little unless people have the opportunity and incentive to act. Accordingly, a major element of national policy on biological diversity on federal lands should and must be the creation of opportunities, partnerships and incentives to encourage private sector involvement in the maintenance and protection of biological diversity.

■ Recommendation — Private Sector Involvement

— Federal land management agencies and other relevant decision makers should pursue a variety of options and opportunities for involving the private sector in conservation of biological diversity on the federal lands. Among the options and opportunities to be considered are cooperative efforts, partnerships, flexibility in permit and lease agreements, incentives for private investments, and outreach by extension services. The Forest Service Challenge Cost Share Program is one example of a positive effort which has already been initiated.

Appendix A

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Appendix B

Cross-Cutting Authorities

In addition to the specific statutory authorities applicable to any given federal land managing agency, all such agencies are subject to a number of laws of general applicability, many of which are of considerable importance for the conservation of biological diversity. These include the National Environmental Policy Act (NEPA), the Endangered Species Act, and a number of other wildlife conservation and pollution prevention laws.

NEPA was enacted in 1969; its purpose was to ensure that all federal agencies both took into account the environmental impacts of their decisions and disclosed those impacts to the public. The mechanism for achieving these purposes is the preparation of an "environmental impact statement" or "EIS" for all major federal actions significantly affecting the environment. NEPA thus compels a federal agency to examine the likely impacts of its planned actions on biological diversity and other aspects of environmental quality. NEPA also requires agencies to consider alternatives to their planned actions and the environmental impacts of those alternatives. NEPA does not, however, compel an environmental point of view. At bottom, NEPA's duties are purely procedural; once an agency has taken a hard look at the environmental impacts of its action and disclosed those impacts in an EIS, it has fully discharged its NEPA responsibilities.

In contrast to the purely procedural duties of NEPA, the Endangered Species Act imposes substantive duties upon federal agencies. The most important of these is found in the Act's Section 7. That provision requires every federal agency to ensure that any action it authorizes, funds, or carries out neither jeopardizes the continued existence of any threatened or endangered species nor destroys or adversely modifies the critical habitat of any such species. The mechanism for compliance with this duty is through a process of "consultation" between a federal agency (here, a federal land managing agency) and the U.S. Fish and Wildlife Service. While the Service's resulting "biological opinion" about the likely effect of the other agency's action is not technically binding upon the other agency, as a practical matter it has enormous influence upon what that agency will do.

Section 7 also affirmatively authorizes all other federal agencies to utilize their various authorities in furtherance of the conservation purposes of the Endangered Species Act. Thus, as a result of Section 7, every agency's mission encompasses endangered species protection. Whether these affirmative responsibilities under Section 7 rise to the level of legally enforceable duties has not yet been clearly resolved.

The provisions of the Endangered Species Act, though far reaching, only apply to species that have been designated as "threatened" or "endangered" by the Secretary of the Interior or Commerce. Unless so designated, a species receives no protection under the Endangered Species Act. It may, however, receive some level of protection under any of several other federal wildlife conservation laws. These include the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Marine Mammal Protection Act. Each of these laws prohibits the "taking" of any of the animals within its scope (as does the Endangered Species Act), subject to certain exceptions.

Many federal pollution control laws also have a "cross-cutting" effect on the programs of federal land managing agencies and offer potentially significant benefits to the conservation of biological diversity. For example, among the most biologically productive of ecosystems are wetlands; the placing of dredged or fill material in wetlands is prohibited by Section 404 of the Clean Water Act, except when authorized by a permit from the U.S. Army Corps of Engineers. The use of pesticides by federal land managing agencies to achieve insect or vegetation control on their lands is subject to the requirements of the Federal Environmental Pest Control Act. The requirements of this law may be further supplemented by the Endangered Species Act when pesticide usage potentially affects a threatened or endangered species.

One other cross-cutting authority that significantly affects biological diversity efforts on federal lands is the Wilderness Act. The National Park System, National Wildlife Refuge System, and National Forest System all contain many designated wilderness areas that are managed to preserve their undeveloped, "untrammelled" character. Under the authority of the Federal Land Management and Policy Act, the Bureau of Land Management also includes many wilderness areas within its jurisdiction. In all of these areas, natural processes are intended to govern the ecological communities that occur there.

Appendix C

Overview of existing biological diversity authorities, policies, programs, and activities and, specific recommendations for the federal land management agencies

Bureau of Land Management

Mission

The Bureau of Land Management is responsible for the balanced management of the public lands and resources and their various values so that they are considered in a combination that will best serve the needs of the American people. Management is based upon the principles of multiple use and sustained yield; a combination of uses that takes into account the long-term needs of future generations for renewable and non-renewable resources. These resources include recreation, range, timber, minerals, watershed, fish and wildlife, wilderness and natural, scenic, scientific, and cultural values.

Lands

The Bureau of Land Management manages approximately 270 million acres of public land, about one-eighth of the nation. In addition, BLM manages the mineral estate underlying another 300 million acres administered by other agencies or owned by private interests. Most of this acreage is located in the western states, including Alaska, although small parcels are scattered across the eastern states.

Most Bureau-managed lands are original public domain status. Other lands include 2.1 million acres of reconveyed and revested timberland in western Oregon and several millions of acres acquired by exchange, donation, and purchase.

These lands include forest lands, woodlands, brushlands, grasslands, and tundra, as well as associated wetlands and water bodies, all rich in biological diversity. A partial survey of (Bailey/Kuchler) ecosystems on BLM administered lands in ten western states identified a total of 114.

Authorities

BLM's primary legislative mandate is the Federal Land Policy and Management Act. A number of other statutes (e.g., the Endangered Species Act) also influence BLM's management policies and plans. In addition, some BLM-administered lands (e.g., the O&C lands of western Oregon) have special legislative mandates that influence management decisions.

The Federal Land Policy and Management Act requires that:

— The public lands and their resources are periodically and systematically inventoried.

— Their management be on the basis of multiple use and sustained yield.

— They be managed in a manner that will protect the quality of scientific, ecological, and environmental values.

"Multiple use" is defined as the management of the lands and their various resource values so they are utilized in the combination that best meets the present and future needs of the American people; a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and non renewable resources, including wildlife, fish, natural scenic, and scientific values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the environment, not necessarily in the combination of uses that will give the greatest economic return.

"Areas of critical environmental concern" are to be identified. These are areas within the public lands where special management attention is required to protect and prevent irreparable damage to important values, including fish and wildlife resources or other natural systems or processes.

Policy

BLM policies are primarily embedded in the regulations set forth in Title 43 of the Code of Federal Regulations and in the BLM Manual. These guidance documents are supplemented by various instruction memoranda and special policy documents. A key example of the latter is the published BLM document, *Fish and Wildlife 2000: A Plan for the Future*. Relevant policy statements from these various sources are:

Manage habitat with emphasis on ecosystems to ensure self sustaining populations and a natural abundance and diversity of wildlife, fish, and plant resources on the public lands. (BLM Manual Section 6500.06 *Policy*)

Conserve endangered and threatened species and the ecosystems which they depend upon. (BLM Manual Section 6840.06. *Policy*)

Introduction of non-native species is strictly controlled and is allowed only if it can be demonstrated that there will be no adverse affect on native species. Maintenance of native population genetics is being included in management objectives. Two examples are the desert bighorn sheep and the desert tortoise. Genetic studies indicate that there are distinct genetic types of each species and BLM's management is designed to maintain those distinct types.

Ensure optimum populations and a natural abundance and diversity of wildlife resources on the public lands. (Fish and Wildlife 2000)

Manage habitats to maintain populations of plants and animals at a level which will avoid endangering the species. (Fish and Wildlife 2000).

Conserve rare, vulnerable, and representative habitats, plant communities, and ecosystems. (Fish and Wildlife 2000)

Management Strategies for Dealing with Biological Diversity

Planning Process:

BLM's planning process includes the means to identify and prescribe management for Areas of Critical Environmental Concern (ACECs), Research Natural Areas (RNAs), and Natural Areas. This process has the capability to include almost any type of land use policy. Because of the regional scope of the system, there is an opportunity to plan for those components of biodiversity necessary to maintain the integrity of natural processes. This includes species, plant communities, ecosystems, and coordination with adjoining landowners to ensure consistent management. The planning process also requires public participation and coordination with other groups or agencies that may have an interest in how the public lands are managed. Field offices are required to include in their land use plans management provisions for the recovery of endangered and candidate species.

Dealing with gaps in biota:

BLM has been conducting inventories of the resources it manages, including wildlife and vegetation, since its beginning. Passage of the Federal Land Policy and Management Act (FLPMA) in 1976 made these inventories mandatory and requires their use in management. While inventory techniques now in use might not detect the absence of some components of the community, they do note declining components, and they do detect that habitats for some missing vertebrate components are present.

BLM has criteria for dealing with these detected gaps in biota. Active transplant and reintroduction programs are returning missing components, such as bighorn sheep, the peregrine falcon, and various desert fishes, to formerly occupied habitats.

Protecting biological diversity:

BLM's multiple use management of the public lands promotes biological diversity since, under it, a variety of ecologic stages of habitat are developed and main-

tained, each with its particular plant and animal community. Additionally, the naturally occurring variety of landscapes or habitat types making up the public lands provides naturally for biological diversity.

Resources management in BLM is guided by land use plans, which not only comply with the Endangered Species Act, but under BLM policy, must contain provisions to promote recovery of listed and other special status species. Land use plans also address special or unique habitats, providing protection to flora and fauna, while maintaining the multiple use concept through designation of Areas of Critical Environmental Concern, Research Natural Areas, and Outstanding Natural Areas. Such designations focus management attention on these areas to assure that their unique values are maintained, while also allowing for the multiple use management of the areas.

Restoration of biological diversity:

BLM's habitat management plan (HMP) program requires management on an ecosystem basis, rather than simply concentrating on one or two species. While certain species may receive priority in an HMP, all components of the ecosystem are to be provided for in the completed plan. As noted above, absent components can be reintroduced to former habitat where possible.

Inventory, Monitoring, Research, Data Management and Information Transfer

The BLM has clear authority and direction for conducting inventory, monitoring, and research on elements of biological diversity. This mandate derives primarily from the Federal Land Policy and Management Act of 1976.

Section 102 of this act states, "The Congress declares that it is the policy of the United States that ... the national interest will be best realized if the public lands and their resources are periodically and systematically inventoried ... ."

Further direction is provided in Section 201 which states "The Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resource and other values ... , giving priority to areas of critical environmental concern."

Specific authority for conducting research is provided in Section 307 which states, "The Secretary may conduct investigations, studies, and experiments, on his own initiative or in cooperation with others, involving the management, protection, development, acquisition, and conveying of the public lands."

Finally, clear authority and direction to coordinate inventory and other data gathering activities with other private and public agencies and organizations is found in Section 202c which states, "In the development and revision of land use plans, the Secretary shall ... coordinate the land use inventory, planning, and management activities of or for such lands with the land use planning and management programs of other federal departments and agencies and of the states and local governments within which the lands are located ... ."

In summary, although "biological diversity" is not explicitly mentioned in any of BLM's legislative mandates, BLM nonetheless has a mandate to inventory and monitor elements of biological diversity and authority to conduct research. Any gaps identified must be attributed to causes other than lack of authority.

Inventory:

The BLM conducts inventories of soils, vegetation, and wildlife. These inventories are used to identify land use opportunities and problems and thus serve as the basis for land use planning.

Soil Surveys

Soil surveys are conducted according to Soil Conservation Service (SCS) National Cooperative Soil Survey standards. The minimum standard for BLM is an Order 3 survey. An Order 3 survey is an intermediate level or extensive soil survey considered adequate for rangeland, forest land, or community planning. BLM has targeted 157 million acres for Order 3 surveys; approximately 82 percent of this acreage (129 million acres) has been mapped with a soil survey, mostly with Order 3 surveys.

Vegetation Inventory

Rangeland vegetation is mapped according to SCS Range standards. Minimum standards for such mapping are that an inventory include: (1) a map of present vegetation communities and an associated acreage for each mapped site; (2) an estimate of ecological status (successional stage) for each site; and (3) an estimate of species composition by air-dry weight for all herbaceous species.

Woodland sites are mapped and inventoried also according to SCS standards, using a system that was developed primarily to evaluate woodlands and forests associated with farms.

Approximately 25 million acres or 15 percent of BLM lands outside of Alaska have vegetation surveys that meet the minimum standards.

Some inventories for rare and sensitive plant species have been conducted, but no comprehensive listing of such surveys or the extent of coverage is available. Some of these inventories are stored using the Threatened and Endangered Species Data System (TEDS) described below.

Wildlife Inventory

Wildlife inventories are conducted for vertebrate species for both terrestrial and aquatic habitats.

Terrestrial habitat inventories are conducted according to the BLM's Integrated Habitat Inventory and Classification System (IHICS). This system provides a standardized approach for mapping and describing vertebrate habitats and occurrence in relation to vegetation, soils, landform, climate, and other ecosystem components. In addition, it provides a standardized methodology for computer storage and retrieval of such data. The "habitat site" is the basic field data gathering unit in the system. It consists of a mapped unit composed of homogenous vegetation, soils, landform, and vertebrate species occurrence. The degree of verification of species occurrence varies considerably, ranging from hypothetical occurrence based upon existing information to statistically reliable sampling for selected species during two or more seasons.

Less than five percent of BLM lands have been inventoried with a complete IHICS inventory.

Riparian/aquatic inventories are conducted and the data are stored and analyzed using the BLM's Riparian/Aquatic Information Data Summary (RAIDS) System. It provides a parallel system to IHICS for computer storage and analysis of data on riparian/aquatic areas. Less than five percent of the riparian/aquatic areas on BLM lands have been inventoried and have data summarized and stored in RAIDS.

In addition, a Threatened and Endangered Species Data System is used to store detailed observation data on plant and animal distribution, ecology, life history, and population structure of threatened, endangered and special status species. Only a very few threatened and endangered or sensitive species, probably less than one percent of those on BLM lands, have data in this system on their biology or status.

Monitoring:

BLM monitors vegetation as well as wildlife (vertebrate) populations and their habitat. Monitoring in BLM is not necessarily a follow-up to inventory, but is done in response to land use problems and actions to determine if changes in management are achieving desired results.

Vegetation monitoring is done primarily to assess the impact of livestock grazing. The program is highly decentralized with monitoring standards being set at the state level, and no bureau wide standardization of techniques used. No comprehensive statistics on the amount of monitoring are available. Some monitoring is done on threatened and endangered and sensitive plant status, but similarly, no comprehensive statistics are available.

Monitoring of wildlife and wildlife habitat is primarily oriented toward determining if ad hoc management objectives are being achieved. Objectives may relate to enhancing populations or to minimizing impacts on populations from a management activity. Each study is developed on an ad hoc basis and there are no bureau-wide standards or standardized techniques. A recent survey of monitoring in the wildlife program (which includes sensitive and threatened and endangered plants) identified a total of 3,043 separately identified objectives that required monitoring. Of these, 1,855 or about 60 percent, were being monitored. However, 2,043 or about 70 percent of the objectives required modification because they were too vague, unmeasurable, or because of other problems.

Much effort in BLM has focused on developing techniques for inventory and monitoring of riparian areas and on implementing such efforts as part of comprehensive riparian management programs. No statistics are available on the extent of riparian monitoring, however.

Research:

Research in BLM has been managed very loosely in the past. There is no organization within BLM responsible for conducting research, and with a few notable exceptions, all research is done by contract or cooperative agreement. Research on various aspects of biological diversity has been funded in the past, although there has not been any systematic methodology for identifying priorities for research related to biodiversity.

The BLM spends approximately five million dollars on research annually, of which approximately one-third or 1.6 million dollars is for projects related to conservation of some element of biological diversity. These cover a wide variety of species and levels, however, they are mostly related to biological diversity at the species and community level. Two studies on genetic variation in the desert tortoise and in desert bighorn have been partially sponsored by BLM.

In the past year there has been an effort initiated to manage research more systematically. As part of this effort, a bureau committee has identified research and development priorities for the 1990's. One major category identified was "Ecological and Environmental Relationships;" under this category, biological diversity has been identified as a specific category as described below:

> "Biological diversity: Research directed toward evaluating existing biological diversity on the public lands and detecting changes in diversity occurring through time; research into improved management practices for maintaining or enhancing diversity, especially at the regional, community, or ecosystem level; research into restoration of vegetation diversity, especially through reestablishment of native grasses, forbs, shrubs, and forests."

Those in BLM responsible for managing research anticipate a more systematic identification and funding of priority projects related to conservation of biological diversity in the future.

Data Management:

BLM is devoting much money and manpower to the development of a large-scale modern computer system that will integrate Geographic Information System (GIS) technology with traditional alpha numeric capabilities. This is termed a Land Information System (LIS). To date, however, the BLM has not made a commitment to include resource data such as the above "biodiversity" data bases in the LIS.

In theory, the LIS will eventually include all resource and administrative data, both alphanumeric and spatial, standardized for both input and retrieval. The LIS would, in effect, automate every function of BLM and all existing data bases whether currently automated or not.

Current schedules and contract specifications call for the LIS to be in place in about 1993, but it is unlikely to be fully operational for at least ten more years. In any case, much of the information this system is designed to contain is not available and is not being collected. This is true for data on biological diversity as well as other resources.

In the meantime, interim data management systems for the wildlife program continue to be developed. A plan for development of such systems has been developed and calls for all systems to be in place by 1993. These include data bases for both terrestrial and aquatic vertebrates and also for all sensitive, threatened, and endangered animals and plants. Provision is also made for incorporating data from Heritage Databases, as well as the Multi-State Fish and Wildlife Information System Project.

Training, Interpretation, and Education

BLM is developing training courses on biological diversity to help develop the skills needed in its personnel and to develop the awareness to bring about commitments in its personnel. The first training course will be offered to managers in middle and upper levels, with the intention of raising their level of knowledge of and sensitivity to biodiversity. Later courses will be directed at field managers, biologists, and other personnel who are working directly with the resources.

Resources Allocated

The endangered species program is the only activity in BLM that has an allocation of funds that can be identified specifically with achieving biological diversity objectives. In FY 1989, $5,000,000 was programmed for carrying out activities associated with management of threatened and endangered and other special status species and plant communities. Other programs, such as planning, livestock forage management, riparian area management, and watershed management have considerable funding, but there is no way to determine how much of it is expended in ways directly related to meeting biological diversity objectives.

Interagency Coordination

Although BLM currently cooperates on a formal basis with other agencies only for specific biological diversity issues and in limited geographic regions, some broad-based Memoranda of Understanding with the National Park Service, Forest Service, and Fish and Wildlife Service define general coordination and cooperation at the national level. Most actual coordination occurs only in response to very specific local concerns. For example, a coordinated inventory, monitoring, and research program for spotted owls is being conducted by the Forest Service and BLM.

Local BLM state offices and districts often have specific coordination and cooperation agreements with corresponding National Park Service and Forest Service and Fish and Wildlife Service offices, but these generally deal with resource management and administrative issues other than biological diversity.

BLM is actively involved with the State Heritage Program in many states. The Heritage Program is used for basic data management on typical and rare elements (species and communities). Formal relationships have been established in many states.

A cooperative agreement with the Center for Plant Conservation provides BLM with a source of plant material for rare plants that may become extinct in the wild. It also provides for assistance on introductions and transplants.

At the state office level, BLM also has several formal agreements with The Nature Conservancy concerning inventory and management of natural areas and on wildlife and other botanical matters, and participates as members of regional natural area committees.

Interagency coordination is also a major element of BLM's planning and other decisionmaking processes.

Gaps and Problems

While much is being done to enhance biological diversity, some gaps do exist in BLM's programs and criteria.

— As indicated earlier, BLM-administered lands are rich in biological diversity which is promoted or fostered through multiple use management. BLM and the public do not fully recognize this fact.

— The amount, and perhaps more importantly, the significance of heterogeneity or homogeneity within species are poorly known and understood; thus little is being done to manage for these factors.

— While BLM recognizes that genetic variation exists, its inventories do not normally look for or detect degree of genetic variation within species. Some work along this line is being done (desert bighorns, desert tortoise, genetically superior trees, and sagebrush varieties).

— Inventories have not been completed for many species and habitats. Especially lacking are inventories of plant/animal communities, and a comparison of BLM resource data with those of neighboring landowners and managers and the relationships between other lands and BLM-administered lands.

— Global climate change is such a new concept that criteria do not yet exist within BLM to deal with it. Current research does not try to distinguish between effects of management and effects of climate change.

— BLM has tied management of some species' habitats (e.g., desert bighorn sheep, desert tortoise) to population viability, but no criteria exist to determine what a minimum viable population is for most species. There is little information to support development of such criteria or of criteria for defining a minimum viable ecosystem.

— Criteria are inadequate to identify and restore linkages between systems or habitats, especially if these systems or habitats overlap ownerships.

Department of Defense

Mission

The mission of the Department of Defense is to provide for the national defense.

Lands

The Department of Defense is a significant owner/manager of federal lands in the United States, its commonwealth, and territories. Approximately 25 million acres are managed by the four services. This inventory is spread out over 900 separate installations ranging in size from over two million acres to less than ten acres. These lands are used for a multitude of defense purposes including troop training and staging areas, air fields, ammunition storage, radar and communication, aircraft training and testing, research and development, shore facilities support for ships, housing for military families, supply depots, ordnance impact areas, etc.

Because military installations vary greatly in size and are so geographically dispersed, the diversity of natural resources managed throughout DoD is substantial. While some installations are located in remote, unpopulated areas, many others are found along coastlines, in agricultural regions, and in or adjacent to urban areas. In many cases these installations contain unique and important habitats that are shielded from development outside the military's boundary.

The land assigned to individual installations may consist of only a few acres, as in a radar site or weather station, or like the Goldwater Air Force Range in Arizona, it may stretch to more than two million acres. These lands support a wide diversity of plant and animal life, topographical configuration, land forms, and natural communities.

Authorities

As with all federal agencies, DoD is required to abide by public laws, including but not limited to, the National Environmental Policy Act and the Endangered Species Act, as well as other broad-based laws governing federal lands and agencies. In addition, certain other public laws are particularly focused on DoD lands and programs including: Public Law 86-797, Fish and Wildlife Conservation and Military Reservations (Sikes Act); Public Law 90-465, Conservation Programs on Military Reservations; Public Law 93-452, Conservation and Rehabilitation Program on Military and Public Lands; and, Public Law 96-561, Fish and Wildlife Conservation and Natural Resource Management Programs on Military Installations. Several sections of U.S. Code (Title 10) provide for the conservation, management and utilization of military lands for hunting, fishing, and trapping, timber harvesting, and outleasing for agricultural and grazing purposes.

Policies

As stated in the Department of Defense Directive Number 4700.4, "Natural Resources Management Program," it is the policy of the Department of Defense (DoD) to "... act responsibly in the public interest in managing its lands and natural resources. There shall be a conscious and active concern for the inherent value of natural resources in all DoD plans, actions, and programs. Natural resources under the control of DoD shall be managed to support the military mission, while practicing the principles of multiple use and sustained yield, using scientific methods and an interdisciplinary approach. The conservation of natural resources and the military mission need not and shall not be mutually exclusive."

Each military department and service issues instructions implementing DoD directives and policy, providing more specific information to military commanders on the management of lands and natural

resources they are responsible for. To assist in the implementation of programs, a series of "Tri-Service" manuals have also been developed and adopted by the Department of Army, Navy, and Air Force. These manuals provide management guidelines for the four major areas of natural resources management which are: land management (soil, water, vegetation); fish and wildlife (including endangered species); forestry, and outdoor recreation.

Management Strategies for Achieving Biological Diversity Objectives

The management and utilization of military lands and resources are aided by or coordinated with facility master plans which provide for development and maintenance of facilities, identify training and other special use areas, and delineate protected or sensitive areas and resources. In addition to the facility master plan, each installation having suitable land areas is required to have an integrated natural resources management plan. This plan is prepared by natural resources professionals working directly for or under contract to DoD. These plans include policy and inventory sections as well as expanded sections on land management, fish and wildlife, forestry, and outdoor recreation, as appropriate to the land base and resources found on each installation. The goal is to attain an integrated, interdisciplinary natural resources program commensurate with carrying out the military mission for the installation.

Protection Programs:

The protection of biological diversity on DoD lands is mandated by DoD Directive 4700.4, "Natural Resources Management Program," which is implemented by each military service through individual regulations, policy guidance, and specific instructions. Since the mandate of this directive is fairly broad, specific details of DoD protection programs are covered mainly through compliance with appropriate federal environmental legislation; primarily the Endangered Species Act and the National Environmental Policy Act (NEPA). Compliance with these directives and laws ensures protection that is focused primarily on specific endangered species, rather than on the broader issue of general protection of biological diversity.

Restoration Programs:

Specific biological diversity restoration programs do not exist in the Department of Defense. Rather, biological diversity restoration is currently achieved primarily through implementation of mitigation called for by the environmental impact analysis. For example, the Air Force has recently completed an environmental impact statement (EIS) in support of the Peacekeeper Rail Garrison Project which will cause the loss of wetlands at several installations. To mitigate these losses, the Air Force will create, enhance, or restore other wetlands. New programs to determine the quality of the wetlands concerned, including their relative biological diversity, will be included in their analysis to ensure that no loss of biological diversity occurs.

Inventory, Monitoring, Research, Data Management and Information Transfer

Inventory:

The preparation of biological inventories by military personnel on military and public lands, both in our country and abroad, has a long and important history. The pioneering collections of Army Lieutenants William Clark and Meriwether Lewis during their famous expedition of the Missouri and Columbia Rivers, the 1838 expedition to the South Pacific and Antarctica by Navy Captain Charles Wilkes and the avian collections of a remarkable series of Army surgeons, including Major Elliot Coues (1842-1899) and General William Alexander Hammond (1828-1900) are a few examples of early military contributions to biological inventory. In modern times, many base natural resources offices have prepared detailed inventories of their native biotas which often represent important base line references. These efforts are typically prepared in cooperation with local colleges and universities or by an interested base natural resources professional. In some cases, inventories have been prepared in cooperation with other federal agencies, such as the *Air Force's Endangered and Threatened Species Manual* prepared by the National Coastal Ecosystems Team of the U.S. Fish and Wildlife Service. Other inventories have been prepared to fulfill NEPA requirements in conjunction with new construction or other projects. A 1988 cooperative agreement between DoD and The Nature Conservancy (TNC) has enabled a number of military installations to use the TNC's local expertise and Natural Heritage Data Base to inventory military lands. The initial TNC inventories have been outstanding and will be conducted on many other DoD lands.

Recommendations — Inventory

1. DoD should continue efforts already underway to determine the degree of biological diversity on its lands. Special emphasis should be focused on areas of heavy use (e.g. training lands) to ensure the protection of biologically rich or sensitive habitats from damage.

2. DoD's current base-by-base effort to work with The Nature Conservancy to identify and develop management strategies for special natural areas should be brought together and accelerated into a program for the overall management of natural resources. The data base developed through such a program would enable DoD to partici-

pate effectively in the national and international dialogues on biological diversity and to address endangered species and environmental impact analyses from a larger perspective than is now possible. The Tennessee Valley Authority (TVA) has a Natural Heritage Program that includes lands in several states and it might be a useful model.

Monitoring:

Environmental monitoring, specifically for assessing biological diversity, is not commonly performed on DoD lands. The monitoring of individual threatened or endangered species occurs in areas of special concern (e.g., southeastern pine forests for the red-cockaded woodpecker, etc.) and several programs by the Air Force and Navy monitor the effects of noise and sonic booms on wildlife populations. The Army, through its recently established Land Condition Trend Analysis program (LCTA), monitors the status of a variety of environmental variables on its training ranges. However, none of these programs address the general status of biological diversity and the information is not shared among DoD components.

Recommendations — Monitoring

1. Procedures for biological diversity monitoring should be incorporated into installation natural resources management plans.
2. Planning and procedures for the conservation of biological diversity should be formally established as inspection items for installation Inspector General (IG) visits.

Research:

With the exception of a few Service Academy faculty members, the DoD does not maintain military personnel or facilities for biological diversity research. Rather, it contracts with civilian universities, private conservation organizations, or other governmental agencies to perform biological diversity research on its land. As with biological monitoring, this research has focused mainly on particular threatened or endangered species. Funding for such research is sometimes provided by appropriated operations and maintenance monies. More commonly, such undertakings are funded from the DoD Natural Resources Reserve Account and other individual services' natural resources accounts. These monies are generated through the sale of hunting and fishing licenses, timber, and from rents paid for grazing and farm leases. In FY 1990, approximately $1.4 million was made available to the individual services from the DoD Natural Resources Reserve Account for natural resources projects, some of which involved biological diversity research on individual bases. In addition, $100,000 was contributed from this account to a larger U.S. Fish and Wildlife Service study to reduce the devastating impact of the brown tree snake on the avian and bat faunas of Guam.

Training, Interpretation, and Education

Many DoD installations have conservation education programs. They are specifically encouraged in departmental regulations, program review, and the criteria for the DoD conservation awards. Typical programs include conservation education centers, nature exhibits, interpretive nature trails, internship programs, scheduled lectures and field trips for school and youth groups, extended liaison with scouting organizations, and articles in base newspapers. This is a sustained effort to promote conservation ethics, but any focus on biological diversity is probably only ancillary to conservation.

Human and Financial Resources

DoD employs over 300 professionally trained natural resources managers. These people work at all levels within DoD from those working at individual installations to those at major commands and on headquarters' staffs. The disciplines represented in this workforce include biologists (terrestrial, aquatic, marine and wildlife), foresters, range and soil conservationists, and agronomists. In addition to this workforce, there are military personnel, both officer and enlisted, who are assigned natural resource functions. Funds for the broad range of natural resources work are derived from the management programs including hunting and fishing fees, timber sales, and revenues from agricultural and grazing leases. In recent years, this has amounted to approximately $30 million in gross revenue per year. This is further supplemented by installation operation and maintenance funds.

Interagency Coordination

To assist DoD in achieving its goal, several cooperative interagency agreements have been established between DoD and other federal agencies including the Department of Agriculture (U.S. Forest Service and Soil Conservation Service) and the Department of the Interior (National Park Service and U.S. Fish and Wildlife Service). In addition, the Sikes Act authorizes tripartite cooperative plans to support installation programs for the conservation and development of fish and wildlife. The cooperators are the Installation Commander, the Regional Director of the U.S. Fish and Wildlife Service, and the Director of the host state's fish and wildlife management agency. These plans provide for mutual cooperation and outline responsibilities for the management of fish and wildlife resources on the installations.

In December 1988, DoD entered into an unprecedented cooperative agreement with The Nature Conservancy. The agreement establishes a policy of cooperation and coordination between DoD and TNC to ident-

ify, document, and maintain biological diversity on defense installations. Technical assistance from TNC and cooperative efforts seek to identify and properly manage areas of exceptional ecological importance, rare or unusual plant and animal communities, and habitats of federal and state listed species. The newly developed cooperative agreement with TNC will enhance the preservation of biological diversity in at least two ways: 1) the continued identification and inventory of important, rare, and sensitive resources and habitat and 2) the contribution to statewide, regional, and national data bases.

There are numerous other cooperative and individually initiated research projects being conducted on DoD lands by federal, state, and local agencies, and colleges and universities. DoD is also working with the Fish and Wildlife Service to identify areas on military installations that are or have the potential to be excellent habitat for waterfowl and associate wetland species. This cooperative effort is in support of the North American Waterfowl Management Plan. Military installations in or near critical waterfowl habitat areas or along migratory flyways are being evaluated for their potential to increase waterfowl population in North America.

Gaps and Problems

DoD and military department policies require inventories and management plans for the natural resources on all installations. The management strategies are based upon the principles of multiple use and sustained yield. Special or unique natural areas are also to be identified and protected. These policies serve to protect biological diversity to a large degree, but the evaluation and preservation of biological diversity have not heretofore been specific policy objectives of either the inventories or the management strategies.

DoD needs objectives, criteria, and management strategies for biological diversity. These probably should be developed in cooperation with the other land management agencies. With them in hand, DoD could issue policies for processing and enhancing biological diversity.

U.S. Fish and Wildlife Service

Mission

The Fish and Wildlife Service has a broad mission involving the long term conservation of migratory and other federal interest public trust resources. The Service implements this mission through several activities including establishing and managing a nationwide network of national wildlife refuges and national fish hatcheries; responsibilities for listing and recovery of endangered species; commenting on wetland, water, and other public works projects; and research on fish and wildlife biology and ecology.

The specific mission of the National Wildlife Refuge System is to provide, preserve, restore, and manage a national network of lands and waters sufficient in size, diversity, and location to meet society's needs for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available.

Lands

The Fish and Wildlife Service manages a network of lands and waters totalling approximately 90 million acres. The National Wildlife Refuge System (Refuge System) includes over 450 national wildlife refuges, 150 waterfowl production areas, and 55 coordination areas. Most of the land base (about 85 percent) is found in Alaska on 16 refuges. The Refuge System dates back to 1903 when Pelican Island, Florida was designated by Executive Order as a preserve and breeding ground for birds.

Most national wildlife refuges have been established by withdrawal from the public domain, federal acquisition of private lands, or by donation or transfer from other agencies. Withdrawn lands enter the Refuge System by Executive Order, Presidential Proclamation, or Public Land Order. Special legislation may also add lands to the Refuge System, such as the Alaska National Interest Lands Conservation Act (ANILCA) of 1980, which expanded the Refuge System by over 54 million acres. Acquisition occurs in fee, by easement, or by lease. Appropriations for land acquisition have derived principally from the Land and Water Conservation Fund and the Migratory Bird Treaty Fund.

Approximately 95 percent of the habitat on refuge lands has been classified, with the remaining unclassified lands found primarily on remote Alaskan refuges. Wetland habitats (marine, estuaries, rivers, lakes, and marshes) make up nearly 37 percent. Principal terrestrial habitats are classified as follows: grasslands (4.6%), forests (19.1%), brush (9.3%), desert (6.5%), tundra (19.6%), and others (4.3%).

Authorities

Refuge management authority derives from several statutes, including the National Wildlife Refuge System Administration Act (NWRSAA), the Refuge Recreation Act (RRA), the Endangered Species Act (ESA), the Fish and Wildlife Act (FWA), the Wilderness Act (WA), the Migratory Bird Treaty Act (MBTA), and ANILCA. Implementing regulations are, for the most part, codified in 50 CFR. The "purposes" for which individual refuges have been established typically originate from one or more of these statutes, other special legislation, or Executive Orders. Refuge "purposes"

play an important role in management policy due to the "compatibility standard" referenced in both the NWRSAA and the RRA. These statutes require that activities permitted on refuges be compatible with "the purposes for which such areas were established." ANILCA adopted the compatibility standard with some modification. It also expressly addressed the biological diversity issue on Alaskan refuges with enabling legislation which reads "to conserve fish and wildlife populations and habitats in their natural diversity."

Numerous authorities also dictate an influential Service role in the review of projects and other activities which may affect fish and wildlife resources on non-Service lands. Examples of pertinent authorities include the Fish and Wildlife Coordination Act, the Water Resources Act, the National Environmental Policy Act, the Food Security Act, the Clean Water Act, the Coastal Barriers Resources Act, the Emergency Wetland Resources Act, and the Endangered Species Act. These and other statutes provide for a particularly important Service role in the protection and restoration of wetland habitats. Statutes which provide authority for Service grant programs (Federal Aid in Fish Restoration Act, Federal Aid in Wildlife Restoration Act, Anadromous Fish Conservation Act) enable states to undertake literally hundreds of projects, many of which contribute directly to the conservation of biological diversity.

The Endangered Species Act, as amended, provides for a variety of Service programs that directly influence the role of federal and state agencies in the conservation of biological diversity. Five hundred sixty-five domestic species and 510 foreign species were listed as threatened or endangered as of April 1990. Approximately four thousand candidate species await further research and consideration for listing. Protective measures in the Act include prohibitions against take and harm; a requirement that federal agencies ensure their actions are not likely to jeopardize listed species; land acquisition authority; recovery programs; and state grant programs. Basic tenets of biological diversity conservation, at species, community, and population levels, are inherent in this legislation.

Policies

The Service's Refuge Manual is the principal source of policy and direction for refuge operations. This document identifies the mission of the National Wildlife Refuge System "to provide, preserve, restore, and manage a national network of lands and waters sufficient in size, diversity, and location to meet society's needs for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available." Four broad goals for management of the Refuge System are also identified in the Refuge Manual:

1. To preserve, restore, and enhance in their natural ecosystems (when practicable) all species of animals and plants that are endangered or threatened with becoming endangered.
2. To perpetuate the migratory bird resource.
3. To preserve a natural diversity and abundance of fauna and flora on refuge lands.
4. To provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment, and to provide refuge visitors with high quality, safe, wholesome, and enjoyable recreational experiences oriented toward wildlife to the extent these activities are compatible with the purposes for which the refuge was established.

In addition to refuge status, areas within (or entire) refuges may be further recognized by supplementary designations. Additional classifications include wilderness, research natural areas, wild and scenic rivers, natural landmarks, international shorebird reserves, biosphere reserves, etc. There are currently 67 refuge wilderness areas totaling 19.3 million acres and another 3.4 million acres on 26 non-Alaskan refuges under consideration. ANILCA specifically directed the Service to conduct a wilderness review of the Alaskan refuge lands set aside pursuant to the Act. Management by the "minimum tool" concept insures that natural diversity values are retained in refuge wilderness. The Service has also designated nearly 200 research natural areas on refuges, as part of a national network intended to represent the full array of North American ecosystems. On these lands, natural processes are allowed to predominate and research is encouraged. The Service participates in the National Natural Landmark program, administered by the National Park Service. As of September 1988, 31 national natural landmarks had been designated on refuge lands and nearly 80 more were under consideration.

Refuge policy relating to biological diversity was also reflected, albeit indirectly, in the Service's Final Environmental Statement on the Operation of the National Wildlife Refuge System completed in 1976. A process to develop a more current programmatic environmental impact statement began in 1986. Numerous public scoping meetings were held throughout the country to gather input in the development of refuge system management alternatives. A draft EIS was published in November 1988 and circulated for public comment. As a result of the overwhelming public response to the 1988 draft EIS, the Service has established a refuge planning team to reinitiate scoping and begin an extensive rewrite of the EIS, to be finalized by spring 1992. The role of the Refuge System in the conserva-

tion of biological diversity will be addressed in considerable detail in the revised EIS.

Management Strategies for Achieving Biological Diversity Objectives

Service activities programs may contribute directly or indirectly to the conservation of biological diversity in a variety of ways. For refuges, system-wide management strategies are stepped down to individual refuges through a hierarchical planning process. "Master Plans" have been developed for several stations where programs are particularly complex and/or controversial. "Management Plans" have been (or will be) developed for each refuge. These plans are organized in three parts: (1) background information, (2) station objectives and strategies, and (3) specific management activity chapters (e.g., forest management, grazing, fishery management, interpretation, etc.). Alaskan refuges have developed "Comprehensive Conservation Plans" pursuant to Section 304 of ANILCA. This Act also directed the Secretary of the Interior to identify and describe "special values" of each Alaskan refuge which include, among others, ecological and wilderness values. The legislative history of ANILCA reflects the intent of Congress that Alaskan refuges be managed to "protect ecological units and processes."

The Service's land acquisition program also addresses the conservation of biological diversity through the processes by which proposed acquisitions are evaluated and ranked. Lands considered for acquisition under the Land and Water Conservation Fund are ranked by the Land Acquisition Priority System, or LAPS. Four "targets" are used for evaluating and grouping acquisition proposals: Endangered Species, Migratory Birds, Nationally Significant Wetlands, and Nationally Significant Wildlife Habitat. Diversity of species is one of several criteria that enter into consideration under each target. Conservation of biological diversity has been among the highest priorities for several refuges which have been added to the System, particularly within the last decade.

Land management programs on national wildlife refuges are designed to perpetuate viable wildlife programs and protect or restore important biological communities. Very few species are confined in their distribution to lands within the Refuge System. However, Service acquisition and land management strategies do address the importance of protecting habitats across the geographic range of migratory birds and threatened or endangered species, in particular. As an example, many refuges have been established throughout the flyway of migratory waterfowl to secure key breeding and wintering areas. Hundreds of other non game migratory bird species benefit directly as a result. Service policies for management of individual habitat types within refuges are addressed in the Refuge Manual. The extent to which management strategies for an individual refuge address ecosystem versus species management depends largely on the purposes for which the particular refuge was established.

On some refuges, wetland habitats may be intensively managed to maximize production or increase food availability for wintering waterfowl. These actions may actually arrest natural successional processes and limit wetland biological diversity. Waterfowl refuges are often managed to provide a diversity of habitat types within refuge boundaries. Though this practice may be focused on key waterfowl species, a wide diversity of other wetland species benefit as well. In contrast, many refuges are managed to perpetuate natural processes. This is particularly evident on the 16 Alaskan refuges which, together, represent nearly 85 percent of the land base in the Refuge System. Over 30 other refuges have been established specifically to promote recovery of threatened or endangered species, largely through the protection and restoration of undisturbed habitats. The unique resource values of habitats or communities within the boundaries of individual refuges are also recognized and protected through supplementary designations. Examples include wilderness, research natural areas, natural landmarks, wild and scenic rivers, biosphere reserves, etc.

Population management strategies on national wildlife refuges are focused on the maintenance and recovery of species for which the Service has primary trust responsibility (e.g., endangered species, migratory birds, anadromous fish). For the majority of refuge lands (particularly in Alaska), direct manipulation of wildlife populations to achieve population objectives is unnecessary. In these situations, management for natural diversity is a realistic objective. On other refuges, restoration of natural diversity may require direct manipulation of wildlife populations (e.g., feral horses, introduced foxes, etc.). On some refuges established to facilitate production in depressed waterfowl populations or endangered species, programs to limit predation are employed.

As a result of its mandated consultative responsibilities, the Service is in a unique position that allows it to affect the land management strategies of other federal agencies. Examples of this type of influence include technical assistance on military lands (Sikes Act), Section 7 consultation pursuant to the Endangered Species Act, Section 10/404 consultation pursuant to the Rivers and Harbors Act and the Clean Water Act, and wetland protection on agricultural lands pursuant to the Food Security Act.

Inventory, Monitoring, Research, Data Management, and Information Transfer

The Service's inventory, monitoring, and research activities provide information for the management of

fish and wildlife on refuge lands; for management of migratory birds and anadromous, coastal, and transboundary fisheries; for the assessment and control of fish and wildlife diseases; for the conservation reintroduction of endangered species; for evaluating the effects of contaminants in the environment; for propagating fish species; and for mitigation of habitat loss.

Inventory:

The Service inventories wetlands throughout North America, wetland plant species, aquatic habitats within the Great Lakes system, threatened or endangered species, and plants, fish, and wildlife on refuges within the National Wildlife Refuge System. These inventories are important for maintaining biological diversity because they provide information on habitat classification, species lists, and geographical distribution of species.

The National Wetlands Inventory was established to generate scientific information on the characteristics and extent of the nation's wetlands and deepwater habitats. Inventory is based on a standardized national classification. scheme.

The Service worked with other agencies to develop a system and approaches for classifying and inventorying aquatic habitat in the Great Lakes and their connecting channels (95,000 square miles). In addition, striped bass, short-nose sturgeon, and Atlantic sturgeon are being inventoried in the Gulf Coast.

Also, more than 6,700 wetland plant species have been identified and classified based on their frequency of occurrence in wetlands for each of 13 regions in the U.S. This work is conducted in conjunction with the Corps of Engineers, Environmental Protection Agency, and Soil Conservation Service.

Most national wildlife refuges have developed and maintain inventories of wildlife species that occur on the refuge, with some indication of the abundance and status of the species. Many also have developed inventories of aquatic species and plants. A new automated information system is currently in development that will allow computer access to a variety of refuge information, including inventory data.

Monitoring:

The Service conducts a series of annual surveys to ascertain the status and long-term population trends of waterfowl, wetlands, non game birds in terrestrial habitats, colonial waterbirds, anadromous fish populations, environmental contaminants, and diseases. These monitoring activities are used as a basis for identifying impending environmental or population problems relevant to biological diversity.

One of the primary monitoring functions of the Service is annual surveys of waterfowl and wetlands. Major waterfowl production areas in North America have been stratified and are surveyed by subsampling. Areas are surveyed in terms of numbers of breeding pairs and their annual brood production to allow determination of population trends. Wetlands are surveyed at the same time to determine long-term trends in wetland numbers. Surveys are conducted by observers in fixed-wing aircraft followed by ground-truthing.

The Office of Migratory Bird Management maintains all records of banding activities of migratory birds. New banding reports are examined for accuracy and incorporated into the data base each year. Over 70,000 band recoveries are reported annually. These data allow monitoring of annual changes in hunting harvest of waterfowl, as well as providing information on movement patterns and mortality of non game migratory species.

Pesticides and toxic chemicals in the environment, particularly in wetland and deep water systems, have been monitored for more than 20 years to develop and provide information on the temporal trends in concentration of persistent chemicals and pollutants in fish and wildlife populations.

The Breeding Bird Survey has been conducted annually since 1966 by volunteers and managed by the Service. The surveys include 2,000 25-mile roadside censuses conducted during the breeding season. The surveys are used principally to determine population trends of non game birds to allow identification of species with long-term declining populations.

The Service also monitors breeding colonial waterbirds to detect population changes. Surveys take place primarily on refuges, although non-Service lands may be surveyed in cooperation with others.

Population sizes, and in some cases productivity of a number of endangered species are monitored annually (e.g., Laysan's duck, Puerto Rican parrot, whooping crane, bald eagle, Kirtland's warbler, Palila).

The Service currently lacks any national fish population data base, but maintains fish stock assessment records for selected populations at regional offices. However, work is underway to develop such a process to gather and computerize fish population data throughout the nation to allow assessment of long-term population trends. This system will be completed by the end of FY 1991.

The National Wildlife Health Research Center provides diagnostic services on diseases as causes of mortality of fish and wildlife.

Waterfowl and other migratory bird populations are monitored on most refuges. Waterfowl-use-days are recorded. In addition, many refuges also conduct broader censuses of other wildlife species. Also, public use (hunting, fishing, camping, hiking) is monitored.

As part of the FY 1991 thrust on global climate change, the Service is going to improve the frequency of sampling and number of sampling stations for a variety of fish and wildlife species. The Service will augment existing sampling programs for waterfowl, migratory birds, fish stock, and endangered species and add new ones to allow monitoring of long-term changes in species populations, including vertebrate species that may be sensitive to atmospheric changes (e.g., amphibians or endangered species with small pockets of critical habitat such as the Kirtland's warbler). A new biological diversity survey is planned to provide a statistically significant subsample of the status of diversity nationwide.

Research:

The Service recognizes the importance of research to the successful completion of its mission to conserve, protect, and enhance fish and wildlife and their habitats. The Service conducts active research on an array of fish and wildlife topics that are relevant to maintaining the conservation of biodiversity.

The Service conducts research to develop innovative methodologies, techniques, and approaches to monitoring, studying, or enhancing fish and wildlife populations. The Service is researching new ways of using radiotelemetry for monitoring life history traits (i.e., survival, reproduction), movements, and requirements of fish and wildlife species. Such research includes exploration of the effect of radio-tagging itself on movements, behavior, and survival of the organisms. Satellite imagery techniques are being developed to allow inventory and monitoring of changes in habitat availability in both aquatic and terrestrial ecosystems. Geographic information systems allow more efficient and effective examination of large-scale changes and trends.

Service research has been conducted on game fish and wildlife species to examine genetic variation among populations and comparisons of stocked versus wild populations. The Service is involved in developing DNA fingerprinting methodology to allow assessment of genetic variation among populations and to examine the role of inbreeding in population viability. The Service is also examining population genetics in common species, such as blackbirds, as models for the conservation genetics of rare species.

Research is conducted to examine the environmental factors underlying the success or decline of populations and species. The Endangered Species Program is responsible for identifying species of animals and plants that are threatened or endangered with extinction and identifying research needed to develop tools and techniques for more effectively managing listed species. Such approaches are also used for other species.

The Service is currently examining environmental factors associated with waterfowl survival. Recruitment of waterfowl and survival of ducklings are being examined in areas with different levels of habitat perturbation. Habitat management programs (e.g., moist-soil management) are being developed to improve food supplies and enhance the physiological condition of birds. Physiological condition in one season can affect survival and reproductive success in other seasons and such cross-seasonal interactions are being examined to determine the effectiveness of management schemes.

Waterfowl is only one of a number of wildlife groups on which studies are conducted. Similar approaches are used for an array of other plant, fish, mammal, bird, amphibian, and reptile species. In addition, field and laboratory experiments are being initiated to examine the temperature and hydrologic limits of key species to assess the potential impact of global climate change in systems expected to suffer large scale ecological change. Key species that are chosen will be those living on the fringe of their range (presumably near the limits of tolerance to environmental constraints on range expansion). Observations and monitoring of these same species in the field will be used to validate the laboratory experiments and to monitor the progress of global change.

The Service is currently assessing the adequacy of existing refuges and reserves to maintain region-wide biological diversity. "Gap analysis" is being used to assess biological diversity of natural vegetation types and vertebrates as surrogates, although invertebrates such as butterflies are sometimes incorporated. Gap analyses are being applied at these larger geographic scales in Idaho, Oregon, Utah, and California. The effects of land use practices on species diversity within habitats are being studied. Habitat fragmentation and its effects on loss of species is recognized and being studied to determine size, shape, and distribution of habitat reserves necessary for maintaining the greatest diversity possible. Population viability of the same species in different habitat conditions is being examined to determine landscape level effects on maintenance of species populations. Water levels will be artificially manipulated in coastal wetlands to examine the potential consequences of global climate change and diking of wetlands. Ecosystem level studies that include detailed examination of both biotic and abiotic components are more regularly included in aquatic studies and typify studies of systems such as the Great Lakes, Chesapeake Bay, and bottomland hardwood wetlands.

Finally, the Service is investigating the change in concentration levels of environmental contaminants and the consequences for system productivity and health of species populations. In addition, the effects of environmental degradation on disease susceptibility and

programs for treatment of diseases in fish and wildlife are active fields of research within the Service.

Training, Interpretation, and Education

Public visitation in the Refuge System currently exceeds 37 million people annually. The Service places a very high priority on the interpretation of wildlife values on refuge lands through publications, signing, exhibits, and visitor centers. Many refuges also have an active environmental education program in place, typically involving outdoor classrooms and teacher workshops. Both programs are greatly facilitated on many stations by volunteers. Although few educational or interpretive programs on refuges have been designed to address biological diversity, per se, much of the subject material presented speaks to related issues such as ecosystem functions, habitat requirements, species interrelationships, resource management, etc. Most refuges also publish species lists for birds and mammals, and in some cases, for reptiles, amphibians, fish and plants. The educational role of the Service includes the publication of numerous study reports, articles, brochures, plans, and other documents which are widely distributed to administrative, technical, and lay audiences.

The Service has not initiated any staff training programs focusing specifically on biological diversity. A single exception would include the recent short course for decision makers entitled "Meeting the Biodiversity Challenge," which was developed in cooperation with other federal agencies. Numerous "on the ground" workshops are conducted regularly at various locations to disseminate information on related topics, such as moist soil management, wildlife inventory techniques, forest management, wetland delineation, etc. Other training is accomplished through refuge and fishery "academies," attendance at scientific meetings, and extension courses. Planning to develop a Service Training Center at Harper's Ferry, West Virginia is well underway. This new facility will provide the appropriate vehicle for expanded training opportunities relating to biological diversity and other subjects.

Human and Financial Resources

It is impossible to define precisely the Service funding and staffing which contributes to the conservation of biological diversity because of the manner in which appropriated funds are budgeted and allocated. However, a review of FY 1990 funding and FTEs (full-time equivalent positions) provides a useful overview. The adjusted "Resource Management" FY 1990 appropriation for the Service was approximately $393 million and 6,100 FTEs. Actual staffing in FY 1990, inclusive of cost recoverable programs, construction, land acquisition, and Federal Aid programs was nearly 7,400 FTEs. A summary of the 1990 Resource Management appropriation follows:

FY 1990 Adjusted Appropriation:

FTEs		Dollars (millions)
	Fish and Wildlife Enhancement	
260	Endangered Species	24.3
484	Ecological Services	23.2
80	Environmental Contaminants	6.5
40	Natl. Wetlands Inventory	1.5
	Refuges and Wildlife	
2249	Refuge Operations/Mtnce.	122.0
399	Law Enforcement	22.7
184	Migratory Bird Mgmt.	12.9
656	*Fisheries*	47.8
1147	*Research and Development*	70.1
595	*General Administration*	58.3
6,094	TOTALS	$ 392.9

Funding provided to states and territories pursuant to the Federal Aid in Sport Fish Restoration Act and the Federal Aid in Wildlife Restoration Act is generated through sales of recreational equipment and related sources. Total funding associated with these programs in FY 1990 is $190.2 million in fish restoration and $127.2 million in wildlife restoration. Nearly 94 percent ($297 million) of the total FY 1990 funding will be allocated in payments to states and territories.

Land acquisition activities have a direct bearing on the Service's role in the conservation of biological diversity. Funding is derived from two principal sources. Acquisition funding through the Land and Water Conservation Fund (LWCF) has accounted for major recent additions to the Refuge System. LWCF funding has grown over the last decade, from $9.3 million in FY 1981 to $68.0 million in FY 1990. Additional funding for wetlands acquisition is derived from the Wetland Loan Act, sale of duck stamps, and other receipts. Funding appropriated under this program has varied from $1 million in FY 1975 to $30.6 million in FY 1990.

Interagency Coordination

The Service participates in interagency and international cooperative agreements, conventions, and programs to sustain viable populations of plant and animal populations throughout their geographic range. For example, the Service participates in the following international conventions and agreements: (1) Convention on International Trade in Endangered Species of Wild Fauna and Flora - directed at controlling international trade in endangered plant and animal populations; (2) Migratory Bird treaties with Canada, Great Britain, Japan, Mexico, and the Soviet Union - coordinates national responsibilities for migratory bird conservation; and (3) Convention on Great Lakes Fisheries - agreement with Canada for cooperative management of commercially important fish populations in the Great Lakes. The North American Waterfowl Management Plan, signed by the governments of the United

States and Canada in 1986, provides a framework to guide the long-range restoration of dwindling North American waterfowl populations. The program is dependent upon the implementation of cooperative joint ventures to identify, protect, and restore important wetland and associated upland habitats. Numerous federal, state, and local agencies are involved in the joint venture process.

Although most national wildlife refuges are managed solely by the Service, several refuges are managed in direct cooperation with other federal and/or state agencies. "Overlay" refuges include those areas where the Service retains wildlife management authority secondary to the primary purpose for which the land is managed. This cooperative arrangement occurs on several military installations. Other agencies with which the Service has joint management agreements for specific refuges include, among others, the Bureau of Reclamation, the Corps of Engineers and various state fish and game departments.

The Service directly influences the management of fish and wildlife resources on non-Service lands through various cooperative agreements and memoranda of understanding. Technical assistance to military agencies is often provided pursuant to Sikes Act authority. In addition, the Service evaluates federal and non-federal activities that affect endangered and threatened species, wetlands and aquatic habitats, and migratory birds, pursuant to the Endangered Species Act, National Environmental Policy Act, the Fish and Wildlife Coordination Act and other statutes. The Service's activities in this arena generally emphasize habitat protection and conservation on federal, state, and private lands to provide the greatest benefit to the broadest array of species. Coordination to protect and restore wetland ecosystems has accelerated in recent years, in large part the result of 1985 amendments to the Food Security Act ("Farm Bill") and the more recent Emergency Wetland Resources Act. The Service cooperates with the Department of Agriculture to reduce the impact of agricultural conversions on wetland ecosystems. The Service also has recently established an estuary program, reflecting increasing responsibilities in the protection and enhancement of the nation's bays and estuaries. Although the longest running multi-agency program has been underway in Chesapeake Bay, other projects have been initiated or are in planning for San Francisco Bay, Delaware Bay, the Gulf Coast, and Puget Sound.

Many of the Service's monitoring and research activities are conducted in direct coordination with other federal and state agencies. One of the older, yet still continuing, cooperative programs is the National Contaminant Biomonitoring Program. This monitoring project has addressed the distribution and accumulation of agricultural contaminants in the environment. The project was designed to complement monitoring by other agencies, such as the Geological Survey and the Food and Drug Administration. The Department of the Interior's Irrigation Drainwater Program is a more recent interagency research effort, focusing primarily on the movement and accumulation of naturally-occurring soil constituents that impact fish and wildlife and their habitats. Finally, the Service's 41 cooperative Fish and Wildlife Research Units provide an instrument for long-term research and technical assistance in a cooperative venture which involves Service scientists, state resource agencies, and academia.

Gaps and Problems

The mission of the Fish and Wildlife Service is, at least, conceptually compatible with a national goal to "reverse the loss of biological diversity." The Refuge System is the only block of federal lands on which conservation of fish and wildlife resources is the highest priority. In addition, one of the four primary objectives for the Refuge System speaks directly to the biological diversity issue ("to preserve a natural diversity and abundance of fauna and flora on refuge lands"). Yet, there are definite gaps and problems that, if addressed, would enhance significantly the Service's role.

Lands:

- With the possible exception of Alaska, the refuge land base does not adequately represent the full array of native ecosystems and biological communities.
- Except on the largest refuges, protected ecosystems remain highly vulnerable to threats originating from land use activities off Service lands.

Authorities:

- Sufficient statutory authority exists to focus greater emphasis on the acquisition of lands high in species richness, but narrowly defined legislative purposes on some existing refuges may conflict with biological diversity objectives.

Policy:

- The Service has no explicit, cross-programmatic policy for the conservation of biological diversity. Specific direction in the Refuge Manual is unclear.
- Direction is lacking regarding the resolution of conflicts between management strategies for single species and biological diversity.
- Policy is unclear regarding the protection of genetic resources or management of diversity at the landscape level. - Organizational responsibilities for planning and implementation of accelerated programs to address biological diversity are unclear.

Management Strategies:

- Conservation of biological diversity, per se, has not been effectively integrated into Service planning and environmental assessment processes.
- Service acquisition processes do not effectively consider ecological integrity, species diversity, gene pool maintenance, wildlife corridors, or impacts of external influences on ecosystem stability.
- Criteria are lacking to evaluate success of land management programs in the conservation of biological diversity.
- Guidance and strategies to manage unique biological communities are lacking and/or poorly disseminated. - Service managers have only very limited data on genetic variability of refuge species.
- Guidance is limited regarding management strategies for areas within refuges under supplementary designations (e.g. wilderness, research natural areas, etc.) as it relates to conservation of biological diversity.

Inventory, Monitoring, and Research:

- Current inventories on Service lands traditionally emphasize waterfowl and endangered species. Other non game species, fish, and plants receive limited attention. Also refuges often do not incorporate important adjacent habitat into monitoring activities so data are not all inclusive or representative.
- Monitoring off Service lands, with the exception of national surveys (e.g., Breeding Bird Survey), is very limited and focused on a small sample of species and habitats.
- Inventory and monitoring of fish populations, on and off Service lands, is focused on key species and select habitats. Potential consequences of fish stocking programs on genetic diversity have not been adequately examined.
- Technique development to assess genetic variation is limited. Only a fraction of listed species have been investigated.
- Research on community-level species interactions has been insufficient. Impacts of habitat degradation and fragmentation on vulnerability of species to other mortality factors need further research.
- More research is needed on recruitment and survival of species under various habitat conditions.
- Research on systems and species most susceptible to consequences of global climate change is lacking.

Training, Interpretation, and Education:

- No systematic process is in place to insure that the concept of biological diversity is integrated effectively into the existing infrastructure for interpretive and educational products and programs.
- No training processes or programs are in place to educate Service managers and staff on biological diversity issues and strategies. Human and Financial Resources:
- While substantial Service funding and staffing is directed toward programs and activities that contribute to the conservation of biological diversity, no process is in place to budget or track expenditures in this area.
- The Service has no clear delineation of responsibility and authority for planning and implementation of biological diversity initiatives.

Interagency Coordination:

- No coordinated strategy is in place to identify and cooperatively plan for protection and management of unique biological communities that extend beyond refuge boundaries. - The Service consultative role with other federal agencies, as it relates to biological diversity, is unclear.
- Conservation of biological diversity has not been effectively integrated into planning and execution of Federal Aid programs.

USDA Forest Service

Mission

The land management mission of the Forest Service is to assure sustained yields of multiple uses of the National Forest System without impairment of the productivity of the land.

Lands

There are a little over 191 million acres in the National Forest System. About two million acres are lakes, ponds, and reservoirs. Approximately 128,000 miles of streams and rivers occur within the System. The national forests cover approximately eight percent of the surface area of the United States. Yet they hold 50 percent of the soft wood timber supply of the country, provide nearly 25 percent of the actual supply to the mills, support at one time or another 75 percent of the big game animals of the western states, sustain more than 40 percent of all recreational activity days that occur on federal lands, and hold over 50 percent of

the spawning and rearing habitat for salmon and steelhead trout in the 48 contiguous states. Most of the water available for drinking and irrigation in the west falls on national forest. About 32 million acres of the National Forest System are in wilderness designations. That is about 17 percent of the total area in a high degree of protection from most human activities. The habitats in wilderness will tend toward ecological maturity, but most are high elevation, rocky, or alpine. Approximately 60 million acres are considered to be potentially suitable for timber production. That is about 32 percent. To the extent that those lands are placed under varying intensities of timber management those habitats will tend toward younger successional stages. However, some proportion of those 60 million acres will be reserved from timber production to protect soils, watersheds, scenic resources, fisheries, or wildlife. Those habitats will tend toward maturity and many will be at lower elevations and productive soils. The remaining 98 million acres will be under a wide variety of land uses and protection classes. The habitats on those acres will range from relatively disturbed to highly protected. It is the business of forest planning to ascertain the exact proportions, locations, and management practices for each of these kinds of land. The forests sustain the major habitats for over 120 endangered species and with a few notable exceptions also sustain the richness of mammals that have disappeared from the national parks in recent years. We care for the habitats of nearly 1,000 sensitive or candidate species.

Authorities

The Forest Service's Organic Administration Act of 1897 defined the purposes of the forest reserves (now known as national forests and national grasslands): to improve and protect the forest within the boundaries, to secure favorable flows of water, and to furnish a continuous supply of timber for the use of the citizens of the United States. Since its creation in 1905, the Forest Service has been entrusted with management of the National Forest System. The Multiple Use Sustained Yield Act of 1960 (MUSY), affirmed these original intents and made it the policy of Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. MUSY authorized the Secretary of Agriculture to develop and administer the renewable natural surface resources of the national forests for multiple uses and sustained yields of the several products and services obtained therefrom.

"Multiple use" means the management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people. "Sustained yield of the several products and services" means the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources ... without impairment of the productivity of the land.

The National Forest Management Act of 1976 (NFMA) affirmed MUSY and directed the Secretary to develop and implement integrated plans for the management of forest and rangeland ecosystems. It specifically directed that these plans provide for "diversity of plant and animal communities ... in order to meet overall multiple use objectives." The Code of Federal Regulations, at 36 CFR 219, provides rules for developing these integrated, ecosystem plans, including the goal to manage habitats to maintain viable populations of native and desired non-native species, well distributed throughout their geographic ranges in the national forests and national grasslands, and to protect and restore natural biological communities. The Forest Service is guided by many other laws and regulations, including the Forest and Rangeland Renewable Resources Research Act of 1978 and the Cooperative Forestry Assistance Act of 1978.

Policies

With passage of MUSY in 1960 and NFMA in 1976, the Forest Service's role has been refined to balance demands that are often in conflict: demands for forest products and demands to protect other resource values. These conflicting demands raise problems and policy questions related to the map scales used for planning, protection of species and wildlands, forest conversion and simplification, fragmentation, pesticide use, and conservation of genetic resources.

Forest Service Policy on biodiversity has been evolving since the draft Forest Service Manual (FSM 2070) of September 1988. At the present time, the Forest Plan appeal process is being used to clarify diversity policies. While addressing these policy questions, the Forest Service continues to play many roles in conserving biological diversity, including renewable resources research, international forestry, aid to state and private forestry organizations and individuals, and of course, stewardship of the National Forest System.

Current Resource Management Policies and Programs include:

- Recovering species listed by the Secretaries of the Interior or Commerce as threatened or endangered (36 CFR 219; Forest Service Manual 2600);
- Sustaining population viability of species sensitive to anticipated trends in environmental conditions or human activities (36 CFR 219; Forest Service Manual 2600);
- Protecting rare, unique and highly productive communities of plants and animals (determined through Forest Plans at the local level); and

— Managing habitats and populations to produce ecological conditions that sustain human uses of species desired as commercial, recreational, or subsistence resources (guided by RPA Program, Forest Plans, and various state agency plans).

Management Programs for Achieving Biological Diversity Objectives

A beginning for practical approaches to conserving biological diversity is being developed for National Forests, consistent with scientific knowledge and under guidance from the legal mandates and mission of the Forest Service to provide for sustainable yields for all the multiple uses and values of forests. Diversity of plant and animal communities in order to meet overall multiple use objectives, the legal mandate provided by NFMA, is being translated into programs, plans, and actions to achieve specific, desired results for the biota in the National Forest System. These include recovery of threatened and endangered species to viable levels; management of habitats and human actions to maintain viability of all other species' populations, well distributed throughout their geographic ranges; protection, management, restoration, or enhancement of special habitats and biological communities; ensuring the structural and functional integrity of regional ecosystems; and managing the genetics and populations of species desired for human well being. Forest Service programs and plans for diversity vary, as we are still learning how to approach this complicated issue.

The overall strategy on biological diversity being developed by the Forest Service combines management of the National Forest System with Renewable Resources Research, International Forestry, State and Private Forestry, and cooperation with other agencies and organizations interested in or responsible for aspects of biological diversity. Ultimately, the conditions and trends of lands, waters, and biotic systems will determine success in conserving biological diversity. Forest Service plans and programs for land and resource management, research and assistance are tailored to integrate goals and management actions for specific aspects of biological diversity. These include genetic resources, species populations, biological communities, and ecosystem processes at geographic scales that begin with distinct, mappable stands or sites and will eventually come together in coordinated regional conservation strategies of all agencies and responsible organizations. This integration and refinement of approaches to conserve biological diversity is ongoing and will improve with new knowledge and technologies. Especially important will be roles for research and monitoring to provide for timely responses to the adverse effects of large scale changes such as global climate change and air pollution.

Inventory, Monitoring, Research, Data Management, and Information Transfer

The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 requires an assessment of the renewable resources on all forest and rangelands in the United States at ten-year intervals. The Forest Service has at least 13 additional laws, 57 manual sections, and 20 national handbooks dealing with or touching upon resource inventories. The National Forest System has the responsibility for inventory and monitoring all of the renewable resources on nearly 191 million acres of National Forests and Grasslands in the U.S. All other federal, state and private forest lands fall within the inventory responsibility of the Forest Service's Forest Inventory and Analysis (FIA) Program conducted by the Forest Experiment Stations.

The Forest Service commitment to maintenance of biological diversity is reinforced in two key pieces of legislation: the Endangered Species Act (ESA) of 1973 and NFMA of 1976. The Endangered Species Act requires all federal departments and agencies to conserve endangered and threatened species. Further, each agency is to insure that its actions will not likely jeopardize the continued existence of any endangered or threatened species. Although NFMA specifically requires that the Forest Service develop land management plans that provide for diversity of plant and animal communities, clear, operational definitions of diversity are lacking. The Act also requires the agency to establish a monitoring program to assure that its practices do not result in impairment of long-term productivity.

In addition to its responsibilities to assure biological diversity in its land management activities, the Forest Service also conducts a program of research to support natural resource conservation and management. This program is authorized by the Forest and Rangeland Renewable Resources Research Act of 1978. Much of the program is directed toward management issues that are of concern to National Forest System professionals, such as monitoring methodology, threatened and endangered species, landscape ecology, and conservation of genetic resources. The Forest Service also provides technical assistance on inventory and monitoring technology to foreign nations through its International Forestry Program.

Inventory:

All Forest Service Regions use some form of mapping and sampling to identify vegetation, stand size, and stocking for resource inventory and planning. Some regions use aerial photography as an inventory base. Others are beginning to use Landsat imagery. Aerial photos and Landsat images are frequently used to stratify the field sampling. The most detailed level of information is obtained for the timber resources.

However, detailed surveys are conducted to identify the presence of threatened or endangered plants and animals prior to initiating management activities. Resource planning also includes threatened and endangered species and wildlife and fish habitat surveys. In fiscal year 1986, the National Forest System budgeted about $4.275 million to inventory 16.6 million acres of forested land; the average cost was $0.26 per acre.

Forest Inventory and Analysis (FIA) conducts forest surveys on a state-by-state basis. The FIA units do not map the resources. Instead, a grid of plots is extended across the survey unit. Aerial photography of plot locations are classified as forest or non-forest, plus other characteristics. A subsample of the photo plots are selected as field plots for gathering ground measurements. The techniques used and the data collected are similar to those of the National Forest System inventory. Timber and other vegetation information is collected.

The need for more specific data and more efficient ways for collecting and managing data is leading to significant changes in the inventory process. Changes being evaluated include use of methods and technology that will: (1) provide resource estimates for specific geographic units and evaluate the reliability of such estimates; (2) display estimates and units spatially; (3) make maximum use of existing information and new technology, such as remote sensing and geographic information systems; (4) provide a base line for monitoring changes in the extent and condition of the resource; (5) eliminate redundant data collection, develop common terminology, and promote data sharing through corporate data bases; (6) utilize information management systems to provide maximum flexibility for data integration, manipulation, sharing, and responding to routine and special requests; and (7) provide up-to-date data bases using modeling techniques, accounting procedures, and re-inventories.

Recommendations — Inventory

1. Scientifically valid definitions of "old growth" should be developed for the forest types in each region and the locations of forests meeting these definitions inventoried and mapped. (Note: this work is underway.)
2. A program to produce detailed maps of all natural communities occurring on each national forest should be initiated.
3. The Forest Service needs to begin a thorough review of the present management indicator species program. This review should include the adequacy of the program in meeting the intent of the National Forest Management Act of 1976 and the sensitivity of approach in measuring environmental change and species viability in the national forests.

Monitoring:

NFMA requires the Forest Service to use monitoring and assessment to assure that the effects of each management system do not result in substantial and permanent impairment of the productivity of the land. The National Forest System currently defines its monitoring at three levels: (1) implementation monitoring to ensure that practices prescribed in standards and guides, in forest land management plans, and in project plans are executed as designed; (2) effectiveness monitoring to determine if prescribed practices accomplish intended objectives; and (3) validation monitoring to determine whether the standards, upon which prescriptions are based, are appropriate and valid. Specific monitoring needs and plans are described in each national forest plan. Forest Service scientists and biometricians have been working with the National Forest Regional Offices to develop statistically efficient and valid monitoring technology. The Inter-mountain Research Station, located at Ogden, Utah, has recently established a research unit to address the statistical aspects of monitoring. Further, a unit based in the Pacific Southwest Research Station is developing wildlife monitoring techniques.

Formal monitoring plans are developed for threatened, endangered, and other key species. For example, detailed plans for inventory (to determine presence and distribution) and monitoring (to determine population trends, reproductive status, etc.) have recently been prepared for spotted owls in Washington, Oregon, and California.

Recommendations — Monitoring

1. Monitoring methodology and data bases should be standardized between Forest Service organizational levels, especially for the same species; and
2. Incorporate monitoring costs into the budget planning for every project, if needed.

Data Management:

The Forest Service now has 900 Data General computer systems installed and about 19,000 terminals. All systems are interconnected, making it the largest integrated network in the world. Personal files can be accessed from any of the individual systems, messages can be created and sent, and documents or files can be electronically mailed to any other user on any system in the network. The Forest Service is installing a new relational data base management system, ORACLE, and is in the process of acquiring a geographic information system (GIS).

The agency is currently evaluating its information needs to ensure that it has the information needed to meet the intent of existing laws and to keep field data collection requirements to a minimum. Recent efforts

include the National Information Requirements (NIRP) and the Resource Information (RIP) Projects. New direction is being developed and will be distributed to all units through the Forest Service Resource Inventory Handbook. This handbook will link NIRP, RIP, and a proposed information structure. Both FIA and the National Forest System are switching from single purpose inventories to coordinated or integrated resource inventories to meet local, regional, national, and international needs. A "Primer on Integrating Resource Inventories" and an "Interim Resource Inventory Glossary" have been prepared to assist in this effort. All units will be gathering more complete information about ecosystems as a whole, including spatial and temporal information about soils, vegetation, water, fauna, and air.

Research:

Forest Service Research addresses several important components of biological diversity, such as threatened and endangered species, sensitive habitats (old-growth forests and riparian ecosystems), and community ecology. Scientists are developing new knowledge and technologies about population viability, ecosystem restoration, landscape ecology, habitat isolation and fragmentation, cumulative effects analysis, and genetic variation.

The total research program related to biological diversity is $4.8 million—$3.5 million for threatened, endangered, and sensitive species and $1.3 million for all other areas.

The Forest Service is preparing an expanded program if additional funding becomes available. Areas to be expanded or initiated within this program include: (1) determine species sensitive to management activities that may limit biological diversity; (2) determine appropriate population sizes to maintain species; (3) define critical habitat limitations that affect species populations; (4) develop measurable units for assessing the maintenance and/or changes in biological diversity appropriate for the scale of resolution (i.e., genetic, species, ecosystem, and landscape); (5) develop in coordination with land managers prescriptions to maintain critical species and ecosystems; (6) verify that recommended prescriptions are performing as expected with particular attention given to the cumulative effects of management actions on the landscape; and (7) initiate efforts to integrate biological information on the broader landscape scale (i.e., landscape ecological research to contribute to better understanding of systems ecology).

Recommendations — Research

The Forest Service should aggressively pursue implementation of its Priority Research Programs (PRPs) including:

1. Threatened, Endangered, and Sensitive Plants and Animals PRP

   — Resource Requirements and Life History Patterns of threatened and endangered species — Identify habitat/site selection, processes and patterns of habitat/site use, factors (resources, competition, predation, disease, genetics, etc.) that influence reproduction, growth, survival, and genetic structure within populations, and dispersal patterns and interactions among populations.

   — Organism and Population Responses to Habitat/Site Manipulation and Changing Environments — Determine plant and animal responses to habitat or site disturbance related to resource development activities, how plants and animals respond to human-related disturbance or stress, such as noise, air pollution, or environmental toxins, how populations and communities change with natural succession and following natural disturbance, how historical land changes (natural and man-made) have influenced the distribution and abundance of threatened and endangered species, and how silviculture and other vegetation management practices can improve habitat/ site quality.

   — Factors Regulating Population Growth and Stability and Develop Population Viability Assessments — Determine variation in sex, age, and genetic structure among populations, relate life history parameters and genetic structure to population growth rate, determine how the spatial and temporal distribution of habitats influence population stability, model the probability of population persistence in relation to genetic, environmental, and demographic variation, and model the probability of species persistence in relation to the spatial distribution of populations, rates of movements among populations, and rates of local extinctions and colonizations.

   — Recovery and Monitoring Technologies — Synthesize knowledge of resource requirements and life history into habitat management guidelines, develop strategies for using silviculture and other vegetation management practices to improve habitat/site quality and guidelines for the distribution of habitats in space and time, develop techniques for monitoring

habitat and population trends, genetic variation and relating genetic parameters to population growth and stability and for translocating individuals and reestablishing populations.

2. Developing an Ecological Perspective for Managing Forests PRP

   — Ecosystem Management at the Stand Level — Undertake basic studies related to the impacts of resource management and use on the structure, composition, and function of ecosystems, determine how biological interactions such as competition, predation, parasitism, and mutualism regulate ecosystem structure and function, develop silvicultural methods for conserving and enhancing species and community diversity including maintaining old-growth forests, relate the structural complexity of forest overstory to ecosystem productivity and compositional diversity, and determine the roles of forest composition and stand structure in nutrient cycling, long-term site productivity, and in providing critical habitats for animal and plant species.

   — Forest Systems at the Landscape Level — Conduct research to examine biological processes, cumulative management effects, and ecosystem responses at the landscape level, develop approaches for maintaining critical habitats and ecosystems in a dynamic landscape mosaic, examine the roles of landscape structure, evaluate landscapes in terms of sources and sinks of species, energy, and materials, relate the genetic structure of populations and their spatial distributions to maintaining viable populations of plant and animal species, and evaluate economic and management implications of an array and mix of management intensities, ranging from intensive culture to preservation and protection.

   — Forest Dynamics and Mechanisms of Ecosystem Recovery Following Disturbance — Develop understanding of natural disturbances and human activities in terms of frequency, severity, and spatial distribution, as factors in ecosystem and resource management, improve methodologies for restoring degraded ecosystems, improve understanding of the relationship between disturbance and the regeneration of important forest species and how human activities alter the frequency, intensity, and distribution of natural disturbances across landscapes.

   — Research and Management Methods — Develop new research techniques, statistical procedures, and a variety of measurement technologies adapted to an ecosystem perspective, develop methods of integrating special or unique habitats, wilderness, research natural areas, and other special interest areas as functional components of broader landscapes, develop methodology to assess and predict the impacts of insects, disease, and environmental stresses on individual trees, stands and landscape patterns, and refine conceptual models into a new generation of prediction systems for individual tree and forest stand development and their roles in landscape patterns under an array of management strategies.

   — Applications to Management and Planning — Undertake efforts to improve our knowledge of the social, political, and economic consequences of developing and applying ecosystem concepts to land management.

3. Tropical Forestry PRP

   — Natural Regeneration of Tropical Forests — Assess the extreme biological diversity, species-richness, or heterogeneity that characterizes tropical forests, determine the relationship between percent of land cleared and percent of species lost, the influence of high species complexity on this relationship, determine the resiliency of tropical forests to recover from varying types of disturbance, and determine the resistance of vulnerability to intrusion, disruption or invasion of tropical forests whether managed or otherwise to exotic species.

   — Management and Improvement of Secondary Forests and the Rehabilitation of Degraded Tropical Forest Lands — Develop methods for managing secondary forests and forested wetlands for the production of various goods and services, develop methods for restoring and rehabilitating tropical forests and degraded or damaged lands, and develop new systems of land and resource use for damaged and degraded lands that will increase their value and productivity in meeting the needs of people.

— Valuation of Tropical Forests — Develop new systems for measuring the non-market values of tropical forests and through modeling, evaluate the sustainability of management systems and land and resource use in the tropics, considering social needs and ecosystem limitations.

Training, Interpretation, and Education

The Forest Service is developing training courses and workshops on biological diversity to help develop the skills needed by its personnel. It is bringing agency personnel, private enterprise, and interested citizens into the process of developing policies to conserve biodiversity. This is being accomplished by holding regional workshops and national and local policy dialogues so that everyone can contribute to the formulation of a national conservation strategy. There are a variety of ongoing Forest Service educational and interpretative programs on the value of biological diversity. Examples of current Forest Service educational efforts on biological diversity include:

— Interpretative programs that educate and inform the public about the values of our forests and rangelands. This includes brochures and other literature, educational programs about the occurrence of natural disturbances such as those at Mt. Saint Helens, and interpretative programs like those on the Alaska Marine Highway designed to develop an appreciation for the temperate rain forest of the Tongass National forest.

— Training programs to aid in the development of conservation-oriented educational infrastructures in recipient countries through the Forestry Support Program in cooperation with U.S.A.I.D. through an expanded training program. Training will be designed specifically for a given country and its habitats, taught on location to the managers most able to make an impact on project implementation.

— Educational programs focused on providing a true value for biological resources. All too often, forest economics/resource valuation is based solely on the value of forest resources as the amount of available fiber. Market demands that drive consumption are the commodities which are usually given the highest priority. The Forest Service has extensive expertise on forest economics which is now focusing on truly valuing timber resources in relation to other values. This includes the integration of resource benefit values for decisionmaking, the valuation of recreation, wildlife, and scenic beauty, water benefit values, and the valuation of benefits from commodity resources not adequately defined by market pricing.

— Policy level training and educational programs could potentially have more impact on the saving of biological diversity than any other single strategy. National policies can provide substantial incentives for developers to clear and burn forest ecosystems for activities that otherwise would be unprofitable. Policy training is aimed at higher management and concentrates on a practical, long-term economic approach to natural resource management and to decisions on the management of individual tracts of land.

— Enhanced public awareness of the values of biological diversity through writing publications and newspaper articles and organizing meetings and seminars. Public education programs, news releases, meetings, and seminars are all used to raise public awareness of the values and uses of biological diversity. Emphasis is placed on making people aware of the benefits of biological diversity by the development of brochures and magazine, journal, and news articles for the general public on government programs. Meetings and seminars are organized to present the ideas, concepts, and needs for maintaining biological diversity.

Human and Financial Resources

The Forest Service employs thousands of professionally trained natural resource managers with backgrounds in forestry, hydrology, entomology, fire ecology, wildlife biology, fisheries biology, botany, silviculture, range science, and ecology. All these people work at different levels to manage the National Forest System. The Forest Service also has a research branch that employs approximately 700 scientists to answer questions focused on sustainable resource management.

Interagency Coordination

Although the Forest Service currently cooperates on a formal basis with other agencies only for specific biological diversity issues and in limited geographic regions, some broad-based Memoranda of Understanding between the National Park Service, Bureau of Land Management, and Fish and Wildlife Service are available for coordination and cooperation at the national level. Most actual coordination occurs only in response to very specific local concerns. For example, a coordinated inventory, monitoring, and research program for spotted owls is being conducted by the Forest Service and Bureau of Land Management. Coordination also occurs between the Forest Service, Fish and Wildlife Service, and the National Park Service related to grizzly bear management in and near Yellowstone National Park.

Local Forest Service regions and national forest often have specific coordination and cooperation agreements with corresponding National Park Service and Bureau of Land Management offices, but these generally deal with resource management and administrative issues other than biological diversity.

The Forest Service is actively involved with the State Heritage Program in virtually every state. The Heritage Program is used for basic data management on rare elements (species and communities). Formal relationships have been established in many states and the Forest Service even shares funding for positions in some states. Every Region and Experiment Station has a Research Natural Area (RNA) Committee that coordinates the RNA Program, reviews candidate areas, and oversees preparation of establishment reports. The Heritage program is used in this process to identify potential RNAs and other critical areas. The Nature Conservancy is often represented on these committees, and in several regions the Forest Service and The Nature Conservancy jointly share the cost of preparing establishment reports. The Forest Service is considering the use of the Heritage Program evaluation scheme for doing risk analysis for determining what species/habitats to monitor as part of Forest Plan implementation.

Finally, the agency is pioneering in opening the public resource decision-making process to broad involvement and interagency coordination.

Gaps and Problems

Like most agencies, the Forest Service needs better inventories of the basic elements of biological diversity. In the National Forest System, these elements are probably known better than for any other large land management system, though they are still known only generally for our comprehensive management purposes. For example, the National Forests and National Grasslands contain nearly 80 percent of the vertebrate species richness in the U.S., 30 percent of the listed endangered and threatened species, over 70 percent of the major vegetation types, 50 percent of the salmon and trout habitat, 50 percent of the standing volume of sawtimber, and 75 percent of the big game populations in the West. They also form the backbone of at least six contiguous wildland ecosystems that range from the three million acre Southern Appalachian Highlands to the 32 million acre Northern Continental Divide. And this only scratches the surface of the base line knowledge needed on biological diversity for these lands.

However, current national forest inventory and national forest system inventory procedures suffer from two weaknesses when applied to the broad issue of biological diversity. First, both are largely driven by the need to obtain information demanded by public and industrial planners for the commercially important species, especially timber. Second, the inventories are limited in scope to one time of year and for vegetation only. The national forests have been directed to inventory timber resources in designated wilderness areas, but not all regions have conducted such inventories. Inventories that have been completed are at a lower level of intensity. We need better inventories and assessments of the current conditions, abundances, distributions, and management direction for genetic resources, species populations, biological communities, and ecological systems. Heritage Programs are perhaps the best example of coordinated inventories, and Geographic Information Systems the most promising of new technologies.

The Forest Service is considering the use of gap analysis methodology. With the implementation of a national GIS network and expanded capability in this area, good use can be made of gap analysis. The existing Wildlife Habitat Relationship Models provide something similar to the results of gap analysis, but currently only at the general habitat level; efforts are underway to expand this to landscape patterns. Part of the problem has been the lack of reliable data to do gap analyses. In collaboration with The Nature Conservancy and State Natural Heritage Programs, the agency has uncovered many rare plants and unusual natural communities. However, serious data gaps still exist, especially for plants and non-game animals. The extent of many species, particularly amphibians, reptiles, and small mammals, are poorly known and will require extensive ground surveys.

However, even a system as large and diverse as the National Forests cannot sustain or rehabilitate its biological diversity without cooperation of adjoining landowners and managers. We need to bring common inventories, research, assessments, plans, and policies into better coordination and coverage. Such multiinstitutional coordination of plans and actions will be tough. Only in Yellowstone, the Southern Appalachian Highlands, and Columbia River fisheries has the Forest Service approached this task. Implementation will be even tougher. People must yield some of their autonomy and there will, no doubt, be adjustments in how areas of lands and waters are managed. That probably means changes in public policies for resource conservation.

The current Forest Service threatened and endangered species program deals primarily with high visibility and/or controversial species (i.e., grizzly bears, spotted owls, red-cockaded woodpecker, etc.). Of about 171 threatened and endangered species occurring on the National Forest System, the Forest Service only deals currently with about 12. About $10 million is spent on inventory, monitoring, and research activities related to spotted owls—this is more than is spent on all other threatened and endangered species combined.

Nationally, implementation of forest plans is at an early stage, so mechanisms for appropriate coordination, data sharing, and inventory and monitoring either exist or are being developed. However, it is too soon to evaluate their effectiveness. Moreover, progress will be difficult to measure until the resource and environmental communities reach consensus on a workable definition of biological diversity and on how it will be assessed. It is unlikely that sufficient funding and staffing will ever be available to accomplish the full inventory and monitoring program needed.

Because funds are lacking to fully address the research needed, the Forest Service has focused upon key species and critical issues that face land managers. Thus, the program includes important components of the needed research, but is somewhat fragmented.

A single national forest may contain several hundred species of vertebrates, a thousand or more species of vascular plants, and an unknown number of invertebrate animals, fungi, and bacteria. Even under the most optimistic scenario of funding and staffing, the Forest Service can monitor only a small proportion of these species—hence the use of management indicator species (MIS). The use of MIS can lead to three critical problems: (1) selection of the wrong species as indicators, (2) selection of too few indicator species for a forest, and (3) failure to use plants and invertebrate animals as MIS.

The MIS approach is effective only when accompanied by an adequate monitoring program. Such a program should consist of: (1) a scientifically sound method for assessing populations of the MIS in question; (2) a reasonable frequency of measurement; and (3) a predetermined population level or degree of change in population size, density, or dispersion that triggers a reanalysis of management activities. At the present, monitoring national forest plans is increasing to meet all of these aims.

National Park Service

Mission

In an Act signed August 25, 1916, Congress established in the Department of the Interior the National Park Service to provide cohesive administration of national parks and similar areas under the Department's jurisdiction. The Act says: "The Service thus established shall promote and regulate the use of the federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Lands

The National Park System of the United States, now in the early years of its second century, comprises 354 areas covering some 79.8 million acres in 49 States, the District of Columbia, Guam, Puerto Rico, Saipan, and the Virgin Islands. These areas are of such national significance as to justify special recognition and protection in accordance with various acts of Congress. The units of the National Park System represent samples of all the major biotic provinces of the United States and most of its trust territories. To some degree in terms of numbers of units, but especially in terms of numbers of acres, this representation is skewed heavily toward several of the more wide-spread biotic provinces of the western states. Because of the Service's decentralized orientation for managing each individual unit as a separate entity in response to both the legislative direction for that unit and the special values of the resources contained in the unit, the bias created by the distribution of the land base does not necessarily affect the Service's ability to protect the native, natural biological diversity represented in the System as a whole. Rather, the Service's ability to protect this biological diversity is more a function of depth of knowledge, intensity of effort, and involvement with neighbors.

Statistical Summary:

Classification	Areas	Acreage
International Historic Site	1	35
National Battlefield	11	12,772
National Battlefield Park	3	8,167
National Battlefield Site	1	1
National Capital Park	1	6,469
National Historic Site	63	179,467
National Historical Park	26	150,741
National Historical Reserve	1	8,000
National Lakeshore	4	225,930
National Mall	1	146
National Memorial	25	7,949
National Military Park	9	34,045
National Monument	77	4,717,182
National Park	49	47,242,673
National Parkway	4	167,090
National Preserve	12	21,960,219
National Recreation Area	17	3,686,830
National Rivers	4	239,004
National Scenic Trail	3	174,226
National Seashore	10	597,060
National Wild & Scenic River and Riverway	8	313,533
Park (Other)	10	32,128
White House	1	18
	341	79,602,165

Authorities

National Park Service authorities and responsibilities are established broadly in the 1916 Act that established the Service. These authorities and responsibilities are twofold: 1) to conserve the natural and cultural resources contained in the parks and 2) to provide for their enjoyment by people of present and future generations. Amendments over the years have refined somewhat this broad directive, especially with respect to instructions to prevent degradation of park resources and to ensure that management of every park is guided by a management plan. In addition, individual park enabling legislation in some cases provides greater direction with respect to biological diversity by specifically mentioning individual components of park biota as significant resources. While the breadth of this legislation regarding the National Park System provides great authority for biotic resources to those who wish to claim it, the generality of the legislation makes it equally possible for others to deny responsibility for individual components of park biotic resources because of lack of specific statutory mention of those components.

The National Park Service exercises these authorities through guidelines with respect to Service management actions and through regulations with respect to human uses of park resources. For example, maintaining viable populations of native species is one purpose of regulations promulgated for controlling resource uses and human activities within parks. Regulations are based on NPS generic enabling legislation, other legislation relating to specific influences (e.g., mining), and legislation establishing purposes and allowable uses for individual NPS areas.

Specific regulations govern the collection of park genetic resources for research and *ex situ* applications. Subsistence uses, when allowed by law, are regulated to minimize effects on ecosystem processes while maintaining benefits to indigenous people.

Policy

The management interpretation of the body of statutes governing the National Park system has evolved as our ecological understanding has grown and as the demands for use of the protected areas and the lands adjacent to them have grown. The *first* response in this evolutionary process was to prevent poaching. The *second* response was to control those features of the ecosystem, such as fire and predators, that were considered to be "bad." The *third* response was to understand that natural components of ecosystems are not "bad" and that human activities such as fire prevention and predator control are, in fact, "bad." The *fourth* response was to recognize that resource degradation due to human activities grows as the intensity of human use increases, and based on this recognition, to institute human use management practices. The *fifth* response was to recognize that the parks do not exist in isolation from neighboring lands (and continents) and to initiate exploration of ways to mitigate impacts on parks resulting from legitimate human activities being conducted outside the parks. The *sixth* response - the harmonious integration of parks into larger, regional land use management patterns that have as a major goal the sustaining of total regional biological diversity - is only beginning to emerge.

The current *Management Policies*, last revised in 1988, represent the culmination of this evolution of thought gained from both legislative and practical resource management experiences. Key features of the 1988 policies include the following statements of mission, definition of terms, ecological process concepts, and mitigation opportunities:

Policy Statement on Mission:

- The National Park Service manages the natural resources of the National Park system to maintain and perpetuate their inherent integrity.
- Perpetuation of a total environment or ecosystem, as compared with protection of individual features or species, is a significant distinguishing aspect of National Park Service management of natural lands.
- Planning and management must be guided by the principle that protection of ecological health is the first consideration and priority.
- Park uses shall be limited to those activities which are dependent upon and protective of the natural values each park was established to preserve.
- The National Park Service provides a leading voice for preservation, serves as a leader in developing and employing exemplary preservation practices, and participates in international exchange of information and providing of technical assistance.
- The National Park Service maintains an interpretation program to promote public understanding of park management goals and to inform people about parks and their significant natural values.
- The National Park Service cannot be the sole preservator of the nation's natural resources.

Definition of Terms:

- Native species are those that occur, or once occurred, due to natural processes on those lands designated as the park.

— Exotic species are species that occur in a given place as the result of direct or indirect, deliberate or accidental actions by humans, which actions have permitted the species to cross a natural barrier to dispersal.

Ecological Process Concepts:

— Natural processes shall be relied upon to regulate gene pools and populations of native species to the greatest extent possible, but unnatural concentrations of native species caused by human activities may be regulated if the human activities cannot be controlled.

— The National Park Service will perpetuate the native animal life of parks and will strive to maintain the natural abundance, behavior, diversity, and ecological integrity of native animals in natural portions of parks as part of the park ecosystems.

— Native insects, diseases, and other organisms that elsewhere may be perceived as pests are recognized as natural elements of ecosystems in parks and will not be controlled unless there is a threat of loss of the host species, the infestation is likely to spread outside the park, the infestation threatens desired plants or animals in developed zones or the historical integrity of cultural resources, or the infestation is a threat to public health or safety.

— Naturally occurring fire, burning under prescribed conditions, is not to be controlled unless specifically identified park resources, human safety, or neighboring property are at risk; the decision on whether or not to control any given fire is based on provisions of a fire management plan.

— Air and water resources are maintained as unimpaired as possible.

— Weather modification is not permitted unless it can be shown that such modification will not alter natural conditions.

— Geological resources are not modified unless specifically necessary.

— Natural quiet and natural sounds are maintained in as natural a condition as possible.

Mitigation Opportunities:

— The natural resources and their use in each park will be managed according to provisions of a natural resource management plan.

— The National Park Service will conduct a program of natural and social science to support management and will encourage the use of parks for scientific studies when such studies are consistent with policy and contribute to park objectives.

— Ecological processes altered by human activities may need to be abetted to maintain the closest approximation of the natural scene where a truly natural system is no longer attainable.

— Active management programs may be carried out to perpetuate the natural distribution and abundance of threatened or endangered species and the ecosystems on which they depend.

— Restoration of native species is encouraged where adequate habitat exists, the restored species will not pose a threat to human safety or to property, the restored species most nearly approximates the extirpated species, and the species disappeared because of human-induced impacts to the population or ecosystem.

— Exotic species may not be introduced into natural zones of parks except where they are the nearest living relatives of extirpated native species or where they may be used to control already established exotic species; exotic species generally may not be introduced into other management zones unless the introduction meets a specifically identified purpose.

— Exotic species are to be removed from park lands wherever practical and in conformance with the approved natural resource management plan.

— Management use of chemical pesticides is to be held to a minimum.

NPS policy, thus, is to maintain natural processes responsible for the continuing evolution of natural ecosystems and to restore elements that have been lost as a result of previous human activities. As a result, the NPS relies on natural ecological and evolutionary processes to regulate species populations and biotic community dynamics to the greatest extent possible. NPS traditionally has not sought to maintain successional communities in natural zones of parks as a biological diversity conservation purpose, but often has sought to maintain successional communities in cultural zones of parks as an historic scene conservation purpose. Development of new policies for the purpose of maintaining representative examples of ecosystems at various successional stages is being discussed, in part as a response to the effects of increasing regional (e.g., habitat fragmentation, pollution) and global (e.g., climate change) influences.

NPS policy also encourages the use of special designations in parks to encourage protection, monitoring, research, and cooperation in conserving outstanding examples of selected ecosystems (i.e., World Heritage

sites, natural landmarks, research natural areas, NPS portions of biosphere reserves).

NPS policy is to maintain biological diversity in naturally evolving ecosystems for its intrinsic value rather than for utilitarian purposes. As a result, visitors are encouraged to pursue inspirational, educational, and recreational activities related to park resources and significant values in non consumptive ways that do not harm or degrade such resources or values except where other types of uses are authorized by law. In keeping with this policy, NPS seeks to foster understanding and appreciation of the biological diversity values of parks and to develop public understanding of park programs for preserving park biological resources through in-park interpretive programs and outreach education efforts with local communities and constituencies.

Policies for Non-Federal Lands:

Within parks, land is protected using available land protection tools that include acquisition of either fee interests or less than-fee interests and cooperative approaches, such as agreements, regulations, zoning, and other measures short of acquisition. Outside park boundaries, NPS has no authority to directly regulate uses and so relies on cooperative approaches to achieve park management objectives related to biological diversity.

Management Strategies for Achieving Biological Diversity Objectives

The NPS's basic natural resource management program seeks to conserve all components of the natural biological diversity found in parks. Because this purpose is so broad, the NPS currently is developing a specific biological diversity program which responds to the need to develop coordinated biological diversity conservation programs both nationally and internationally. This developing program is based on a history of NPS-sponsored and interagency activities. These activities have included:

- Co-sponsoring a review by The Nature Conservancy of public and private efforts to protect natural diversity (1975);
- Sponsoring a mini-workshop on impacts of insularization (1976);
- Co-sponsoring a symposium on genetics and management of wild plant and animal populations (1982);
- Co-sponsoring a book-length study of the value of conserving genetic resources (1984);
- Convening an NPS genetic diversity task force (1986);
- Co-sponsoring an interagency workshop on biological diversity (1988);
- Convening an NPS workshop to draft a proposed biological diversity plan (1988);
- Implementing a Service-wide biological diversity education program that includes supporting preparation of a poster on biological diversity, a biological diversity handbook for interpreters, and a biological diversity curriculum for teachers and interpreters (1988-present);
- Publishing revised Management Policies that specifically mention such aspects of biological diversity as genetic resources, migratory species, natural resource collections, paleontological resources, the relationship of park resources to events occurring outside parks, and the importance of developing cooperative programs with others (1988);
- Sponsoring several biological diversity policy-oriented research projects through the Natural Resources Special Initiatives Program (1987-present), including topics in the genetic resources of park historic orchards, the genetics of disjunct jack pine stands in Maine, preparation of a data base on park flora and fauna, preparation of an ethno- botanical data base for several parks, co-sponsorship of a Smithsonian effort to develop biological diversity monitoring protocols, and assessment of cross-boundary effects on park biological diversity;
- Participating in the interagency, non-governmental organization biological diversity Dialogue sponsored by The Keystone Center (1989-1990);
- Participating in developing an interagency training course on biological diversity for managers (1990);
- Participating in developing a departmental biological diversity initiative (1990-);
- Co-sponsoring an inter-institutional conference on the effect of global warming on biological diversity (1988).

Planning Process:

Each park has a General Management Plan that identifies how visitor use and supporting developments will be provided and managed, discusses the conceptual approach to managing park resources, provides the strategy for integrating the park into its regional context, and for developing appropriate cooperative programs relating to conservation and use of park ecosystems and their genetic resources. As a subset of the General Management Plan, each park has a companion or separately published Resource Management Plan which identifies influences affecting park resources,

including its biota, as well as inventory, monitoring, research, protection, and management activities and needs. These plans provide the basis for programming all park natural resource projects. A Service-wide assessment, updated periodically, identifies national priorities based on Resource Management Plan needs and special studies of issues of Service-wide importance.

Current Program Development:

The Service is developing additional steps that will improve its current status. The attention given to park resource management plans as the source of all resource-oriented activities has been increased with the adoption of a guideline for resource management plans that includes scheduled times for plan review and revision and for annual reporting of progress. The orientation toward biotic diversity as a management goal has been increased with the addition of several new sections to the Management Policies. The annual reporting of research progress is being revised and converted to an ADP format. A Service-wide structure for guiding development and management of inventory and monitoring programs is being constructed. A Service-wide plan for conserving biotic diversity is being developed.

Inventory, Monitoring, Research, Data Management and Information Transfer

Inventory:

The Service's depth of knowledge about its biological resources is highly variable, both among biotic diversity elements and among park units. In some cases, the Service deliberately has been acquiring information for almost 100 years, such as with large mammals in parks like Yellowstone National Park. In other cases, the only information that exists is what has been obtained by the chance occurrence of research by interested investigators, such as with much of the existing information on mosses or soil biota. In general, most park units have checklists that may be as much as 75 percent to 95 percent accurate for such taxonomic groups as vascular plants, mammals, birds, fish, and perhaps most of the remaining vertebrates. The majority of parks have written descriptions of the major vegetation types found within them, and many of these also have vegetation maps of one level of accuracy and precision or another. Most of the parks, as part of their resource management planning efforts, have identified at least several factors that threaten their ability to maintain the natural condition of the park's biotic diversity. Because much of the inventory information is fragmentary, only a small number of parks are in a position to integrate existing inventory and threat information into models of probable change with and without management intervention to mitigate known or suspected threats.

In addition to conducting biological inventories on park system lands, the National Park Service, through the National Natural Landmark Program, also inventories and monitors the status of exceptional biological and geological features found on other public and private lands. This program uses a natural region theme structure to identify the locations of exceptional features and to encourage landowners to voluntarily manage their lands to protect the recognized features.

Recommendation — Inventory

Inventories of park resources done to meet Service-wide or interagency needs must be conducted in ways to meet individual park needs as well.

Monitoring:

The monitoring of park biotic diversity components is equally as varied. Again, the most intensively monitored resources include weather, large mammals, birds, air pollutants, exotic plants and animals, effects of human use of park resources, fish, distribution and abundance of natural fuels for potential fires, and reproduction and behavior of selected threatened or endangered species (often mammals, birds, or fish). In most cases, monitoring is limited to a few, focused locations in a park that respond to the park's capability to do work and the immediacy of the management need for the monitoring information. Several parks are expending intensive effort to identify key components of their biotic diversity for inclusion in monitoring programs, to develop monitoring programs based on statistically oriented sampling approaches, and to develop park-specific manuals to describe how the monitoring is to be conducted and how the data are to be handled and analyzed.

Recommendation — Monitoring

Monitoring in the Park Service units should be designed so it will contribute to interagency needs for status information about indicator resources.

Research:

Service-sponsored research on park biotic diversity is targeted to meeting high priority management needs for information, and so generally is focused on local situations, and again, on the most visible biotic components. These components include large mammals, selected plant species and vegetation, exotic plant and animal species and their impacts on native species and communities, ecological roles and effects of fire, threatened and endangered species, and biological effects of air pollutants. Because the research is so focused on specific management questions, it leaves many promising channels of inquiry unexplored. As a result, the research being conducted provides only spotty contributions to the broader question of how to

manage resources to preserve all of the natural biotic diversity contained within the park units.

Recommendation — Research

Emphasis should be given to making research conducted in one park applicable to all parks having similar resources or resource problems.

Data Management:

The Service's development of management structures for the inventory, monitoring, and research data being acquired through the efforts summarized here is equally as decentralized as the data acquisition efforts themselves. There is an overriding effort to have all research activities generate, at a minimum, a report for management, a data report, and annual summary statements of progress. In addition, many research projects are reported to the scientific community, either as reports presented to professional meetings or as papers published in peer-reviewed journals, books, and other documents. Inventory data generally appear within reports to management and sometimes are published separately as data reports. Monitoring data generally are presented in reports to management, file reports, or data reports, and rarely in formats directed to the scientific community. Some resource data are being accumulated in geographic information systems being developed for approximately 40 parks at this time. One administrative region is developing a data management structure that will permit accessing data on a park-by-park basis in a format that will permit compiling and comparing data among the 14 park units within the region. Service-wide data management structures exist for threatened and endangered species (with 142 parks currently being represented), vascular flora (with approximately 150 parks currently being represented), and exotic species (with little to no data currently being loaded). Information about biological material contained in park museum collections is being consolidated into an automated information system. Notwithstanding these developing Service-wide programs, the great bulk of park inventory, monitoring, and research data is stored individually within parks in paper files, notebooks, uncommunicative computer files, and personal knowledge.

Technology Transfer:

The Service's major effort to date in transferring technical knowledge about biotic diversity to non-specialists has been co-sponsorship of the development of interpretive materials for park interpretive programs and for preparing school curriculum topics on biological diversity. In addition, the Service has injected biological diversity components into several Service-wide training courses and has held several Service workshops on the topic of developing a Service-wide biological diversity plan.

Training, Interpretation, and Education

A Service-wide biological diversity education program was called for by former Director Mott in the fall of 1987, a plan was produced in April, 1988, and the program was begun in 1989. Its purpose is to increase public awareness and understanding of the biodiversity issue. The program, conducted mainly through interpretative activities in parks, is intended to be a permanent element in park interpretative programs.

To assist park staff in carrying out this program, an interpreter's manual on biodiversity was prepared and provided to each park. Several regions purchased the Smithsonian traveling exhibit on biodiversity for use in parks. A brochure for the public is in the review stage. A slide program and a videotape version of this slide program are in preparation and a repository of slides on biodiversity, for use Service-wide, is being developed.

Human and Financial Resources

The FY 1989 budget for all park-oriented natural resource programs provided $59.7 million and 953 FTEs for inventory, monitoring, research, protection, restoration, and management activities for individual species, ecosystems, and air, water, and geographical components of these ecosystems.

The total budget for all interpretative activities in park units was approximately $48 million and 2,100 FTEs. An additional $13.5 million and 235 FTEs were allotted for development of interpretative media. About $50,000 was allocated for development of specific materials for the Service-wide Biological Diversity Interpretation Initiative. About 16,000 volunteers assisted in NPS interpretative programs.

In addition, the National Natural Landmark Program was allocated $168,000 and 4 FTEs to monitor the status of designated landmarks and assess the suitability of proposed additions to the National Register of Natural Landmarks.

Interagency Coordination

Recognizing that cooperation with other land managers can accomplish ecosystem-stability and other resource management objectives where the best efforts of a single manager might fail, the National Park Service is committed to working cooperatively with federal, state, and local agencies, Native American authorities, user groups, adjacent landowners, and others in the management of natural resources. In exercising this commitment, the NPS seeks to establish formal and informal lines of communication and consultation to better achieve park objectives for plant, animal, and ecosystem management.

Such communication may involve coordinating management activities in two or more separate areas, integrat-

ing management practices to reduce conflicts, coordinating research, sharing data and expertise, exchanging biological resources through transplants, establishing native animal habitat corridors, and providing essential habitats adjacent to park boundaries.

Examples of Cooperative Arrangements:

The NPS participates in interagency cooperative agreements or programs to coordinate management of endangered and threatened species (e.g., grizzly bear, Florida panther, spotted owl), to control exotic species (e.g., weeds in south Florida, gypsy moths in Virginia and West Virginia, exotic plants in Hawaii), and develop species data bases (e.g., with The Nature Conservancy). Many research projects are conducted through cooperative agreements with universities. Of the 20 natural resource oriented Cooperative Park Studies Units now existing, 13 have permanent NPS staff and most have senior university scientists as designated contacts. Cooperative programs with state natural resource agencies also provide coordinated research on, and management of, selected fish and wildlife populations.

Interagency agreements have been used to establish cooperative regional arrangements to carry out several programs mentioned above (Greater Yellowstone Coordinating Committee, Southern Appalachian Man and Biosphere Cooperative, and Virginia Islands Resource Management Cooperative).

Cooperating National Park Associations publish and distribute written and other media on park biological resources and biological diversity. An NPS - Ohio State University cooperative agreement provides for joint development of educational media and programs.

A Memorandum of Understanding with the Soil Conservation Service focuses on mutual development of native plant materials for use in re-vegetation of disturbed spots in natural areas. The Cooperative Park Studies Unit at the University of California at Davis has a program on the biology of small-sized populations of animals and plants.

Gaps and Problems

Inventory, Monitoring, Research, Data Management, and Technology Transfer:

— Existing inventories contain little information on the less obvious elements of biological diversity and often are structured more qualitatively than quantitatively.

Existing monitoring programs focus on only one or very few components of biological diversity and most are weak methodologically. There is very little monitoring of process elements.

— Most of the research effort is focused on developing information to solve known resource problems. Very little addresses efforts to anticipate and define new resource problems.

— Little work has been done to date on developing mechanisms for tying together what information is available or for making Service information more readily available to other agencies. The use of mathematical models is still in its infancy in National Park Service analysis and application of biological information about the parks.

— Although the Service actively transfers technical information to park managers and visitors, it sometimes is deficient in properly documenting the technology that is being transferred or in providing effective follow-up training and quality assurance where such follow-up activities could be appropriate.

Appendix D

Overview of Biological Diversity Activities in the Environmental Protection Agency

Introduction

The mission of the EPA is to protect human health and the environment. The protection of biological diversity can be viewed as an important aspect of that responsibility, since it seeks to mitigate the adverse impacts of pollutants and other stressors on human health and the environment. "Environment" and "stressor" can be interpreted quite broadly; hence, EPA's mission is larger than that of other federal environmental or land management agencies. EPA sees biological diversity as an "emerging issue" in which its involvement will undoubtedly increase in the future. Many in the Agency also think it appropriate that biological diversity be considered a fundamental part of the environment that EPA is broadly mandated to protect. Elevating EPA to the "Department of Environmental Protection" will undoubtedly result in new responsibilities. This change should strengthen the Agency's involvement in biological diversity.

Authorities

EPA authorities and responsibilities are derived from a number of laws which regulate different media (e.g. air, water), harmful substances (e.g., pesticides, toxics, hazardous waste), or activities (e.g., federal activities, solid waste management, ocean dumping). While none

of these explicitly require the protection of biological diversity, several contain language that is applicable.

The Clean Water Act (CWA) is designed to ensure the protection and propagation of fish, shellfish, and wildlife, and to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires the registration of pesticides to prevent "unreasonable adverse affect on the environment." The Marine Protection, Research, and Sanctuaries Act (MPRSA) prevents or strictly limits the dumping into ocean waters of any material which would "adversely affect" or "unreasonably degrade or endanger ... the marine environment ... or ... ecological systems." The National Environmental Protection Act (NEPA) authorizes EPA to review all major actions of federal agencies in order to "preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity." Additionally, section 7 of the Endangered Species Act requires that all federal agencies take into consideration the effects of their activities on listed species and their critical habitats.

Policies

The Office of Policy, Planning, and Evaluation (OPPE) has initiated several efforts to both raise the issue of biological diversity within the Agency and facilitate implementation of relevant policy. An informal, agency-wide Biodiversity Interest Group (BIG) has been formed to facilitate communication and serve as a focal point for discussion. In addition, an inventory of Agency programs relating to biological diversity is planned for fiscal year 1991. This will provide a comprehensive source of information on current EPA efforts. Finally, the Science Policy Branch will soon release a report investigating and ranking the various threats to biological diversity in the United States. This report will be useful in educating Agency personnel and others, and in determining the degree of the threat posed by various stressors, including many which fall under EPA's direct jurisdiction.

A related endeavor within OPPE is the work on environmental indicators by the Environmental Results and Forecasting Branch (ERFB). The work of this branch, which has historically included collaborating with EPA media offices to develop environmental indicators to serve as measures of environmental progress, has increased since the Administrator directed the various program offices to incorporate environmental indicators in March 1989. This group is currently working to 1) research various scenarios of environmental condition which may occur in the next several decades and consider the effect of management and policy strategies; 2) track and comment on domestic and international environmental policy activities (including biological diversity); and 3) identify and track possible regional, continental, hemispheric, and/or global indicators of environmental condition.

At least one program office has begun the development of biological criteria to supplement traditional measurements and provide a better assessment of actual wildlife effects. EPA's Office of Water Regulations and Standards is currently developing national technical guidance for states to incorporate biological criteria in their water quality standards. This guidance would encourage states to integrate wildlife, sediment, and biological criteria into water quality standards in order to afford more appropriate protection to biological systems. Additionally, both the Superfund Hazard Ranking System and the Superfund Sites Guidance Documents consider the significance of ecological risks.

In a related area, the Office of Pesticide Programs has invested significant resources (several million dollars in 1989) into endangered species protection programs.

Inventory, Monitoring, Research, Data Management and Information Transfer

The Office of Research and Development (ORD) is charged to provide high quality, timely scientific and technical information on environmental problems. Many research programs within ORD are involved in environmental inventory, monitoring, research, and data management related to biodiversity, but at this time the Environmental Research Laboratory in Corvallis, Oregon (ERL-C), is the only ORD institution with a project explicitly focused on biological diversity. Biological diversity is being addressed to some extent in the Environmental Monitoring and Assessment Program (EMAP) and in Wetlands and Aquatic research. The following is a brief overview of ORD biological diversity research with an emphasis on ERL-C's Biodiversity Project.

Inventory:

The Biodiversity Project at ERL-C with support of the Global Climate Program in the Office of Policy, Planning and Evaluation is initiating a series of regional case studies to determine status and trends in biological diversity and anticipated response to major stressors. The first case study beginning in the fall of 1989 (FY 1990), is for the Pacific Northwest, defined as Oregon, Washington, Idaho, and parts of California, Montana, and British Columbia. The first task in each case study is to map the distribution of biological diversity indicators (e.g., vegetation types, ranges of species in particular taxonomic or "management" groups) in the region of concern. Hence, each case study begins with a synthesis of biological inventory information and will include funding additional inventory work to fill critical data gaps.

Biological diversity data will be assembled from a variety of sources, relying heavily upon the State Natural Heritage Programs and the "gap analysis" project (U.S. Fish and Wildlife Service). The Biodiversity Project will work cooperatively with this group in this effort. All data will be integrated in a geographic information system (GIS) and mapped at a scale of 1:250,000. More detailed inventories and higher-resolution maps will be prepared for particular "hot spots" of concentrated biodiversity within the region. In the Northwest, two areas that will receive more intensive survey are the Klamath-Siskiyou and North Cascades bio-regions.

The Biodiversity Project is funding one extramural project that includes biological inventory as part of the Northwest case study: a survey of the historic and current ranges of all narrow endemic taxa (i.e., taxa with ranges not exceeding 50,000 km^2) in the region for the purpose of analyzing potential impacts of climate change. Areas of high overlap in the ranges of endemic taxa will be recognized as centers of endemism. Similar inventory work will be initiated for forthcoming regional case studies.

Each regional case study will be conducted over a period of two to three years. The current proposal is to have a number of studies overlapping. The Northwest study is scheduled for FY 1990-1992, with an annual budget of approximately $100,000. Other regional studies will be added as funding permits, with the next planned for the Southeastern U.S. Other priority regions are the Southwestern U.S., Mexico, and the Caribbean. As presently proposed, all case studies and the Biodiversity Project will terminate in FY 1994, although extension is likely.

A related biological diversity inventory project is being carried out by EPA's Environmental Monitoring Systems Laboratory in Las Vegas. This "Federal Species Project" is compiling information on federally-listed and candidate species to determine association of these species with certain ecosystems and habitat types, and to compare these findings with EPA's emphasis on certain ecosystems believed to be at highest risk. Several ecosystem classifications will be used, including Kuchler's potential natural vegetation and Bailey's eco-regions. The project also will assess the quality of federally-listed and candidate species information and the extent to which these data can be used to determine ecosystems at risk. Data will be obtained from a variety of sources (particularly the State Natural Heritage Programs) and compiled in a single relational data base (Revelation). Note that this project is not an inventory in the sense of mapping locations of species or ecosystems, but rather is directed at associating species with particular ecosystem types. This project began with the U.S. Fish and Wildlife Service, and is being conducted on a small budget.

At this writing, the EPA (ORD) and the Smithsonian are discussing the possibility of jointly establishing a National Center for Biodiversity. Such a Center may be established prior to any national legislation.

Recommendation — Inventory

EPA will more likely be a user than a generator of ecological inventories. It will have to assure that the information available will be adequate to develop the assessment needed to undertake mandated activities. Accordingly, EPA's role will be to assure that the inventory activities of others will be adequate for national needs and can be assembled and analyzed at regional, national, or global scales. EPA should, however, have a major role in the development of compatible inventories of stressors, such as land use practices, climatic variables, pollutant levels, and human demographics.

Monitoring:

The major monitoring effort within the EPA is a new and ambitious project known as the Environmental Monitoring and Assessment Program (EMAP). Currently under development, EMAP is designed to monitor the status and trends in the environmental resources of the entire U.S. EMAP is scheduled for full implementation in 1992 and will continue indefinitely. A major early component of this program is the identification, testing, and implementation of indicators of ecological condition in three categories: 1) response; 2) exposure; and 3) stressor. The unique goals of EMAP are reflected in the focus on biotic indicators to assess condition rather than solely on pollutant sources or ambient concentrations. Indicators related to biological diversity include measures of landscape pattern, habitat structure, and demographic status of keystone species.

The EMAP sampling framework is a systematic grid of 12,000 points overlaid on a map of the United States and its territories. Ecosystems will be sampled in proportion to their occurrence in 40 km^2 hexagons centered on a sample of approximately 3,000 points in the 12,000-point grid. Both remote sensing and ground level measurements will be utilized. The budget for EMAP is uncertain, but is expected to exceed $20 million annually.

Another EPA monitoring project has focused on aquatic ecosystems. The Long-Term Monitoring (LTM) Project has worked in cooperation with several states since 1982, collecting data on aquatic species composition and abundance with an emphasis on lakes. The budget has been about $750,000 per year. These data are used to assess long-term trends in the health of these ecosystems. This project will develop response indicators for species composition and abundance. Different species groups will be used to assess different systems. For example, fish and macrovertebrates would be the

focus in streams and rivers, fish and phytoplankton in lakes and reservoirs.

The Biodiversity Project at ERL-C will implement monitoring projects in high risk ecosystems identified in its regional case studies. As of this date, the Project has put considerable effort into the identification of indicators of biological diversity (compositional, structural, and functional) at four major levels of organization (genetic, population-species, community-ecosystems, and landscape).

Recommendation — Monitoring

EMAP and other EPA monitoring programs should place emphasis on monitoring biological diversity and its stressors. EPA should explore the development of a program of preferential, intensive sampling of areas of high biological diversity and high risk to complement the otherwise appropriate randomized systematic grid planned for EMAP. This would assure coverage of biological diversity "hot spots" which statistical likelihood suggests would otherwise be missed.

Research:

The Biodiversity Project at ERL-C will examine the potential effects of major anthropogenic stressors on biological diversity at several levels of biological organization (e.g., genes, species, ecosystems). Although the Biodiversity Project is part of the Global Effects Team, research will not be limited to impacts of climate change, but will consider effects of multiple stressors, including airborne pollutants, invasive introduced organisms, and landuse changes. The potentially synergistic effects of habitat fragmentation and global warming will receive particular attention.

High risk ecosystems will be defined by overlaying two sets of criteria 1) biological or ecological significance; and 2) degree of stress. Significant ecosystems include regions of high native species-richness, centers of endemism, concentrations of threatened and endangered species, and other areas of high biodiversity as determined from the inventory phase of the regional case studies (above). Stress measures will be developed from remote sensing (e.g., indices of habitat fragmentation and modification), Agency data on pollutant levels, and other data related to sensitivity of areas to global change. Modeling studies will seek to predict impacts of stressors at several levels of biological organization and to evaluate alternative mitigation measures. As part of each regional case study, autecological assessments will be made of the vulnerability of vertebrate species to various stressors.

Other research projects within EPA that address specific aspects of biological diversity include the following:

— The Wetlands Research Program focuses on inland wetlands and is examining a) the cumulative effects of wetland loss, b) mitigation and restoration efforts as specified by section 404 of the Clean Water Act, and c) wetland water quality. Cumulative impacts of wetland loss on landscape function involve the secondary and interactive effects of human disturbances on multiple wetlands. Researchers at Corvallis are attempting to quantify the relationship between ecological function and incremental disturbance of wetlands in a region. Research on wetland mitigation includes the development of a data management system that will track impacted and created wetlands. The wetlands program was initiated in 1986 and is budgeted at approximately $1 million per year. Only a portion of that budget concerns what might normally be considered biological diversity.

— Research on the potential effects of ozone on endangered and threatened plants was initiated in 1988 as a subproject of the Ozone Forest Effects project at ERL-C and is budgeted at about $60,000 per year. Work completed to date includes the identification of areas of high ozone stress that are inhabited by endangered plant species. A biodiversity/air pollutants symposium is being planned to further discussion on this issue.

— The Ecotoxicology Branch at ERL-C conducts research on the ecological effects of toxic chemicals and introduced organisms. This includes effects on animals, plants, microbial and soil systems, food chain contamination, and biological transport, fate, and exposure. The Ecotoxicology Branch is in the final stages of a $215,000 experimental assessment of direct and indirect effects of xerobiotic chemicals on small mammal populations.

— The Episodic Response Project, initiated in 1988, is assessing the impacts of acidic episodes on aquatic organisms with an emphasis on fish species. The approach is experimental and is funded at $2 million per year.

Recommendations — Research

1. EPA should carefully consider the operational value of using biological diversity as one of the integrating organizational principles for its ecology research program. EPA should consult the Agency's statutory Science Advisory Board (SAB) regarding this question. The SAB, in turn, should strengthen and broaden its expertise in the area of conservation biology.

2. EPA should conduct risk assessments at regional and larger scales to evaluate the impacts of various stressors on biodiversity, as well as of options for mitigation and remediation. These

assessments should not be limited to terrestrial ecosystems, but must also address threats to biological diversity in aquatic and marine ecosystems.

Risk assessment, as the term is applied to regional-scale analyses of threats to biological diversity, includes 1) geographic overlays of biological diversity and stressor data to identify "hot-spots" at significant risk of biotic impoverishment; 2) life history analysis and experimentation to assess the vulnerability of species and guilds to various stressors; and 3) development and use of predictive models to assess the degree of risk under alternative mitigation, remediation, and management scenarios.

Data Base Management:

Each research group within EPA maintains its own data base. Data base management is not a separate program or exercise within the EPA.

Recommendation — Data Management

EPA, working with other agencies and organizations, should integrate and coordinate inventory efforts of other agencies and private groups so that data can be assembled and analyzed at regional to global scales for risk assessment. EPA should require the Center for Environmental Statistics to use this data to make national analyses, trend evaluations, and forecasts about biological diversity.

Information Transfer:

A Center for Environmental Statistics has recently begun to work within the Science, Economics, and Statistics Division of OPPE. Statistics related to environmental integrity and biological diversity will be produced. Additionally, the Office of Information Resources Management has produced and updates an Ecological Information Resources Directory which could provide relevant information.

Recommendation — Information Transfer

EPA should use its National Advisory Committee for Environmental Technology Transfer (NACETT) to educate corporate America about biological diversity, and to develop a model corporate policy for addressing issues associated with biological diversity.

Appendix E

Overview of The Nature Conservancy and The Natural Heritage Network

Introduction

The Nature Conservancy is the only major national conservation organization that is entirely devoted to biological diversity conservation. Its method is the direct establishment of nature preserves, alone or in cooperation with government agencies or other institutions. Biological and conservation inventory has always been one of the organization's major activities. Geographically, the Conservancy's area of concentration has always been the U.S., but it has also been active in Latin America and Canada and in recent years has been rapidly increasing its international efforts, particularly in the tropics.

The Conservancy Program may be thought of as three-parted — the identification and design of potential preserves, protection of the land, and long-term management of the biota and ecosystems on the established preserves. Inventory of biological diversity resources and related data is a crucial part of this work and in cooperation with various partner institutions, the Conservancy has established a network of State Natural Heritage Inventories and Conservation Data Centers which have collectively done the most comprehensive work in this field. Long-term monitoring is a natural outgrowth of the basic inventory work and the amount of monitoring being carried out by TNC and its close cooperators is continuously growing. Given the current concerns with maintaining biological diversity in a changing environment, there is also a growing interest and involvement with ecosystem management research.

Inventory

Beginning with South Carolina in 1974, State Natural Heritage data centers have now been established in all fifty states as cooperative ventures of the Conservancy and various state agencies. The Conservancy has also helped establish such data centers in ten Latin American countries, Quebec, TVA, and the Navajo nation.

Satellite data centers operate in several staffed preserves, including two National Parks, and in various offices of cooperating state and federal agencies and private institutions. The usual pattern for state data centers has been to begin under Conservancy supervision, often with partial private funding, and then for the staff and operation to transfer into state government after the initial phases. About two-thirds of the

State Heritage Programs are now fully transferred. The Conservancy's central and regional science task forces continue to supply technical support to all programs and to facilitate data sharing.

These data centers are the successors of an earlier tradition of "natural area inventories" with which TNC and its predecessor committees were closely identified, but they differ in organization and concept. One of the most important differences is that earlier inventories were carried out as short-term projects whereas the current data centers are designed to be permanent operating units which can continuously add to a cumulative knowledge base. Earlier inventories were mainly compiled descriptions of "natural areas" selected mainly for minimum human disturbance, whereas the Heritage data centers are more specifically focused on "occurrences" of "elements" of biological diversity. This orientation makes it possible to carefully assess the status and conservation needs of each such element.

The main "elements" treated by Heritage data centers are natural community types and individual species. "Sites" of conservation significance are mainly selected and designed to encompass occurrences (populations, stands, localities) of all elements. The idea is that sites selected with representatives of all the major natural communities will act as a "coarse filter" to capture populations of the great majority of biological species (with a high probability of containing all the more common ones, including multitudes of invertebrates, protista, etc. which are too numerous to inventory individually) while sites selected specifically for populations of known rare species will act as a "fine filter" for what is least likely to be represented on the first group of sites (including lots of uninventoried rarities associated with the target species in their unusual habitats).

To make sure that other sensitive biological diversity resources are not overlooked because of classificatory inadequacies, another class of elements called "other (or miscellaneous) types" is included. All Heritage programs also amass and organize data on land ownership tracts associated with priority sites, existing "managed areas" (preserves and protected areas), secondary information sources (including publications, repositories, individual experts, institutions), and key individual contacts (key data users, agency personnel, mailing lists, etc.).

Standardization of terminology, methods, formats, and systems has been achieved and maintained to an unprecedented degree among the many Heritage programs. This facilitates the exchange of information, efficient methodological research and development and technical support, consistent forms of communication with users, and combining information from many programs for various purposes.

Species:

Each Heritage data center tries to maintain information on all the vascular plants and vertebrate animal species in its state or area of coverage along with information on a limited number of invertebrates and non-vascular plants which are believed to be particularly rare or otherwise of conservation interest. A systematic ranking process is employed to ascertain the relative degree of biological endangerment of each species included and this is documented in element ranking records. Each species is ranked as to its status on a global and state basis and the global ranking is overseen by the Conservancy's central Heritage Support Unit at the Arlington, Virginia headquarters. Originally, Heritage programs only dealt with rare species, but it was gradually found desirable to include at least limited amounts of information on all vertebrates and vascular plants. However, for efficiency's sake, total inventory effort is still allocated among species in proportion to their relative endangerment. TNC believes this is appropriate and necessary because many verge on being ineradicable while others clearly don't need any immediate attention to survive. Further up the line there are species for which a little help now can probably prevent their becoming seriously threatened, while at the extreme are the serious cases that need every sort of help that can be directed their way.

Currently the Heritage data network contains the most comprehensive and currently accurate information in existence on the species groups it covers. This information is made available to a constantly widening array of users.

Communities and Ecosystems:

Each State Heritage data center develops a classification of natural community types known within its geographic area. In places where there is a well-developed local tradition of community classification the local system is adopted as a beginning point and modified as knowledge and perspective accumulates. Where there is no prevailing local classification, the program ecologist begins developing one for him or herself as the first order of business. In most cases attempts are also made to crosswalk the Heritage classification with others such as Kuchler, SAF, Cowardin, etc. Heritage classifications are taxonomic classifications rather than eco-regionalizations like Bailey or Omernik (Kuchler is also partly a regionalization), but many programs make certain uses of these regionalizations as well.

With communities as well as species there has been an emphasis on rare and vanishing types, but less so than with species because of the "coarse filter" idea of providing a full range of habitats. We have attempted to include occurrences of all community element types (for which extant occurrences can be found) among

our conservation sites. In site selection and prioritization we typically apply a "most different rule" in choosing multiple occurrences of a given community type in order to increase the species diversity captured by such sites.

"Other Types":

Other types can include anything else that seems to merit inventory and conservation planning, such as areas of seasonal wildlife concentration, breeding colonies of common species (which wouldn't otherwise be tracked as specific element occurrences because of the overwhelming number of populations and localities), outstanding individuals (such as champion trees), areas of historical field work concentration, etc. Some Heritage programs have also incorporated other classes of elements at the behest of the state (cultural landscapes in Massachusetts, recreational amenities in West Virginia, scenic resources in Arkansas, caves in several states, historic and archaeological resources in Tennessee, geological features and landforms in many states, etc.), but the Conservancy does not attempt to provide systematic technical support in classifying or surveying non biological element types.

Managed (or Protected) Areas:

All State Heritage programs gather and organize information on all protected and semi-protected areas in their states, regardless of ownership (the term "managed area" was adopted so as to avoid unproductive disputes about what degree of protection is required to merit inclusion and to emphasize the importance of long-term management). Gathering and organizing mapped, manual, and computerized data on managed areas is not a trivial task; some states have over a thousand such areas under various ownerships. In most states, the Heritage data center is the only place where this information has ever been drawn together to provide a comprehensive picture of protected natural land and habitat for the state.

Inventory of species and community contents of these managed areas is a crucial part of setting biodiversity conservation and management priorities. Many State Heritage programs also have direct responsibility for preserve management or management supervision within their government agencies and all of them work closely with various land managing institutions such as federal agencies and the Conservancy itself.

Conservation Sites and Landownerships:

As Heritage data centers mature, the selection and design of potential nature reserves and the redesign of recommended improvements in various existing managed areas becomes a major program undertaking. It is rare for such site designs not to include multiple property tracts and ownerships, so identification of owners and delineation of relevant tract boundaries are important parts of Heritage conservation planning. In most states, various public and private landowner contact and registry programs have sprung up to inform the various public and private landowners of the important attributes of their land, their comparative value (people sometimes know what they have on their lands, but still have no idea of its rarity or significance), and to encourage appropriately non-destructive management on a voluntary basis. Many such contacts blossom into full-fledged negotiations leading to permanent protection.

Et cetera

Managing all of the information related to *in situ* biological diversity conservation is a complex affair and the entire data content of Heritage data centers cannot be adequately described here. The standard operating procedures manuals alone run to hundreds of pages. Other data modules worth mentioning include those for secondary information sources, important contacts, hierarchical classification and standardized nomenclature for geo-political units, taxonomic data bases on synonyms, land protection project data bases and management action tracking data bases (both used particularly in Conservancy offices), etc.

The Data System

Heritage data centers have always employed what is called a "balanced" information system consisting not just of computer data bases, but also of systematically designed manual files and manual map modules all integrated and cross-referenced for efficient operation.

Maps and Aerial Photography/ Imagery/Videography:

One of the most important parts of Heritage data systems is a comprehensive series of USGS topographic quad maps (or similar maps outside the U.S.). On these, all element occurrences and managed areas are mapped. Priority conservation site boundaries are sometimes depicted also, but more extensive information is usually available for these in manual site files containing larger scale or more detailed site design maps.

Like most parts of the Heritage data system, the maps are continuously improved through successive approximation. Initially, most information for them comes from secondary sources and may be inaccurate or out-of-date. Different symbols are used to distinguish those element occurrences pinpointed exactly on the map from those for which only a general locality is known. As field survey verifies localities and identities, this is made evident and where inaccuracies are discovered, these are corrected. Historic element occurrences

which have been eliminated by habitat destruction, for example, are flagged as "confirmed destroyed." Element occurrence boundaries as discovered through aerial or ground survey are also denoted (sometimes only on file copies of the maps). Collectively the Heritage data centers have accurately mapped hundreds of thousands of species and community element occurrences.

This mapped information has proven extremely valuable for many applications and is very widely utilized by many agencies and institutions.

In addition to the quad maps, individual element range maps are frequently included in manual files. Site survey and design is increasingly being done with the aid of aerial photographs, imagery, or in some cases, videography. Detailed site data is usually more easily and accurately depicted on such aerial pictures which show natural boundaries and landmarks than on maps. The TNC rule now is not to go into the field without such aerials.

Manual Files:

TNC has always believed that nothing is more important to knowledge retention than a well-organized set of manual files and TNC has spent nearly as much time developing and refining manual filing conventions as on computer programs and map annotation systems.

The main manual files employed are element files, managed area files, geographic manual files (corresponding to the quad maps), site files, and information source files (mainly reprint files and a well organized library). Ancillary files such as contact files and user request files are also important and there are a number of manual indices employed such as museum logs (to facilitate review of data in repositories), user logs, place name gazetteers, map indices, etc. Many of these indices are in the process of being computerized or can be generated mechanically from TNC's latest generation of computer programs.

These files are very voluminous, and because of the care given to their organization and their standardized architecture, can be used very effectively in conjunction with the maps and computers or alone.

Computer Databases:

The Conservancy is now supporting the sixth generation of data base management systems used in conjunction with this inventory work. The current system, called the Biological and Conservation Data System (BCD) is a PC-based system using Advanced Revelation dbms software. It replaces a fifth generation system on PC's in dBase III+ which replaced a mini-computer system in IMAGE which replaced a mainframe system in PL1, and so on. Each of these systems has evolved out of the last one and we have arranged carefully for upward compatibility and direct transfer of data in each system upgrade. About one third of the Heritage programs now operate on BCD and most of the rest are expected to convert within the next year. TNC is also in the process of installing BCD in TNC state and regional field offices and in the offices of various cooperators so that their efforts can be more efficiently connected to those of the main data centers.

The current BCD is unquestionably the most comprehensive and integrated system in the conservation field. It consists of over thirty individual data bases with over 2,000 data fields covering the whole scope of information outlined above. The software alone occupies over twelve megabytes of computer storage. The BCD continues to expand and evolve almost continuously (as do all parts of the data system) in response to user demands, suggestions from data center staff, advancing technology, etc. All changes in this and other aspects of the overall methodology are reviewed by an "Operating Procedures Group" which must approve modifications to ensure continued standardization and integration.

Computer Mapping, Image Processing, and GIS:

Over the years TNC has experimented continually with various computer mapping systems, but although the functions of such systems seem ideally suited to the heavy geographic emphasis of Heritage inventories, we have never found any that could affordably be operated within the usual Heritage staff and budget limitations. Most State Heritage programs have a relationship with one or more multi-resource geographic information system (GIS) programs somewhere within state government and typically supply heritage mapped data to such systems to facilitate environmental review and various planning initiatives. A few State Heritage programs have utilized GIS directly (one operated entirely on a GIS for several years) and as system cost effectiveness improves, more and more are moving to acquire GIS capacity.

At TNC headquarters, the experiments have focused increasingly on two systems (MIPS and ARC-INFO), but we have also had experience with several others (GRASS, SPANS, DELTA, ATLAS-GRAPHIC, ERDAS, PMAP, etc.). MIPS has now been installed in two State Heritage programs, DELTA in one, and PC ARC-INFO as an adjunct to several. Within the next several years it is probable that almost all Heritage centers will have GIS capability of one sort or another. It is the job at headquarters to see if we can successfully integrate these capacities into the rest of the existing system.

Along with computer mapping, TNC has also experimented with satellite and aerial image processing, and more recently, with aerial videography. Again TNC recognizes the great applicability of this technology to its problems, but has not yet found it affordable except

for individual projects in scattered localities. This, too, is probably beginning to change.

Networking and Central Data

Because of the standardization of methods, the various Heritage data centers act in one sense as one giant information system covering the entire United States, parts of Canada (all of Canada for some data), and about one quarter of the rest of the western hemisphere. These are actually linked together, to a certain extent, by their ability to exchange data and by the existence in TNC headquarters of central data bases. However, since almost all real data use is local, there is little justification for pulling the total data content together into one big data center. Instead, the vast majority of the data resides only in the individual local centers and the central data bases consist just of a highly distilled body of data which is of mutual use to multiple states or regions and can, therefore, be most efficiently stored centrally and distributed as needed to the local centers. Of the hundreds of thousands of element occurrence records in the state programs, for example, only a small number are duplicately stored in Arlington for various specific reasons (e.g., the element occurrences located on TNC preserves). On the other hand, information can be assembled upward with relative ease when there is a reason, such as when some national assessment is needed to set priorities for centrally allocable resources (e.g., TNC's national critical wetland campaign, a grant to establish selected endangered species preserves, assessment of the range-wide status of a given species, etc.).

One important network efficiency is the division of labor on commonly useful data by assignment of lead responsibilities among the various programs. For instance, a given endangered species may occur in ten states, and rather than all of the affected data centers duplicating each others' efforts in abstracting data on basic biology, creating information source abstracts on relevant secondary sources, etc., one program can take the lead with the centrally stored data made available to the other nine.

In addition to the State Heritage programs, the national CDC's, and the Conservancy field offices, there are a growing number of close network cooperators in the public and private sector which operate satellite or partially overlapping data centers themselves and exchange data with the main central and/or state data bases. So far, most of the overlapping centers are associated with staffed reserves, but there are also specialized cooperators on state non-game, national species taxonomy, agency specific endangered species responsibilities, etc. A great many agencies and management area managers have already asked TNC to help them set up their own on-site data centers and there would already be a hundred of these except that TNC's technical support capability is already overstrained. Assuming that TNC eventually finds a way around this problem and that the network of such cooperating data centers continues to widen to include more institutions, bureaus, offices, individual reserves, research centers, etc., the sorts of efficient access to widely useful data which are outlined above should increase greatly and as the number of new participants available to accept lead responsibilities grows TNC should be able to make the process ever more powerful and utilitarian.

Products and Applications

Natural Heritage data centers are very widely used. The most prevalent applications are in biological diversity conservation planning, environmental impact review/development planning, land and resource management, and scientific research facilitation. They also respond to innumerable less applied requests for information from school teachers, birders, amateur naturalists, etc. Many of the programs generate reports or otherwise respond to hundreds of inquiries a month. TNC's conservative estimate is that the U.S. network data alone is used in over 100,000 conservation and development decisions a year.

Biodiversity Conservation Planning:

One of the things Heritage programs do well is review species statuses for threatened or endangered species listing review and recovery planning at the federal and state level. Probably the bulk of the data upon which listing determinations are based in the U.S. now comes from Heritage data centers. Heritage programs are not advocacy groups, however, and they maintain a strict posture of objective neutrality; as many taxa are delisted or dropped from candidate lists as a result of Heritage data as are listed from it. Because of the focused attention made possible by cumulative element specific data, Heritage staff and cooperators have been able to discover more new populations of rare species, including first rediscoveries of species thought extinct, than everyone else combined, and this new data has radically changed our perceptions of the relative status of a great many species.

The ranking of species and communities by Heritage staff permits them to assign relative priorities for conservation and to generate "natural diversity scorecards" and "site tracking reports" which identify those lands most critical for the perpetuation of each species, community, or other element. These scorecards and site tracking lists set the basic land conservation agenda for the Conservancy and are becoming part of the agenda for many other agencies. In about twenty states, an interagency protection planning committee now meets periodically to divide up responsibilities for protecting and managing areas on these lists. For the selected priority sites, Heritage programs also are main

agents for preserve design, in which they are joined by Conservancy staff and various other cooperators. All of this design information flows back into heritage maps, files, and data bases.

In addition to the *in situ* conservation priorities, the network shares data with key *ex situ* conservationists, particularly with the Center for Plant Conservation, but also with the state and federal wildlife agencies involved in captive propagation of animal species.

Environmental Impact Review and Development Planning:

Probably the main use of Heritage data on a volume basis is in environmental impact review. The locality specificity and the comparative capability made possible by standardized element lists, ranking, etc. allows Heritage data to make a unique contribution in development siting and design decisions by indicating what specific elements, occurrences, sites, and managed areas would be affected, what this would mean to their status in a wider context, and what modifications could be made to avoid or minimize damage. Again, objective neutrality is the watchword and this information is inserted into the planning process in such a timely fashion that an enormous amount of unnecessary conflict is avoided. Most State Heritage programs are plugged into statewide clearinghouse processes so that most of the relevant state-level decisions are referred to them as a matter of course. Tens of thousands of such reviews are efficiently carried out every year across the country. For example, the Maryland program alone has been reviewing over 2000 development project proposals and permit applications every year.

In addition to review of already formulated proposals, Heritage program information is freely available to any legitimate users, and thousands of consultants and planning firms receive data from the data centers all the time. In this way critical biological diversity resources are considered even earlier in the planning process with even less likelihood of unnecessary conflicts arising. Heritage programs also inform local environmentalists about the relative importance of local areas and resources so they can avoid raising objections to unimportant impacts.

Land and Resource Management:

Data on the ecology of species and communities, as well as the locational and status information, is called for in making management decisions about sites and systems. There are simply too many kinds of decisions involved here to try to summarize, but a few examples might be indicative. Whenever a lightning fire starts on Great Smoky Mountains National Park these days, one of the first steps is to consult the newly developed Heritage maps to see what might be affected and to develop or modify fire management strategies immediately to minimize damage. Heritage programs are often consulted by new managers of preserves because it is easier to find out about important biological diversity resources from them than to try to dig the information out of undocumented files on site. Species lists for sites or community elemnet occurrences are consulted to see which might need to be taken into consideration in burning prescriptions. Site data may be consulted to compare the species composition of one managed area to a similar one to detect the effects of different site histories, etc.

Action data bases added to the biological and conservation data system in the last year or two are being used by Conservancy land stewards to carefully plan, organize, schedule, and track element and land management activities. Element stewardship abstracts on a growing number of species and community types are being used to disseminate management data among many people and preserves with similar problems. In addition to rare species, many element stewardship abstracts are now about intrusive exotics and the best ways to control these. Information source abstracts are used to develop bibliographies of useful publications and lists of outside experts that can be consulted for additional information. As in other parts of the data system, the assignment of lead responsibilities creates efficiencies by avoiding duplicate efforts.

Monitoring

As the inventory process grinds on and more mission-oriented users connect to the network (especially land managing agencies), monitoring of individual species populations and community occurrences is an area of growing activity. Well-conducted element occurrence surveys can establish a benchmark to which repeated observations and measurements can be related. Historic information derived from the scientific literature, museum collections, expert recollection, and other sources also provides a certain backward perspective on dates first observed, and so on. A major force for monitoring within the existing network is the stewardship staff of the Conservancy itself, mainly in the state offices and on staffed preserves, who are carrying out a continually growing number of on-site monitoring projects to develop better guidance on habitat management. Such studies are becoming increasingly sophisticated in study design and statistical analysis and at least two regional and one national steward are providing technical assistance to further enhance the effort.

Research

The connections of the data network to ecosystem research activities are many, but this topic will not be dealt with in this appendix.

Deficiencies

As the tone of the above document probably shows, those who have participated in the creation of the natural Heritage data center network are proud of it and are enthusiastic about its potential to continue to grow and develop. This is not to say that what exists so far is perfect. Some of the deficiencies are touched on above and this section will try to highlight a number of the biggest problems that are currently recognized.

Communities:

Community classification is a difficult field about which no two people seem to exactly agree and where the utility of a given classification depends partly on the application. A classification that meets one kind of need will not meet another. Our emphasis has been on classifications that reflect biological composition to serve primarily as biodiversity planning devices. Such classifications do not necessarily constitute the best way to think about related matters like ecosystem management.

An important difficulty for TNC is that even good and successful Heritage classifications developed for a given state are often not compatible with that of surrounding states so that it becomes difficult to estimate the status of communities on a range-wide or global basis. At the state level, there is a serious peripheral effect wherein any community type barely extended into a state is automatically rare. The same peripheral effect in species is compensated for by the ability standard taxonomy gives TNC to combine information from many states to do global ranking.

TNC also has a lot of work to do on aquatic communities or ecosystems. Although it has been TNC's intent to develop classifications of aquatic communities as well as terrestrial ones, classification is even more difficult and the work has lagged in most states. Aquatic species tracking may partly make up for this deficiency, but not entirely.

Some improved procedures for community classification and inventory are in the works and TNC hopes to eventually solve this problem to everybody's satisfaction.

Landscape Level Diversity and Megasites:

Because of concerns of global change and the viability of small reserves TNC is increasingly called on to select and design much bigger sites than the sort that are mainly identified for their remnant community stands or rare species populations. While the Heritage system has quite rigorous capabilities at these levels, "megasites" are so complex that developing yardsticks to objectively measure and compare all the variable factors needed to definitively choose between one and another is extremely difficult.

One potentially helpful approach that is being experimented with in this area is Mike Scott's "gap analysis" program. The main idea here is to overlay maps of existing managed areas on a base map showing regional vegetation patterns to identify major regional systems not currently represented or inadequately represented in the existing preserve systems. To identify sites that might fill these gaps, one can survey the under-represented vegetation regions by aerial reconnaissance, satellite imagery review, or other means, looking for promising natural areas. This search can also be supplemented by existing element occurrence data from Heritage and perhaps from species range information as well. Besides Dr. Scott's work in the Northwest, Heritage programs are in cooperation with somewhat similar approaches in other areas such as that of Crumpacker and Fernald in Florida, and various university GIS specialists in many states. In Latin America, where selecting and establishing large biosphere reserves is perhaps the major thrust of biological diversity conservation, the conservation data centers themselves are carrying such work through "rapid assessment inventories."

Another thing that may help identify priority megasites is the county-by-county photo-interpretation survey of natural areas that is underway in a great many Heritage programs, especially in the Midwest. These have traditionally focused on identifying the least disturbed community fragments or individual species habitats but could be expanded to include identification of relatively intact larger landscapes as well.

One other approach to megasite selection and design involves individual species habitat modeling, and extensive efforts are underway in a number of states and by some of the federal agencies. Results from any of these initiatives can be incorporated into Heritage data systems to facilitate integrated analysis.

GIS:

Perhaps the remarks in the main text will suffice to indicate where TNC stands in its investigations of computer mapping systems. It seems clear to TNC that the Heritage data system must incorporate such capacity in the fairly near future. Increasingly data users and decisionmakers expect to see compelling map outputs in addition to tabular or other types of information.

Networking and Accessibility:

The natural Heritage knowledge base represents an extremely valuable resource which is currently less accessible than it should be for maximum utility. If Heritage information could be made more efficiently accessible to county planners, for example, the data could probably be put to use in about ten times as many environmental decisions as are made at the state level. If TNC could make the data more accessi-

ble to various scientists and research institutions, they could make considerable use of it, avoid the necessity of duplicating the effort, and contribute new knowledge gained from their ongoing research and field work. If TNC could overcome various system incompatibility problems and provide adequate dial-in access to central and state data bases, it would be of immense assistance to many federal agencies who today only have indirect and cumbersome access. TNC is working on these issues.

Staff and Funding:

Of course, this is the single biggest problem. Individual Heritage data center staff are overwhelmed by data volume and user demand. Conservancy headquarters and regional staff are overwhelmed by the burgeoning technical support demand. Things like GIS capability and telecommunications linkages will not come cheaply. The size and capability of State Heritage programs varies considerably depending on various factors including budget and staffing constraints. With the growing interest in biological diversity and the recognition of the importance of knowledge and information management, one would hope that additional public funding would become available. The most challenging funding to obtain is that which supports the ongoing methodology development that keeps the Heritage enterprise current and capable of solving new information needs. Agencies that are asked to pay for this frequently want to make program modifications to meet their specialized needs. If too many special purpose modifications are made, the system compatibility necessary to efficient cooperation and networking can be compromised.

Negative Information:

Some users have expressed concerns about negative information, or the presumption that if a State Heritage program does not have data at a specific location this means there are no elements of biological significance at that site and, therefore, development activities can proceed without further inquiry. Users are routinely advised that information supplied by Heritage programs may not be complete and further inventory may be required. In many instances, probable but unconfirmed species, communities, or other important entities are identified as targets for additional survey.

Appendix F

Gap Analysis: A New Tool for Protecting Biological Diversity

The U.S. Fish and Wildlife Service in cooperation with the National Fish and Wildlife Foundation, Idaho Department of Water Resources, Oregon Department of Fish and Wildlife, as well as the Oregon and Idaho Natural Heritage Programs, have initiated a survey of existing preserves and natural resources (vegetation types and vertebrate species) to assess how well biological diversity is protected in those two northwestern states. The method being used, "gap analysis," can be applied elsewhere. Additional programs are scheduled for Utah, California, and Washington. The analysis of these states will be done in cooperation with the U.S. Environmental Protection Agency for a comprehensive review of biological diversity protection in the Northwest region. This research was prompted by the increasing number of species on the endangered species list and the loss of species in North America and elsewhere. Simply stated, the objective of the gap analysis program is to determine what percent of present biological diversity, as indicated by vegetation types, vertebrate species, and butterflies, is protected in our current system of reserves. Geographical Information System (GIS) technology is being used to help answer that question. The study's first step is identifying plants and animals already living in protected areas. Those outside the protected areas are "gaps" in the protection of biological diversity. That's where GIS comes in. By comparing the locations of species-rich areas with the locations of existing preserves, the GIS can show where biological diversity already is well protected and where additional preserves will do the most good.

Most animal species are not endangered; they range from abundant and widespread to uncommon and localized. However, given changing patterns of land use, we cannot estimate with any confidence how many will survive to the year 2100. Worse, we cannot identify the minimal areas whose protection would ensure the survival of 98 percent, 90 percent, or even 50 percent of today's species. No one has analyzed the distribution of plant and animal species in a way that would identify the number of species or vegetation communities occurring on existing preserves or the number that could be saved through the intelligent planning of future development.

We must act now to prevent species from becoming endangered, rather than waiting until each has been reduced to a few hundred individuals and then initiating Emergency Room recovery activities. Not only is it cheaper, but the chances of success are greater if we fight extinction in the long-term by maintaining self-perpetuating populations of more common species. Prevention is cheaper than treatment! For example, in the 7,200 hectare Sacramento National Wildlife Refuge, there are 257 vertebrate species, 170 with resident populations. The populations of many of these species number in the tens of thousands. The annual cost of managing this system, estimated at one million dollars, is less than the annual expenditures on the recovery

effort for the critically endangered California condor, a species found only in captivity.

Based on these arguments, a useful approach to developing a long range strategy for preserving biological diversity is a multifaceted analysis of the gaps in the network of protected areas. This analysis examines the distribution of several key elements of biological diversity relative to areas currently under protection management or ownership at scales of 1:100,000–1:500,000. At minimum, these include the following:

- Vegetation types (existing rather than potential);
- Terrestrial vertebrate distribution including: Identification of centers of species-richness for native vertebrates in management groups (e.g., non game mammals, waterbirds, uncommon species, etc.); analysis of species in each vegetation type and biogeographic province; centers of endemism; and species-by-species protection status;
- Terrestrial invertebrate (butterfly) distribution including centers of native species-richness in each biogeographic province, centers of endemism, and species-by-species protection status;
- Areas of species-richness for threatened, endangered, and sensitive species; and
- Distribution of other taxa (e.g., vascular plants, when data bases are available or can be readily assembled); at the very least, centers of endemism for vascular plants.

Attempts to quantify biodiversity must begin by describing its distribution. Plant and animal species are the most easily identifiable element of biodiversity. All are distributed in time and space. Most distribution maps are based on records of occurrence, usually specimens of observations. The boundaries of traditional "range maps" enclose known records of occurrence. Both dot-distribution maps and range maps predict the presence of a species in a given area based on historical data. Unexplored regions will be blank on a dot-distribution map, and species will be predicted to be present in any areas of inappropriate habitat that fall within the boundaries of most range maps.

One way to refine the predictive ability of a range map is to sample intensively over large areas. Since there are over 150,000 described species in the United States and Canada and possibly more than 30,000,000 in the world, this approach is impractical. Vegetation is a component of biodiversity that is always visible and easily mapped. Many species of plants and animals are usually found within certain vegetation types. In his "Mammals of Coahuila, Mexico," Rollin Baker observed that, "Mammals generally are confined to specific kinds of plant associations from which they derive either food or shelter or both. Once the investigator has learned the ecological preferences of a given kind of mammal, he can map the occurrence of that mammal by noting the occurrence of the plants." Similarly, David Armstrong stated, "It is a fact that an experienced observer can look at a given local site and predict with considerable accuracy the kinds of organisms that will be found to occur there." It follows that a detailed map predicting the distribution of a species could be constructed from a knowledge of the limits of the species' range and its habitat affinities within those limits.

The University of Idaho's Cooperative Fish and Wildlife Research Unit is applying this concept to produce Geographic Information System maps for most terrestrial vertebrates in the state. Where range limits and habitat affinities are known, this methodology could be extended to other groups, such as invertebrates or plants. A GIS cannot "create" new knowledge of species distributions, but can combine existing data sets to predict distributions at as large a scale as local vegetation maps allow.

This approach uses existing specimen records to create a general boundary to the range. For Idaho birds, considerable effort has gone into building a data base of observations within each cell of a geographic grid (one degree latitude by one degree longitude—about 50 x 70 miles in central Idaho). The GIS is instructed to predict a species as present within each area of a county or "latilong" cell that has an appropriate habitat type for that species and within which the presence of the species has been documented by other means. Where a vegetation "polygon" crosses a county or grid cell boundary, the species will be predicted to be present within that particular vegetation polygon, but not in others of the same vegetation type in the adjacent county or cell unless there is other documentation of the species being present in the adjoining county or cell. In Idaho, we are using a county-of-occurrence data base for terrestrial vertebrates that was compiled by The Nature Conservancy's Natural Heritage Program to predict general distributional limits for mammals and reptiles.

Not all species lend themselves to this approach to distribution mapping. Some species are associated with micro-habitat types within larger areas of terrestrial vegetation. This is especially true for aquatic specialists. For example, the Great Basin spadefoot toad occurs in open, arid regions of southern Idaho, but must have access to some source of water during breeding season. The American dipper is found throughout much of Idaho, but mainly along streams, not in the interior of forests. Such species are excluded from the general analysis and are associated only with those areas that are identified by another set of "aquatic" data layers (wetlands, lakes, streams) as having aquatic microsites.

Some species have adapted to human-altered habitats, and occur widely outside of natural vegetation types. These are likewise excluded. A few species are dependent on geologic features (bats roosting in caverns). Their distribution is difficult to predict by vegetation type and they are excluded. Finally, some species are very localized in distribution, either because of habitat destruction, over-exploitation, or because they naturally occur in relict environments. The locality data for such species is best tracked by a locational data base, and these localities will be provided by the Idaho Natural Heritage Program.

About two-thirds of Idaho's native breeding species can be mapped using the methods described above. An example of this approach is appended for the Iguanid lizards. Seven species occur in Idaho, mostly in the arid southern third of the state. A few (the western fence lizard, sagebrush lizard, and short-horned lizard) extend north through Oregon and Washington to the Canadian border. All are present only in the southwestern corner of the state. If Iguanids were an indicator of the distribution of the biological diversity of the Great Basin biome in Idaho, then this analysis would indicate that, to protect this biome in Idaho, an area in the southwest corner should be selected.

Stages in a multifaceted gap analysis at the state level might be as follows:

- Draft or compile and digitize a map of vegetation type distribution.
- Ground truth the vegetation map.
- Draft and digitize vertebrate and invertebrate (butterfly) distribution maps.
- Ground truth the animal distributions.
- Input data on landownership status.
- Generate a map depicting species-richness for all species.
- Generate a map depicting species-richness for vertebrates only.
- Generate a species-richness map for special interest species (e.g., threatened, endangered, and sensitive plants and animals, endemic taxa, uncommon species found in less than three vegetation types, and other groups of special biological or political interest).
- Define and outline centers of species-richness.
- Rank centers of richness by contribution to state, regional, and continental biological diversity.
- Determine current percentage of each area of species richness in protected areas.
- Determine which species are adequately protected.
- Determine which percent of vegetation types are adequately protected.
- Identify minimum and optimum areas required for protection of predetermined levels of statewide species-richness.
- Identify landscape corridors between areas of high species richness.

Some of the questions that are being asked in Idaho and Oregon are:

- What percentage of the ranges' threatened, endangered, and sensitive species are found within existing preserves?
- What vegetation types are found within existing preserves?
- What percentage of each vegetation type is found within existing preserves?
- Are the areas with highest species-richness for uncommon species found within existing preserves?
- What percentage of endemic taxa are found within existing preserves?

A key question managers and conservationists ask is how would changes in land management practices on federal and state-owned lands further protection of biological diversity without additional purchases of land? These same questions will be asked on a regional basis and within regional ecosystems as the analyses for individual states are completed.

Using the information obtained during the gap analysis, new preserves can be established to fill the gaps in the existing set of biological diversity preserves. Many of these gaps can be filled on state and federally-owned lands simply by changing landuse practices. Other gaps will have to be filled through purchase, in fee, or easements of private lands. In both instances, the results of the gap analysis inventory will provide the direction to the most efficient way to create new preserves or change zoning and other regulatory measures regarding landuse to better protect biological diversity.

The gap analysis approach to protecting biological diversity by mapping and digitizing information on biological diversity landownership and existing preserves is one that insures that the greatest number of species will survive into the 22nd century.

Focusing on species-rich areas and vegetation types and guaranteeing protection of a viable preserve for each vegetation type offers an efficient and cost-effective way to retain maximal biological diversity in the future. Given the inevitability of further habitat

loss, this strategy may be the only way to resolve conflicts between development and the preservation of biological diversity. The gap analysis method allows managers and conservationists to be proactive rather than reactive in their efforts to save biological diversity. While not abandoning the concept of protecting individual endangered species, there is an urgent need for the conservation movement to supplement current programs with an ecosystems approach to the preservation of biological diversity.

Appendix G

Background on Genetic Diversity

Genetic diversity is the basic building block of biodiversity. It occurs on at least three levels within species:

- within individuals
- among individuals within local populations
- among populations

When the entire range of a species is considered, genetic diversity may be so great that we recognize subspecies or varieties. However, much of the genetic diversity among individuals and populations is invisible to the careless observer. Categorization of plants and animals into the "pigeon holes" we call species obscures a lot of important distinctions.

Nevertheless, genetic diversity is critical in governing the range of species, the range of habitats and community associations in which they find themselves, their resistance to stress, their short- and long-term evolutionary potential, and their productivity or ability to fill human needs. As a result, genetic diversity within species affects ecosystem structure and function.

Most plant and animal species, like ponderosa pine and the house mouse, have a wealth of genetic diversity within and among populations, and much of this diversity is adaptive. Others, like red pine and the elephant seal, have virtually no diversity. Some species have a complex genetic structure within populations, imposed by mating system and dispersal patterns, like impatiens, or following micro-environmental patterns, like Douglas fir. In some, genetic differences among populations are pronounced, like Torrey pine, and in others, like western white pine, they are nearly nonexistent. The boundaries may be abrupt, like those between serpentine and non-serpentine populations in several annual plants, or one genetic form may intergrade gradually into another, like the wide-ranging leopard frog, or both patterns may exist in different portions of the range of a single species. Research has not determined the amount of genetic variation for every species, of course, nor how it is distributed within and among populations. Resources are simply insufficient. In managing for diversity, however, it is probably safe to adopt a conservative stance and assume the presence of genetic diversity and adaptive differences among populations even when they have not been measured.

The danger in losing genetic diversity is the same as the danger in losing "pieces" of the puzzle at other levels of biological organization (e.g., species or habitat types). Populations are adapted to their habitat, and if the local population is lost the species may never be able to reinvade the site. For example, sugar maples at high elevations in the White Mountains have evolved a leaf morphology and high rates of photosynthesis that allow them to persist despite a short growing season. Along the same elevational gradients, balsam fir has evolved a continuum of temperature races. If locally adapted populations were extirpated, tens to hundreds of generations would elapse before they would reevolve from adjacent populations. In fact, their competitors might meanwhile exclude them from reinvading, so that in a practical sense the genetic structure is lost forever and diversity reduced. An example is the low-elevation brushfields in the Sierra Nevada foothills where ponderosa pine was eliminated by destructive harvesting-methods a century ago.

The prevalence of local adaptation and the importance of genetic diversity in adapting species to their habitat suggests that peripheral populations (populations at the ecological margins of the species, particularly isolated pockets) should receive special attention. These environments are unique for the species and may have elicited unique, genetic responses. However, some managers may be inclined to pay little attention to peripheral populations because the species is abundant elsewhere. One tactic to overcome this tendency is to focus more attention on state and Nature Conservancy lists of threatened and endangered species. These often target locally threatened, marginal populations of species that are plentiful in other states.

The "structure" of genetic diversity (how it is organized in species) should not only be preserved from loss, but also protected from contamination. Genes interact in development, so genetic diversity must be "packaged" in appropriate combinations. Contamination by inappropriate hybridization of populations or species can result in homogenization and a loss of adaptation. The stocking of non-local trout and the replanting with non-local seed after forest fires or harvest can reduce diversity, degrade genetic resources, and reduce productivity. After three centuries of fire and clearcutting, black and red spruce are mixed and hybridized throughout the Canadian Maritime Provinces, to the detriment of forest productivity; the hybrid shows evidence of developmental problems and suffers a 25 percent reduction in photosynthetic rate.

Genetic diversity is important to individuals as well as populations. In most species, each plant or animal carries two copies of each gene, one received from its mother and one from its father. Copies, even of the same gene, may differ slightly, and progeny that have two different copies often grow more rapidly or are more resistant to stresses than individuals that receive identical copies from both parents. The loss of genetic diversity will mean the loss of productivity and increased susceptibility to stresses, such as atmospheric pollutants or climate change, and therefore, a reduction in the ability to fill human needs.

The loss of genetic diversity is a loss of genetic resources and productive populations. It is also a reduction in the associated species that fed on, lived in, or shared other mutualisms with it. Loss of genetic diversity may change the balance within communities; it is difficult to predict the reverberations. One thing is certain: through loss of genetic diversity we will come closer to homogenizing our world.

Maintaining representative populations of species does not mean locking up every place where the selected species occur. In fact, utilization may be possible even in areas designated for protection of genetic diversity (and might even be an important management tool for maintaining some species), as long as the reserve could be restocked with representatives of the local, native population. However, we should not exploit species without committing ourselves to managing their genetic diversity. Reserve size should depend on how intensively we are willing and able to manage; for example, if we plan to harvest timber or game species, such as elk, with no research, mitigation, or monitoring activities, large natural areas are needed. On the other hand, if we manage in ways that sustain or restore natural diversity, small reserves may suffice and we may need few additional reserves beyond those in our present system of natural areas to maintain genetic diversity and genetic structure.

Appendix H

Biological Diversity and Relative Endangerability

Rarity per se does not automatically mean a species is endangered or is likely to become endangered. In fact, some species seem to have evolved adaptations specifically to being rare. Rabinowitz (1981) argued that "rarity" is too coarse a term for conservation purposes and delineated at least seven different classes of "rare" species. Most people mean, by "rare," species with very specialized physical requirements, while others mean species with a very restricted geographic range. On the other hand, some people feel that "rare species" are those that do not have high population densities anywhere, even if they have wide geographic ranges and can survive and reproduce in many habitats.

Some prairie grasses fall in the latter category - found over a broad geographic region and not requiring very specialized physical habitats, but nowhere common. Yet Rabinowitz et al. (1984) found no reason to view these species as endangered in spite of chronically low densities. Their demography is such that they grow best when sparsely intermixed among the common species - a type of density - dependence that insures that they never get common, but never go extinct either. Further, some rare prairie plants have lighter seeds and so are better than common species at "finding" rarely available and widely dispersed "open" micro-habitats (Rabinowitz 1978). Unfortunately, there has been virtually no systematic research of the general traits of rare species except by Rabinowitz and her students on a few groups of plants, and she died in 1987. However, there have been numerous studies by population biologists of the significance of life history traits and other aspects of species' biology and it seems likely that modern conservation biologists will eventually synthesize this information into some generalizations about how life history traits affect density and range, and whether life history traits that predispose to rarity are automatically maladaptive and endangering.

Many ecologists have followed Mertz (1971) in arguing that, all other things being equal, species whose current success depends on high survival rather than high reproduction are more likely to be endangered by any impact, human, climatic, or whatever. That is, one can imagine two equally common and equally widespread species, also occupying an equal diversity of habitats. One might produce few offspring per year, but most of these typically survive infancy and live a long time; the other might typically produce many offspring per year, most of which die young and none of which live to be very old. On average, the former would be placed at much greater risk of endangerment or even extinction than the latter when some new impact occurs.

Leigh (1981) and Goodman (1987) have refined this demographic approach and believe that species whose intrinsic rates of increase fluctuate greatly are most likely to go extinct, even if their population sizes and birth rates are high, on average. Pimm et al. (1988) argue that large species are more likely to go extinct than small ones, on average, though their theory is questioned by Tracy and George (1989).

These papers are just the main efforts in a long tradition of trying to determine, a priori, before they are endangered, which species are likely to become endangered because of their biological traits alone. There is as yet no way to use these generalizations as hard

and fast rules, yet some of them (like that regarding high survival versus high reproduction as tending to endanger a species) seem quite well-founded, based on both theory and some empirical data. Furthermore, many of these biological traits are not abstruse data, but are available for many species (clutch size, average longevity, etc.).

A similar guide may be available at the community level. That is, certain types of communities, by the nature of their structure, may be more prone to damage and even extinction. Paine (1969) and Gilbert (1980), among others, have pointed to the concept of the "keystone" species whose interactions with others exert an effect on the entire community all out of proportion to the density of these species in the community or even their apparent role in energy flow. For example, particular predator species, by specializing on prey species that would otherwise dominate space or some other resource, can completely change the nature of a community. Similarly, "keystone mutualists" that provide critical support in the way of food and/or shelter to other species can also structure an entire community.

Goodman (1981) rather conclusively argued that the apparent instability of many kinds of communities is not really a community-level property, except insofar as the community is greatly affected by one particular keystone or dominant species. Much of the literature on the community-level effects of exotic species leads to exactly the same conclusion (Simberloff 1990). Thus, one can imagine that an understanding of the keystone roles, if any, within particular communities would tell us much about which communities are likely to be threatened. For example, the fact that some dominant tree species have but one insect or vertebrate species that pollinates them or disperses their seeds suggests that their communities are very likely to be threatened.

Appendix I

Glossary

ACRONYMS:

ACEC – Area of Critical Environmental Concern
ANILCA – Alaska National Interest Lands Conservation Act
BCD – Biological and Conservation Data System
BLM – Bureau of Land Management
CDC – Conservation Data Center
DNA – Deoxyribonucleic Acid
EIS – Environmental Impact Statement
EMAP – Environmental Monitoring and Assessment Program
EO – Element Occurrence
EPA – Environmental Protection Agency
ERL-C – Environmental Research Lab – Corvallis
ESA – Endangered Species Act
FIA – Forest Inventory and Analysis Program
FLPMA – Federal Land Planning and Management Act
FTE – Full-Time Equivalent Position
FWA – Fish and Wildlife Act
GIS – Geographic Information System
HMP – Habitat Management Plan
IG – Inspector General
IHICS – Integrated Habitat Inventory and Classification System
IPA – Intergovernmental Personnel Act
LAPS – Land Acquisition Priority System
LCTA – Land Condition Trend Analysis program
LIS – Land Information System
LTM – Long-Term Monitoring Project
LWCF – Land and Water Conservation Fund
MA – Managed Area
MBTA – Migratory Bird Treaty Act
MIS – Management Indicator Species
MUSY – Multiple Use Sustained Yield Act
NACETT – National Advisory Committee for Environmental Technology Transfer
NFMA – National Forest Management Act
NIRP – National Information Requirements Project
NPS – National Park Service
NWRAA – National Wildlife Refuge System Administration Act
O & C Lands – Oregon and California Lands
ORD – Office of Research and Development
OT – Other Types
PRP – Priority Research Program
R & D – Research and Development
RAIDS – Riparian/Aquatic Information Data Summary System
RIP – Resource Information Project
RNA – Research Natural Area
RPA – Forest and Range Renewable Resources Planning Act SAF – Society of American Foresters
SAB – Science Advisory Board
SCS – Soil Conservation Service
TEDS – Threatened and Endangered Species Data System
TNC – The Nature Conservancy
TVA – Tennessee Valley Authority
USAID – United States Agency for International Development
USGS – United States Geologic Survey

DEFINITIONS:

Adaptation – A genetically determined characteristic that enhances an organism's chances for survival and reproduction.

ARC-INFO – A geographic information system.

Areas of Critical Environmental Concern – A BLM designation where special management attention is required to protect and prevent irreparable damage to important values, including fish and wildlife resources or other natural systems or processes.

ATLAS-GRAPHIC – A geographic information system.

Autecology – Study of the ecology of a single species, its requirements, tolerances, and responses.

Autecological – Of or relating to the ecology of a single species.

Bailey's Ecoregions – A classification system for regional ecosystems.

Biological and Conservation Data System (BCD) – A Nature Conservancy information system that integrates biological diversity and land conservation data.

Biome – A major portion of the living environment of a particular region characterized by its distinctive vegetation and maintained by local conditions of climate.

Biota – All of the organisms found in a given area.

Biotic – Pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.

Candidate Species – A species being considered for listing as a federally endangered or threatened species.

Community – An integrated group of species inhabiting a given area.

Conservation Data Center – A foreign country equivalent of the Nature Conservancy State Natural Heritage inventory.

Cowardin – A wetland classification system developed by Lou Cowardin and others.

DELTA – A geographic information system.

Ecosystem – The organisms of a particular habitat together with the physical environment in which they live; a dynamic complex of plant and animal communities and their associated non-living environment.

Element – Heritage program terminology for natural community types and individual species.

EMAP – An EPA geographic information system.

Endemic – (n. Endemism) Restricted to a specified region or locality.

ERDAS – A geographic information system.

Exotic Species – Species which occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans, and for which introduction has permitted the species to cross a natural barrier to dispersal. For the purposes of this report, domestic livestock species are excluded from the definition of exotic species.

Ex situ – A conservation method that entails the removal of germplasm resources (seed, pollen, sperm, individual organisms) from their original habitat or natural environment.

Extinct – No longer existing.

Forest Inventory and Analysis Program (FIA) – Forest Service surveys conducted by the Forest Service experiment stations on a state by state basis.

Gap Analysis – U.S. Fish and Wildlife program to determine distribution and status of biological diversity and assess adequacy of existing management areas to protect biological diversity.

Gene – The functional unit of heredity. The part of the DNA molecule that encodes a single enzyme or structural protein unit.

Gene Bank – A facility established for the *ex situ* conservation of individuals, seeds, tissues, or reproductive cells of plants or animals.

Genotype – The genetic constitution of an organism as distinguished from its physical appearance, which is the result of both heredity and environment.

Geographic Assessment and Diagnosis of Aquatic Systems (GADAS) – An EPA program to develop response indicators.

GRASS – A geographic information system.

Guilds – A group of organisms that share a common food resource.

Habitat – The environment in which an organism lives. Habitat can also refer to the organisms and physical environment in a particular place.

Habitat Site – Basic field data gathering unit in the BLM's Integrated Habitat Inventory and Classification System (IHICS) inventory system. It consists of a mapped unit composed of homogenous vegetation, soils, land forms, and vertebrate species occurrence.

Heritage Program – Refers to The Nature Conservancy's network of State Natural Heritage inventories and conservation data centers.

Hybridization – Crossing of individuals from genetically different strains, populations, or species.

In situ – A conservation method that attempts to preserve the genetic integrity of biotic resources by conserving them in their original habitat or natural environment.

Integrated Habitat Inventory and Classification System (IHICS) – A BLM inventory system.

Kuchler's Potential Natural Vegetation – A vegetation classification system.

Land Acquisition Priority System (LAPS) – A U.S. Fish and Wildlife Service system for prioritizing land acquisitions.

Land Condition Trend Analysis Program (LCTA) – An Army program for monitoring on training ranges.

Land Information System (LIS) – A system which integrates geographic information system technology with traditional alphanumeric capabilities.

Listed Species – For the purposes of this report, a species that is included on the federal endangered species list.

Long-Term Monitoring Project (LTM) – An EPA project for collecting data on aquatic systems.

Managed Area (MA) – In Nature Conservancy terminology, a protected or semi-protected area.

MIPS – A geographic information system.

Multiple Use – The management of the lands and their various resource values so they are utilized in the combination that best meets the present and future needs of the American people.

Occurrence – Heritage program terminology for populations, stands, or localities of elements.

Omernik – A system for classification of regional ecosystems.

ORACLE – A Forest Service relational data base management system.

Other Types (OT) – Heritage program terminology for anything not already covered in the Heritage classification scheme, but which merits inventory and conservation planning.

PMAP – A geographic information system.

Population – A group of individuals with common ancestry, that are much more likely to mate with one another than with individuals from another such group.

Revelation – A relational data base.

Riparian/Aquatic Information Data Summary System (RAIDS) – A BLM data system, parallel to IHICS, for computer storage and analysis of data on riparian/aquatic areas.

Sites – Heritage Program terminology for sites of conservation significance which are mainly selected and designed to encompass occurrences of elements.

Sensitive Species – A species not formally listed as endangered or threatened, but thought to be at risk.

SPANS – A geographic information system.

Species – A population or series of populations of organisms that are capable of interbreeding freely with each other but not with members of other species.

Stressors – Physical or biotic factors that stress individual organisms/communities.

Taxon (pl. taxa) – The named taxonomic unit to which individuals or sets of species are assigned.

Threatened/Endangered Species – Species formally listed by the federal government as in danger of extinction or endangerment.

Threatened and Endangered Species Data System (TEDS) – A BLM system that compiles detailed observational data on plant and animal distribution, ecology, life history, and population structure of threatened and endangered and special status species.

Vascular plants – Plants with well-developed vascular systems that transport water, minerals, sugars, and other nutrients throughout the plant body. (Excludes the bryopytes; mosses, hornworts, and liverworts).

Viability – The likelihood of continued existence in an area for some specified period of time.

Xerobiotic – Drought-adapted biota.

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