Report to the Director
of the National Park Service

on

THE ROLE OF THE NATIONAL PARK SERVICE IN PROTECTING BIOLOGICAL DIVERSITY

Produced by the appointed Task Force

and compiled by

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IN PROTECTING BIOLOGICAL DIVERSITY

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Preface

This report is the result of a task force that convened in September of 1986 to define the role of the National Park Service (NPS) in protecting biological diversity and provide suggestions for implementating that role.

After preparatory reading and correspondence the task force, organized at the requests of Director William Penn Mott and Associate Director for Natural Resources Richard H. Briceland of the NPS, met for 2 1/2 days to summarize its findings.

The Biological Diversity Task Force attempted to define the role and suggest methods for its implementation. The latter included a five-year action plan proposal to initiate NPS activity in this area. This report consists of a statement of the challenge facing the NPS and its duties in the face of this challenge (the role); a discussion of vital elements affecting the agency's ability to meet this challenge with associated options for implementation; the five-year action plan; long-term suggestions; a review of the "Leopold Report" taken in the context of the defined role; and, finally, appendices of background papers, written comments provided by task force participants, and comments on earlier products of the task force.

In October 1986, the findings of the task force were summarized and the proposed five-year action plan described for Director Mott. In December 1986, a similar briefing was provided to NPS regional directors. During the development of the proposed five-year action plan, coordination took place with the Director's Task Force on Inventory and Monitoring to maximize cooperation and complementariness of recommendations.

The results of the task force meeting and this report do not necessarily address the cultural and historic requirements of preservation, but they do to some extent cover natural area components of some large historic and cultural sites. The emphasis, however, has been on natural areas.

The statements made herein do not necessarily reflect statements or policies made by the US National Park Service, but are exclusively those of the authors.

A. "Protector of Biological Diversity: The National Park Service's Unique Role and Leadership Responsibilities"

Based upon the legislated mandates and unique characteristics of the NPS, national parks within or containing natural areas should, first, protect biological diversity and underlying processes that maintain and generate natural biological diversity. Just about any park (national or other) can be made adequate for preserving tourism, but no national park can be made adequate for preserving biological diversity without a superior investment in protection.

National Park Service lands are increasingly unique. They must be treated as relatively undisturbed areas imbedded in grossly disturbed systems that can contribute to the erosion of natural biological diversity of national parks and of the nation.

Consequently, the protection of biological diversity remaining within the national park system, including supporting ecological and evolutionary processes, should be institutionalized as the increasingly unique leadership role of the NPS.

Because national parks are not by themselves capable of preventing extinctions, the task of protecting biological diversity is beyond the scope of the NPS working alone, or the capabilities of **any** single agency. Accomplishing this role will require a mandate for inter-organizational cooperation.

B. Summary Observations and Recommendations

U.S. national parks, as they are currently organized and managed, are destined to loose biological diversity. The National Park Service must use science, cooperation, training, and new management methods to document, monitor, research, and protect biological diversity and underlying processes within and adjacent to its national parks.

1. Problems exist with regard to the size and shape of national parks. While size may affect the number of diverse habitats and species, or the sizes and structure of their respective populations, shape affects their stability and exposure to adjacent pressures.

2. National parks are too small, and the NPS too poorly funded and trained, to maintain the biological diversity of the national parks. The national parks will depend upon increased funding, training, and cooperation with adjacent land owners and other non-adjacent protected habitats and with public and private universities to reduce losses in diversity.

3. Natural ecological and evolutionary processes should be emphasized in protection, and this includes processes of natural extinction as well as speciation. However, most extinctions are caused or accelerated by humans, and can be counteracted only by intervention. Too much intervention can create imbalances among natural processes. Thus, a careful balance must be struck between intervention and non-intervention to counteract unnecessary losses of populations and species while still protecting natural ecological and evolutionary processes.

4. Managers of U.S. national parks are unaware of the nature and stability of the biological diversity contained in the national parks, and are even less aware of changes that affect this diversity. Major shifts among priorities need to be made favoring inventory and monitoring of biological diversity.

5. The National Park Service has too few resources managers, and they are not trained to inventory, monitor, or protect biological diversity. These managers should be trained and provided with input from the scientific fields that contribute to the protection of biological diversity.

6. Too little use is made of existing knowledge and of scientists, both within and external to the NPS, who can convey that knowledge and assist management. Furthermore, there is no funding source to which U.S. scientists may turn to pay for research having to do with the documentation or protection of biological diversity.

7. The distribution and condition of biological diversity is neither assessed nor taken into consideration in the planning of land purchases, nor in most zoning, construction, or restoration operations affecting national parks.

8. The public, as well as the NPS, is largely unaware of the difficulty and complexity of the task of protecting biological diversity in national parks, and should be made aware of the purposes of national parks and the complex and expensive requirements for stewardship.

C. General Definitions

1. Gene Pool

A group or aggregation of interbreeding individuals (not usually a reflection of total diversity within a species). Within each gene pool there is a certain amount of genetic diversity, and for each gene pool the nature and amount of genetic diversity characterizes the pool. Diversity can be stored between gene pools as well as within them. The gene pool (a genetic term) is also used frequently in the zoo and botanical garden community when referring to the captive groups of a species. In the wild, scientists and managers more frequently use the demographic term, population, to denote a group of interbreeding individuals.

2. Population

The organisms, collectively, inhabiting an area or region; as, the frog population of a pond. For our purposes, the terms "gene pool" and "population" (of a given species) are synonymous; "population" will be used unless specific reference must be made to the genetic properties of a group of interbreeding individuals.

3. Species

One or more populations of individuals that are reproductively **compatible and comprise a distinct form of animal or plant.** Noteworthy exceptions are not the object of discussion here. This simpler definition is thought to be sufficient for this report, although for reference purposes, Webster defines "species" as "a category of classification lower than a genus or subgenus and above a subspecies or variety; or as a group of animals or plants which possess one or more characters distinguishing them from other similar groups, and do or may interbreed and reproduce their characters in their offspring, exhibiting between each other only minor differences bridged over by intermediate forms and differences ascribable to age, sex, polymorphism, individual peculiarity or accident, or selective breeding by man."

4. Community

A group of populations that are ecologically and geographically interconnected, and represent a few to several species. Such a group constitutes an assemblage of plants and animals living in a common home, under similar conditions of environment, or with some apparent association of interests.

5. Genetic Diversity

Diversity within the individual, among genes to produce the phenotype (or outward manifestations of the individual); **diversity between individuals of a gene pool; and diversity between gene pools or individuals of a species.** Thus, inherited (structural) diversity at or below the species level. Also important are functional diversities, such as behavioral, physiological, etc.

6. Biological Diversity

The sum of diversity within and between species, between communities and between higher taxonomic levels (family,...,class, ...,phylum, kingdom); includes genetic diversity. Biological diversity is not necessarily equal to species diversity. Some groups may house more biological (including genetic) diversity than others.

7. Conservation

Compromise between protection and multiple land, species and/or resource use. Visitation, concessions, recreation, logging, hunting, and mining are various forms of compromise with protection.

8. Management

Human involvement in the protection of biological diversity (for purposes of this report). Management, taken alone, suggests administrative management or all forms of management combined, depending on context, whereas resources management suggests management of resources. Management can either be passive (non-interfering) or active (manipulative or interventionist), the distinction at times being vague. Management implies the manner of treating, for a purpose or out of a desire to control, and the use for a purpose (or, more important, in this context, the judicious use) of means to accomplish an end.

9. Preservation

Protection of biological diversity (in the context of this report) without intentional compromises; it includes protection of parts and processes. Preservation suggests the act of preventing injury, destruction, or decay; maintaining a state of preservation; or assuring the existence or intactness of biological diversity.

10. Natural

Unhampered or unmodified by recent humans of the American continent. (This definition is purposely vague.) No fixed time frame should be set with reference to the word "recent," since characteristics that were adaptive or communities that were natural at an earlier time may no longer be adapted to 20th-21st century conditions. The term "natural" should be used with care, and one's points of reference and values should be specified as one goes along. A more conventional definition (from Webster) might be "in accordance with, or determined by, nature; characteristic of the operations of the physical world; normal. Of, pertaining to, or concerned with nature, or the physical universe."

11. Evolutionary Processes

Changes in gene frequencies owing to natural selection or stochastic processes. Or, more simply, temporal (short- and long-term) changes in diversity at all levels. In nature, speciation and extinction are both characteristic of the evolutionary processes. Anthropogenic (humanly derived) extinctions or anthropogenically accelerated extinction rates may be undesirable, but a basal extinction rate is natural (i.e., one that must be specified and studied). Evolutionary processes are those by which (by means of a series of continuous changes or step changes) any living organism or group of organisms has acquired the morphological or physiological characters that distinguish it, a process that shows a continuous change over time, as do the processes of nature. It suggests continued forward movement, procedure, and progress, but not necessarily advance in the sense of human values. Processes occur in a series of actions or events (being slow, gradual, rapid, and/or step-wise).

12. Ecological Processes

Interactions within and between communities (at all levels), including interactions with abiotic environments and short- as well as long-term interactions; or, processes affecting mutual relations between organisms and their environment. ("Processes" is used with the same implications referred to in #11 above in the paragraph beginning, "In nature, ...")

13. Intensive Management

Cases in which exceptional technologies are incorporated into overall management procedure, such as "captive population management" by zoos. This is a strained or extreme degree of management; manifested in the nearly "domesticated" treatment, extreme effort and strong and sustained stimulation of the population resource; such management is profoundly earnest or intent. (Some examples include restoration programs for peregrine falcons, condors, nene, tule elk, and desert bighorn sheep.)

14. Charismatic Species

A species that is culturally popular. By virtue of receiving legal protection, such a species can offer protection to less conspicuous and potentially biologically more important species.

15. Ecologically Important Species

A keystone species is one that supports the stability or existence of several to many other species or is biologically important. It is not necessarily a charismatic species but can be.

16. Short-Term/Long-Term

Based upon current knowledge of ecosystem and evolutionary processes:

Short-Term

25 years administratively. Biologically it depends upon the species or processes one focuses upon, and is measured in generation times or recurrent population cycles.

Long-Term

100 years administratively. Biologically it depends upon the species or processes one focuses upon, and is measured in generation times or recurrent population cycles.

Of course, politics require that yet smaller time intervals be used for short-term and long-term definitions, and it is these shortest definitions that predominate in current use by the NPS. These conceptual and administrative constraints placed on "time" are in direct conflict with requirements for study and documentation (biological, physical, and anthropogenic processes) and for protection of biological diversity. (Unfortunately, ecological and evolutionary processes and time do not change for human convenience.)

17. Extinction

The cessation of existence for a given form, or a previous loss of a given form.

18. Extirpation

Local extinction (not necessarily by mortality) can include the driving out of an organism from its habitat by various means, such as by newly introduced competitors or human disturbance.

D. Legislative and International Initiatives

There is consensus on the following statement: **Consistent with the World Conservation Strategy, management of visitors and their requirements should be subservient to the goal of maintaining environmental system integrity.**

Legislative initiatives should be generated to assist interagency efforts to predispose national parks and adjacent federal land holdings (at the very least) toward a biosphere reserve model. The NPS should be a lead agency in the effort, and cooperation should be mandated.

Legislative initiatives may be necessary to shift the priorities of the NPS away from short-term actions into stewardship of biological diversity by inventory, monitoring and long-term research. The latter is not equivalent to monitoring. Such initiatives will require special funding and possible increases in resources management and science personnel. Subject-specific centers and inventory and monitoring eco-region centers may need to be established to support inventory and monitoring activities.

E. Policy regarding Resources Management

1. Legislation

Current policies should be reinterpreted by reexamining existing legislation. New legislation is needed to specify NPS priorities and make more explicit the requirements for protection of biological diversity. Formalization of cooperation agreements at the department and agency levels are also needed to institutionalize the modification of practices. The welfare of the U.S. is dependent upon a conservation strategy, and the NPS can help to formulate one.

The legislation mentioned above must be enacted to help the NPS afford the sort of inventories, monitoring, long term research, technological development, and long-term planning that is necessary to maintain its stewardship and contribute to the protection of national biological diversity. This dual mandate must be more explicitly restated. Environmental impact statements on policy could be required by law to disseminate information to a broad public audience. This could be accomplished by means of announcements in the Federal Register.

2. Leadership in Cooperation and Protection of Biological Diversity

The National Park Service must lead a cooperative effort to achieve its goal of preserving biological diversity nationally; this includes biological diversity existing externally to the parks upon which national parks also depend.

a. I & M Efforts

The NPS should logically be a leader in developing inventorying and monitoring techniques for biological diversity, and in consolidating and disseminating information about biological diversity, cooperatively with the U.S. Fish and Wildlife Service and the U.S. Forest Service, The Nature Conservancy, and other organizations. Because of its nonpartisan interests in the biological diversity, the NPS is likely to take the least biased and most comprehensive approach, serving as a model in the future. The uniqueness of biological diversity in national parks should stimulate the NPS to move ahead in this area.

b. Cooperation

Only nominal leadership in cooperation is offered at present, even at national and regional levels. The NPS is in a position to take a major and aggressive leadership role to increase cooperation. (The suggestion that it assume such a role is not to imply federal control or even a primary responsibility by the NPS.) Both the American public and scientists interested in national parks are seeking such leadership.

3. <u>Administrative Obligations to Biological Diversity</u>

Management of the NPS should be part of the biological diversity protection plan and should be subservient to it, not vice versa.

a. Key Initiatives

Policy guidance and NPS directives should be issued for resources management in this regard and provisions made for supporting research. This means that the NPS should secure **permanent base funding** of long-term research, including technological research for technological applications, for inventory and monitoring, and for the management of a system-wide data base. All of this needs to be developed by the NPS cooperatively with other agencies and organizations.

b. Leadership Guidance

The director of the NPS should have an advisory board that meets frequently to examine methods and progress in the protection of biological diversity. It could assist in long-term planning and reviewing allocated priorities. Such a board should, however, report to another authority, such as the Office of the Assistant Secretary of the Interior to ensure that comments and recommendations are not ignored; this can and does happen, particularly when changes of leadership take place.

c. Management Plans

All parks should be required to have a detailed long-range management plan to cover conservation of biological diversity; these plans should be technically more substantial than current general and resources management plans. Perhaps public review of these plans might provide a good quality check. Long-term planning calls for many things, at the very least, public involvement.

d. Resources Management

Guidelines need to be established to direct resources management to include a mandate for inventory and monitoring, and for cooperation with long-term research as well as short-term projects. Interval periods for repeats of inventories and rethinking of long-term planning should be firm.

e. Resources Management Plans

The resources management plan should incorporate the long-term plan. Five years are biologically meaningless, long enough for only short-term biological assessments. Planning should be at least for the next 25 years in addition to ultimate goals. Short-term review can be five years or less to match administrative requirements.

f. Public Use

Human use of parks does not need to be consumptive only; it can be supportive by helping in restoration or in conjunction with other management efforts. Attempts should be made to change the premise by which people interact with the parks. Beyond current designations that can be deceptive with regard to a park's purpose or orientation, some parks might be administratively designated as visitor-parks, and others as no-visitor parks (i.e., no visitors other than resources management volunteers). Some parks should sacrifice specified parts completely to visitors but eliminate visitation in other parts.

4. Resources Management-related Issues

The key word in all policy and management is flexibility. Management especially should recognize that species and populations are dynamic and to some extent adaptable. Evolution is under way, changing ecology, changing genetics, etc. -- and management must adapt. Management decisions must be based on all available evidence and on a case-by-case analysis of each management unit rather than a blanket national policy. Maintenance of ecosystem integrity should be the foremost objective in trying to preserve biological diversity.

a. Zoning

Zoning, for example, should be based on knowledge and understanding of a park's biological diversity and ecosystem processes, and should change as the system changes. Methodologies for zoning should be developed, as is being done at the international level.

b. Exotic and Endangered Species

Exotic species and extinction are two more examples, and in these areas management is reportedly already flexible; however, this is not at all apparent in practice. We've disrupted ecosystems sufficiently to warrant intervention with exotic species or extinction. But we must also acknowledge natural species replacement and extinction and they must be allowed to occur.

1. Non-native Species (Exotics)

Non-native plants and animals are discouraged in national parks, and as a general policy, exotic species should continue to be until they are eradicated. But special circumstances may require short-term tolerance or use of non-native species. The policy and treatment of non-natives in the ecosystem should also be flexible, especially in cases where the non-native may have developed an important ecosystem function that no other native species can substitute; this is especially true when the non-native species supports endemic, rare, and endangered species.

2. Extinction

Some extinctions (though not the majority) that are being accelerated by humans were already under way. When we lose populations, it is sometimes hard to identify the real cause of the extinction. We need to give the ecosystem more opportunity to determine survival, and we should acknowledge evolutionary and ecological processes that give rise to new diversity and eliminate other diversity. In cases in which doubt exists as to the ultimate cause of a species decline, we should give natural recovery and natural response a greater opportunity. The natural evolutionary and ecological responses of species and communities they comprise may prove more than adequate.

c. Overabundant Plants and Animals

Overabundant plants and animals will occur infrequently. These should be removed to reestablish (with consideration given to population, genetic, and demographic characteristics) or maintain more balanced ecological communities.

5. Making Choices on Resources Issues

To maintain flexibility of management practices, decisionmaking concerning individual national parks should be performed at the local level, with careful attention paid to leaving decision trails, and with the ultimate goal of minimal intervention.

a. Intervention and Ecosystem Stability

In some cases intervention may be necessary in order to achieve the primary goal. When intervention is deemed necessary, management should be adaptive, risk-averse, and consider risks in the context of both positive and negative expected results.

In general, ecosystem stability and evolutionary processes should take precedence over individual species when ecosystem function, and consequently biological diversity, is threatened by habitat modification. Sometimes, When threats to key species that support ecosystem stability and evolutionary processes arise, or catastrophic events occur, management technology may take short-term precedence and manipulate species or processes to achieve long-term natural system stability.

b. Species or Gene Pool and Process, or Versus Process

Maintenance and restoration of a species or gene pool may be in conflict with maintenance of natural ecological functions or processes of the community, park or ecosystem. For example, when native predators have been extirpated, they may not feasibly be replaced. In such cases, introduction of a somewhat different but compatible genome may be advised, or perhaps the use of aboriginal hunting by traditional methods may be substituted for predation. For some parks that cannot feasibly maintain large-bodied carnivores or herbivores, and for which adjacent areas are uncooperative, the park may consider concentrating on process and overall biological diversity rather than individual species preservation.

c. Necessary Human Intervention

Examples of human intervention necessary to ensure system integrity include prescribed burning, water-level control, and hydro-period control. Other necessary short-term and interventionist management actions may include restoration of predators, replication of predator practices, or selective genetic decisionmaking. The latter might involve inbreeding or not inbreeding providing introductions of new animals into a breeding population (gene flow), or cooperating with zoos or botanical gardens to preserve genetic biological diversity that would otherwise be impossible to obtain, maintain or poorly controlled. In some cases disturbed areas should be manipulated to encourage rare species to reenter the disturbed area and become reestablished there.

F. The 1963 "Leopold Report"

The 1963 "Leopold Report," which was well ahead of its time, is still considered valid by most people working in or with national parks. Starker Leopold himself recognized that there would be problems when the NPS made a policy document out of a consultation document without compensating for language and breadth of coverage.

Because of the controversies that have arisen concerning objectives, priorities, and methods of protection, the task force decided to make some generalized comments on language adjustments and reinterpretation. Additionally, knowledge and attitudes among ecologists, conservationists, etc. during the last two decades have changed and support the need for a reexamination. Recognizing that the director's blue ribbon panel will make an in-depth analysis, this group concentrated on material relevant to the objectives of the Biological Diversity Task Force.

Below is a generalized summary and some comments delivered by task force members regarding the report. Some participants gathered comments from NPS personnel, who were more familiar with the "Leopold Report" and its impact on the NPS than most task force members. Thus, some of the following comments are excerpted from contributions of non-task force members as well.

In summary, the task force felt that the report focuses on internal matters, and does not look at the park in the context of its surrounding lands and land use practices. There is too much emphasis on the manipulative aspects of protection, although the task force recognizes that new needs for manipulations have arisen that are not necessarily the kind that prevailed more than 20 years ago.

The group agreed that it is not practical, and is potentially damaging to manage for any point in time. Rather, the focus should be on maximizing particular conditions.

Processes are dynamic, and include natural extinction as well as diversification. So, while extinction is natural, it is the rate of current extinction that is unnatural. The influences of U.S. settlement culture should be minimized except in historic or other cultural areas.

1. Parks as Parts of a Park System

The NPS should manage its parks as a system of lands representing fragments of North American biomes. Emphasis should be placed on protection within the parks and on their interconnections, both with each other and non-NPS lands.

2. The Focus of the Park Mandate

Historically, the establishment of many parks was primarily to create "scenic wonder," not primarily to protect biological diversity. Geological, meteorological and historical preservation must, in these cases, be integrated with the preservation of biological diversity, an aspect not emphasized in the report.

Maintaining the physical integrity of natural areas provides support to the biological diversity characteristic of the ecosystem in addition to preserving scenic wonders. In historic and cultural areas, preservation of biological diversity should adapt to the primary mandates of the park.

3. "Vignettes": Illusions of the Past vs. Natural Ecosystem Stability

To some, the concept of maintaining "vignettes" suggests maintaining an illusion of a past time, a role characteristic of historic and cultural areas. The concept of the "vignette" is contradictory, even when it is not intended to be, to the concept of "natural."

The vignette is our perception of what nature was at a given point, and not necessarily of where it is now or where it should be to maximize natural diversity and stability. We should manage for temporal changes in genomes. If we manage only for short-term evolutionary responses, we must consider the consequences to the species' natural evolutionary capability.

To attempt to preserve the earlier, pre-Columbian era is to preserve a museum. The NPS must officially recognize dynamic processes at play in ecosystems and evolution. Today's natural processes should be permitted to proceed, unaltered except for the excision of Western culture.

4. The Process of Protection

A prior definition of the purposes and objectives of each park is needed to identify its starting point, i.e., before protection. This should be based upon the area's enabling legislation, its administrative history and congressional record, and the factors that will influence the ability to preserve biological diversity .

The goals and objectives of the park's mandates should be set forth clearly in the General Management Plan for the area, the Statement for Management, and the program to accomplish these goals and objectives as outlined in the Natural Resources Management Plan. The plan's time frame centers around a five-year financial plan and thus does not adequately reveal an outline of the long-term needs, steps, means, and measures necessary to reach the ultimate goal or mandates of the enabling legislation.

5. Focal Species

a. Native Immigrants

With the ever-increasing removal of natural habitats in areas adjacent to NPS lands, the Service needs to consider the appropriateness of allowing NPS lands to serve as refuges for naturally immigrating native species, at least in the case of threatened and endangered species if not all native species.

Some Rocky Mountain parks are concerned about the possibility of mountain goats immigrating into parks where there is no historical record of them. What might paleontological records reveal? Historic biogeography and systematics are poorly understood even for such frequently studied species as bear, elk and sheep. Appearances and disappearances over recent paleontologic history are also in need of study to support or negate current "claims" on species ranges and historic abundances.

b. Threatened and Endangered Species and (helpful-?) Exotics

The report needs to contain more information concerning threatened, endangered, and exotic species and the priority of managing them. In the Southwest, the tamarisk invasion has been extensive. With Lake Powell reaching full pool in 1981, the increase in tamarisk along the lakeshore and in riparian zones is thought to have contributed to the increase in the small bird population of the area.

Glen Canyon has a substantial population of peregrine falcons that are reproducing naturally. Peregrine specialists believe the only limiting factor for this population is the prey base. If it is confirmed through research that the small-bird population is increasing along with tamarisk, and that the prey base is the main limiting factor for the peregrine population, which should take priority-control of an exotic, or natural enhancement of the habitat/prey base for an endangered species?

c. Replacement of Extirpated Subspecies and Species

Another consideration is whether to allow alternative subspecies and species to exist or replace extirpated species in some instances. Hypothetical examples could be, e.g., a stream in which brook trout are non-native but also serve as the prey base for river otter. In the Pacific Northwest, freshwater fish populations were exceedingly depauperate. This derived from the recent glacial retreat in that part of the country. Restocking of lowland lakes with non-native species was well under way at the close of the 19th century. The full impact of these early stocking programs has not been evaluated, but certainly a prey base was provided for certain aquatic predators that had not existed before.

6. <u>A Single-Species vs. the Ecosystem or Community Approach</u>

As management currently functions, we are promising to restore integrity of the natural biological diversity, to various degrees, sometimes for vegetation, sometimes for prey species, and sometimes for predators, and sometimes for a combination of these.

One can maintain a static system with management, but the loss of species (which has the potential for becoming even greater) will occur nonetheless, though perhaps less conspicuously. As some have suggested, current "still-shot" (frozen points in time) concepts of preservation can undermine the planning and effectiveness of protection.

7. "Recycling"

In the expression "recycled through the ecosystem," the emphasis is on vegetation/trees but should clearly include wildlife as well. We still tend to prefer that surplus wildlife be utilized by man rather than recycled. Shouldn't this change?

8. "Grazing" by livestock

a. Carrying Capacity

An NPS definition of carrying capacity needs to be established, utilizing the indices of natural communities or an index of biologic diversity; this definition should not utilize Bureau of Land Management (BLM) or USFS range management carrying capacity definitions, which relate to palatable species and not natural diversity.

b. Consulting with Other Agencies vs. Relinquishing Management Responsibility?

"Where the conduct of grazing occurs through others, such as BLM, the Service will consult and cooperate to achieve the same goal." Because the NPS is the primary land managing agency, this statement is not specific or strong enough. The responsibility for preservation should not be relinquished to the cooperating agency.

9. Avoiding "Artificiality"

a. Human Artifacts

The statement that "observable artificiality in any form must be minimized and obscured in every possible way" in context refers to the elimination of exotic species. Later on the report states that tourists should be kept from crowding the parks. How would such a standard be implemented with regard to visitor- and NPS-derived artificialities such as roads, visitor centers, and recreational vehicles and other traffic?

b. Hiding Preservation "in Practice"

The report suggests that protection be regarded as a stage set in which the park is the stage; park employees are the backstage workers, so to speak, and visitors are the audience. This is a questionable suggestion, since there is no need to hide research or resources management. On the contrary, such management should be visible for educational purposes and is preferable to maintaining a vignette or creating an illusion of a pre-settlement landscape.

Early public awareness and involvement should be promoted in national parks to make the public conscious of the ease with which natural systems are perturbed and the complexity of preserving biological diversity.

c. Making Adjustments for New Developments

Adjustments must be made for NPS compliance with new legislation and new types of threats that have begun to affect NPS protection of biological diversity.

For example, A summary of the new regulations could be included to emphasize the need for an adequate plan of operations, resource surveys, clearances, NEPA requirements, monitoring and reclamation plans, etc.

G. **Administration, Management, and Research**

1. Priorities and Planning

a. Revamping Priorities

Any advances in conservation will require some internal preparation and support, such as revamping general priorities for biological diversity and related objectives, and the development of information bases within the existing national park system, that house existing as well as the integration of new information.

b. Planning

Staff should be designated to carry forward planning and organizational activities relating to biological diversity objectives. These should organize NPS-sponsored conferences, seminars, and workshops on protection of biological diversity to assist in planning, training, and increasing the extent of scientific exchange.

c. Short- and Long-Term Projects

The NPS should rethink its short- versus long-term orientation and apply this to product planning, staff reorganization, research, and the setting of priorities. The latter should emphasize application of theory/data, and should consider both grant and contract funding mechanisms of supporting research not conducted in-house. The NPS should contract short-term studies and plan long-term projects using in-house scientists and collaborators.

2. Enhancing Capabilities for Protecting Biological Diversity

a. Monitoring the Utilization of Funds

Monies specified for long-term and short-term research should be carefully monitored to avoid their diversion. Similarly, monies specified for inventory and monitoring and general resources management should be closely monitored. All of these conditions should be written into the performance standards of superintendents and regional officials.

b. Improvement of Technological Capabilities

The NPS should develop technology and synthesis, and support or add personnel. It should stimulate participation by potential collaborators and cooperators. It should use science to apply ecological theories to management and restoration, initiating activities in this area.

1) **In-house scientific capabilities:** Cooperation will require an upgrading of NPS scientific capabilities. This in turn will require increased support and funding for research and provide sabbatical leave for researchers; the NPS should consider adopting, at least partially, the U.S.D.A or other models of research programs. The NPS is not a "research" institution, but it depends heavily upon in-house research as well as on contracted research.

2) **The role of scientists in the organizational structure:** Clearer definition should be made of scientist's role in the overall organizational structure of the NPS. The mobility of scientists into higher-level administrative positions needs to be accommodated.

While there is no doubt that some parks need in-house scientists, regional and national centers with multidisciplinary or specialty teams that can be shared among a number of parks should be established, and existing regional centers (NPS cooperative units at universities) be expanded and better utilized.

A dedicated biological diversity committee should meet periodically within the NPS to monitor progress in NPS development of scientific capabilities.

3) **The importance of specialization and consistency in research:** More effort should be made to categorize types of research. Talents in addition to threats analysis, monitoring, and translation are needed for applications development. Demands made upon individual scientists should vary according to their specialty/orientation; they should not be required to conduct research outside of their subjects of expertise.

4) **Augmenting scientific capabilities for Inventory and Monitoring (I & M) tasks:** There is a need to access scientific techniques for developing, conducting, and analyzing inventory and monitoring projects. The NPS needs to make use of national and local advisory groups of scientists. Experience should be borrowed from organizations already heavily involved in inventory and monitoring. The NPS needs to set up technological centers and establish operational core funding for each center to assist in guiding the inventory and monitoring process.

Basic biological diversity-related and natural history skills are becoming rare in the natural history community. The need for these by the NPS and by the nation for use in inventory and monitoring work could by highlighted by NPS support.

5) **Augmenting scientific capabilities via cooperation:** Stronger and more numerous ties with universities and museums will be necessary to obtain the full complement of discipline specialties necessary for NPS research. A caution with regard to universities, however, is that peer review will tend to disparage monitoring and regard applied science as being poor science or no science at all. Reviewers should be chosen very carefully from among quality scientists from private and public institutions; these should be scientists that think broadly and recognize the ways in which ecology and evolution are seriously affected by the presence of humans.

6) **Translation and communication of research:** Scientists must make efforts to communicate with other NPS personnel, and must be willing occasionally to give tentative answers when findings are slow in coming. But the manager must recognize and take responsibility for decisions based on tentative results of quality research and not blame the scientist if difficulties result.

To maximize the effectiveness of conservation, the NPS should increase the effectiveness of the science-resources management interface. A cadre of personnel should be assigned a primarily interface responsibility. Microcomputer programs aiding in decisionmaking and other means of fostering the relationship between research and resources management ought to be explored.

c. Training

The NPS needs to train existing personnel to plan, carry out, and maintain inventory and monitoring activities throughout the national park system. It must be strongly emphasized that resources management programs should be enhanced with information synthesis and exchange programs and with additional training and internships.

H. Leadership and Cooperation

1. The Emergency That Calls for Cooperation

There have been no national parks that successfully contain entire ecosystems, well insulated from external changes; national parks are not self-contained in terms of ecosystem function. Even communities within ecosystems exist within regions, but they are not generally delimited by national park boundaries even when interrupted by them.

a. The Dependence of Protection upon Internal and External Forces

To learn which ecosystem fragments the national parks can protect, the NPS must acquire knowledge of intraspecific genetic diversity and population viability, as well as familiarity with the general biological diversity of a site. At the very least, both internal and external influences on fluctuations in biological diversity are continuous across administrative boundaries and must be monitored across and beyond national park boundaries.

b. The Fragmentary Nature of National Parks

National parks are not core areas. They are merely representatives of some of the diversity that exists locally, which may not necessarily be the best representatives. Achieving the goal of preserving biological diversity in national parks requires multiple sites. Such linking of several sites into one cooperative function will ensure representation of the full range of within-species as well as between-species diversity characteristic of the ecosystem or local community.

c. The Problem of Size and Shape

National parks are inadequate, in terms of their sizes and shapes, in their representation of the total existing biological diversity and in controlling the movements of biotic and abiotic elements both within and outside their boundaries. Thus, national parks are not large enough to maintain viable populations of many species. On the basis of information access, logistics, economics, and geographic scale, the national parks, working alone, cannot achieve preservation of the processes that sustain biological diversity.

d. Requirements for Multinational Cooperation

The survival of multinational range distributions of many non-migratory species and the existence of many multinationally ranging migratory species require multinational as well as national/inter-organizational cooperation.

The impacts of human activities on climate throughout the world will affect the NPS efforts to preserve biological diversity; climate changes or acid rain, for example, may cause species to shift distributions out of their original ranges and national parks.

e. Who in NPS Needs to Cooperate?

Cooperation can occur in every aspect of NPS functioning: administration, resources management, experimentation, translation and development of technological applications, exchange of technical methods and information, enforcement, interpretation, and public education.

2. Enhancing Leadership and Cooperation Simultaneously

To accomplish this very large agenda, the NPS should strengthen its existing research and resources management priority-setting processes. External influences affecting the cooperation and protection of biological diversity should be addressed at all levels from national park to global scale.

a. The Man and the Biosphere (MAB) Program

Progress in cooperation can be accelerated by making use of existing programs such as the MAB-8 program. The NPS should support the reactivation of MAB funding; strengthen participation in biosphere reserve networks and in the international network; increase use of natural national parks as benchmarks for comparative analysis of ecosystem change; study the interfaces and interactions between national parks and adjacent areas; and make increased use of special designations to highlight the uniqueness of designated areas.

b. Advisory and Policy Committees

A national technical advisory committee and a national policy committee, representing expertise and constituency, respectively, for protection of biological diversity, ought to be established. Regional, national, and international programs promoting cooperation among scientists should be encouraged.

c. Suggestions for Cooperation and Leadership

Leadership, sometimes shared with other organizations, can occur at many levels. In cooperative ventures, leadership should not be stressed to the detriment of cooperation. Leadership is the natural byproduct of successful cooperation.

Cooperation and leadership at the national level (outside parks):

1. Advance a national-level conservation strategy.

2. Request a legislated base (in the range of $4 million) to respond to requests from foreign governments.

3. Establish an interorganizational group to support and oversee cooperation throughout the nation (include public and private groups) in which the NPS takes an active leadership role.

4. The National Science Foundation (NSF) will not at present fund surveys; the NPS could give support to a change in policy by illustrating the research and applications values of biological surveys. Presently, scientists have no regular funding source to turn to in order to develop surveys.

5. The NSF does not fund development of conservation technologies; a change in policy is to be encouraged in this area as well as in inventory and monitoring studies.

Cooperation and leadership in the national parks and adjacent lands

1. Give official recognition to leadership and achievement in the protection of biological diversity at the scientific and management levels.

2. The NPS director should champion achievement and furtherance of research in the protection of biological diversity.

3. Form local cooperative groups with jurisdictional authority and increase the number of informal cooperative agreements.

4. Strengthen cooperation with the National Man and the Biosphere Program, United Nations agencies (including the international Man and the Biosphere Program), international organizations, and international development agencies to identify opportunities for integrating conservation of protected areas and surrounding development.

5. Actively participate in the development of a strategic national plan for expanding biosphere reserves, other networks of cooperating land ownerships, and special designation programs. These activities should involve the public and be accompanied by the establishment of data exchange networks.

6. Create other examples of the Greater Yellowstone Ecosystem Model. Such examples must work "on the ground" as well as on paper. Cooperation within a larger management unit should endeavor to transcend ownership boundaries.

7. Involve the NPS in other agency planning teams and with private development planning in a more aggressive manner than is presently employed.

8. Make protection of biological diversity a major feature of general management plans in contexts of resources management, operations, interpretation, administration, etc. Presently these activities appear purposely disconnected.

9. Establish multi-organizational (regional or national) technical centers and bring NPS scientists together into these topic-oriented or biome-oriented centers. In such settings the groups should function as expert teams that serve the entire biome for inventory and monitoring consultation and development of management plans. The centers may also serve across all NPS regions for special topic consultation and research and program assistance (in conservation biology, non-native species management, toxic wastes, and visitor and visitation impact studies, for example), respectively. The centers should serve as both key training and educational resources and as centers for selected types of internships for new resources management and research staff.

10. Establish a director's advisory committee to provide guidance at the national and international levels for the NPS director.

11. Establish a national coordination center for science that, together with the director's advisory committee and centers of specialization, can assist parks and regions in implementing a cooperative planning framework for scoping issues, establishing objectives, determining information needs for developing strategies, communicating to the field and to constituencies, developing budgets and monitoring programs.

12. Coordinate, facilitate, and support science and scientific exchanges (in the form of special workshops and working teams).

13. Expand the role of the social sciences in the NPS and develop research programs in ethnobiology, landscape ecology, boundary processes, and park planning.

14. Support service-wide initiatives to educate the public in the value of biological diversity, the role of protected areas in protecting biological diversity, and the importance of biological diversity for the nation.

15. Institutionalize the biosphere reserve system throughout the national park system and integrate national parks, corridors, and buffers into regional, state, and county planning.

Cooperation and leadership at the international level

1. Creating linkages via MAB to other countries.

2. Establish a NPS base budget to respond to special requests relating to the protection of biological diversity and exchanges of scientific expertise.

3. Draw on World Heritage funds for World Heritage Sites, and establish exchanges with World Wildlife Training Center, an expansion of current international training programs sponsored by the NPS Office of International Affairs.

4. The NPS should position itself to respond more broadly to requests for technical assistance, cooperation, and training by other governments in areas involving the conservation of biological diversity. This could be encouraged by arranging interactions in which scientists and resources managers are exchanged and exposed to the techniques and complexities of protection in both the U.S. and the cooperating country.

5. The Department of the Interior should actively pursue implementation of a U.S. Government biological diversity strategy.

3. Attracting and managing cooperation

The NPS can easily attract cooperation because of its access to the natural resources of the U.S. existing in their least hampered states.

a. The Purpose of Cooperation: Development of Knowledge about Biological Diversity

Non-exploitative access to these resources are essential for discovery of new, potentially useful species that may have become rare elsewhere (outside parks); such access may also be useful for measuring the natural rate of mutation and species change, or the rate of assimilation of new characteristics from one population into another, and may provide many other types of economically or medically useful information.

b. Cooperative Park Studies Unit (CPSUs)

The NPS has strong planning and design capability to offer potential cooperators. Existing CPSUs offer quality sites for maintenance and expansion of cooperation. National park scientists and managers possess on-the-ground resource knowledge that is unique, and the parks possess a public audience matched by no other land-holding organization.

c. The Potential Data Base

The NPS may have a valuable resource in its (potential) central or centrally coordinated data base.

d. Acid Rain, Fire Management, and Other Successful Research/Resources Management Training Programs

NPS work on acid rain can serve as a model of legislated interagency cooperation that can work for other subject areas.

e. Interpretation

The NPS can bring interpretation into a cooperative alliance.

4. <u>I & M Cooperation Requirements</u>

a. The Rate-limiting Step

The quality of protection and the speed with which we inventory and monitor, for example, are absolutely linked to cooperation and coordination. The NPS has demonstrated some excellent examples of cooperation in grizzly bear (and now spotted owl) protection, but has not nearly begun to make full use of this resource. As a result, the NPS suffers from shortages of funds, expertise, and data.

b. NPS Cooperation: Levels and Participants

Coordination of and cooperation in inventory and monitoring should occur at the national, continental, or intercontinental levels in step with existing programs. Such activities might be undertaken with the U.S. Biological Survey of the U.S. Fish and Wildlife Service (USFWS), or with similar programs of the Canadian and Mexican governments, for example, and of other major U.S. landholders (such as the USFS, BLM, and state governments). Additional cooperation should occur at the regional and local park level.

c. Specific Protection Needs Requiring Cooperation

Specific needs with regard to cooperation can be summarized as follows:

1. Multi-agency and multinational cooperation in managing for viable populations of target species

2. Multi-agency and multinational preservation of variation within species in communities extending beyond national park boundaries

3. Multi-agency and multinational cooperation addressing external breaks in distributions and resultant losses of migratory species to the effects of tropical deforestation, pollution, or climate change

4. Multi-agency and multi-national cooperation for the development and translation of technologies and exchanges of information on inventory, monitoring, long- and short-term research, interpretation, education, and funding of protection for biological diversity

[**Note**: Items 1-4, above, also provide an excellent direction for NPS long-term research and funding that should take place concurrently with inventory and monitoring and shorter, impact-related research.]

I. Inventory and Monitoring

It is our impression that most national park superintendents do not understand why we need to inventory and then monitor. There is also an unclear perception on the part of the NPS staff of how to inventory and monitor, and of what value inventories and monitoring have to the functioning of the national park and the future of the nation.

1. The I & M Process

In the process of inventorying and monitoring one needs to do three things: (1) obtain information on the status of what is known/unknown about the national park's biological diversity, (2) develop the objectives of the inventory and monitoring, and (3) subsequently take action to find out what is there.

Analysis of the inventory provides direction for management and planning as well as documentation for legal actions or defense (to be used in justifying legislative initiatives); it also supplies the basis for future discoveries about biological diversity and human relationships to this diversity.

2. Inventory

a. Definition

Inventory determines what animal and plant species and populations exist in the ecosystems. The purpose of inventory is to establish a baseline condition of the national park's biological diversity for comparisons with future conditions. Inventories are necessarily repeated for notation of change not covered by monitoring.

b. Organization

Inventories should document the broad range of animal and plant groups, including fungi, lichens, and soil organisms. In cases where choices of emphasis must be made because of financial reasons, the NPS should begin with those elements the NPS can uniquely preserve (or else begin with what is suspected to be the most exposed and vulnerable habitats), in addition to other legislated priorities. But even taking this precaution is not enough; plans must be made to continue the inventory beyond this limited scope. The inventory process relies heavily on the discipline of systematics, which is not represented in most departments of universities. Most systematists work in museums, and there are too few of them.

c. The Use of Systematics

The NPS should encourage the field of systematics, upon which the inventory of biological diversity will rely heavily now and in the future. Presently, only selected museums and few universities support systematic research and field staff. Even so, very little funding is available to conduct the needed systematic reviews that are the underpinnings of good conservation efforts. The lack of funding for proposals to examine systematic relationships among North American bears, for example, undermines the reliability and therefore the quality of bear research and management in the U.S. and Canada.

d. Priorities: Genetic Diversity to Community Biological Diversity

Studies of genetic variation are also important to the inventory but cannot be started until species assemblages are defined and species are selected for their probable critical roles in the ecosystem, i.e., for their rarity or vulnerability. Natural national parks are unique among federal land-holding agencies in that management ideally regards all native species and ecosystems within them with equal respect. Thus, ideally, the NPS should not give preference to organisms or communities, other than to determine sequence of efforts; even then this should be according to hypothetical ecological and evolutionary importance and vulnerability.

3. Monitoring[1]

a. Definition

Monitoring defines normal variations and temporal shifts in structure and change of an ecosystem. Monitoring occurs regularly, each event being repeated more frequently, less broadly, and in greater detail than the inventory. Monitoring looks at the ranges and means of variation, the changing status of and trends in the system, from population to ecosystem, and predicts normal patterns where they (population to ecosystem) are to be found for the biological diversity of the national park and surrounding region.

b. Organization

Monitoring measures the effectiveness of protection and management, and evaluates the local park management's expectations for systems of the future. Once analyzed, the information derived from the

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[1] Monitoring for air pollution, acid rain, and other major threats, for example, is already being dealt with by another task force. The following, therefore, deals with biological diversity and more generalized ecosystem analysis.

combination of inventory and monitoring aid in determining protection and management objectives for the national park.

c. Kinds of Information Sought

At the community level we may ask, "How is our lodge-pole pine forest doing?" Of a specific population, we may inquire, "How are the numbers and age groups changing? Or, of another population, "How is the distribution of genotypes and phenotypes changing in response to random events over time, and in response to specific impacts felt by the national park? Is a species still present?

d. Experimental and Manipulative Studies

Answering these questions may require that some experimental manipulative studies be conducted, since these may be crucial to the protection of the resources. Sometimes manipulative work may be done in adjacent areas, but at other times the NPS may have no choice but to conduct these within the national park.

4. The I & M Processes (Methodology)

a. Preparation

1. Preliminary Work

The development of inventory and monitoring (discussed below) projects involves a preliminary literature search and synthesis, collection and analysis of aerial photos, and possible satellite imagery to determine what is known or unknown. Data formats for this first analysis should be as compatible as possible with potentially cooperative NPS and other federal/non-federal inventory programs (such as within the State Heritage Program, for example).

2. Gaps

Gaps in knowledge should be well defined. What parts/species of the national park are the least understood in terms of what is there? Herbaria and museum records should be examined. (The Association of Systematics Collections may be consulted for guidance on appropriate museums. The Association has a computerized database for this purpose, an extremely useful science of information since the nearest museums are not always the only ones with specimens from the area nor do they always house the best collections.)

3. Synthesis

Good maps should be developed from overlays of all pertinent, available information including topographic, hydrological, soils, land ownership, zoning, and other maps. It should be hypothesized which are the vulnerable, the supporting, and the rare elements of the ecosystem and what part of NPS biological diversity depends upon other (non-NPS) units for preservation.

Such background searches could be accomplished centrally (the Washington,D.C., office, or by a special center, by each region, or by the local park).

b. Data Management

The development of a centralized clearinghouse to synthesize this information seems essential and should include capabilities to generate data, graphs etc... quickly for use by the local park or region, the NPS in general, or other cooperating organizations.

Such data management and clearing house will be fundamental to NPS progress in inventory, monitoring, and subsequent data handling, and would have to be centrally coordinated even if decentralized.

c. Variation in Approach

Inventory and monitoring projects vary not only with location, but with geographic scale, information kind, volume, and emphasis. In the listing below, for example,

Species	Systematics	National
Populations	Biogeography	Eco-Region (Province)
Communities	Genetics	State
Fragmented Systems	Demography	Plant cover type
Ecosystems	Reproductive Biol.	Locale or Site
	Ecology[2]	

It should ultimately be up to the local park or region as to determine what is to be examined and in what detail. The agency should move to develop centralized guidelines and a centralized data base or clearinghouse for interagency sharing of inventory and monitoring data.

d. Model Sites

Some sections of parks should be designated as focal points of inventory and monitoring development and models of biological diversity protection. These should be specified elements of ecosystems, and these should be highlighted in budgeting, management, and research as well as in major public education programs.

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2 * and associated sociological and abiotic fields

e. The Need for Cooperation

Interconnectedness with neighboring landholdings across boundaries of national parks mandates cooperative approaches to inventory and monitoring. Lack of data from outside the park produces deceptive results that can mislead planning and management, and consequently undermine protection.

5. Variations in I & M Processes

There is of necessity a great deal of variation in how one can go about preparing for, carrying out, facilitating, and improving the inventory and monitoring process. Inventory and monitoring projects can and sometimes must include the following:

a. Creation of voucher collections by networking with other museums for comparison of voucher collections.

b. Coordination of data formatting regionally and nationally (within an NPS unit and between other NPS units) by creating national retrieval networks for inventory and monitoring data.

c. Establishment of germplasm collections for restoration and reliance on germplasm collections for restoration.

d. Coordination of inventory and monitoring through specialized CPSU-like units; in addition, increased availability of technical/regional expertise for inventory and monitoring and for the purpose of making valuable contributions to localized training and interpretation.

e. Cooperation with adjacent landowners across park and boundaries to obtain information on whether diversity inside the national park is depressed, the same as, or greater than diversity in adjacent land holdings.

f. Focus on the monitoring of keystone species or other indicators of system function, thus allowing for stop-gap readings on changes in health and stability of the ecosystem.

g. Maximum use of outside consultants to reduce contract costs. This is accomplished by sharing design and field work with specialized local expertise and scientists from other agencies, universities, and museums.

h. Inventory and monitoring which contributes to ecological, evolutionary, systematics, and biogeographical knowledge of species and decreases dependency on in-house staff that may be in short supply.

i. Training resources managers and other resources management personnel to conduct and supervise the largest portion of inventory and monitoring. Seasonals and nonprofessional field personnel and trainees could be trained to assist. Some resources management trainees or other resources management staff could reside in CPSUs on a rotation basis and increase the interface between scientists and park management.

j. Translation of science into terms that may make it better applicable to inventorying, monitoring, and resources management generally. The ability to preserve species and assemblages of species in the U.S. depends upon understanding evolutionary relationships between species, not just ecological relationships. Sound management for protection and restoration depends upon this information, and more effort must be made to disseminate it.

k. Cooperation in inventory and monitoring with other NPS or adjacent units which serve as experimental manipulation sites for projects in which the national park is the control. This allows for better understanding of other components of ecosystem (present, recent, or ancestral--e.g., the influence of ethnobiology on local botany), and is important for the discovery of habitat function and for management effectiveness.

l. An increasingly multidisciplinary (not just "interdisciplinary") approach to inventory and monitoring. This would create better interfaces between resources management, park science, and new technology.

m. Increased grassroots efforts to keep costs down. This involves greater public and external scientific support than in-house, purely contractual study can provide. (Unfortunately, it involves some disadvantages in continuity of study and speed of completion for inventory and monitoring.)

n. Concentration on short-term, discrete project successes (especially at the local level) to gain credibility and momentum, the long-term goals. (This requires special concentration and good documentation). Such efforts permit smaller outlays for each occasion and engender greater public cooperation and external scientific support, they do, however, carry with them the same disadvantages as above.

o. Increasing participation in MAB, using the biosphere reserve concept to foster cooperation between the National Park Service and different agencies and organizations. This increases the quality of participation and increases the probability of long-term interest.

6. Guidelines for I & M

What is unique about the inventory of "biological diversity," and how does it differ from the inventory and monitoring projects conducted in the past?

a. Inventory Characterization

Rather than just a collection of absence/presence data about species, there is an inventory of the genetic diversity within and between selected populations. Maps are also kept of the geographic distributions in relation to pertinent socio-geographic and biogeography variables for subsequent monitoring and analysis. Inventory is continuous though diminished in volume-of-activity during interim periods specified for the locality and may be repeated, full scale, at predetermined intervals for comparison of new data to baseline.

b. Monitoring Characterization

In monitoring, the types of data that may be collected are similar to those of inventory; however, the examination is focused on ecologically and evolutionarily important species, and data are collected in greater detail than those of inventory. Monitoring is continuous at a fixed level-of-activity in which we may examine population demography and genetics for selected species, for example. Monitoring, thus, has a different emphasis than inventory and occurs regularly with field assessments being repeated more often than with the full-scale inventory (see Figure 1, for clarification).

Species are chosen for monitoring based on criteria reflecting those features that support the biological diversity of the area and the health of associated ecological and evolutionary processes. In monitoring for threats, for example, species are selected based upon how sensitive they are to the presence of, say, acid rain, water pollution, air pollution, etc.

c. National Guidelines for Inventory and Monitoring

The NPS needs to develop flexible service-wide guidelines and standards of what inventory and monitoring might entail for a given national park. These should be supportive of the unique requirements of the national park and allow specifics to be addressed locally. Nonetheless, a statement needs to establish standards on data analysis and handling, and should press for compatible formats, storage, and access methods nationally.

d. Use of Localized Inventory and Monitoring Plans

Inventory and monitoring should assist in the development of preservation plans, to rank management action, and to plan for continued monitoring and cooperation. Plans need to provide for specific measures to be taken in cooperation with partner agencies and organizations. Monitoring should relate to specific objectives in management plans to adjust the course of management.

e. Delimiting Inventory and Monitoring Efforts

Because most biological communities near the periphery of the national parks spill over into neighboring lands, and vice versa, the NPS must extend its interests beyond its boundaries. It should cooperate with neighboring land owners to improve/facilitate the gathering of data on communities they share in common. The NPS should not attempt to conduct inventory and monitoring projects alone but should make use of assistance in funding and on site cooperation. Pilot projects could assist in the development of cooperative liaisons among both private and public organizations.

7. The Size of the I & M Task

a. The Problem of Catching Up

Because the NPS is so far behind in its inventorying and monitoring, there will be considerable catching up to do in several areas. There is in general more information available than is being utilized, and less inventory and monitoring under way than necessary. The staffing and funding of the Service are insufficient to accomplish these functions.

b. The Need to Catch Up

It is apparent that inventory and monitoring of biological diversity alone, not including the effects of acid rain or air and water quality, will be costly for between 200 and 337 units (excluding strictly historic sites with no associated undeveloped land). It is also apparent that 10-50 national parks need to start their inventories shortly so that the NPS can accumulate at least 10 years of monitoring results before the year 2000. It is suggested that the NPS petition for additional legislation to ensure the direction and sufficiency of funds to carry out these essential functions.

J. Training, Interpretation, and Public Education

Training in methods of protecting biological diversity and raising awareness of national park dependence upon cooperation (at all levels) will be required, especially for park staffs. This includes training for superintendents and for professional as well as non-professional staff who engage in activities that affect protection of biological diversity, (resources management, interpretation, enforcement, construction, etc.). These will be the people who implement protection and communicate their knowledge to visitors and the public.

1. Expansion of Existing Programs

Training programs should be expanded to include video presentations, more specialized university training courses, and interagency training workshops. Some managers might profit from a return to college, either for one-year sabbaticals, or periodically, for a single semester or quarters at a time, to take university courses in specific areas of expertise or to remedy deficiencies. Scientists should take sabbaticals for similar purposes -- to write a book summarizing several years' work, for example, or to study with other scientists at another location. Employees should be permitted to pursue these types of training at full salary.

2. Participation

Rangers should participate in resources management training and share some of the duties. All park staff should take at least one short course per year on a topic of conservation of biological diversity, to demonstrate its importance in management and to show management's commitment to it.

3. Science Image

Efforts should be made to improve the NPS's science image. A better climate for research ought to be created. Managers need to realize that the fact that answers may be complex and/or slow in coming is not due to personal factors but to the nature of the work or discipline. This does not reduce the responsibility of the scientist to produce a product (even a preliminary one) within a defendable time span.

The difficulties of translation go both ways: not only should scientists translate their findings, but the manager working for the NPS should be sufficiently trained to understand the basic language of ecology and evolution and be acquainted with basic processes.

4. Science Quality

In addition to the sabbatical and training courses suggested above, scientists should be encouraged to regard travel to professional meetings as high-priority travel. Professional meetings should be regarded as training, and as contributing to the improvement of the NPS science function and NPS public education (regardless of whether the scientist presents a paper at the meeting). NPS scientists should be encouraged to collaborate with outside investigators. Some seed monies should be made available specifically to encourage collaboration. In addition, a computer network should be established that connects scientists nationwide to a central data network of the Service, and also connects them to each other via an electronic bulletin board and a message exchange.

5. Translation

A great deal of scientific literature is available in disparate fields that has value for immediate conservation application. However, this work is not in a form that can be understood or necessarily utilized by park managers. In many cases, masses of literature have not been summarized to find the trends that facilitate management assessments of the health of biological diversity or management planning for protection of biological diversity. It is from this body of work that translation activities have been proceeding to produce recommendations for small-population management and restoration as well as methods for inventory and assessing the health of communities. No means but agency support presently exist to conduct this translation, which makes progress in this area particularly slow and manager dissatisfaction with science particularly acute.

6. Interpretation

Interpretation should be expanded in scope and depth. Complexities of management and protection, and damages in the ecosystem should not be hidden but described, visited and utilized to raise public consciousness about the difficulties of modern protection. This and public education programs should be more aggressive, including television advertisements and specialized video programs.

7. Education

The NPS should concentrate its efforts and cooperate with other organizations (including agencies) to teach the public about the its dependence upon biological diversity and the complex problem of protecting that diversity. This should be done at both national and state levels, through public education and promotion. The NPS should attempt, for example, to incorporate such education into school curricula, broadcast channels (radio and television programs), and advertisements.

K. The Five-Year Action Plan as of January 1987

1. First Recommendations

The following is the action plan as it was delivered to the associate director of the National Park Service in late September, 1986. It was recommended that the director of the N.P.S. should:

a. Issue a directive to the N.P.S. defining the change in emphasis.

b. Brief superintendents on the new program, and develop new performance standards for the superintendency.

c. Establish a National/Regional Technical Advisory Committee for these Rocky Mountain/California/Hawaii park service areas taken as a group.

d. Review the General Management Plan/Natural Resources Management Plan and create a biodiversity plan.

e. Review inventory and monitoring needs.

f. Engage in inventory/monitoring at Lassen Volcanic National Park.

g. Develop guidelines for inventory/monitoring.

h. Review the purpose and goals of parks in their conservation role.

i. Set up training programs for interpreters and resource managers.

j. Set up cooperation agreements with adjacent neighbors.

k. Develop international contacts.

l. Appoint a preliminary group to function as a biome/topic center.

It should be mentioned that a strong correspondence between the proposed action plan and the director's 12-point plan was noted (see table 1 for 12-point plan).

Table 1. Director Mott's 12-Point Plan

NPS 12-POINT PLAN

1) Develop a long-range strategy to protect our natural, cultural, and recreational resources.

2) Pursue a creative, expanded land protection initiative.

3) Stimulate and increase our interpretive and visitor service activities for greater public impact.

4) Share effectively with the public our understanding of critical resource issues.

5) Increase public understanding of the role and function of the National Park Service.

6) Expand the role and involvement of citizens and citizen groups at all levels in the National Park Service.

7) Seek a better balance between visitor use and resources management.

8) Enhance our ability to meet the diverse uses that the public expects in National Parks.

9) Expand career opportunities for our employees.

10) Plan, design, and maintain appropriate park facilities.

11) Develop a team relationship between concessioners and the National Park Service.

12) Foster and encourage more creativity, efficiency, and effectiveness in the management and administration of the National Park Service.

Table 2. Suggested Distribution of Ecoregional Technical Centers

1) Tiaga
2) Eastern Forest
3) Southeastern Forest
4) Prairie
5) Short-Grass Prairie
6) Rocky Mountain
7) Great Basin
8) Californian
9) Desert
10) Pacific Forest
11) Alaskan
12) Sub-Tropics

Table 3.

Suggested Composition and Functions

of the National Technical Advisory Committee (NTAC)

1) Regional Technical Advisory Committees Chairmen

2) NPS Associate Director, Natural Resources

3) Other NPS Associate Directors (Cultural, Operations, etc. as Deemed Necessary)

4) 1-2 Representatives of Other Panels and Project Leader

5) 1-3 Representatives of Other Non-NPS Institutions

NTAC FUNCTIONS

1) Recommend project priorities for national funding.

2) Recommendations for upgrading science and resource management capabilities.

3) Develop evaluations of science and long-term projects.

4) Provide consultation to associate director.

5) Facilitate interagency and institutional cooperation.

6) Facilitate international cooperation.

7) Assist development of Biodiversity Plan.

Table 4.

Suggested Composition and Functions

of the Regional Technical Advisory Committees (RTAC)

12-13 Biotic Divisions of the U.S.A.

1) Biome Specialists (including Chair)
2) 1 NPS Scientist Representative
3) 1 NPS Resources Manager

RTAC FUNCTIONS

1) Review management plans.
2) Recommend long-term research needs.
3) Review/recommend inventory and monitoring needs/techniques.
4) Suggest training needs.
5) Assist in development of Biodiversity Plan.
6) Recommend priorities to NTAC for national funding.
7) Assist upgrading science/resources management capabilities.

Table 5. Recommended Forms of Cooperation

1) NTAC Outside scientists with NPS,
   RTAC develop NPS Biodiversity Plan.

2) International programs (coordination and exchange of information and databases).

3) Training programs (non-NPS & NPS instructors).

4) Professional meetings, of federal, state and private organizations.

5) Inventory, monitoring, and other long-term (15-25 years) research teams.

6) Nearest neighbors function as teams for inventory/monitoring, long-term research, and resources management.

7) Meta-population concept applied through cooperation of a local cluster of NPS/non-NPS lands.

8) Subject-specialist teams (units) hold workshops to develop needed technology.

The following is the resulting proposal approved by the associate director for Natural Resources. It was this proposal that was used to brief NPS Director Mott on October 16-17, 1986.

5-Year Action Plan

1. The NPS's recommended actions presently include:

    a. Inventory and monitoring

    b. Management and policy decisions

    c. Interagency cooperation

    d. Training, translation, education

    e. Appropriate technical guidance

2. The National Park Service needs to institute an inventory and monitoring program as soon as possible.

    The NPS does not know the status of the elements of biological diversity in the NPS system.

    Recommended actions:

    a. Inventory the distribution and abundance of major elements of the ecosystem.

    b. Establish a monitoring program to detect trends in these elements and in ecosystem processes.

    c. Create a data storage and retrieval system.

3. Implement management and policy decisions that reflect NPS concern with biological diversity.

    A concern with biological diversity and interest in inventory and monitoring of diversity have not been principal concerns of the NPS.

    Recommended actions:

    a. Redirect key policy elements to reflect concern with biological diversity.

    b. Rewrite NPS job descriptions and performance standards to include awareness.

4. Foster cooperation between federal agencies, states, and non-government organizations.

   a. The parks, by themselves, are too small to preserve viable populations of many species, and they are strongly affected by surrounding lands.

   b. Recommended actions: The NPS should take the lead in establishing cooperative programs to:

      a. Recover threatened and endangered elements.

      b. Conduct inventory and monitoring.

      c. Implement educational and training programs.

      d. Promote and facilitate involvement in biological diversity issues by both the public and the private sectors.

5. Increase and redirect training and education.

   In general, NPS personnel and the public are not aware of biological diversity issues.

   Recommended actions:

      a. Implement translation and training activities at all levels within the NPS to increase awareness of biological diversity issues and to bridge gaps between science and management.

      b. Increase public outreach through interpretation and education programs.

6. Take steps to ensure that the NPS has the best possible technical guidance on biological diversity issues.

   Expertise in conservation sciences, such as the young field of conservation biology, is not widespread.

   Recommended actions:

      a. Establish technical advisory committees on biological diversity.

      b. Establish cooperative ecoregional and subject-oriented centers.

7. The Five Year Action Plan/Pilot Program will comprise the following:

   a. A pilot inventory and monitoring program

b. A director's advisory committee

c. A pilot ecoregional technical center and advisory committee

d. Training, translation, interpretation, and education

8. <u>Establish a pilot inventory and monitoring program.</u>

In choosing a park for this purpose, it was recommended that a small park be selected, one that suffers relatively few threats and has (1) a low diversity of communities, (2) an enthusiastic staff (toward this project), (3) no ongoing inventory or monitoring project, and (4) close to the committee that is developing the plans for a pilot inventory and monitoring project.

The selection was tentatively Lassen Volcanic National Park. Comparative material will be drawn from ongoing inventories in other parks. The work is to be conducted collaboratively by NPS personnel and several university scientists. So far, potential collaborators include individuals from Montana State University, Stanford University, the University of California at Davis, the University of California at Berkeley, and the NPS.

The park superintendent and the resources manager of Lassen Volcanic National Park have been interviewed; the preliminary approval of Director Mott has been received and there has been no objections by the 10 regional directors. This operation is to be coordinated with the activities of the Natural Resources inventorying and monitoring task force.

During the first year, preliminary generic guidelines for the inventory and monitoring of biological diversity will be prepared. Simultaneously, some preparatory field work will be under way at the pilot site. Enabling legislation, management plans, maps, literature, on ground and aerial photographs, and satellite imagery will be analyzed for use in the planning process. Figure 1 demonstrates the schedule for field work and analysis of the inventory and monitoring for the test park.

Integration of Nature Conservancy inventory methods, demographic and genetic analysis of selected populations, geographic information systems, and boundary analysis will produce the forthcoming methodology for the inventorying and monitoring processes for biological diversity.

At the end of the five years final guidelines will be prepared (adjusted by field experience and comparisons of this with results from other ongoing projects) for use by the NPS.

9. <u>Establish a director's advisory committee on biological diversity.</u>

The advisory committee is expected to meet regularly to provide advice to the director on multi-regional, national, and international issues relating to the protection of biological diversity.

The advisory committee will act on matters within the scope of this report, and will respond to specific requests by the director. The scope of this committee's work will not be as broad as that of the advisory board that covers cultural as well as natural issues and policies. It is suggested that, initially, this committee also serve as the oversight committee for the pilot inventory and monitoring program.

10. Establish a pilot technical center and advisory committee.

This center should provide the technical support for the biological diversity projects; coordinate cooperative programs; function as a clearinghouse for technical information; house and manage the inventory and monitoring data base; be responsible for project design, operation, analysis and information dissemination; and originate training, translation, interpretation, and educational programs on biological diversity issues. Additional work will be carried out to conduct outreach programs on biological diversity aimed at non-visiting public and private sectors.

The activities of this center would be coordinated with NPS offices and personnel engaged in similar activities, making maximum use of NPS resources as well as of the scientific community.

11.a. The Five-Year Pilot Program Budget

Item	**Cost Per Year** (in thousands	**Total Cost 5 yrs** of dollars)
a. Inventory and monitoring	250-650	1,250 - 3,750
b. Director's advisory committee	50	250
c. Program coordination	100	500
d. Pilot bio-regional center (last year only)	200	200
e. Interpretation	?	?
f. Training and education	?	?
g. Outreach	?	?

Total budgeted for Natural Resources: $0.6 600 - $1.100 million/yr.

Total known cost for Nat. Resources budget: $2.200 - $4.700 million for total of 5 yrs.

11.b. <u>Budget presented to Regional Directors</u>

Proposed Budget: Year 1

	Yr 1 Subtotals	Yr 1 Totals	Project Totals
I. Inventory and Monitoring:			
A. Develop Service-wide Guidelines			
1. Vertebrates	30k		
2. Invertebrates	30k		
3. Aquatics/climate	15k		
4. Annuals/soil	30k		
5. Perennials/remote sensing	30k		
6. Sampling/statistics	5k		
7. GIS/software application	15k	155	
B. Coordination Workshops (2)	9k	9	
C. Inventory and Monitoring Demonstration Project			
1. Compile information and background data	26k	26	
2. Cooperation workshop	4k	4	
3. Inventory (yrs. 2-5)	--		300k
4. Monitoring (yrs. 2-5)	--		600k
5. Analysis and interpretation (yrs. 2-5)			200k
II. Training, Public Education, and Outreach:			
A. Training			
1. Inventory needs and develop materials	27k		
2. Training workshop	30k	57	
3. Implement training program	--		500k
B. Develop and implement park interpretive program			400k
C. Develop and implement public education and outreach programs	--		400k
III. Management and Cooperation			
A. Develop interagency coordination mechanisms	16k	16	
IV. Director's Steering Committee	15k	15	
V. Development of final guidelines for inventory and monitoring and protection of biological diversity			
VI. Bioregional Technical Center			
Administrative Support (yr. 1)	34k	34	
Administrative Support (yrs. 2-5)			
Total yr 1		301k	
Total whole project			2.2-2.6 M

L. Concluding Recommendations of the NPS Director's Task Force on Biological Diversity

With respect to "natural" parks and natural areas within parks:

--The NPS should seek to protect biological diversity at all levels of its organization.

--The NPS should officially recognize that the loss of biological diversity in the U.S. and globally is a major concern.

--One of the primary NPS missions should be to maintain and restore native biological diversity.

--Conservation of biological diversity must become the central and overriding principle for organizing management and administration of NPS "natural" parks and zones.

--Because parks are too small, scattered, and otherwise inadequate to achieve this goal, cooperation between the NPS and federal, state, local, and non-governmental organizations is mandatory.

--We affirm the general thrust of the "Leopold Report" with modifications of language that reflect advances in our current knowledge of biological systems.

--We also affirm the importance of maintaining natural ecological and evolutionary processes similar to those in presettlement times.

--Currently the NPS obtains insufficient technical information on the conservation of biological diversity, and there appears to be no focus on biodiversity.

--The NPS has inadequate inventory and monitoring capabilities.

--This mission is so fundamental that training and translation within the Service and interpretation to the public are mandatory.

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N. Appendices

1. The Mandate of the National Park Service

A Background Paper for the Task Force on Conserving Gene Pools
Washington, D.C. - March 17-19, 1986

John G. Dennis
February, 1986

Introduction

National Park Service involvement in efforts to preserve genetic diversity must be conducted within the framework of the statutory directions that govern National Park Service activities. These directions occur primarily as a general set of instructions presented in the 1916 National Park Service's "Organic Act" together with the individually specific sets of instructions presented in each of the many park enabling acts. These directions also occur secondarily in the various sets of more general instructions that apply simultaneously to several bureaus or departments of the federal executive branch. Because these statutory directions are necessarily broad, the National Park Service has promulgated a set of Management Policies to interpret and explain the statutes and to provide uniform guidance to its individual regional and field managers in carrying out their statutory responsibilities. The goal of the following discussion is to highlight those elements of statute and policy that may be applicable for guiding development of a National Park Service initiative regarding the preservation of genetic diversity, with the concept of "preservation of genetic diversity" assumed to include ensuring the survival of both genetic material (information) and the processes that shape that material.

Statutory Directions

The first statutory expression of the concept of natural resource preservation in a national park was passed in 1872 as the Yellowstone Park Act. This act withdrew public land from disposal and dedicated the land "...as a public park or pleasuring ground for the benefit and enjoyment of the people...." This act further established the making of regulations providing "...for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within the park, and their retention in their natural condition..." and prohibited the "wanton destruction of the fish and game found within said park...(or) their capture or destruction for the purposes of merchandise or profit." Follow up legislation in 1884 expanded these prohibitions by stating, "...all hunting,...killing, wounding, or capturing...of any bird or wild animal, except dangerous animals...to prevent them from destroying human life or inflicting an injury, is prohibited...; nor shall any fish be taken...in any other way than by hook and line...."

Many park enabling acts (statutes that establish parks) in the years following establishment of Yellowstone incorporated similar statements regarding the natural resources. With passage of the National Park Service Act in 1916, the statutory recognition of the purpose of national parks, monuments, and similar reservations became refined to include the dual intent "...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." In implementing this dual purpose of in situ conservation for the intrinsic value of the resources plus provision of inspirational and recreational opportunities, the National Park Service was permitted both to dispose of timber for control of insect or disease attack or for conserving scenery or natural or historic objects, and to destroy animals and plant life detrimental to the use of an area.

The increase in number, diversity, and specific purpose of land management units managed by the National Park Service led to a statutory declaration in 1970 that "...these areas, though distinct in character, are united through their interrelated purposes and resources into one national park system as cumulative expressions of a single national heritage; that...these areas derive increased national...recognition of their superb environmental quality through their inclusion jointly...in one national park system preserved and managed for the benefit and inspiration of all the people of the United States...." Further instruction promulgated in 1978 stated that "...administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress." Parallel direction legislated in 1976 instructed the administration (now acting through the National Park Service) to present annually a list of all areas included in the Registry of Natural Landmarks that exhibit known or anticipated threats to their integrity.

In addition to the statutes that specifically address the purpose of the National Park System, other statutes, such as the Endangered Species Act and the National Wilderness Preservation System Act, provide additional guidance for the management of park resources. The Endangered Species Act recognizes that plant and animal species can be rendered extinct as a consequence of economic growth and development; establishes that such species are of aesthetic, ecological, educational, historical, recreational, and scientific value to the nation and its people; and provides both a means for conserving the ecosystems upon which endangered and threatened species depend, and also a program for conserving the endangered and threatened species themselves. The National Wilderness Preservation System Act establishes a system of wilderness areas for the primary purpose of present and future use as wilderness where one may experience solitude and an absence of the works of man, and for the secondary purpose of protection and management to preserve natural conditions, including ecological, geological, or other features of scientific, educational, scenic, or historical value.

Policy Interpretation

The management interpretation of the body of statutes summarized above has evolved as our ecological understanding has grown and as 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 "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 of legitimate human activities being conducted outside the parks. The sixth response to recognize the need for 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 1978, represent the culmination of this evolution of thought gained from both legislative and practical resource management experiences. Key features of the 1978 policies include the following statements of mission, definition of terms, ecological process concepts, and mitigation opportunities:

Mission Statements:[3]

- The National Park Service manages the natural resources of the National Park System to maintain and perpetuate their inherent integrity.

- Perpetuation of a total natural environment or ecosystem, as compared with the protection of individual features or species, is a significant distinguishing aspect of National Park Service management of natural lands.

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[3] Editor's note: Emphasis of N.P.S. policy on dual mission is recognized. However, the mission relating to natural resources is focussed upon because of Task Force's purpose and statements made by the Task Force on page 12 of the report.

- Planning and management must be guided by the principle that protection of ecological health is our first consideration and priority.

- Park uses shall be limited to those activities that 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 exchanges of information and in providing 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 preserver of the nation's natural resources.

Definition of Terms

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

- Exotic species are species that 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.

Ecological Process Concepts

- Natural processes shall be relied upon to regulate 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 and diseases 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 unique plants or plant communities, the infestation threatens desired plants or animals in developed zones, or the infestation is a threat to public health or safety.

- Naturally occurring fire 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.

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 permit 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 on 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 management 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.

Application of Statute and Policy to the Preservation of Genetic Diversity

The summary of statutes and policies stated above demonstrates an evolution of thought regarding management of park natural resources, with the 1978 Management Policies representing the culmination of this evolutionary process. Development of an initiative for preservation of genetic diversity can build on this evolutionary trend and can be founded on the statutes and policies cited above. For activities to be conducted within the parks, the key statutory phrases are those that (1) call for conserving the natural features to leave them unimpaired for future generations; (2) refer to the National Park System as the cumulative expression of a single national heritage; (3) instruct that the administration of national park units shall not be exercised in derogation of the values and purposes for which the units were established;

(4) authorize manipulation of at least some park resources in support of resource management activities; and (5) state that species threatened with extinction (and, by extension, all species) are of aesthetic, ecological, educational, historical, recreational, and scientific value to the nation. For activities to be conducted by the National Park Service outside the National Park System, the key statutory phrases include the endangered species language mentioned here, the reference to the Registry of Natural Landmarks, the inclusion of park wilderness areas as part of the National Wilderness Preservation System, and the statement that one purpose of wilderness is the preservation of natural conditions, including ecological and other features of scientific value. For both in-park and extra-park genetic preservation activities that might be proposed for the National Park Service to conduct, existing National Park Service policy provides many key phrases that are supportive of the Service's taking an active participatory and leadership role in efforts to preserve genetic diversity. Existing legislation and policy may be incomplete, however, if the concept of preserving genetic diversity is taken to include ecological, economic, cultural, inspirational, and informational components. Under this concept, existing legislation and policies support the ecological, inspirational, and perhaps cultural components, but are silent regarding the economic and informational components. This silence may be significant if the long-term goal of preservation of genetic diversity is to preserve the information content of the genes of wild plants and animals for economic, as well as intrinsic, purposes.

2. Conserving Gene Pools - the NPS Role

Vernon C. Gilbert

The director of the NPS has determined that the Service should play a leading role in conservation of gene pools in the U.S., and that it will also assist other nations in conserving their genetic resources. The following are points related to this goal that I believe should be given consideration.

1. Adequacy of Habitats Devoted to the Purpose

As adequate habitats are essential to the conservation of gene pools, so then are improved inventories and assessments of habitats and the species they contain. Therefore, the NPS should conduct necessary inventories as well as utilize other agencies recent inventories and assessments of ecosystems in the U.S. to develop priorities, along with other agencies, to devote as many habitats as possible to the goal of conservation of gene pools. This can best be accomplished on the scale of ecological regions through federal interagency, state, and local cooperation, and using approaches such as those developed by the MAB Program and inventory systems such as those developed by The Nature Conservancy. Although there may always be controversies over habitat classification systems, it is feasible to identify key localities for species conservation and to develop deliberate plans to cooperate with various sectors and jurisdictions to accomplish the goal. This type of regional ecological approach is discussed under 3. below.

The Service should also give high priority to research in population dynamics, studies of minimal size of habitats, and other determinants of species diversity and survival, as a means of determining the adequacy of habitats.

2. Leadership, Policy and Management

a. Leadership

Since a basic responsibility of the NPS is to take care of ecosystems and the plant and animal species they contain, much higher priority must be given to scientific research and the application of its findings to the solution of problems such as maintenance of natural systems and conservation of gene pools. Barbee and Varley (1985) indicate that science in the National Parks has recently gained acceptance as the essential basis for management actions, and that its importance today is unquestioned. I am not sure that this is yet reflected in NPS priorities. However, the NPS has a director who has now given high priority to this goal of conservation of gene pools, so there should be a deliberate plan and program to increase funding for research, especially in the applied discipline of ecology, i.e., conservation biology. An effort should also be made to work more closely with other agencies and institutions to utilize the latest scientific information in conserving biological diversity. This requires qualified personnel who are allowed to work with their colleagues in other agencies and institutions and the necessary time to keep up their rapidly advancing fields.

NPS leaders will also have to provide stronger support for programs in environmental education and interpretation. In 1980, the former Natural History Division proposed plans to cooperate with the Forest Service and other agencies in a MAB-sponsored programs on conservation of gene pools, which would have included an education and training follow-up to M. Oldfield's work on the value of conserving genetic resources, but the plans were abandoned. Similar efforts should be initiated now that the priorities have changed.

b. Policy and Management

NPS Policy related to conservation of gene pools is generally adequate, or, at least should not be regarded as the main problem. For example, it is Service policy to identify all threatened and endangered species within park boundaries and their critical habitat requirements, but this policy has been neglected. Most parks need better inventories of their plant and animal species as well as stronger research on the ecosystems that the NPS manages. So while policies, and even legislation, can and should be strengthened, it is not as important as improved management. Another example is the control of exotic species that are known to be threatening the perpetuation of natural habitats, and native species as in the case of European wild hogs in the Great Smoky Mountains National Park. There is nothing wrong with NPS policy, which states that control will be undertaken, but, largely because of political pressures from special interest groups, management has not been able to carry out stated policy. In cases such as this, every effort should be made to inform the public about the policy and about the destruction of their natural resources and native species in order to counteract the influence of local special interest groups.

3. Cooperation on a Regional Scale

a. A "Common Concern" Approach

In order to develop much-needed broad scale cooperation in conservation of natural systems and biological diversity, a different attitude and approach should be developed toward management of natural resources. For example, use of terminology such as "threats to the parks," "mitigation of impacts," and "buffer zones" conveys a kind of adversarial, "protect the fortress" attitude that may not be as effective as focusing on issues or environmental problems that are of common concern to people. In this way most of the problems that affect the parks can be dealt with, and possibly more public support obtained for necessary programs in conservation.

b. MAB Regional Projects

The "sixth response" to the mandate of the NPS described in the background paper by John Dennis is to recognize the need for "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." As he states, this response is only beginning to emerge. The only way that it can emerge is through planned and deliberate action with strong national and regional public and political support. One way that it could emerge would be to use the MAB Biosphere Reserve concept and approach regardless of whether or not national parks have been designated biosphere reserves. More than a decade of experience has gone into developing this concept and program, which is described in the attached paper, "An Approach to Improving Natural Resources Management In the Southern Appalachian Region."

4. Use of Biotechnology Along with In-Situ Conservation

Policy and programs should be developed to use the latest biotechnology, especially in plant tissue culture, as a tool for propagation and conservation of threatened and endangered species. This is a rapidly developing science in which increasingly greater numbers of species are being successfully cultured and propagated. However, priorities have naturally been given to important crop and horticultural species, and there have been no organized large-scale efforts to culture threatened and endangered indigenous species. This should be done through collaborative work with selected institutions in each region of the U.S. that have tissue culture labs, and it should be developed as a cooperative effort among land managing agencies. Some of the potential advantages are:

a. Many plant species and many individual plants can be regenerated from cells or tissues such as embryos, stems, leaves, or roots with very little or no damage to the parent plants.

b. The process can be economical because large numbers of plants may be produced in the laboratory in a few weeks or months and in a very small space.

c. At one plausible extreme, scientists may be able to isolate useful mutations in cell cultures and thereby increase disease resistance or stress tolerance of species. They can also increase chances of survival of species through selection for certain traits.

Since a great deal of the success in culturing plant species has come from many trials to find the appropriate growth media and methods, there should be a large-scale effort to screen and experiment with as many endangered species as possible, for this could possibly be a means to help conserve species and genetic resources. Plant tissue culture could also be a means of propagating traditionally useful species. It could, therefore, be an excellent means of demonstrating values of in-situ conservation through utilization of gene pools with little impact on the habitats.

5. International Role

The only practical means of reducing the great and growing loss of species throughout the world is through improved studies, management, conservation and utilization of the world's diverse natural ecosystems and the genetic resources they contain. Therefore, the U.S. experience and expertise in planning, managing, and protecting national parks and in developing associated research, educational, and training activities must be shared, especially with less-developed countries (L.D.C.s). The NPS has a relatively small international program, but it has been an excellent one that has not received the recognition and priority it deserves. The director of the NPS supports these views. He wrote in a recent letter to me, "The Service can and will assist in the conservation of biological diversity and the protection of nationally and internationally significant heritage in other countries. This in turn, I believe, will result in the infusion and exchange of ideas that are directly in the interests of the United States."

The following are some points that the conference should consider in recommending a strengthened NPS international program.

a. Assistance, in cooperation with I.U.C.N. and U.S.A.I.D., to L.D.C.s to develop National Conservation Strategies.

b. Assistance to L.D.C.s to identify and assess critical and endangered habitats, and in other areas of NPS responsibility such as research, planning, management, and training related to management of parks and reserves. (Refer to Kenya's "Endangered Resources for Development" Project as a type of project that should be supported.)

c. This conference and the NPS should respond to the request by the NPS and the A.A.A.S. Consortium of Affiliates for International Programs (C.A.I.P.) for suggestions of potential topics for consideration as new global initiatives of the Foundation. A coordinated U.S. approach to assisting L.D.C.s in gene pool conservation and related research should be recommended, which would include NPS assistance in its respective fields. The Action Plan for the U.S. Strategy on the Conservation of Biological Diversity being prepared by U.S. A.I.D. should provide a basis for this coordination of U.S. efforts.

d. Develop brief, attractive materials on the values of in-situ conservation to inform the public and political leaders of the need for international assistance, such as recommended above, as a means of establishing or enhancing stability and peace in the world. (M. Oldfield's book, The Value of Conserving Genetic Resources, provides excellent background material and rationale.)

3. Biosphere Reserves

William P. Gregg, Jr., and Phelan Reed Fretz

The Man and the Biosphere Program (MAB) was launched by UNESCO in 1971 in an intergovernmental effort to develop the knowledge, skills, and human values needed to develop and sustain harmonious relationships between people and the environment. Since its inception, 105 nations have elected to participate in MAB through the voluntary establishment of their own national MAB committees, which are responsible for planning and coordinating national MAB programs. The United States has played a key role in the development of MAB from its inception, and established its own National MAB Committee in 1972.

MAB is organized around 14 project areas, within which research, educational programs, and demonstration projects are encouraged. The best known is Project 8: Conservation of Natural Areas and the Genetic Material They Contain. The project was established to provide the basis in the natural and social sciences for selection, management, and intelligent use of protected areas for the sustainable conservation of the world's ecosystems. The principal emphasis is on the establishment and functional development of an international network of biosphere reserves to conserve representative examples of the ecosystems of 193 biogeographical provinces, as delineated by UNESCO. The goal is to include large units of natural and managed landscape as centers for demonstrating the practical value of conservation through research, demonstration, training, and cooperation at the local, regional, and international levels. The biosphere reserve project is being coordinated internationally under the Action Plan for Biosphere Reserves, approved by MAB's International Coordinating Council in December 1984 (pp. 155-175 in the Biosphere Management Conference Proceedings, available from C. Schonewald-Cox). The Plan clarifies biosphere reserve functions and characteristics, sets forth project objectives, and identifies 35 actions for consideration by United Nations agencies, international nongovernmental organizations, and MAB national committees.

National policy, priorities, and institutional coordination for the U.S. MAB Program are established by the U.S. MAB National Committee, consisting of government and private sector scientists. Project planning and implementation are accomplished through MAB project directorates, which are active in 10 MAB project areas. The MAB Secretariat at the Department of State administers the budget provided to MAB by the funding federal agencies (State, USFS, NPS, NOAA, NASA), assists in administrative coordination of directorate projects, and disseminates MAB literature.

NPS Policy

The NPS has repeatedly voiced strong support for the biosphere reserve concept. Since 1982, the official NPS concurrence in each U.S. MAB nomination of an NPS site has included an acknowledgement of NPS responsibility to make the site available for research, to plan for its management in a regional context, and to refrain from taking actions which would impair the value of the area for research. The implications of biosphere reserve status on management of national parks and other protected areas were the subject of a conference on the management of biosphere reserves, convened in Gatlinburg, Tennessee, in November 1984, and cosponsored by UNESCO, U.S. and Canadian MAB communities, the NPS, and other U.S. agencies and organizations. The participants recommended actions for administrators to consider in putting biosphere reserve status to work for improving resources information, cooperation, and management. The proceedings are widely used by NPS and U.S. MAB for orientation and training.

On February 3, 1986, the director underscored the value of biosphere reserves in conserving ecosystems and gene pools, and requested each NPS biosphere reserve to explore ways to implement the concept (memorandum attached) and cited a listing of specific actions that could be taken (see pp. 183-185 in management conference proceedings). However, there are as yet no NPS management policies specifically applicable to biosphere reserves.

NPS Program

The NPS has contributed personnel and funds to MAB. At various times during the 1970s, the Service seconded an NPS scientist to the UNESCO MAB Secretariat (Paris) and the U.S. MAB Secretariat at the Department of State to assist in program planning and administration. In 1980, the NPS established a full-time MAB coordinator position for planning and coordinating NPS participation in MAB. The MAB coordinator represents the NPS on the U.S. MAB National Committee, serves on MAB's International Advisory Panel for Biosphere Reserves and as co-chairman of the U.S. MAB Project Directorate on Biosphere Reserves, and is the key liaison between other bureaus of the Department of the Interior and MAB.

In recent years, the NPS has supported MAB by directly funding projects involving NPS biosphere reserves, and by transferring funds under an interagency agreement with the Department of State for projects of specific interest to the Service. In FY 1983, about 40 percent of the NPS science budget was spent in the biosphere reserve parks. As the number of NPS sites has increased since that time, the figure may be higher today. As biosphere reserve status has not been a significant factor in programming, these figures reflect the particular research requirements of the large natural area parks, many of which are included in the biosphere reserve network. In a few cases, projects can be appropriately identified as "MAB" where developing biosphere reserve functions is an explicit objective or where the U.S. MAB Secretariat is a cosponsor. In FY 1985, total allocations amounted to $270,000--$235,000 for NPS biosphere reserve projects and $35,000 for projects through the Secretariat.

MAB Projects Relating to Genetic Resources

Since 1980, MAB has been an important source of support for projects relating to the conservation of genetic resources, many involving NPS areas. These projects (list attached) include a major conference on genetic resource management, research in conservation biology, the first ethnobiological assessment of the biota of a national park, a national geographic information system on large protected areas, a protocol and process for managing information on biological resources in biosphere reserves, a classification methodology for coastal and marine ecosystems, and a variety of interpretive and educational materials relating to biological diversity and biosphere reserves.

An Idealized Biosphere Reserve

Biosphere reserves are designed to conserve, gather, analyze communicate, and employ information for the purpose of sustaining natural and managed ecosystems. While no model of a biosphere reserve applies universally in practice, an idealized model is helpful in illustrating potential functions and their interactions.

An essential component of each biosphere reserve is the core zone, an undisturbed, self-sustaining landscape embracing as much of a region's natural diversity as possible. Within the core may be studied biological evolution and natural processes that are largely free of human interference; thus the core serves as a global bench-mark of ecological health. It also sets the ecological standard against which to compare the effects of human uses and scientifically planned manipulations occurring elsewhere in the reserve. In the U.S., the core is typically a national park, national monument, Nature Conservancy preserve, or similar area, which is protected legally and managed for the least possible human disturbance. More than 80 percent of the biosphere reserves worldwide presently consist solely of such areas. Twenty-two NPS units, all of them basically core zones, are included within the 41-unit U.S. network (see pp. 194-199 in management conference proceedings for directory).

Surrounding the core of the model reserve are a number of ecologically similar areas that are used for research, education, and demonstration. Collectively, these areas develop knowledge, skills, and values that serve material human needs through use of ecosystem resources. Activities within such areas, for example, can provide the scientific basis for economic uses that have minimal impact on natural ecological processes and genetic resources. In experimental research areas, manipulative research is directed to the development of farming, grazing, forest management, and other production systems that are ecologically sustainable, technologically feasible, and acceptable to local people. These areas are also sites for experiments to evaluate techniques for managing habitats and genetic resources. Most of these sites in the U.S. are experimental forests and rangelands administered by bureaus of the Department of Agriculture. In rehabilitation areas, experiments are carried out to find ways to improve the capability of degraded areas to conserve natural diversity and/or support sustainable production of commodities. Although most of these areas have been damaged by human use, areas disturbed by national events such as hurricanes are sometimes included. As with the experimental research areas, comparison with the unaltered core permits assessment and long-term monitoring. Rehabilitation areas have not yet been incorporated into most U.S. reserves. However, a good NPS example is the historically logged Redwood Creek watershed in the Redwood National Park unit of the California Coast Ranges Biosphere Reserve.

Finally, biosphere reserves may contain areas illustrating compatible uses by indigenous people, which are often the result of centuries of cultural evolution. The inclusion of such traditional use areas--where harmonious uses are conserved, studied, and judiciously improved in ways that respect local traditions--is a unique feature of the biosphere reserve model. Particularly in developing countries, biosphere reserves may be our best hope for maintaining endangered human traditions and traditional cultivars, applying traditional knowledge to modern problems, and fostering pride among indigenous people in their cultural heritage. In the U.S., opportunities for including such areas exist in subsistence areas of Alaska, in Indian reservations, and in local areas elsewhere. (A diagrammatic representation of an idealized biosphere reserve may be found on p. 182 of the management conference proceedings.)

The core zone, along with the areas for experimental use, rehabilitation, and traditional use, comprise the reserve's center for gathering information and the focus for scientific research and cooperation. In the idealized model, a multiple use area surrounds this center. This area includes human settlements and a wide range of enterprises managed to harmonize with the purpose of the reserve. The multiple uses create an area of cooperation, within which the knowledge and skills gained in the information-generating areas are applied to maintain genetic diversity as well as to improve resource management capabilities and the well-being of people in the region. The boundaries of the area of cooperation may in some cases be delineated, but are often indefinite, and change according to the nature of the activities undertaken. The biosphere reserve thus provides a framework for integrated landscape management, and can help encourage and reinforce voluntary cooperation to conserve genetic resources.

U.S. Approach

Since 1981, the U.S. has relied primarily on the opportunistic establishment of multiple-site biosphere reserves. The intent is to build, through voluntary linkages, large, ecologically delineated conservation units, variously consisting of contiguous and noncontiguous complementary sites that collectively provide for effective protection and management of gene pools. Under this approach, biosphere reserves are named after biogeographic features rather than administrative units, thereby providing a symbolic framework for cooperation and allowing for expansion of the reserve as opportunities arise. The California Coast Ranges Biosphere Reserve, which includes Redwood National Park, became the first of these regional cooperative linkages in 1983. It includes clusters of ecologically and functionally complementary sites in three geographic areas, liking a total of eight sites under various federal, state, and private administrators. Similar linkages have been established in the Mojave Desert (five administrators) and the Atlantic coastal plain (two), and UNESCO designations are pending in southeast Alaska (two) and the southeastern Atlantic coast (seven). In the Caribbean, a MAB workshop on "Biosphere Reserves and Other Protected Areas for Sustainable Conservation of Small Caribbean Islands" introduced the concept of a multi-island biosphere reserve in the Lesser Antilles as a way to assist island states in attracting the scientific and financial resources needed to conserve biological diversity and help solve shared resource management problems. Following the workshop, a consortium of regional institutions launched a major research program to demonstrate the practical value of the biosphere reserve approach in the Virgin Islands. The NPS-funded program focuses on Virgin Islands National Park, which was designated as a biosphere reserve in 1976. This is the only U.S. national park outpost in a developing region, and affords unique opportunities as a center for disseminating conservation knowledge and technology.

National Parks and Biosphere Reserves

The table below, adapted in part from Eidsvik (p. 11 in conference proceedings) highlights symbolic and operational distinctions between national parks and biosphere reserves, and to illustrate the complementarity of the two concepts.

Biosphere Reserve	National Park
*Emphasizes information values	*Emphasizes spiritual and recreational values
*Evokes empathy for human condition and desire for cooperation	*Evokes awe at creation and pride in national heritage
*Roughly 10 years of age	*More than 100 years of age
*Internationally designated	*Nationally designated
*Part of a global system (biogeographic distribution)	*Nationally significant natural features
*Contains a large natural area under strict protection	*A large natural area under strict protection

*Emphasis on research and education	*Controlled recreation and interpretive use
*Link to sustainable use/integrated management	*Tendency toward isolation within fixed boundaries
*Protection a moral obligation	*Protection a legal commitment
*Cooperative/participatory approach	*Regulatory approach
*Cooperation multi-level	*Cooperation mostly local
*More complicated to establish	*Less complicated to establish

SUMMARY OF SOME POTENTIAL BENEFITS OF BIOSPHERE RESERVE DESIGNATION

Conservation

Links ecologically and functionally complementary protected areas under different administrators in same biogeographic region.

Promotes integration of conservation and development.

Encourages emphasis on conserving genetic resources and traditional use systems.

New symbolism: protected areas as informational reservoirs for human welfare (complements national park).

Science

Fosters emphasis on:

Standardization of data collection, analysis, and reporting methods
Protection of research sites
Use by scientific community
Demonstration research and development projects
Ecosystem and genetic resource studies
Interdisciplinary research involving natural and social sciences (e.g., ethnobiology)
Coordination of basic and applied research

Education

Fosters ecological perspective, conservation ethic, and world view conducive to solving problems at local, regional, and international levels.

Promotes understanding of role of protected areas in general, and the particular biosphere reserve, in solving interrelated environmental, land use, and socioeconomic problems, and in conserving biological diversity

Encourages use for professional training and technology transfer (domestic and international).

Cooperation

Encourages "volunteerism"

Promotes development of regional cooperative institutions to support management of ecosystems and gene pools (e.g., Southern Appalachian Research and Resource Management Cooperative, Virgin Islands Resource Management Cooperative).

Promotes framework for cooperation with local people and in fostering local support for conservation (e.g., Waterton BR, Canada).

Provides framework for sharing conservation information and technology through a growing international network.

List of MAB Projects Relating to Genetic Resources

(O) = ongoing project
(C) = completed project

Biosphere reserve nomination panels (two per year) and managers' workshops (five) (O)

U.S. national inventory and geographic information system on macroreserves (U.S. MAB, NPS, USGS, Florida State U., Yale U., U. Colorado, Nat. Geog. Soc.). P.I.: D. Wilson Crumpacker (O)

Biogeographical classification of coastal/marine areas (UNESCO, IUCN, U. Virginia). P.I.: G. Carleton Ray (O)

Symposium and Workshop on the Applications of Genetics to the Management of Wild Plant and Animal Populations. Washington, D.C. August 1982. MAB Cosponsorship (C)

Conference on the Management of Biosphere Reserves. Gatlinburg, Tennessee. November 1984. MAB Cosponsorship. (C)

Ethnobiology of Great Smoky Mountains National Park Biosphere Reserve (NPS, Tennessee State U., U. Tennessee, Tennessee Tech. U.). P.I.: James Campbell (O)

*Plant and wildlife diversity associated with native agriculture in the Sonoran Desert (U. Arizona). P.I.: Charles Hutchinson and Gary Nabhan (C)

*Biosphere reserves as reservoirs of genetic resources (U. North Carolina) P.I.: Alan E. Stiven and Richard C. Bruce (C)

*Ecology of Amazon forest trees: baseline data for forestry and reserve design (World Wildlife Fund). P.I.: Thomas Lovejoy (C)

*The structure and design of a biosphere reserve: assessing effectiveness in preservation of diversity and evaluating boundary placement. (NPS) P.I.: Peter S. White and Susan P. Bratton (C)

Boundary effects pilot study (U.S. MAB, NPS, NASA, U. California at Davis, U. Arizona, The Institute of Ecology-Mexico). P.I.: Christine Schonewald-Cox (O)

Biological resource information system for biosphere reserves (UNESCO, IUCN, U.S. MAB, Smithsonian, The Nature Conservancy-International, INIREB-Vera Cruz.) P.I.: To be determined (Smithsonian)

Park issue on biosphere reserves, Summer 1985. (C)

Panel exhibit on biological diversity (U.S. MAB, NPS, Institute of Ecology, Metagraphics). Coordinators: Elliott Norse, Susan Marcus (C). (Poster series based on exhibit pending)

Public television film on biosphere reserves (Public Broadcast System, NPS). Coordinator: Roland Wauer

Brochures on biosphere reserve project (UNESCO, U.S. MAB, NPS). Coordinators: William Gregg, Susan Marcus (O)

Sonoran Desert Biosphere Reserve Program -- Reference Text on Pinacate/Gran Desierto (UNESCO, The Institute of Ecology-Mexico, U. Arizona). P.I.: Richard Felger (O)

Virgin Islands Biosphere Reserve Program (Virgin Islands Resource Management Consortium). P.I.: Edward Towle (O)

*MAB Consortium Project. From FY 1978 through FY 1981, U.S. MAB administered the Consortium for the study of man's relationship to the global environment, which provided grants for research furthering the goals of MAB and the missions of the contributing federal agencies. In FY 1980, awards totaled $660,000. The consortium is now inactive because of lack of funding.

4. The Global Endowment of Genetic Resources: International Perspectives for the U.S. National Park Service

Dr. Norman Myers

Splendid news! The US National Park Service is trying to come up with a systematized strategy to safeguard genetic resources within its network of protected areas. This is a measure that is more than urgent. More power to the NPS, in that it can do much to help preserve the nation's heritage in genetic resources.

But the NPS can do much, too, to assist other nations in safeguarding their endowments of genetic resources--indeed, the global heritage in genetic variability. This short paper addresses some international perspectives on the issue and identifies some options for initiative on the part of the NPS.

Research and Inventorying

First off, we have only a vague idea of where the world's richest stocks of genetic resources are located. For sure, we know a good deal about the global total of species, generally estimated between 5 and 10 million. We further believe that two-thirds of them reside in the tropics and half in tropical moist forests. Yet we plainly have only a very crude estimate of the total number of species, somewhere [sic] between 5 and 10 million, and some recent appraisals suggest there could be 30 million insects alone in tropical forest canopies alone--which would basically alter our reckonings on the tropical proportion, and the tropical forest proportion, of all species. So it is urgent that we tackle the task of inventorying the planetary complement of species. The task could be undertaken at a modest cost of a $5 million for each of 10 years.

Herein lies scope for a good deal of professional leverage on the part of the U.S. NPS. Through loan and secondment of professional staff, through financial support, and through supply of some of the sophisticated equipment required, the NPS could "do much with a little" in those one dozen tropical nations that may well harbor at least half of all species. We already have a model for incisive intervention along these lines, through the work in Brazil of Dr. Gary Wetterberg.

Were we unable to document species numbers in more than a small part of the tropics, we could well focus on 20 or so localities that are known to contain exceptional concentrations of species with high levels of endemism that are unusually threatened. These are--all in tropical forest territories--as follows: the Mosquitia Forest of Nicaragua and Honduras; the Choco Forest of Pacific-coast Colombia; western Ecuador; between four and six of the so-called Pleistocene refugia along the periphery of

Amazonia; the Atlantic coastal forest of Brazil; the Tai Forest of the Ivory Coast; the Pleistocene refugia of Cameroon/Gabon and eastern Zaire; the montane forests of Eastern Africa; Madagascar; the remaining wet forest of Sri Lanka; the foothill forests of the Himalayas; the Malay Peninsula; northwestern Borneo; northern Sulawesi; the lowland Philippines; and New Caledonia, among other islands of the South Pacific. These localities total little more than one million square kilometers, and they surely contain at least one million species. Without stronger safeguard measures, they may well have been eliminated by the end of this century.

So much for a cataloguing of species. Fine advance as this would be, it would be only a first step insofar as genetic resources are concerned. Species richness is not always the same as genetic richness. According to electrophoresis and related techniques, certain species, and certain categories of species, possess more genetic variability than others; some of them much more. The least endowed tend to be those nearest the poles, the best endowed those nearest the equator. These findings reinforce the conclusions of the previous paragraph, to wit that the priority attention should be directed toward the tropics. Yet when we look at current spending on inventorying, cataloguing, and the like, we find that nine-tenths of all expenditures are outside the tropics. The same stricture applies to sheer scientific muscle: the great bulk of tropical taxonomists, systematists, etc., are located outside the tropics.

Safeguards for Genetic Resources outside the U.S.

Even if tropical nations, and especially tropical forest nations, were to come up with good documentation of their genetic-resource stocks, they would then need to protect those that are threatened. Again, many nations in question lack the scientific skills, management know-how, and sheer all-around manpower to do the job. Here again the NPS can make a sizeable contribution, at marginal cost to itself.

5. Gene Pools, Biological Diversity, and Genetic Resources--Concepts and Definitions

Bruce A. Wilcox
Center for Conservation Biology
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The charge of this task force, to address the role of the National Park Service in conserving gene pools, launches the agency into the forefront of a rising tide of legislative and policy activities aimed at addressing the need to protect the full range of diversity within natural ecosystems. This concern for diversity distinguishes current developments in the conservation movement from previous ones--developments in which NPS has played a historical role. The first step in addressing how the NPS can best continue that role in fulfilling its own mandate to conserve gene pools is the precise definition of concepts relating to natural diversity.

First, a gene pool is the sum of the genetic material in an interbreeding population. Its plural, gene pools, can be construed in two different ways: to denote all the genetic material in a species (a single species is typically composed of many, genetically different populations, and thus consists of many gene pools), or to denote all the genetic material contained within an ecological community (since a community consists of the assemblage of plant and animal populations living in the same ecosystem).

Because it would be technically impossible to quantify the total genetic material in a population, we cannot quantify gene pools per se; instead, population geneticists measure the genetic variation or genetic diversity of a population in terms of allelic variation, by such means as electrophoresis.

Genetic diversity is just one component of biological diversity, which describes the totality of diversity in nature; it denotes "the variety of life forms, the ecological roles they perform and the genetic diversity they contain" (Wilcox 1984). Diversity in life forms, then, occurs not only at the molecular level through genetic variation, but at least three other levels of biological organization: population-level, specific, and ecosystem-level (see Table 1, from Wilcox 1984). Biological diversity thus consists of a hierarchy of increasing complexity and variety starting at the molecular level.

Table 1. Relationships between functional levels, components, and elements of biological diversity. Functional levels refer to levels of complexity of biological organization; components refer to the basic unit contributing to diversity at each functional level. Elements are concrete examples of components.

Functional level	Component	Element (example)
Molecular	Gene	Genes for salinity tolerance and resistance to verticillium wilt in the strawberry _Fragaria chiloensis_
Population-level	Population	Yellowstone grizzly population
Specific	Species	Grizzly bear (_Ursus arctos_)
Ecosystem-level	Community	Douglas fir -- western hemlock forest

Unfortunately, perhaps since genetic diversity is the ultimate source of natural diversity at higher levels of biological organization, the term "genetic diversity" is often used to express the totality of diversity in ecosystems--i.e., as a synonym for biological diversity. This should be discouraged since it tends to obscure the need for the preservation of the components of diversity at levels other than the molecular. Populations that are not genetically unique may nonetheless contribute importantly to the diversity and integrity of an ecosystem. A community whose constituent species are all abundant may provide important services (e.g., watershed).

In addition, the above construct enables us to consider relationships between the different levels that are relevant to the maintenance of diversity (Wilcox 1984). Processes at the population level, such as genetic drift, affect diversity at the molecular level. Likewise, ecosystem-level processes like disturbance-succession dynamics affect diversity at the specific level. In theory, it is even possible for processes at the community level to influence processes at the genetic level. Therefore, preserving genetic diversity, or any other component of biological diversity, requires consideration of all levels.

Nevertheless, specific conservation efforts, for practical reasons, may focus more narrowly on a particular community, species, or genetically distinct population. It is important to stress, in this context, that conserving ecosystems is not the same as conserving species. Since communities are classified according to vegetation structure and the **dominant** plant and animal species, it is quite possible to preserve a community-type and still lose many species. Nor is conserving species the same as conserving genes: it is possible to preserve a species and lose genetically distinct populations, although this loss may contribute in the long term to its extinction.

The term "resources" frequently accompanies discussions of gene pools, genetic diversity, and biological diversity. Miller et al. (1985) suggest the term "biological diversity resources" to denote the portion of biological diversity that is of actual or potential use or importance to humans. They urge that in view of human ignorance of the potential usefulness of biological diversity, virtually all biological diversity must be assumed to be a resource. Consistent with the definition of biological diversity, biological diversity resources include elements of biological diversity at all levels of organization, as well as the "free services" they provide (nutrient cycling, pollination, watershed creation, climatic amelioration, etc. [Ehrlich and Mooney 1983]).

With specific reference to genetic diversity, Oldfield (1981, 1984) identifies two kinds of genetic resources: "germplasm resources" and "gene pool resources." "Germplasm resources" primarily refers to intraspecific variation at the molecular level, derived from individual organisms and preserved _ex situ_ as seeds, tissue cultures, and so on. "Gene pool resources" is more encompassing, referring to interspecific or interpopulational genetic diversity; it consists of all the genetic material existent _in situ_ (Oldfield 1981).

This distinction is perhaps best understood by considering how these resources are discovered and put to use. When seeking new economically valuable species, workers look among the taxa constituting the wild, semi-domesticated, or domesticated populations at their disposal. These represent gene pool resources. They may opt to store, cultivate, or attempt to improve the potentially economically valuable species. At this stage, they have identified or are manipulating an organism for specific, desirable genetic attributes, referred to as germplasm resources.

The imperative to conserve gene pools in National Parks goes, of course, beyond the consideration of the potential extraction of germplasm for economic purposes. The viability of ecosystems themselves depends upon the genetic diversity within species. Species require genetic diversity for long-term evolutionary change as well as short-term adaptation; the loss of genetic diversity can thus lead to the extinction of populations in the face of environmental change.

The concept of diversity is itself diverse and pervasive--a unifying theme that emerges in consideration of virtually every aspect of conservation. It even goes beyond biological diversity to include the physical or abiotic elements of the natural environment.

This too warrants consideration by resource managers. For example, ecologists have long known that "habitat diversity," which relates not only to the physical environment (e.g., microclimate), but to the physical aspects of the biotic environment (e.g., vegetation structure), is fundamental to the maintenance of species diversity. Population biologists have shown the diversity of habitat to which a population is exposed, often termed "habitat heterogeneity," can ameliorate the destabilizing effects of temporal environmental variation (Wilcox and Murphy, 1985) and maintain genetic variation (Schonewald-Cox et al., 1983). Habitat heterogeneity thus minimizes the likelihood of population extinction. Indeed, while genetic variation may be the ultimate source of all biological diversity, physical environmental variation (temporal and spatial) is the ultimate shaping and diversifying force.

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