Chapter 1

Chapter I
Introduction

BACKGROUND

Human welfare is inextricably linked to, and dependent on, biological diversity.[1] Not only does the human species rely on other organisms to provide essential sustenance and products that enhance the quality of life (e.g., food and fiber), but the interactions among species affect essential processes (e.g., nutrient cycling) without which the human species could not survive. Concern about biological diversity also has an ethical aspect, deriving from the notion that the human species should avoid causing the extinction of other species that share the planet.

Understanding the components of biological systems and how these components interact is crucial for developing an effective strategy to maintain biological diversity on-site, that is, within the environment where it occurs naturally. A first step in developing such understanding is to document the various components—species, communities, and ecosystems. Once acquired, data about the components can be manipulated to provide information on how best to address concerns about maintaining biological diversity. To be effective in meeting these objectives, however, the acquisition, dissemination, and use of data must be defined within the context of clearly defined goals. Accumulation of biological data should not be considered an end in itself but should be considered a means for achieving various ends, such as maintaining biological diversity.

Over the past two decades, increased interest in natural resources and concerns about environmental quality have produced a deluge of information on the biota of the United States. Proliferation of such data at Federal agencies reflects the growth in stewardship responsibilities the agencies have been given for maintaining the Nation's biological resources, particularly on federally owned lands. State and private institutions also have been generating increasing amounts of information on U.S. flora and fauna.

Data acquisition, for the most part, has been prompted by narrow sets of objectives defined within the contexts of the operational responsibilities of the various agencies and institutions acquiring the data, Not surprisingly, these data are widely scattered and generally incompatible with each other. Information about the existence of data seldom seems to be communicated to potential users of the data. Moreover, maintaining biological diversity has been, at best, only a tangential consideration in most data collection efforts. Consequently, it is difficult, if not impossible, to develop a comprehensive assessment of biological diversity based on the vast amount of data that currently exists,

In response to congressional needs, the Office of Technology Assessment has produced this background paper in support of a broader study, which will identify available and emerging technologies to maintain biological diversity, This paper briefly assesses the state of existing biological data and proposes ways to improve the use of such data for the purpose of maintaining biological diversity. Because of the large amount of data available and the number of institutions involved, the scope of this paper is limited *primarily* to Federal agencies and to data generated from field studies by Federal agency personnel.

This document does not address many collections of biological resources that exist in the Smithsonian Institution and other museums, in U.S. Department of Agriculture facilities, and in universities, private research centers, and other institutions. Although bibliographic

[1] Biological diversity refers to the variety and variability within and among living organisms and the ecological complexes in which they occur.

information systems serve an important function by providing centralized locations for obtaining information on sources of inventory, monitoring, and baseline biological data, this document does not cover bibliographic databases.

THE USES OF BIOLOGICAL DATA IN MAINTAINING BIOLOGICAL DIVERSITY

Maintaining the continuing diversity of plants and animals is a large and complex task, which requires the acquisition, storage, retrieval, and manipulation of enormous quantities of biological data. Biological data consist of information that can indicate the abundance, condition, and distribution of species, communities, and ecosystems. These data can reveal the status of the biological diversity and disclose any changes that may be taking place, and the data can be used to develop effective plans for managing resources. To ensure the continued health of the natural biota the data can be used to provide a baseline from which to monitor the effectiveness of a plan once it is implemented.

For Dermining Status and Trends

The status or number and kinds of organisms within a given area can be obtained through field inventories. This information serves as a starting point, or baseline, from which to measure changes that occur and from which to determine the effects of various activities, such as timber harvesting, on the biological diversity of an area. Similarly, data collected in one geographic area can be compared with data collected (using similar methods) from other areas to evaluate spatial differences in biological diversity.

Data also allow the assessment of trends, which are changes in distribution and abundance or in rates of change that occur overtime, For example, the Fish and Wildlife Service (FWS) reports that approximately 400,000 acres of wetland habitat are altered or lost each year (11), The rate of alteration has been established by comparing aerial photos of a statistical sample of wetland areas taken during the 1950s with photos of the same areas taken during the 1970s,

Data on the status and trends of biological data can help decisionmakers to identify species, populations, or habitats that may need protection. FWS, for example, evaluates the current status of species and subspecies and how their populations have changed over time in order to identify candidates for listing as threatened or endangered species or for recovery efforts under the Federal Endangered Species Act (Public Law 93-205, as amended). State agencies responsible for State laws that protect endangered species carry out similar evaluations.

For Planning and Management

Planning and management efforts to maintain biological diversity can take many forms, but all of them require reliable information on biological resources. Data on the abundance and variety of species or ecosystems can be used to establish priorities for land acquisition or designation. Congressional acquisition of National Park Service (NPS) land, for example, is based on available information about nationally significant esthetic, biological, or cultural resources and about the potential threats to those resources. The Bureau of Land Management's (BLM) designations of Areas of Critical Environmental Concern are supported by evidence of the areas' unique biological or cultural resources.

In determining the size and shape of an area required to protect a particular species or habitat, it is necessary to gather various kinds of information including habitat requirements, the existing population size, the available food and cover, and the population's migration habits. Such data are used to determine the minimum size of the area and the minimum number of individuals required to sustain healthy popula-

tions or species. The U.S. Forest Service (FS) and other agencies, for example, undertook extensive studies of the northern spotted owls on national forest lands in the Pacific Northwest to establish the minimum area needed for a breeding pair of owls. By tracking the owls' use of their habitat and by noting the seasonal changes in that use, the agencies were able to determine how much land was used for feeding and nesting by a breeding pair. The data generated in this project are helping resource managers to identify the minimum population size and protected habitat needed to conserve viable breeding populations of spotted owls in national forests (8).

Baseline biological data also feed into the development of plans for habitat or ecosystem management. In general, an area is surveyed to identify its resources, and a plan is devised to create the best possible habitat conditions for the chosen plant or animal species or type of ecosystem. To prepare the Burro Creek Riparian Management Plan in west central Arizona, for example, the BLM conducted intensive inventories of the area's flora and fauna between 1977 and 1982, The biota inventoried included the following: birds (3,6); amphibians and reptiles (4); mammals (7,10 fish (5); and vegetation (2,9). Data from these inventories were used to identify the status of the resources and to identify management options for maintaining the habitats in the area as well as for restoring degraded habitats.

In developing management plans for a wide geographic area that contains different habitats, such as a national forest, data are needed on each kind of habitat in the area. The capability of the land or water to support economic activities (e. g., timber harvesting) and recreational opportunities as well as to maintain biological resources must be considered, Decisionmakers determine the best uses of each area and devise appropriate management options. Without some baseline measure of the available resources, and without data on what the land and water can support, the consequences of particular courses of action are likely to be projected inaccurately.

Finally, species recovery efforts, such as those conducted by the Federal Office of Endangered Species of the FWS, require extensive information about the endangered or threatened species or subspecies. Data on habitat affinities, interspecies interactions, dietary habits, and reproductive needs, all must be analyzed if the efforts are to be effective (12).

For Monitoring

Once a management strategy is implemented, data are needed to monitor its effectiveness. Successful monitoring of resources depends on obtaining sound information about the status of a species, habitat, or ecosystem prior to application of the plan. Data showing how the status of the resources has changed over time help decisionmakers evaluate their past decisions. previously unidentified changes in an area's biological diversity can lead to alteration of management strategies or reconsideration of the need to acquire or designate land for protection. For example, the National Marine Fisheries Service (NMFS) Alaska and Northwest Fisheries Center maintains a database on more than 2,400 species or species assemblages within its jurisdiction (RACE Ground Fish Data Base). The data, collected over time, indicate trends in abundance and distribution of these organisms so NMFS can monitor changes. The monitoring data can then be used to determine how commercial harvesting affects species' populations. This, in turn, may lead to alterations in fishing guidelines (l).

The following discussion begins with an assessment of the institutional mechanisms that promote biological data collection. Existing Federal biological databases and gaps in the available information regarding biological diversity are examined. And the technological opportunities to facilitate biological data collection, storage, and retrieval are briefly described. The paper provides an assessment of factors that constrain or enhance opportunities for collecting biological data and concludes with a discussion of several avenues to improve the data collection efforts for maintaining biological diversity.

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