

# 1. INDICATORS AND THE CONSERVATION OF BIODIVERSITY

Biodiversity conservation has become an important concept in the thinking of government officials, conservationists, and even diplomats. A new convention on biodiversity has been signed by over 150 countries, and the topic was one of the main agenda items for the United Nations Conference on Environment and Development held in June 1992. In 1992, a Global Biodiversity Strategy was released by the World Resources Institute (WRI), The World Conservation Union (IUCN), and the United Nations Environment Programme (UNEP). It lays out a comprehensive plan of action to conserve diversity. Eighty-five proposals for action are outlined in the strategy, including several geared toward improving data collection and monitoring. The World Bank is working with other United Nations organizations to provide several hundred million dollars in grants and loans to support the efforts of developing countries to conserve biodiversity of global importance. Countries as dissimilar as Indonesia, Canada, and Costa Rica are developing national plans to conserve biodiversity.

The influential works of Soulé (1986), Wilson (1988), Juma (1989a), and others have helped to place biodiversity conservation on the sustainable development agenda. However, the push for action to conserve biodiversity has outpaced the development of an analytical framework for

monitoring its status and trends and for establishing priorities and targets. Without such a framework, conservation actions may be ineffective and inefficient, and biodiversity conservation may change quickly to merely a rhetorical flourish on unaltered paths of resource exploitation. This paper provides a framework for developing a set of indicators that can be used to guide the establishment of conservation policies and to assess whether the plans and programs carried out to implement those policies actually achieve their stated objectives.

## **The Goal of Conserving Biodiversity**

The fundamental goal of biodiversity conservation is to support sustainable development by protecting and using biological resources in ways that do not diminish the world's variety of genes and species or destroy important habitats or ecosystems. Thus, biodiversity conservation encompasses three basic policy concerns:

- to minimize the loss of genetic diversity
- to minimize the loss of species diversity
- to manage biodiversity within and among biological communities so that human

needs are met without reducing potential contributions to future generations.

The third concern, involving biodiversity at higher levels of organization than genes and species—namely, communities, ecosystems, and landscapes—is distinct from the first two for several reasons. First, many different "units" of diversity are involved at the supra-species level, among them the pattern of habitats in a community, the relative abundance of species, the age structure of populations, the pattern of communities on the landscape, trophic structure, and patch dynamics. Given the many components of biodiversity at this level of organization and their complex interactions, no simple normative statement comparable to those made for genes and species is possible. A strict focus on "minimizing" the loss of biodiversity at the level of a community, for example, might lead to the inappropriate goal of preventing a community from reaching a climax state in order to maintain the greater diversity of components and interactions present in earlier stages.

Second, at levels of organization higher than the species, unambiguous boundaries delimiting units of diversity do not exist. Biological communities are defined subjectively at a scale relevant to a specific research or management objective. Thus, the research or management question may relate to the "rocky intertidal community of Tatoosh Island," or adopt the larger spatial scale of the "intertidal community of Washington State," or the "Eastern Pacific coastal community."

Finally, communities are transient associations of species; communities do not possess temporal continuity like individual species. Paleoecological evidence for North America, for instance, indicates that most modern plant communities are less than 8,000 years old (Hunter *et al.*, 1988). Consequently, although communities can be defined based on their existing species composition and structure over shorter time periods of tens or hundreds of years, communities are too ephemeral

to be considered important entities in their own right, particularly during periods of significant environmental change (Hunter *et al.*, 1988).

Therefore, a more appropriate statement of the concern for biodiversity conservation above the species level is stated in terms of the "management" of biodiversity. Consider the two basic reasons for maintaining diversity at the level of communities:

- ensuring the maintenance of the species comprising the community
- helping to maintain the benefits obtained from healthy ecosystems, such as pollutant filtration, nutrient cycling, climate control, and the maintenance of the productivity of resources harvested from the ecosystem, as well as nonconsumptive recreational, scientific, and aesthetic values.

In order to achieve the objective of species conservation, all of a community's attributes need not be preserved in their existing state (community attributes are bound to change through time). Rather, the diversity of community attributes and functions must not be altered in ways that would result in the loss of species. In some cases, certain aspects of the community (for example, ancient forests) may need to be preserved to achieve this end, while other changes in diversity may be entirely acceptable—the colonization of the western hemisphere by the African cattle egret (*Bubulcus ibis*) changed community-level diversity through a natural process. Similarly, to maintain the benefits that humanity obtains from healthy ecosystems, the concern is not the preservation of specific attributes of the community but, rather, the management of the system to meet human needs, support species and genetic diversity, and enable the system to adapt to changing conditions.

## The Character and Usefulness of Indicators

Indicators are key statistical series that can be used to help policy-makers and the public assess conditions and trends and the achievement of specific goals. More specifically, indicators can be used to provide decision-makers with useful information on the status of and trends in biodiversity and to help determine if broad goals and targets for conservation are being attained. Indicators also enable policy-makers to ascertain whether existing policies are having the desired effects on biodiversity and to help clarify where problems exist in the current policy framework. Other uses include forecasting and projecting trends, negotiating and implementing regional and international treaties, and broad program planning. In these ways, indicators help determine priorities for action.

For maximum benefit, indicators should be based on data that are timely, accurate, of known quality, and available at both the level of decision-making (local, national, regional, global) and at biologically defined levels of observation, such as ecosystems or biogeographic regions. Traditionally, the highest quality and the most useful indicators are based on data from institutionalized monitoring programs, and their development and use involve solid scientific research, careful analysis, and effective reporting to the public.

Indicators are most valuable in the context of a specific policy concern or objective. Some of the ambiguity in the concept of biodiversity conservation results from disagreements over basic conservation objectives, which lead to the use of many different systems for measuring and monitoring biodiversity. If the objective is to minimize species extinctions, then a useful indicator would be changes in the number of species over time.

Alternatively, if the objective is to minimize the loss of species "diversity," where diversity encompasses both considerations of the number of species and their distinctiveness, then a measurement of the number of species would be insufficient. Using measures of species richness only, some would argue that the ocean has less biodiversity than the land because it has fewer species, while others—using a measure incorporating richness and distinctiveness—could argue that the ocean may be of comparable or greater diversity because of its diversity in higher taxonomic levels, both phyla and classes (Ray, 1988).

This paper presents a set of policy-relevant indicators of biodiversity conservation. Distinction is made between indicators needed to assess pursuit of the broadly stated biodiversity conservation concerns listed above and indicators that measure instrumental or management goals such as personnel, budgets, and the management of species and habitats. The numerous biodiversity indicators presented by Noss (1990), for example, are of greatest value at the level of the management of communities and species, while the indicators described in this paper are better used in provincial, national, regional, or global policy-making.