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Economic and Environmental Benefits of Biodiversity

David Pimentel, Christa Wilson, Christine McCullum, Rachel Huang, Paulette Dwen, Jessica Flack, Quynh Tran, Tamara Saltman and Barbara Cliff

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Economic and Environmental Benefits of Biodiversity

The annual economic and environmental benefits of biodiversity in the United States total approximately \$300 billion

David Pimentel, Christa Wilson, Christine McCullum, Rachel Huang, Paulette Dwen, Jessica Flack, Quynh Tran, Tamara Saltman, and Barbara Cliff

All ecosystems and human societies depend on a healthy and productive natural environment that contains diverse plant and animal species. The earth's biota is composed of an estimated 10 million species of plants, animals, and microbes (Pimm et al. 1995). In the United States, there are an estimated 750,000 species, of which small organisms, such as arthropods and microbes, make up 95%.¹ Although approximately 60% of the world's food supply comes from rice, wheat, and corn (Wilson 1988), as many as 20,000 other plant species have been used by humans as food. Some plants and animals provide humans with essential medicines and other diverse, useful products. For instance, some plants and microbes help to degrade chemical pollutants and organic wastes and recycle nutrients throughout the ecosystem.

The rapidly growing world population and increased human activity threaten many of these species. The current extinction rate of species ranges from approximately 1000 to 10,000 times higher than natural extinction rates (Kellert and Wilson

Some aspects of conserving biodiversity are expensive, although they may return major dividends

1993), and if this trend continues, as many as 2 million species of plants and animals will be exterminated worldwide by the middle of the next century (Pimm et al. 1995). This forecast is alarming because biodiversity is essential for the sustainable functioning of the agricultural, forest, and natural ecosystems on which humans depend (Myers 1994, Raven and Johnson 1992, Wilson 1994). For example, the loss of a key species (e.g., a pollinator) can cause the collapse of an ecosystem (Heywood 1995).

When humans cause extinctions or pollute or deplete resources on which biological services are based, contributions from biodiversity are jeopardized. For example, although the United States spends \$150 billion each year to clean polluted water, air, and soil (Allen 1996), 40% of the lakes in the United States are unfit for swimming and other uses (Zimmer 1996). This pollution not only threatens public health, but also reduces aquatic biodiversity.

In this article, we analyze the vital services that are provided by all biota

(biodiversity), including their genes and biomass, to humans and to the environment. We assess the economic and environmental benefits of the following major contributions of biodiversity: organic waste disposal, soil formation, biological nitrogen fixation, crop and livestock genetics, biological pest control, plant pollination, and pharmaceuticals. Such an assessment can serve as a foundation to develop strategies and policies to preserve biological diversity and maintain ecosystem integrity.

Biomass and the recycling of organic wastes

Humans, other animals, and microbes depend on plants to collect solar energy and to produce and store essential biomass and nutrients. Including managed agricultural and forestry biomass production, more than 50% of total photosynthetic production on land is used by humans.²

To produce enough animal food products for the growing world population, approximately 20 billion domestic animals are maintained worldwide, 9 billion of which are raised in the United States (Table 1; Agrostat 1992, USBC 1995, USDA 1995). The biomass of domestic animals in the United States totals 4.5 times that of the human population. Worldwide, domestic animals outweigh the human population by 2.5 times (Table 1). Nearly one-third of the world's

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¹P. H. Raven, 1996, personal communication. Missouri Botanical Garden, St. Louis, MO.

²D. Pimentel, C. Wilson, C. McCullum, R. Huang, P. Dwen, J. Flack, Q. Tran, T. Saltman, B. Cliff, unpublished manuscript.

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