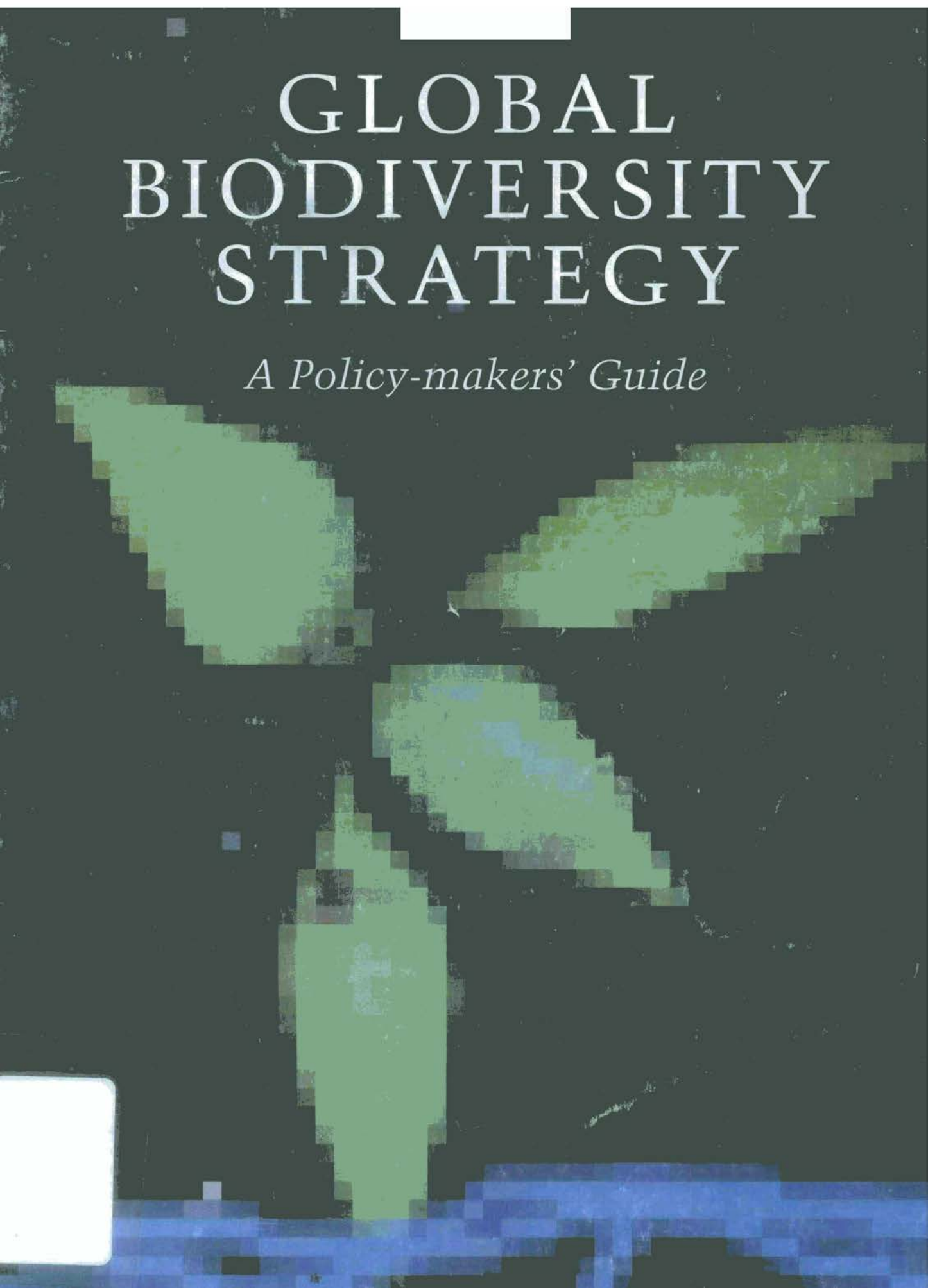
GLOBAL BIODIVERSITY STRATEGY

A Policy-makers' Guide



Global Biodiversity Strategy

Policy-makers' Guide

World Resources Institute (WRI)

The World Conservation Union (IUCN)

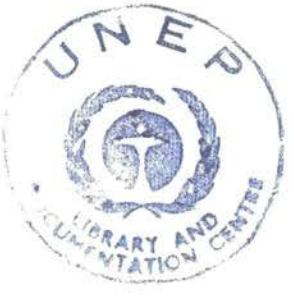
United Nations Environment Programme (UNEP)

In consultation with

Food and Agriculture Organization (FAO)

United Nations Education, Scientific and Cultural Organization (UNESCO)

1992



This report represents a timely, scientific treatment of a subject of public concern. Its sponsors take responsibility for choosing and focusing the study topics and guaranteeing its authors and researchers freedom of inquiry. The report's authors have also solicited and responded to the guidance of advisory panels and expert reviewers. Unless otherwise stated, however, all the interpretations and findings set forth here are those of the authors.

Printed on Recycled Paper

The Global Biodiversity Strategy *was developed through a process of research and consultation beginning in 1989 and involving six consultations, six workshops, and more than 500 individuals. This Policy-makers' Guide to the* Strategy *provides an overview of the actions needed to respond to the needs for biodiversity conservation worldwide. Those actions are detailed in the complete* Strategy*—a different document.*

Sponsors of the Biodiversity Strategy Program
British Overseas Development Administration
Dutch Ministry of Foreign Affairs
Government of Switzerland
Norwegian Royal Ministry of Foreign Affairs
Swedish International Development Authority
The Surdna Foundation
United Nations Development Programme
United States Agency for International Development
W. Alton Jones Foundation

Organizing Committee of the Biodiversity Strategy Program
Kenton Miller, *World Resources Institute, USA*
Jeffrey McNeely, *World Conservation Union (IUCN), Switzerland*
Reuben Olembo, *United Nations Environment Programme, Kenya*

Biodiversity Strategy Program Coordinator
Kenton Miller, *World Resources Institute, USA*

International Coordinating Group
Suraya Afiff, *Indonesian Environmental Forum (WALHI), Indonesia*
JoAnne DiSano, *Department of the Arts, Sport, Environment, Tourism, and Territories, Australia*
Rodrigo Gamez, *National Biodiversity Institute, Costa Rica*
Vernon Heywood, *IUCN Plants Office, U.K.*
Calestous Juma, *African Centre for Technology Studies, Kenya*
Michael Lesnick, *The Keystone Center, USA*
Jeffrey McNeely, *World Conservation Union (IUCN), Switzerland*
Kenton Miller, *World Resources Institute, USA*
Reuben Olembo, *United Nations Environment Programme, Kenya*
Maria Tereza Jorge Padua, *Fundacão Pro-natureza (FUNATURA), Brazil*
Robin Pellew, *World Conservation Monitoring Centre, U.K.*
Samar Singh, *Ministry of Environment and Forests, India*

Principal Writers
Walter Reid, *World Resources Institute, USA*
Charles Barber, *World Resources Institute, USA*
Kenton Miller, *World Resources Institute, USA*

Editor
Kathleen Courrier

Editorial Consultant
Raisa Scriabine

Production Manager
Hyacinth Billings

Graphics
Allyn Massey, Gary Ridley

Cover Design
Pamela Reznick

Book Design
Gary Ridley

Project Staff
Donna Dwiggins, Lori Scarpa, Janet Abramovitz, Joanna Erfani, Lea Borkenhagen, Vinay Gidwani, Bruce Goldstein, Kathy Quick, Patrice Kent

Foreword

All life on Earth is part of one great, interdependent system. It interacts with, and depends on, the non-living components of the planet: atmosphere, oceans, freshwaters, rocks, and soils. Humanity depends totally on this community of life—this biosphere—of which we are an integral part.

In the remote past, human actions were trivial when set against the dominant processes of nature. No longer. The human species now influences the fundamental processes of the planet. Ozone depletion, worldwide pollution, and climate change are testimonies to our power.

Economic development is essential if the millions of people who live in poverty and endure hunger and hopelessness are to achieve a quality of life commensurate with the most basic of human rights. Economic progress is urgent if we are not only to meet the needs of the people alive today but also to give hope to the billions born into the world over the next century. Better health care, education, employment, and other opportunities for a creative life are also essential components of a strategy for keeping human numbers within the planet's "carrying capacity."

Development has to be both people-centered and conservation-based. Unless we protect the structure, functions, and diversity of the world's natural systems—on which our species and all others depend—development will undermine itself and fail. Unless we use Earth's resources sustainably and prudently, we deny people their future. Development must not come at the expense of other groups or later generations, nor threaten other species' survival.

The conservation of biodiversity is fundamental to the success of the development process. This policy-makers guide to the *Global Biodiversity Strategy* has been prepared to provide leaders with quick access to the rationale for action and investment in biodiversity and to the specific proposals offered in the *Strategy*. The *Strategy* itself was prepared by our joint international program during 30 months of intensive research and consultation throughout the world.

As the *Strategy* explains, conserving biodiversity is not just a matter of protecting wildlife in natural reserves. It is also about safeguarding the natural systems of the Earth that are our life-support systems; purifying the waters; recycling oxygen, carbon and other essential elements; maintaining the fertility of the soil; providing food from the land, freshwaters, and seas; yielding medicines; and safeguarding the genetic richness on which we depend in the ceaseless struggle to improve our crops and livestock.

Recent years have seen many major reviews of the world situation and of human needs. A decade ago, the *World Conservation Strategy* drew attention to the inseparable link between conservation and development and emphasized the need for sustainability. The report of the World Commission on Environment and Development—*Our Common Future*—brought this necessity home to a

worldwide audience, whose governments examined the need for action in their *Environmental Perspective to the Year 2000 and Beyond.* Biennial *World Resources* and *Environmental Data* reports and annual *UNEP State of the Environment* reports have provided authoritative—and often disturbing—overviews of the state of the planet. Most recently, the successor and complement to the *World Conservation Strategy,* entitled *Caring for the Earth: A Strategy for Sustainable Living* has once more emphasized the need for the world community to change policies, reduce excessive consumption, conserve the life of the planet, and live within the Earth's carrying capacity.

The three organizations that jointly produced the *Global Biodiversity Strategy* have also been involved with these other major reports and reviews. In that process, we have become more and more aware that a report is useful only if it leads to action—more action and better action than would have been taken otherwise. That is precisely why this new *Strategy* is built around 85 specific proposals for action and why it spells out what should be done in sufficient detail for governments and non-governmental organizations to take up these proposals and develop them further.

This *Strategy* appears at a time when representatives of many of the world's governments are negotiating a Convention on Biological Diversity. We offer this *Strategy* as a complementary initiative. We see it as a basis for the practical action that should be taken while the Convention is being ratified and entering into force. And we see it as an outline for the diverse actions that will need to be taken by governments and non-governmental organizations alongside and in support of the Convention.

Similarly, governments and civic groups are preparing for the United Nations Conference on Environment and Development (UNCED), which will address biodiversity as one among the most pressing issues facing the world in the 1990's. Individuals involved in the preparation of the *Strategy* have also contributed to the development of the UNCED Agenda 21 program of action, to help assure consistency. Other initiatives, including the Global Environment Facility (GEF) and the General Agreement on Tariffs and Trade (GATT) are related in important ways to the equitable and sustainable management, distribution, and use of biodiversity. We urge all involved in these discussions to take account of the provisions of the *Strategy.*

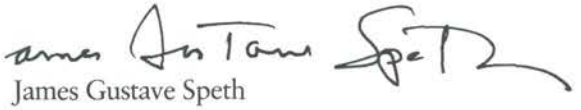
What happens next? Our first concern is to support the development and ratification of the Convention on Biological Diversity. The world needs a permanent international instrument and a program of action and investment that will help governments and local communities save, study, and use wisely the Earth's biodiversity. The UNCED process, GEF and GATT are also central in forging international agreements to share financial and technological resources and capabilities for common benefit.

We will seek the designation by the United Nations of an International Biodiversity Decade to give the mandate and framework for long-term international cooperation on biodiversity issues. A new international mechanism will be established that keeps open the lines of debate and dialogue on biodiversity, involving all interested parties in the exploration of options for biological resource management that sustain society while maintaining the diversity of the planet. And an early warning system will be put in place that will inform official bureaus and citizens alike of pending danger to their biotic wealth and elicit appropriate responses.

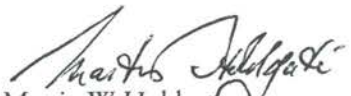
But perhaps most important, it is our growing community of partners from all over the world that will follow up with action at the country and local levels. They are forming coalitions of organizations to analyze biodiversity issues and opportunities, foster dialogue, mobilize local expertise, and prepare plans of action and investment that integrate biodiversity considerations equitably and sustainably into national and local development.

Our own organizations are already deeply involved in action to conserve biodiversity. This

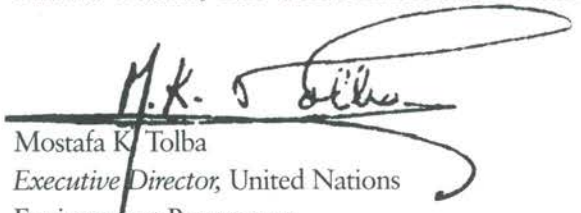
Strategy is as much for us as for other organizations and governments. We shall be further developing our own programs in its light. We will be monitoring its implementation and all our own work will reflect the assumption that successful action to conserve the diversity of life on earth is essential for a sustainable human future.



James Gustave Speth
President, World Resources Institute



Martin W. Holdgate
Director General, The World Conservation Union



Mostafa K. Tolba
Executive Director, United Nations Environment Programme

The Nature and Value of Biodiversity

Earth's plants, animals, and microorganisms—interacting with one another and with the physical environment in ecosystems—form the foundation of sustainable development. Biotic resources from this wealth of life support human livelihoods and aspirations and make it possible to adapt to changing needs and environments. The steady erosion of the diversity of genes, species, and ecosystems taking place today will undermine progress toward a sustainable society. Indeed, the continuing loss of biodiversity is a telling measure of the imbalance between human needs and wants and nature's capacity. *(See Box 1.)*

The human race had 850 million members when it entered the industrial age, sharing Earth with life forms nearly as diverse as the planet has ever possessed. Today, with population nearly six times as large and resource consumption proportionately far greater, both the limits of nature and the price of overstepping them are becoming clear. A turning point is upon us. We can continue to simplify the environment to meet immediate needs, at the cost of long-term benefits, or we can conserve life's precious diversity and use it sustainably. We can deliver to the next generation (and the next) a world rich in possibilities or one impoverished of life; but social and economic development will succeed only if we do the first.

The Value of Biodiversity's Components

From both wild and domesticated components of biodiversity humanity derives all of its food and many medicines and industrial products. Economic benefits from wild species alone make up an estimated 4.5 percent of the Gross Domestic Product of the United States—worth $87 billion annually in the late 1970s. Fisheries, largely based on wild species, contributed about 100 million tons of food worldwide in 1989. Indeed, wild species are dietary mainstays in much of the world. In Ghana, three out of four people look to wildlife for most of their protein. Timber, ornamental plants, oils, gums, and many fibers also come from the wild.

The current economic value of domesticated species is even greater. Agriculture accounts for 32 percent of GDP in low-income developing countries and 12 percent in middle-income countries. Trade in agricultural products amounted to $3 trillion in 1989.

The components of biodiversity are also important to human health. Once, nearly all medicines came from plants and animals, and even today they remain vital. Traditional medicine forms the basis of primary health care for about 80 percent of people in developing countries, more than 3 billion people in all. More than 5,100 species are used in Chinese traditional medicine alone, and people in

BOX 1

The Diversity of Life

Biodiversity is the totality of genes, species, and ecosystems in a region. The wealth of life on Earth today is the product of hundreds of millions of years of evolutionary history. Over the course of time, human cultures have emerged and adapted to the local environment, discovering, using, and altering local biotic resources. Many areas that now seem "natural" bear the marks of millennia of human habitation, crop cultivation, and resource harvesting. The domestication and breeding of local varieties of crops and livestock have further shaped biodiversity.

Biodiversity can be divided into three hierarchical categories—genes, species, and ecosystems—that describe quite different aspects of living systems and that scientists measure in different ways:

Genetic diversity refers to the variation of genes within species. This covers distinct populations of the same species (such as the thousands of traditional rice varieties in India) or genetic variation within a population (which is very high among Indian rhinos, for example, and very low among cheetahs). Until recently, measurements of genetic diversity were applied mainly to domesticated species and populations held in zoos or botanic gardens, but increasingly the techniques are being applied to wild species.

Species diversity refers to the variety of species within a region. Such diversity can be measured in many ways, and scientists have not settled on a single best method. The number of species in a region—its species "richness"—is one often-used measure, but a more precise measurement, "taxonomic diversity," also considers the relationship of species to each other. For example, an island with two species of birds and one species of lizard has greater taxonomic diversity than an island with three species of birds but no lizards. Thus, even though there may be more species of beetles on earth than all other species combined, they do not account for the greater part of species diversity because they are so closely related. Similarly, many more species live on land than in the sea, but terrestrial species are more closely related to each other than ocean species are, so diversity is higher in marine ecosystems than a strict count of species would suggest.

Ecosystem diversity is harder to measure than species or genetic diversity because the "boundaries" of communities—associations of species—and ecosystems are elusive. Nevertheless, as long as a consistent set of criteria is used to define communities and ecosystems, their number and distribution can be measured. Until now, such schemes have been applied mainly at national and sub-national levels, though some coarse global classifications have been made.

Besides ecosystem diversity, many other expressions of biodiversity can be important. These include the relative abundance of species, the age structure of populations, the pattern of communities in a region, changes in community composition and structure over time, and even such ecological processes as predation, parasitism, and mutualism. More generally, to meet specific management or policy goals, it is often important to examine not only compositional diversity—genes, species, and ecosystems—

northwestern Amazonia have tapped some 2,000 species. Traditional medicine is now encouraged by the World Health Organization, and in many countries—including industrialized countries—its use is expanding rapidly. Nearly 2,500 plant species in the Soviet Union have been used for medicinal purposes and the demand for drug plant material has tripled in the last decade.

As for modern pharmaceuticals, one-fourth of all prescriptions dispensed in the United States con-

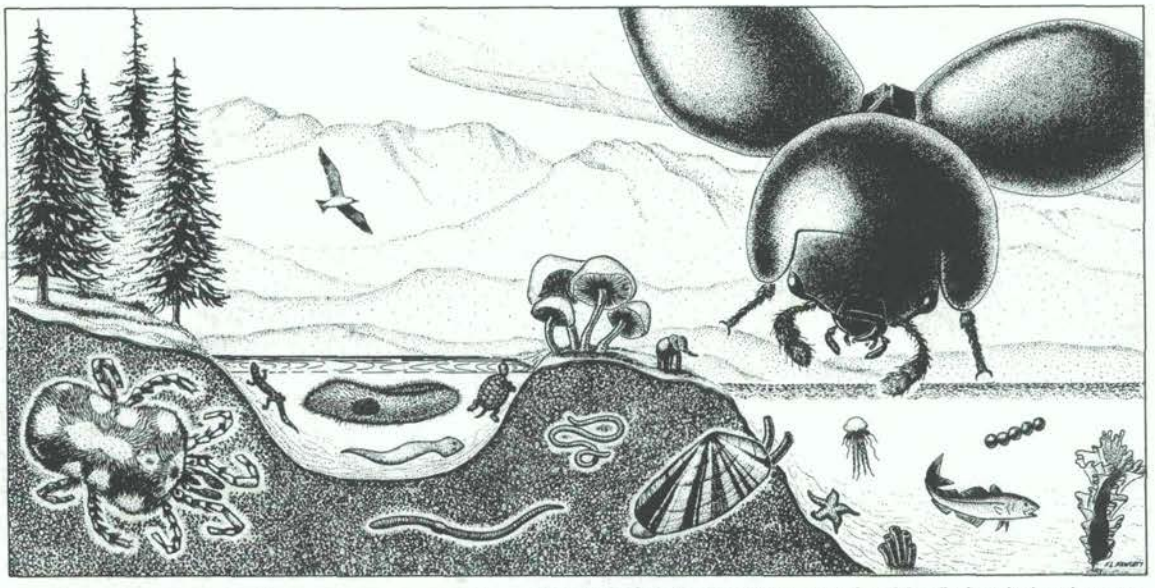
but also diversity in ecosystem structure and function.

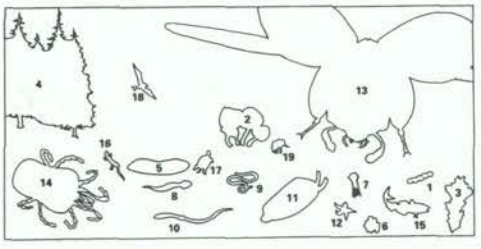
Human *cultural diversity* could also be considered part of biodiversity. Like genetic or species diversity, some attributes of human cultures (say, nomadism or shifting cultivation) represent "solutions" to the problems of survival in particular environments. And, like other aspects of biodiversity, cultural diversity helps people adapt to changing conditions. Cultural diversity is manifested by diversity in language, religious beliefs, land-management practices, art, music, social structure, crop selection, diet, and any number of other attributes of human society.

FIGURE 1

Relative Number of Described Species in Major Taxa

(Size of Organisms Represents Number of Described Species)





Size of individual organisms represents number of described species in major taxon.
Unit Area: □ = approximately 1,000 described species.

	Taxon	No. of Described Species		Taxon	No. of Described Species
1	Monera (Bacteria, Blue-green Algae)	4,760	11	Mollusca (Mollusks)	50,000
2	Fungi	46,983	12	Echinodermata (Starfish etc.)	6,100
3	Algae	26,900	13	Insecta	751,000
4	Plantae (Multicellular Plants)	248,428	14	Non-insect Arthropoda (Mites, Spiders, Crustaceans etc.)	123,161
5	*Protozoa*	30,800	15	Pisces (Fish)	19,056
6	Porifera (Sponges)	5,000	16	Amphibia (Amphibians)	4,184
7	Coelenterata (Jellyfish, Corals, Comb Jellies)	9,000	17	Reptilia (Reptiles)	6,300
8	Platyhelminthes (Flatworms)	12,200	18	Aves (Birds)	9,040
9	Nematoda (Roundworms)	12,000	19	Mammalia (Mammals)	4,000
10	Annelida (Earthworms etc.)	12,000			

Illustration by Frances L. Fawcett. From Q.D. Wheeler. 1990. Ann. Entomol. Soc. Am. 83:1031-1047.

Source: "Species-scape" illustration in which size of organisms are proportionate to the number of species in group it represents. Drawing by Frances Fawcett. From: Wheeler, Quentin D. 1990. Insect diversity and cladistic constraints. Annals of the Entomological Society of America, *vol. 83, pp. 1031-1047*

tain active ingredients extracted from plants, and over 3000 antibiotics—including penicillin and tetracycline—are derived from microorganisms. Cyclosporin, developed from a soil fungus, revolutionized heart and kidney transplant surgery by suppressing the immune reaction. Aspirin and many other drugs that are now synthesized were first discovered in the wild. Compounds extracted from plants, microbes, and animals were involved in developing all of the twenty best-selling drugs in the

United States, drugs whose combined sales approached $6 billion in 1988.

Biotic resources also serve recreation and tourism. Fully 84 percent of all Canadians fish, photograph wildlife, or base other recreational activities on nature—a national passion and pastime worth $800 million annually. Worldwide, nature tourism generates as much as $12 billion in revenues each year. In Namibia, the national constitution itself includes a call to protect the "beauty and character" of the environment. And for many, simply knowing that a particular species or ecosystem exists is inspiring or comforting.

The Value of Diversity

The sheer *variety* of life has enormous value. The variety of distinctive species, ecosystems, and habitats influence the productivity and services provided by ecosystems. As the variety of species in an ecosystem changes—a legacy of extinction or species introduction—the ecosystem's ability to absorb pollution, maintain soil fertility and micro-climates, cleanse water, and provide other invaluable services changes too. When the elephant—a voracious vegetarian—disappeared from large areas of its traditional range in Africa, the ecosystem was altered as grasslands reverted to woodlands and woodland wildlife returned. When the sea otter was all but exterminated from the Aleutian Islands by fur traders, sea urchin populations swelled and overwhelmed kelp production.

The value of variety is particularly apparent in agriculture. For generations, people have raised a wide range of crops and livestock to stabilize and enhance productivity. The wisdom of these techniques—including their contributions to watershed protection, soil fertility maintenance, and receptivity to integrated pest-management strategies—is being reaffirmed today as farmers around the world turn to alternative low-input production systems.

The genetic diversity found within individual crops is also of tremendous value. Genetic diversity provides an edge in the constant evolutionary battle between crops and livestock and the pests and diseases that prey on them. In age-old systems, several genetically distinct varieties of crops are planted together as a hedge against crop failure. The Ifugao of the Philippine island of Luzon can name more than 200 varieties of sweet potato, and Andean farmers cultivate thousands of varieties of potatoes.

Breeders and farmers also draw on the genetic diversity of crops and livestock to increase yields and to respond to changing environmental conditions. The opportunities provided by genetic engineering—which allows the transfer of genes among species—will further increase the opportunities genetic diversity provides for enhancing agricultural productivity. A wild tomato, found only in the Galápagos Islands, can grow in seawater and possesses jointless fruitstalks—a trait that has been bred into domesticated tomatoes to make them easy to harvest mechanically. A wild relative of rice collected in India provided a "resistance gene" that now protects high-yielding rice varieties in South and Southeast Asia from their nemesis, the brown plant-hopper. Plant breeding is to thank for fully half of the gains in agricultural yields in the United States from 1930 to 1980: an estimated $1 billion annually has been added to the value of U.S. agricultural output by the widened genetic base.

Over time, the greatest value of the variety of life may be found in the opportunities it provides humanity for adapting to local and global change. The unknown potential of genes, species, and ecosystems represents a never-ending biological frontier of inestimable but certainly high value. Genetic diversity will enable breeders to tailor crops to new climatic conditions. Earth's biota—a biochemical laboratory unmatched for size and innovation—hold the still-secret cures for emerging diseases. A diverse array of genes, species, and ecosystems is a resource that can be tapped as human needs and demands change.

Because biodiversity is so closely intertwined with human needs, its conservation should rightfully be considered an element of national security. It has become increasingly apparent that national security

means much more than military might. Ecological dimensions of national security cannot be ignored when countries fight over access to water or when environmental refugees strain national budgets and public infrastructure. A secure nation means not only a strong nation, but also one with a healthy and educated populace, and a healthy and productive environment as well. National security will be strongest in countries that care for their biodiversity and the services it provides.

For many, these technical definitions and economic calculations may be eclipsed by still more basic reasons for conservation. Attitudes toward biodiversity and the respect that people show for other species are strongly influenced by moral, cultural, and religious values. The reason is not surprising. Biodiversity is closely linked to cultural diversity—human cultures are shaped in part by the living environment that they in turn influence—and this linkage has profoundly helped determine cultural values. Most of the world's religions teach respect for the diversity of life and concern for its conservation. Indeed, the variety of life is the backdrop against which culture itself languishes or flourishes.

Even so, some reduction in biodiversity has been an inevitable consequence of human development, as species-rich forests and wetlands have been converted to relatively species-poor farmlands and plantations. Such conversions are themselves an aspect of the use and management of biodiversity, and there can be no doubt that they are beneficial. But many ecosystems have been converted to impoverished systems that are less productive—economically as well as biologically. Such misuse not only disrupts ecosystem function, it also imposes a cost. In the United States, the destruction of estuarine ecosystems between 1954 and 1978 cost over $200 million annually in revenues lost from commercial and sport fisheries alone. Expensive engineering was needed to defend against storms as substitutes for the natural defenses provided by coastal wetlands.

The many values of biodiversity and its importance for development suggest why biodiversity conservation differs from traditional nature conservation. Biodiversity conservation entails a shift from a defensive posture—protecting nature from the impacts of development—to an offensive effort seeking to meet peoples' needs from biological resources while ensuring the long-term sustainability of Earth's biotic wealth. It thus involves not only the protection of wild species but also the safeguarding of the genetic diversity of cultivated and domesticated species and their wild relatives. This goal speaks to modified and intensively managed ecosystems as well as natural ones, and it is pursued in the human interest and for human benefit. In sum, biodiversity conservation seeks to maintain the human life support system provided by nature, and the living resources essential for development.

Losses of Biodiversity and Their Causes

Biological diversity is being eroded as fast today as at any time since the dinosaurs died out some 65 million years ago. The crucible of extinction is believed to be in tropical forests. Around 10 million species live on earth, according to the best estimates, and tropical forests house between 50 and 90 percent of this total. About 17 million hectares of tropical forests—an area four times the size of Switzerland—are now being cleared annually, and scientists estimate that at these rates roughly 5 to 10 percent of tropical forest species may face extinction within the next 30 years. *(See Figure 2.)* This estimate may prove conservative, however. Rates of tropical forest loss are accelerating, and some particularly species-rich forests are likely to be largely destroyed in our lifetime. Some scientists believe that about 60,000 of the world's 240,000 plant species, and perhaps even higher proportions of vertebrate and insect species, could lose their lease on life over the next three decades unless deforestation is slowed immediately.

Tropical forests are by no means the only sites with endangered biodiversity. Worldwide, nearly as much temperate rain forest—once covering an area nearly the size of Malaysia—has also been lost. Although the total extent of forest in the northern temperate and boreal regions has not changed much in recent years, in many areas the species-rich, old-growth forests have been steadily replaced by second-growth forests and plantations. Evidence of accelerating clearance of temperate forests is also appearing: between 1977 and 1987, 1.6 million hectares of forest was lost in the United States alone.

In several spots in Europe, fungal species diversity has dropped by 50 percent or more over the past 60 years. In

such "Mediterranean" climes as California, South Africa, central Chile, and Southwest Australia, at least 10 percent of all plant and animal species are imperilled. The largest number of recent extinctions have been on oceanic islands: some 60 percent of plant species endemic to the Galápagos Islands are endangered, as are 42 percent of the Azores' endemic species and 75 percent of the endemic plant species of the Canary Islands.

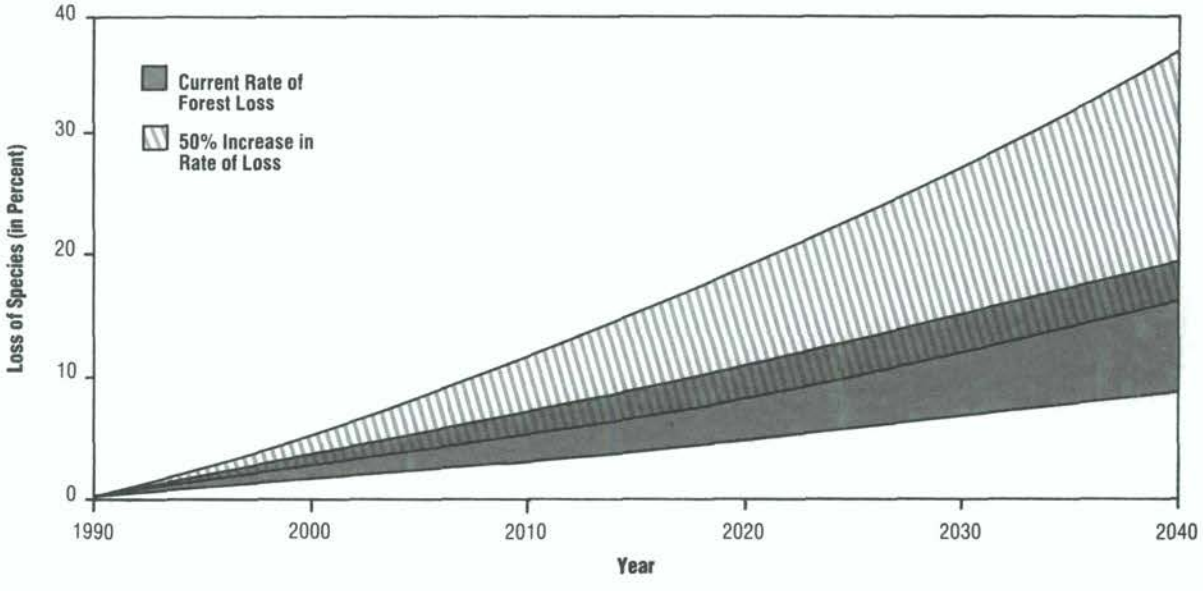
The biodiversity of marine and freshwater systems faces serious loss and degradation. Perhaps hardest hit of all are freshwater ecosystems, battling long-term pollution and the introduction of many alien species. Marine ecosystems too are suffering from the loss of unique populations of many species and are undergoing major ecological changes.

The number of documented species extinctions over the past century is small compared to those predicted for the coming decades. This difference is due, in part, to the acceleration of rates of habitat loss over recent decades but also to the difficulty of documenting extinctions. The vast majority of species has not yet even been described, and many may disappear before they are even known to science. Moreover, species are generally not declared to be extinct until years after they have last been seen—so figures for documented extinctions are highly conservative. Finally, some species whose populations are reduced by habitat loss below the level necessary for long-term survival may hang on for several decades without hope of recovery as their population dwindles—these are the "living dead."

Still, evidence of extinction, especially of distinct populations of species, is only too plentiful. In 1990, the otter died out in the Netherlands, and in 1991 Britain declared the mouse-eared bat extinct. In the eastern Pacific, elevated sea temperatures in the 1980s caused the extinction of a hydrocoral. In the past decade, at least 34 species or unique populations of plants and vertebrates have become extinct in the United States while awaiting federal protection. Worldwide, over 700 extinctions of verte-

FIGURE 2

Percent of Tropical Forest Species Likely to be Sentenced to Extinction in Coming Decades



Source: Ehrlich and Wilson, 1991; Reid, 1992

brates, invertebrates, and vascular plants have been recorded since 1600. How many species went extinct elsewhere, unnoticed?

Habitat loss not only precipitates species extinctions, it also represents a loss of biodiversity in its own right. In many countries, relatively little natural vegetation remains untouched by human hands. In Bangladesh, only 6 percent of the original vegetation remains. Forests around the Mediterranean Sea probably once covered 10 times their current area, and in the Netherlands and Britain, less than 4 percent of lowland raised bogs remain undamaged.

The dramatic losses of species and ecosystems obscure equally large and important threats to *genetic* diversity. Worldwide, some 492 genetically distinct populations of tree species (including some full species) are endangered. In the northwestern United States, 159 genetically distinct populations of ocean-migrating fish are at high or moderate risk of extinction, if they have not already slipped into oblivion.

Loss of genetic diversity could imperil agriculture. How much the genetic base has already eroded is hard to say, but since the 1950s, the spread of modern "Green Revolution" varieties of corn, wheat, rice, and other crops has rapidly squeezed out native landraces. Modern varieties were adopted on 40 percent of Asia's rice farms within 15 years of their release, and in the Philippines, Indonesia, and some other countries, more than 80 percent of all farmers now plant the new varieties. In Indonesia, 1500 local rice varieties have become extinct in the last 15 years. A recent survey of sites in Kenya with wild coffee relatives found that the coffee plants in two of the sites had disappeared, three sites were highly threatened, and six were possibly threatened. Only two were secure.

The impact of such losses of genetic diversity often registers swiftly. In 1991, the genetic similarity of Brazil's orange trees opened the way for the worst outbreak of citrus canker recorded in the country. In 1970, U.S. farmers lost $1 billion to a disease that swept through uniformly susceptible corn varieties. Similarly, the Irish potato famine in 1846, the loss of a large portion of the Soviet wheat crop in 1972, and the citrus canker outbreak in Florida in 1984 all stemmed from reductions in genetic diversity. In such countries as Bangladesh, where some 62 percent of rice varieties come from a single maternal plant, Indonesia (74 percent), and Sri Lanka (75 percent), such outbreaks could occur at any time.

Gene banks have slowed the loss of genetic diversity, but the high costs of periodically regenerating the seeds and the risk of mechanical failures make seedbanks less than fail-safe. In 1980, experts estimated that even in developed countries between one-half and two-thirds of the seeds collected in past decades had been lost. In 1991, representatives of 13 national germplasm banks in Latin America reported that between 5 and 100 percent of the maize seed collected between 1940 and 1980 is no longer viable.

The loss of genetic, species, and ecosystem diversity both stems from and invites the loss of cultural diversity. Diverse cultures have bred and sustained numerous varieties of crops, livestock, and habitats. By the same token, the loss of certain crops, the replacement of traditional crops with export crops, the extinction of species embedded in religion, mythology, or folklore, and the degradation or conversion of homelands are cultural as well as biological losses. Since 1900, experts say, about one Indian tribe has disappeared from Brazil each year. Almost one half of the world's 6000 languages may die out in the next 100 years. Of the 3000 languages expected to survive for a century, nearly half will probably not last much longer.

Causes and Mechanisms of Biodiversity Impoverishment

The current losses of biodiversity have both direct and indirect causes. The direct mechanisms include habitat loss and fragmentation, invasion by introduced species, the over-exploitation of living resources, pollution, global climate change, and industrial agriculture and forestry. *(See Box 2.)* But these are not the root of the problem. Biotic impov-

erishment is an almost inevitable consequence of the ways in which the human species has used and misused the environment in the course of its rise to dominance.

As people awaken to the damage unsustainable development is increasingly inflicting on the web of life and the human prospect, the search for solutions must turn inward. The roots of the biodiversity crisis are not "out there" in the forest or on the savannah, but embedded in the way we live. They lie in burgeoning human numbers, the way in which the human species has progressively broadened its ecological niche and appropriated ever more of the earth's biological productivity, the excessive and unsustainable consumption of natural resources, a continuing reduction in the number of traded products from agriculture and fisheries, economic systems that fail to set a proper value on the environment, inappropriate social structures, and weaknesses in legal and institutional systems. Just as biodiversity is an essential resource for sustainable development, finding sustainable ways to live is essential if biological diversity is to be conserved.

Six fundamental causes of biodiversity loss

■ *the unsustainably high rate of human population growth and natural resource consumption*

In most countries with high fertility rates, about half the population is under the age of 16. The resulting demographic momentum—that is, high birth rates in coming years due to the large number of people who will be reaching their reproductive years—means that global population will continue to grow for at least the next half century and probably longer, barring catastrophe. *(See Figure 3.)* Another billion people are likely to be added to the world population for each of the next three decades. The rates and magnitude of this growth and the eventual size at which the global population stabilizes—critical considerations for biodiversity—depend on social and economic measures, especially on the rate of economic development in the developing countries.

As numbers have increased and new technologies have developed, humanity has appropriated an ever-increasing share of the earth's resources. People consume, divert, or destroy an estimated 39 percent of the terrestrial productivity of photosynthetic plants, algae, and bacteria, the fundamental source of the energy available for virtually all living systems. This trend is unsustainable. The world's biotic systems simply cannot accommodate an ever-growing claim on primary productivity to meet further growth in human population and consumption. The inherent limits of the natural resource base will impose a corresponding limit on the number of people who rely on it. Of course, an ecosystem's (or, for that matter, a planet's) "ecological carrying capacity" can be increased by technology (as the history of agriculture demonstrates), but ultimate constraints on consumption are nevertheless real.

Critical environmental resources are now under stress. Emissions of pollutants, including greenhouse gases, are already overtaxing the tolerance of ecosystems and the dispersal capacity of the atmosphere. Ozone layer depletion, acid rain, and air pollution are all taking a toll on biodiversity today and may threaten it even more severely in the future, particularly if climate change accelerates. Excessive consumption of minerals and other non-renewable resources and a gross over-use and waste of energy, especially by the industrialized nations, aggravates these problems. The developed countries bear the principal responsibility for these impacts, and they need to move swiftly toward a more sustainable way of life. New patterns of development are essential if projected population growth is to be accommodated without straining the planet's carrying capacity.

■ *the steadily narrowing spectrum of traded products from agriculture, forestry, and fisheries*

For millennia, the world was a patchwork of relatively autonomous regions. Knowledge, subsistence strategies, and social structures evolved in each region more or less independently, and people's demands on the environment rarely exceeded nature's capacity. In forest areas, traditional agri-

culture did not appreciably erode diversity where population densities remained low, market pressure was slack, and the combination of shifting cultivation, hunting, fishing, and the gathering of forest products that formed the backbone of most traditional subsistence strategies was well-balanced. No one group could undermine biodiversity overall, and some even enhanced it. But the global exchange economy that has emerged over the past century, based on principles of comparative advantage and specialization, has increased both uniformity and interdependence.

In agriculture, producers now specialize in the relatively few crops that provide an edge in the world economy. As the number of crop species declines, local nitrogen-fixing bacteria, mycorrhizae, predators, pollinators, seed dispersers, and other species that co-evolved over centuries with traditional agricultural systems die out. The use of fertilizers, pesticides, and high-yielding varieties to maximize production and profits over the short-term exacerbates this loss. In forest areas, the rapid and total conversion of forests (often to monocultural cash crops) is widespread. When the price of coffee or palm oil drops, the plantation cannot quickly revert to the biologically diverse forest that preceded it, even if left alone. Similarly, large global markets have fostered the development of what might be called blanket fishing. Monofilament drift nets, for instance, catch enormous quantities of target species—and enormous numbers of "incidental" marine mammals, birds, and so-called non-target fish.

■ *economic systems and policies that fail to value the environment and its resources*

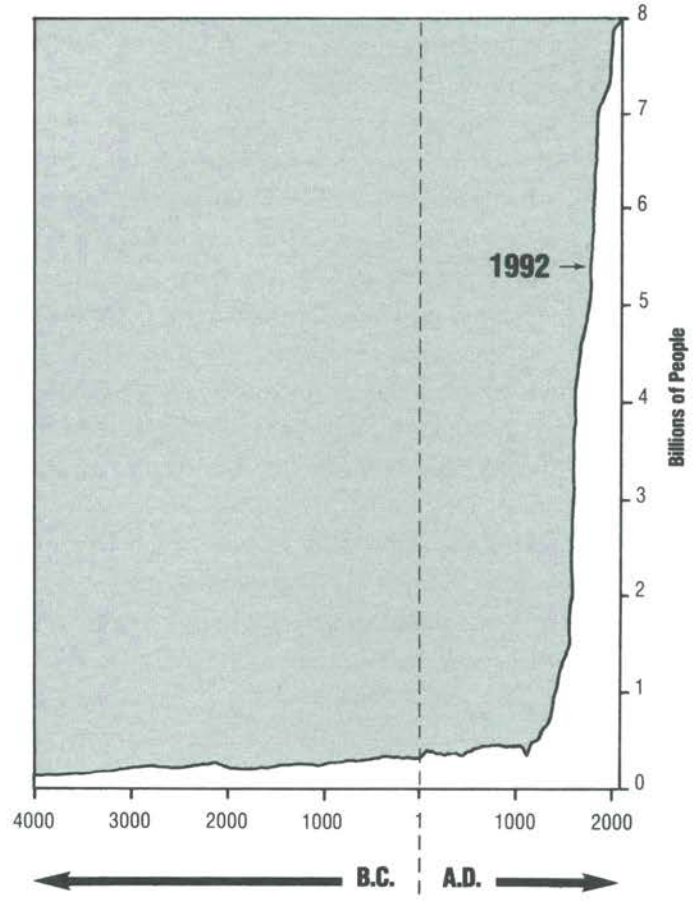
Many conversions of natural systems—such as forests or wetlands to farmlands and rangelands—are economically and biologically inefficient. They happen partly because of the urgent need for land to cultivate, regardless of how sustainable cultivation is, and partly because natural habitats are commonly under-valued economically.

There are several reasons for the misvaluation of biological resources. First, many biological resources are consumed directly and never enter markets. Among forest products, sawn timber, pulpwood, rattan, and gums are likely to be marketed while much of the food, fuelwood, and medicinal plants harvested by local people and the clean water supplied by the forest to the rivers will not. Accordingly, the economic values of logging and other potentially exhaustive uses are overestimated while sustainable uses (and aesthetic and spiritual benefits) are underestimated, creating incentives to impoverish the forest.

Second, biodiversity's benefits are in large part "public goods" that no single owner can claim. Wet-

FIGURE 3

Human Population Growth



land protection, for example, benefits the public tangibly and quantifiably, but the benefits are so diffuse that no market incentives for wetland conservation ever develop. This undervaluation then justifies government policies—such as tax incentives—that further encourage wetland conversion to use with greater "market" value.

Third, property rights are more likely to be granted to those who clear and settle forests and other lands covered with natural vegetation than to forest dwellers living by the sustainable harvest of natural products. Formal property rights are also often easier to obtain by people living in cities and working in the formal sector of the economy—which itself favors the extraction and marketing of products such as timber over the sustainable harvest of products with limited market value. Any uncertainty over property rights weakens incentives for stewardship and encourages over-exploitation. Few farmers will plant woodlots that they might not own five years later. People who do not benefit from a tourist industry, but need food, are more likely to kill than to protect wild animals. People who have no stake in a resource are the least likely to care for it and the most likely to alter it if doing so establishes ownership.

Correctly valued, biologically diverse natural systems are major economic assets. But because such systems are commonly undervalued, biodiversity conservation is seen as a cost rather than an investment. Correcting this error is essential to conserving global and national biodiversity.

■ *inequity in the ownership, management and flow of benefits from both the use and conservation of biological resources*

In most countries, ownership and control of land and biotic resources, and all the benefits they confer, are distributed in ways that work against biodiversity conservation and sustainable living. The rapid depletion of species and the destruction of habitats are the norm in many countries where a minority of the population owns or controls most of the land. Quick profits from excessive logging or overfishing flow to the few, while the local communities dependent on the continued production of the resources pay the price.

A second problem arises from the concentration of resource control and responsibility for environmental policy decisions primarily in the hands of urban men. In many societies women manage the environment and possess far greater knowledge of biodiversity's value to farming and health.

A third issue is the way international trade, debt and technology transfer policies and practices foster inequities that resemble—and often reinforce—those found within nations. By 1988, developing countries were transferring $32.5 billion net to industrialized countries, excluding other implicit resource transfers not involving direct financial flows. (At the beginning of the decade, $42.6 billion had been flowing to developing countries.) To conserve biodiversity, industrialized countries must reverse this flow. If the developing countries continue to be shut out of markets, deprived of access to technology, and burdened with debt, they will have neither the means nor the incentive to conserve their resources for the future.

■ *deficiencies in knowledge and its application*

Scientists still do not have adequate knowledge of natural ecosystems and their innumerable components. This ignorance is compounded by the destruction of cultures that possess a traditional understanding of nature. Even where knowledge exists, it does not flow efficiently to decision-makers, who have in consequence often failed to develop policies that reflect the scientific, economic, social and ethical values of biodiversity. Information also fails to flow properly between central decision-makers and the local communities who depend directly on biological resources, and who may have their livelihood jeopardized by inappropriate development projects and other actions. A final difficulty stems from public reluctance to accept policies that reduce excessive resource consumption, no matter how logical or necessary such policies may be.

■ *legal and institutional systems that promote unsustainable exploitation*

Ecological and economic realities clearly call for a cross-sectoral approach to biodiversity conservation and management. Yet, many national and international institutions operate along rigidly sectoral lines, and many environmental institutions are small and short of resources. Cross-sectoral coordinating machinery is being introduced, both at international level and within countries, but it has yet to prove its effectiveness.

A second problem is the overcentralization of government and corporate planning, which hinders local implementation, discourages local participation, and closes the process to citizen's groups and non-governmental organizations.

A third problem is the weakness of most agencies and organizations charged with nature conservation. Few have the personnel or financial resources needed even to support minimal programs. Their efforts are commonly fragmented and overlapping; what conservation planning they do is neither comprehensive nor strategic, and they do not integrate *in situ* and *ex situ* conservation tools and technologies.

Adding to these difficulties, many countries lack an adequate system of environmental laws and other instruments to ensure the protection of the environment and the sustainable use of its resources. In many developing countries, customary laws that conserved biological resources well have been replaced by less effective legal systems; national policy-making and planning processes are ineffective, the use of economic instruments to promote environmental protection is insufficient, and basic scientific knowledge is inadequate.

Largely because of these legal and institutional constraints, biodiversity conservation has typically been piecemeal and concentrated on traditional wildlife protection techniques—a protected area here, a regime for managing an endangered or threatened species there. Even multiplied many times, such efforts seldom fulfill species' habitat requirements, particularly those of migratory animals, since land-use practices outside protected areas can alter water supplies, introduce pollutants, and change micro-climates. And such efforts do nothing to ensure that policies for sustainable resource use are integrated, which is at the heart of biodiversity conservation.

Region-wide management approaches are needed to address the habitat needs of whole biotic communities and to integrate conservation with regional development. In most situations, managing entire regions as national parks, forest reserves, or marine reserves is inappropriate. But lack of the integrated expertise and authority needed to manage a mix of developed and wild ecosystems impedes sound regional management. Regions big enough for effective development and resource management incorporating biodiversity conservation typically come under various local, state, or provincial government jurisdictions, and some involve two or more nations—an administrative nightmare.

BOX 2

Mechanisms for the Loss of Biodiversity

Habitat Loss and Fragmentation

Relatively undisturbed ecosystems have shrunk dramatically in area over past decades as the human population and resource consumption have grown. Ninety-eight percent of the tropical dry forest along Central America's Pacific coast has disappeared. Thailand lost 22 percent of its mangroves between 1961 and 1985, and virtually none of the remainder is undisturbed. In freshwater ecosystems, dams have destroyed large sections of river and stream habitat. In marine ecosystems, coastal development has wiped out reef and near-shore communities. In tropical forests, a major cause of forest loss is the expansion of marginal agriculture, though in specific regions commercial timber harvest may pose an even greater problem.

Introduced species

Introduced species are responsible for many recorded species extinctions, especially on islands. In these isolated ecosystems, a new predator, competitor, or pathogen can rapidly imperil species that did not co-evolve with the newcomer. In Hawaii, some 86 introduced plant species seriously threaten native biodiversity; one introduced tree species has now displaced more than 30,000 acres of native forest.

Over-exploitation of plant and animal species

Numerous forest, fisheries, and wildlife resources have been over-exploited, sometimes to the point of extinction. Historically, both the great auk and the passenger pigeon succumbed to such pressure, and the Lebanon cedar that once blanketed 500,000 hectares now is found in only a few scattered remnants of forest. Over-exploitation of the Peruvian anchovy between 1958 and 1970 dramatically reduced the population size and the catch. Today, the Sumatran and Javan rhinos have been hunted to the verge of extinction, along with numerous other vertebrates. Many extinctions attend the human harvest of food, but the search for precious commodities—notably, ivory—and for pets, curiosities, and collector's items has also impinged on some populations and obliterated others.

Pollution of soil, water, and atmosphere

Pollutants strain ecosystems and may reduce or eliminate populations of sensitive species. Contamination may reverberate along the food chain: barn owl populations in the United Kingdom have fallen by 10 percent since new rodenticides were introduced, and illegal pesticides used to control crayfish along the boundaries of Spain's Cota Donana National Park in 1985 killed 30,000 birds. Some 43 species have been lost in Poland's Ojcow National Park, due in part to severe air pollution. Soil microbes have also suffered from pollution as industry sheds heavy metals and irrigated agriculture brings on salinization. Acid rain has made thousands of Scandinavian and North American lakes and pools virtually lifeless, and, in combination with other kinds of air pollution, has damaged forests throughout Europe. Marine pollution, particularly from non-point sources, has defiled the Mediterranean and many estuaries and coastal seas throughout the world.

Global climate change

In coming decades, a massive "side-effect" of air pollution—global warming—could play havoc with the world's living organisms. Human-caused increases in "greenhouse gases" in the atmosphere are likely to commit the planet to a global temperature rise of some 1° to 3°C (2° to 5° F) during the next century, with an associated rise in sea level of 1 to 2 meters. Each 1°C rise in temperature will displace the limits of tolerance

of land species some 125 km towards the poles, or 150 m vertically on the mountains. Many species will not be able to redistribute themselves fast enough to keep up with the projected changes, and considerable alterations in ecosystem structure and function are likely. In the United States rising seas in the next century may cover the entire habitat of at least 80 species already at risk of extinction. Many of the world's islands would be completely submerged by the more extreme projections of sea level rise—wiping out their fauna and flora. And protected areas themselves will be placed under stress as environmental conditions deteriorate within and suitable habitat for their species cannot be found in the disturbed land surrounding them.

Industrial agriculture and forestry

Until this century, farmers and pastoralists bred and maintained a tremendous diversity of crop and livestock varieties around the world. But on-farm diversity is shrinking fast thanks to modern plant-breeding programs and the resulting productivity gains achieved by planting comparatively fewer varieties of crops that respond better to water, fertilizers, and pesticides. Similar trends are transforming diverse forest ecosystems into high-yielding monocultural tree plantations—some of which now resemble a field of maize as much as a natural forest—and even fewer tree genes than crop genes have been preserved off-site as an insurance policy against disease and pests.

Source: Reid and Trexler, 1991; IPCC, 1990; Thorsell, 1990; Reid and Miller, 1989; Schneider, 1989; Janzen, 1988; Vitousek et al., 1987; MacKenzie, 1986; Chaney and Basbous, 1978

The Strategy for Biodiversity Conservation

The Goal of Biodiversity Conservation

Successful action to conserve biodiversity must address the full range of causes of its current loss and embrace the opportunities that genes, species, and ecosystems provide for sustainable development. Because the goal of biodiversity conservation—supporting 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 and ecosystems—is so broad, any biodiversity conservation strategy must also have a broad scope. But the campaign can be broken down into three basic elements: saving biodiversity, studying it, and using it sustainably and equitably.

Saving biodiversity means taking steps to protect genes, species, habitats, and ecosystems. The best way to maintain species is to maintain their habitats. Saving biodiversity therefore often involves efforts to prevent the degradation of key natural ecosystems and to manage and protect them effectively. But since many of the world's habitats have been modified for such human uses as agriculture, the program must include measures to maintain diversity on lands and in waters that have already been disturbed. A third component is restoring lost species to their former habitats and preserving species in genebanks, zoos, botanic gardens, and other off-site *(ex situ)* facilities.

Studying biodiversity means documenting its composition, distribution, structure, and function; understanding the roles and functions of genes, species, and ecosystems; grasping the complex links between modified and natural systems; and using this understanding to support sustainable development. It also means building awareness of biodiversity's values, providing opportunities for people to appre-

ciate nature's variety, integrating biodiversity issues into educational curricula, and ensuring that the public has access to information on biodiversity, especially on developments that will influence it locally.

Using biodiversity sustainably and equitably means husbanding biological resources so that they last indefinitely, making sure that biodiversity is used to improve the human condition, and seeing that these resources are shared equitably. "Use" does not, however, automatically imply consumption. Often, the best economic use of biodiversity may be to maintain it in its natural state for its ecological or cultural values, as in the cases of forested watersheds or sacred groves.

The biodiversity conservation agenda must encompass much more than concern for protected areas, threatened species, zoos or seedbanks, and its constituency must be broad-based. It has to take place within the wider context of the move toward sustainable living discussed in *Our Common Future*—the report of the World Commission on Environment and Development—and detailed in *Caring for the Earth*, the successor and complement to the *World Conservation Strategy*.

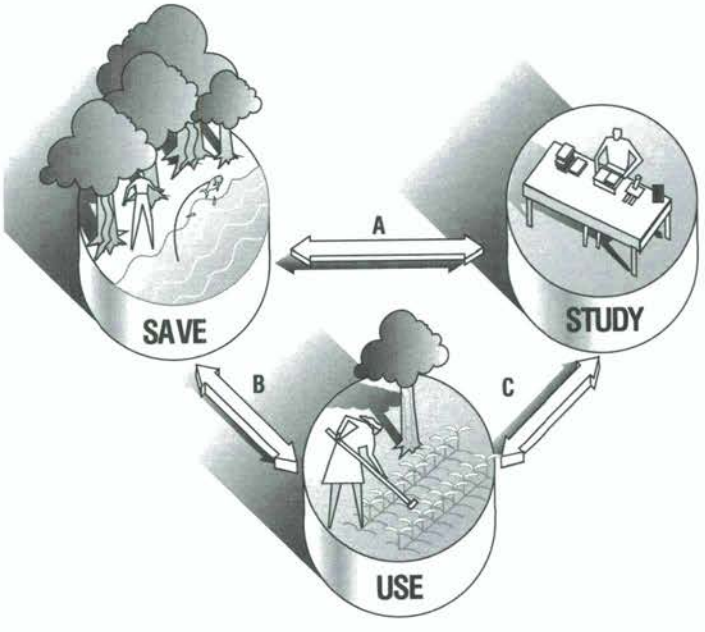
How can biodiversity conservation be addressed within the context of sustainable development, as it must to succeed? There must be new contacts and partnerships within communities, bringing biologists and resource managers together with social scientists, political leaders, businessmen, religious leaders, farmers, journalists, artists, planners, teachers, and lawyers. There must be dialogue between central and local governments, industry, and citizen's groups, including non-governmental environment and development organizations, and women's and indigenous peoples organizations. New mechanisms for discussion, negotiation, and common action are all essential.

Biodiversity conservation must take place at the individual level, the global level, and in between. Effective conservation efforts begin in the fields, forests, watersheds, grasslands, coastal zones, and settlements where people live and work. But complementary governmental efforts are needed to address the many facets of biodiversity conservation beyond the capacity of local communities, or involving resources that are of national importance. By the same token, international cooperation is essential, given the global nature of the biodiversity crisis and the lack of national resources in many countries.

Many essential elements of biodiversity conservation require sustained commitment, but will not show immediate results. Policies, institutions,

FIGURE 4

Elements of Biodiversity Conservation



A. Slowing the loss of biodiversity requires greater understanding of its role in ecosystems and its importance for human life. Conversely, to increase understanding of biodiversity, representative and viable samples of ecosystems, species, and populations must be maintained.

B. Greater incentives will exist to slow the loss of biodiversity if its immediate value to humanity is increased. Conversely, the many current and potential benefits that biodiversity can provide to humanity cannot be sustained unless the biological resource base is maintained.

C. Developing sustainable uses of biodiversity requires the application of both traditional and modern knowledge of biodiversity and biological resources. Conversely, users needs should help set biodiversity research priorities.

laws, and attitudes do not change overnight; expanding human capacity, carrying out first-rate research, and conducting biodiversity inventories take time and money and may have no immediate pay-off. But they create the larger context in which enduring change can take hold and emergency measures have at least a hope of succeeding.

Still, immediate action *is* needed. Irreplaceable genes, species, and ecosystems are disappearing at a rate unprecedented in human history, and essential development is at risk as a result. Immediate action is needed to defend these threatened living resources; to reform the policies that invite such losses; to conduct inventory and study of resource use in key ecosystems and countries; to monitor changes and impending threats; to better manage threatened protected areas; to mobilize funding; and to support national and grassroots conservation initiatives.

The Approach of the Strategy

The limited conservation resources available must be focussed strategically on opportunities likely to yield the greatest conservation benefits, and five key strategic objectives offer significant possibilities for effective action.

The first objective of a strategy for conserving biodiversity must be the development of national and international policy frameworks that foster the sustainable use of biological resources and the maintenance of biodiversity. The economic policies and legal frameworks established by national governments create the incentives and obstacles that influence decisions about how to utilize and manage biological resources, and these policies—ranging from those covering natural resource exploitation to incentives for technological innovation—need to be revised. To support such changes, better techniques must be developed for determining the value of biological resources and incorporating those values into local and national accounting and cost-benefit analyses.

Nations must also take steps to ensure that benefits from the use of genetic resources are gained nationally and locally. Biotechnology is radically altering the market value of genetic resources. If the right policies are established, countries rich in species and genetic resources stand to benefit substantially from these assets. Aided by the international community, all countries should establish policies that foster the development, acquisition, and adaptation of biotechnologies and the development of in-country technical expertise.

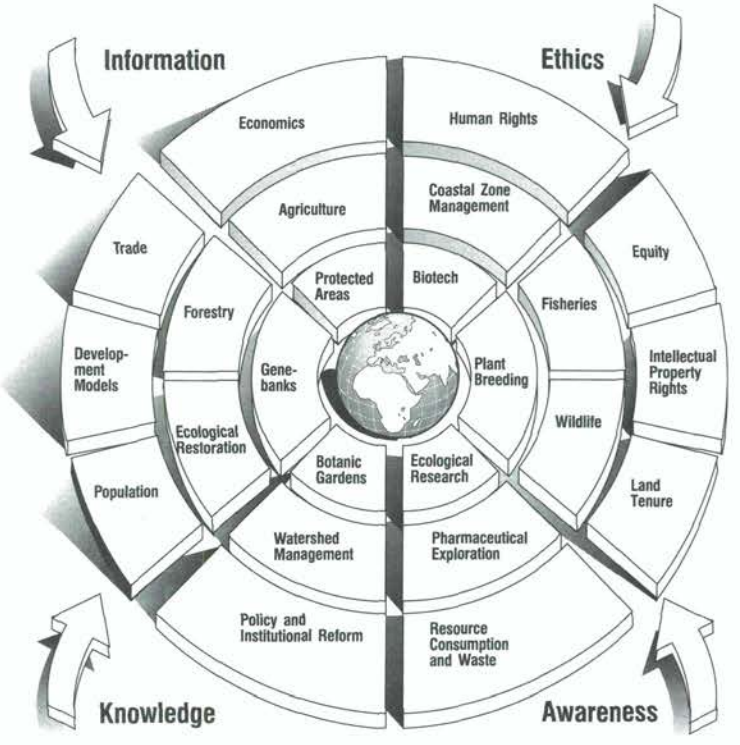
Internationally, the increasingly interconnected global economy conditions what nations and communities can do to conserve and benefit from biodiversity. Trade patterns and practices greatly influence what individuals and nations grow, harvest, buy, and sell. The crushing debt burden shouldered by many developing countries absorbs public resources and makes producing cash commodities to generate foreign exchange irresistible. Development assistance neglects biodiversity conservation, and some contributes to projects that hasten biodiversity loss. Many transnational investment practices drain resources from developing countries, and do nothing to help host communities and countries develop their own technological, professional, and institutional capacities significantly.

The second strategic need is to create conditions and incentives for effective conservation by local communities. Action to conserve biodiversity must ultimately be carried out where people live and work. Unless local communities have the incentives, the capacities, and the latitude to manage biodiversity sustainably, national and international actions are unlikely to produce results. Thus, the policy reforms likely to have the greatest short-term impact on biodiversity conservation will be steps taken to create conditions for conservation locally.

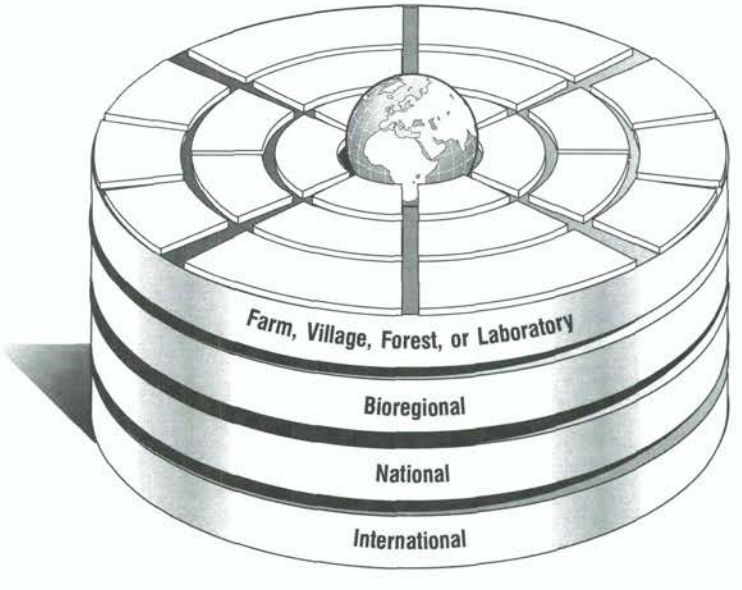
Local biodiversity conservation cannot succeed unless communities receive a fair share of the benefits, and assume a greater role in managing their biotic resources—be they protected areas, coastal fisheries, or forests. In particular, countries should ensure that people who possess local knowledge of genetic resources are rewarded financially when that knowledge is used. Local communities

FIGURE 5

The Scope of Biodiversity Conservation



Levels For Action



should play a fundamental role in the management of wildlands, as well as in stewardship of their natural resources as a whole. In the many countries where land-tenure systems and the skewed distribution of land ownership pose almost insuperable barriers to conservation, they should be changed. These conditions cannot be met without community empowerment and organization, the development of new resource-management skills, the adaptation of traditional practices to current pressures and conditions, and respect for cultural differences and basic human rights.

Third, the tools for conserving biodiversity must be strengthened and applied more broadly. The world's protected areas are vital tools for conserving biodiversity. Combined with such off-site facilities as zoos, botanic gardens, and seedbanks, they can protect a substantial fraction of the world's biodiversity and help to mobilize its benefits. But these conservation tools cannot serve this role if they remain underfunded and understaffed.

But more funding and personnel are not all that is needed. Biodiversity conservation efforts must be planned and implemented "bioregionally" to reflect both ecological and social realities. The division of government responsibilities among such specialized "sectors" as forestry, agriculture, and fisheries reflects neither. Under a bioregional approach, cooperation among sectors, and sometimes across national boundaries, would be built in. This approach is also characterized by some degree of decentralization, receptiveness to variations in local conditions, and the integration of social and ecological objectives. Changes in the organization of government agencies are needed to carry it out, as is broad participation in decision-making.

Protected areas would retain their central importance if planning were done bioregionally, though their role would be increasingly complemented by forestry, agricultural, and fisheries-management techniques that adopt biodiversity conservation among their management objectives. Additionally, national networks of protected areas must be strengthened and expanded to cover all

BOX 3

Ten Principles for Conserving Biodiversity

These ten principles have guided the individuals and institutions involved in development of the Global Biodiversity Strategy.

1. Every form of life is unique, and warrants respect from humanity.

2. Biodiversity conservation is an investment that yields substantial local, national, and global benefits.

3. The costs and benefits of biodiversity conservation should be shared more equitably among nations and among people within nations.

4. As part of the larger effort to achieve sustainable development, conserving biodiversity requires fundamental changes in patterns and practices of economic development worldwide.

5. Increased funding for biodiversity conservation will not, by itself, slow biodiversity loss. Policy and institutional reforms are needed to create the conditions under which increased funding can be effective.

6. Priorities for biodiversity conservation differ when viewed from local, national, and global perspectives; all are legitimate, and should be taken into account. All countries and communities also have a vested interest in conserving their biodiversity; the focus should not be exclusively on a few species-rich ecosystems or countries.

7. Biodiversity conservation can be sustained only if public awareness and concern are substantially heightened, and if policy-makers have access to reliable information upon which to base policy choices.

8. Action to conserve biodiversity must be planned and implemented at a scale determined by ecological and social criteria. The focus of activity must be where people live and work, as well as in protected wildland areas.

9. Cultural diversity is closely linked to biodiversity. Humanity's collective knowledge of biodiversity and its use and management rests in cultural diversity; conversely, conserving biodiversity often helps strengthen cultural integrity and values.

10. Increased public participation, respect for basic human rights, improved popular access to education and information, and greater institutional accountability are essential elements of biodiversity conservation.

key biomes and ecosystems, and the management objectives of protected areas must be harmonized with those for the surrounding ecosystems and human communities. By employing management techniques ranging from strict protection to extractive reserves and conservation easements on private lands, a nation's network of protected areas can both conserve diversity and meet short-term economic needs.

In many parts of the world, the best means of strengthening protected areas is to better integrate them with local social and economic needs. This *Strategy* emphasizes mechanisms for increasing benefits to local communities through ecotourism and sustainable use of non-timber forest products, the establishment of effective buffer zones between protected areas and surrounding communities, compensation to local communities for lost resources, and the use of integrated conservation/development strategies in establishing protected areas.

Often, the protection of ecosystems must be supplemented by the conservation of extremely vul-

nerable or valuable species either in the wild, or off-site in zoos, botanic gardens, aquaria, or seedbanks. In many cases, off-site options represent the last resort for the rescue of threatened species and populations, but they are indispensable tools for increasing public awareness, and for discovering and developing new or improved products and services from biodiversity. Unfortunately, many gaps in the off-site conservation of species remain to be filled, and the integration of off-site conservation with conservation in the wild is embryonic at best.

Fourth, the human capacity for conserving and using biodiversity sustainably must be greatly strengthened, particularly in developing countries. Conservation can succeed only if people understand the distribution and value of biodiversity, see how it influences their own lives and aspirations, and learn to manage areas to meet human needs without diminishing biodiversity. But this capacity is woefully inadequate today: resource managers are not trained to conserve biodiversity; the number of taxonomists specializing in tropical species is grossly inadequate; no country has a complete listing of its species; and for most ecosystems little information exists on indicator and keystone species.

Chronic underinvestment in human capacity-building accounts for these gaps. Indeed, many governments have considered actions to save and study biodiversity wasteful expenditures, mainly because they have not grasped biodiversity's current and potential contribution to national development and human needs. But if taxonomic research for its own sake seems like an extravagance, taxonomy as a tool for managing biodiversity and mobilizing its benefits is a necessity.

Committed, skilled people are needed in all countries to work on biodiversity conservation. Experts in the biological and social sciences, economics, law, policy analysis, ethics, and community organizations are all required. Needs are most acute in many developing countries, where biodiversity losses are high.

The key to conserving genes, species, and ecosystems is increasing our knowledge of biodiversity and its role in human society. Research must be explicitly linked to national and local resource and development needs. Findings, in turn, must be accessible and understandable to decision-makers. The capacities for undertaking research and disseminating data should be developed close to those who need the information—at the national or sub-national level—though the support of international networks is vital. Similarly, the priorities for research and information systems should grow out of consultation with those who need and will use new data and analyses. For many countries, the best option is establishing institutions such as "national biodiversity institutes" to catalogue and explore a nation's biotic wealth, thus helping to mobilize biodiversity to meet national needs.

Finally, conservation action must be catalyzed through international cooperation and national planning. The international cooperation needed to slow biodiversity loss requires more effective international mechanisms than those we have now. International law and institutions must be able to establish widely accepted international norms of conduct, elicit firm commitments to action from governments, mobilize financial resources, develop accurate and timely information, and invite broad participation from scientific and non-governmental sectors. Existing mechanisms simply cannot perform these functions.

As important as international cooperation is, national or regional planning processes are also key mechanisms for catalyzing and focusing policy reform to ensure sustainable resource use and support biodiversity conservation. During planning, biodiversity concerns can be injected into mainstream economic development policy provided that planning mechanisms are more broadly cross-sectoral and participatory than is usually the case. Of course, the changes needed to slow biodiversity loss will involve policy adjustments, some of which will not be easy. If disputes are anticipated and mechanisms for resolving them established now, any hardships born of change can be minimized.

The Strategy: Contents and Catalysts

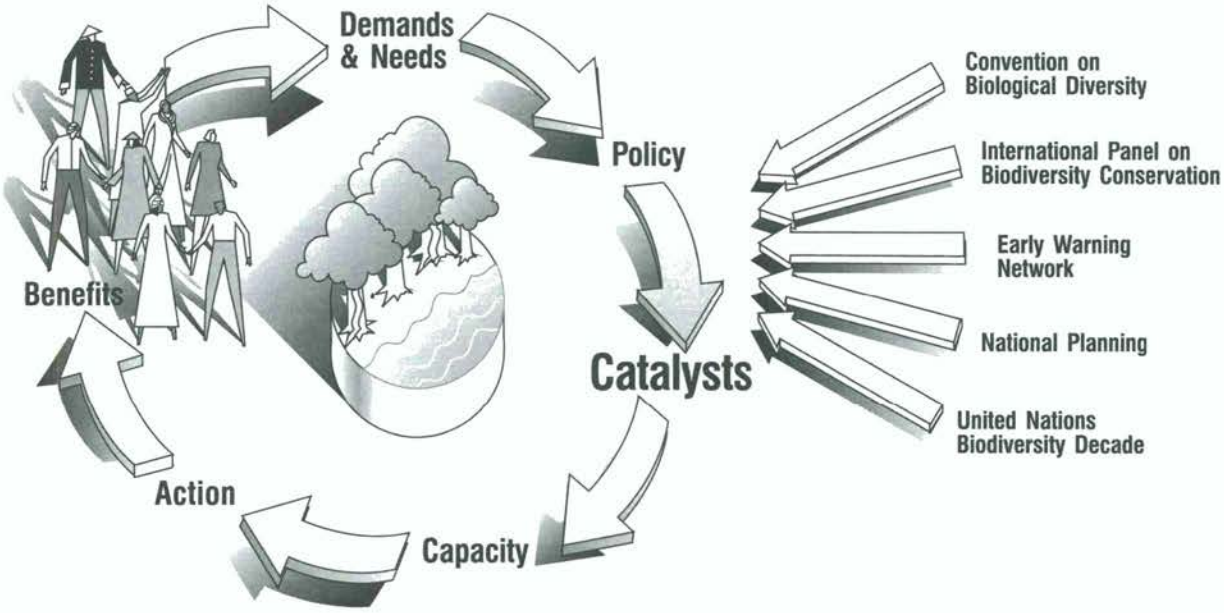
The Global Biodiversity Strategy calls on all nations and peoples to initiate and sustain a Decade of Action to conserve the world's biodiversity for the benefit of present and future generations.

During this period, a new and broader policy context must be created—one that addresses the fundamental need for sustainable development and tackles such international issues as world trading patterns and economic policy, debt and technology transfer, and such national issues as population growth, resource consumption and waste, land tenure, education, health care, and poverty. Supported by this policy context, biodiversity must be managed and conserved on the entire landscape, and throughout the full spectrum of human interactions with the environment. Traditional approaches to conservation must be at once strengthened and modified to fit into a more comprehensive approach. At the same time, the human capacity to live sustainably and advance conservation must be expanded through education, information and training.

The 85 actions proposed in the *Global Biodiversity Strategy* support these broad goals and involve a diverse array of individuals and institutions, including international institutions, national governments, non-governmental organizations, scientists, and the private sector. They cannot and should not be undertaken or controlled by a single institution or program. Nevertheless, the *Strategy* will not work without a mechanism to stimulate the actions proposed here. For this reason, five of the 85 actions called for here have been identified as catalytic actions that can be undertaken quickly and at low cost to set off a cascade of subsequent actions by various sectors and institutions.

FIGURE 6

Five Catalysts for Action



First, a key catalyst for conservation action will be the adoption, in 1992, of the international Convention on Biological Diversity currently being negotiated under the auspices of UNEP. Until this international legal framework is adopted, an international response to the current crisis will be hindered.

Second, to implement the actions detailed in the Global Biodiversity Strategy, a minimum of a decade of concerted work at local, national, and international levels is required. Accordingly, the General Assembly of the United Nations, should consider designating 1994-2003 the International Biodiversity Decade to ensure that this issue does not fade from governments' attention—or the public's—once the first actions are taken.

Third, a mechanism such as an International Panel on Biodiversity Conservation, composed of governmental representatives, scientists, citizen groups, industry, UN organizations, and non-governmental organizations should be created immediately to ensure broad participation in international decisions concerning biodiversity. This panel would be linked to the Convention on Biological Diversity and provide a forum for continuing dialogue on conservation needs and focus sustained attention on the threats created by biodiversity loss. The panel would immediately begin to develop priority lists of endangered species, sites, and ecosystems; and to advise on international priorities for research, funding, and action. Once the Biodiversity Convention comes into force, this same panel can help implement it.

Fourth, timely information on immediate threats to biodiversity must be provided to individuals and organizations that can act directly or indirectly to avert those threats: an Early Warning Network—which will again need to be appropriately linked to the Convention on Biological Diversity—should be established to monitor urgent threats to biodiversity and mobilize action against them. This Network would strengthen the global Earthwatch System, as called for by the U.N. General Assembly.

Since most of the actions needed to conserve biodiversity must be taken at the national level, the fifth critical catalytic action is the integration of

biodiversity conservation into national planning processes. When governments incorporate biodiversity conservation into planning processes—a move that will probably take place only if public pressure mounts—the stimulus to build capacity, strengthen conservation tools, and mobilize biodiversity's benefits will be institutionalized and self-perpetuating.

Although these five catalytic actions, explained in detail below, can trigger action, mobilize funding, build awareness, and ensure broader dialogue and participation, they are not a substitute for action in the field. Nor are they the only catalytic elements of the action agenda. Many other measures that will stimulate governments, non-governmental organizations, and local communities to act are not featured here because their purpose is clearer in the context of other actions proposed in later chapters.

Financial support is urgent and could be considered another catalytic action. New international funding for biodiversity conservation is urgently required. Wide and balanced participation of countries in the North and South in the decisions over how those resources will be allocated is vital, as are equitable mechanisms for raising and spending funds. So is *national* commitment, since it is in each nations' interest to spend substantially more on conserving their own biodiversity.

Similarly, the identification of specific national priorities for protected areas and *ex situ* conservation will also help catalyze action. *The Global Biodiversity Strategy* proposes both national and international assessments of present and future protected area needs and calls for steps to strengthen genetic resources conservation capacity, building on the recently concluded Keystone International Dialogue on Plant Genetic Resources.

The complete set of guidelines for action to save, study, and use Earth's biotic wealth sustainably and equitably is presented in the following pages and described in detail in the *Global Biodiversity Strategy.*

Action at the National Level

Objective:

Reform existing public policies that invite the waste or misuse of biodiversity.

Adopt new public policies and accounting methods that promote conservation and the equitable use of biodiversity.

Reduce demand for biological resources.

Support biodiversity conservation initiatives in the private sector.

Incorporate biodiversity conservation into the management of biological resources.

Integrate biodiversity conservation into national planning processes.

Action:

Abandon forestry policies that encourage resource degradation and the conversion of forest ecosystems to other less valuable uses.

Reform policies that result in the degradation and loss of biodiversity in coastal and marine ecosystems.

Reform policies that hasten loss of biodiversity in freshwater ecosystems.

Eliminate agricultural policies that promote excessive uniformity of crops and crop varieties or that encourage the overuse of chemical fertilizers and pesticides.

Assert national sovereignty over genetic resources and regulate their collection.

Strictly regulate the transfer of species and genetic resources and their release into the wild.

Establish incentives for effective and equitable private-sector plant breeding and research.

Modify national income accounts to make them reflect the economic loss that results when biological resources are degraded and biodiversity is lost.

Provide universal access to family planning services and increase funding to support their adoption.

Reduce resource consumption through recycling and conservation.

Audit the consumption of biological resources to raise awareness of the balance between local consumption and production.

Establish tax incentives for conservation.

Support the establishment of private Biodiversity Conservation Trusts.

Incorporate biodiversity conservation practices into the management of all forests.

Promote agricultural practices that conserve biodiversity.

Restore degraded lands in ways that enhance their productivity and biodiversity.

Virtually all countries have various explicit or de facto processes for setting policy priorities, allocating resources, and dividing authority and responsibility among government agencies, between national and local governments, and between government and the private sector. In most, however, biodiversity concerns are neglected. Until biodiversity conservation becomes a stated national goal, investments will not be targeted to developing the national human, technological, and institutional capacity required to save, study, and use biodiversity comprehensively. Nor will the appropriate policy environment be established.

Action at the International Level

Objective:

Catalyze action to conserve biodiversity through international cooperation.

Integrate biodiversity conservation into international economic policy.

Strengthen the international legal framework for conservation to complement the Convention on Biological Diversity.

Make the development assistance process a force for biodiversity conservation.

Increase funding for biodiversity conservation, and develop innovative, decentralized, and accountable ways to raise funds and spend them effectively.

Action:

Adopt, in 1992, the international Convention on Biological Diversity.

Adopt, in the General Assembly of the United Nations, a resolution designating 1994-2003 the International Biodiversity Decade.

Establish a mechanism such as an International Panel on Biodiversity Conservation (preferably within the Convention on Biological Diversity), including scientists, non-governmental organizations, and policy-makers to provide guidance on priorities for the protection, understanding, and sustainable and equitable use of biodiversity.

Establish an Early Warning Network, linked to the Convention on Biological Diversity, to monitor potential threats to biodiversity and mobilize action against them.

Develop a principle and policy of "national ecological security" to ensure that international trade policies do not intensify biodiversity loss.

Establish an International Debt Management Authority to purchase debt on the secondary market.

Facilitate the exchange and development of technologies for conserving and using biodiversity sustainably.

Ensure that the activities of transnational corporations (TNCs) that destroy biodiversity are curbed in the countries where they are based and where they operate, and that compensation for, or restoration of, damages is sought where applicable.

Ensure that countries are free to decide whether to adopt intellectual property rights protection for genetic resources and how strong that protection should be.

Strengthen the effectiveness of existing international conventions and treaties covering the conservation of ecosystems, species, and genes.

Ensure that international agreements on climate change and forests are compatible with the Convention on Biological Diversity and that they support biodiversity conservation.

Incorporate biodiversity values into the criteria for choosing, designing, and evaluating development assistance loans and projects, and for assessing developing countries' economic performance.

Open the development-assistance process—the design, implementation, and evaluation of projects and the policies that guide them—to public scrutiny, participation, and accountability.

Ensure that development assistance strengthens the role of women in the sustainable use of biological resources.

Involve governments, multilateral development agencies, and non-governmental organizations jointly in establishing new biodiversity conservation funding sources and mechanisms, initially totalling at least $1 billion per year.

Improve debt-for-nature swaps as a means of protecting biodiversity.

Promote the use of trust funds or endowments for biodiversity conservation.

Develop mechanisms to fund grassroots organizations and initiatives.

Action to Create Conditions and Incentives for Biodiversity Conservation at the Local Level

Objective:

Correct imbalances in the control of land and resources that cause biodiversity loss and develop new resource management partnerships between government and local communities.

Create the institutional conditions for bioregional conservation and development.

Expand and encourage the sustainable use of products and services from the wild for local benefits.

Ensure that those who possess local knowledge related to genetic resources benefit appropriately when it is used.

Action:

Reduce pressure on fragile ecosystems and wildlands by using land already under cultivation more efficiently and equitably.

Increase incentives for local stewardship of public lands and waters.

Recognize the ancestral domains of tribal and indigenous peoples and support their efforts to maintain traditional practices and adapt them to modern pressures and conditions.

Compensate individuals and local communities who own or depend on land or resources taken for public purposes.

Manage living resources on public lands through new forms of community-state partnership and cooperation.

Develop new methods and mechanisms at the bioregional level for dialogue, planning, and conflict resolution.

Give weak and disenfranchised groups the means to influence how the bioregion's resources should be managed and distributed.

Establish intersectoral and interagency task forces to facilitate bioregional planning and action.

Establish bioregional information centers to heighten public awareness and support biodiversity conservation.

Recognize and quantify the local economic value of wild products in development and land-use planning.

Encourage local communities to explore opportunities for developing a larger market share for wild products harvested sustainably.

Increase the local benefits of tourism in natural areas—"ecotourism"—and ensure that tourism development does not result in biodiversity loss or cultural conflict.

Strengthen local capacity for maintaining and benefiting from crop and varietal diversity.

Develop the role of traditional medicines and ensure their appropriate and sustainable use.

Promote recognition of the value of local knowledge and genetic resources and affirm local peoples' rights.

Base the collection of genetic resources on contractual or other agreements ensuring equitable returns.

Action to Strengthen the Tools and Technologies of Biodiversity Conservation

Objective:

Identify national and international priorities for strengthening protected areas and enhancing their role in biodiversity conservation.

Ensure the sustainability of protected areas and their contribution to biodiversity conservation.

Strengthen capacity to conserve species, populations, and genetic diversity in natural habitats.

Strengthen the capacity of off-site conservation facilities to conserve biodiversity, educate the public, and contribute to sustainable development.

Action:

Conduct national reviews of protected area systems.

Propose immediate and long-term action to establish and strengthen protected areas.

Undertake an international assessment of present and future protected area needs.

Provide incentives for establishing private protected areas.

Promote international cooperation on protected area management.

Broaden participation in the design of protected area management plans and expand the range of issues addressed by those plans.

Expand the management objectives of protected areas to include the full scope of biodiversity conservation.

Enhance the ecological and social value of protected areas through land purchase and zoning outside the protected area and by providing financial incentives for conservation on adjacent private lands.

Enhance the ecological and social value of protected areas by increasing the benefits to people in and around them.

Restore degraded lands within protected areas and in adjacent lands and corridors.

Integrate the conservation of species, populations, and genetic resources into regional management and protected area reviews.

Use flagship species to increase support for conservation.

Improve and expand legal mechanisms to protect species.

Strengthen crop and livestock genetic resource conservation, and implement the Global Initiative for the Security and Sustainable Use of Plant Genetic Resources.

Develop the world's collections of cultures of microorganisms as an ex situ network.

Fill major gaps in the protection of plant genetic resources.

Develop the world's botanic gardens as a major off-site network for conserving wild plant resources.

Strengthen the conservation role of zoological parks.

Strengthen the role of public aquaria in the conservation of biodiversity.

Strengthen collaboration among off-site and on-site conservation institutions, partly to enlarge the role of off-site facilities in species reintroduction, habitat restoration, and habitat rehabilitation.

Action to Expand Human Capacity to Conserve Biodiversity

Objective:

Increase appreciation and awareness of biodiversity's values and importance.

Help institutions disseminate the information needed to conserve biodiversity and mobilize its benefits.

Promote basic and applied research on biodiversity conservation.

Develop human resources capacity for biodiversity conservation.

Action:

Build awareness of the importance and values of biodiversity into popular culture.

Use the formal education system to increase awareness about biodiversity and the need for its conservation.

Integrate biodiversity concerns into education outside of the classroom.

Establish or strengthen national or sub-national institutions providing information on the conservation and potential values of biodiversity.

Undertake national biodiversity inventories and produce periodic national biodiversity assessments.

Establish a global biodiversity information network to speed the flow of data for local, national, regional, and global assessments.

Provide all citizens with legal and institutional guarantees of access to information on development projects and other activities with potential impacts on biodiversity.

Systematically assess national biodiversity research priorities.

Promote basic and applied natural sciences research on biodiversity conservation.

Strengthen social science research on the connections between biological and social processes.

Strengthen research on ethical, cultural, and religious concerns related to conserving biodiversity.

Increase support for training biodiversity professionals, particularly in developing countries.

Revise career incentives provided by governments to increase the attractiveness of work in the field.

Strengthen the influence and capacity of non-governmental conservation and development organizations to promote biodiversity conservation.

Global Biodiversity Strategy

Order Form

WORLD RESOURCES INSTITUTE
THE WORLD CONSERVATION UNION (IUCN)
UNITED NATIONS ENVIRONMENT PROGRAMME

Please send _____ copies of the *Global Biodiversity Strategy*. I have enclosed $19.95 per copy plus $3.00 for postage and handling.

Please inquire for bulk discount rates.

Name _____

Organization _____

Address _____

City/State _____ Zip Code _____ Country _____

Mail this form, with payment, to:

World Resources Institute Publications
P.O. Box 4852
Hampden Station
Baltimore, Maryland 21211, USA

WOGBP

Complimentary copies are available to journalists, government representatives, and developing country non-governmental organization (NGO) representatives. The aforementioned individuals may request copies by contacting : Information/Distribution Coordinator, World Resources Institute, 1709 New York Avenue, NW, Washington, DC 20006.

World Resources Institute
The World Conservation Union (IUCN)
United Nations Environment Programme