

ENCYCLOPEDIA ARTICLE

Conservation of resources

Management of the human use of natural resources to provide the maximum benefit to current generations while maintaining capacity to meet the needs of future generations. Conservation includes both the protection and rational use of natural resources.

Natural resources

Earth's natural resources are either nonrenewable, such as minerals, oil, gas, and coal, or renewable, such as water, timber, fisheries, and agricultural crops. Natural resources are the basic goods and services that sustain human societies. Renewable resources play central roles in providing air, water, and food. Nonrenewable resources provide the energy essential for industrial economies and are the source of important products ranging from iron tools to silicon chips.

Although humans are entirely dependent upon Earth's natural resources, the combination of growing populations and increasing levels of resource consumption is now degrading and depleting the natural resource base. The world's population stood at 850 million at the onset of the industrial age, sharing the Earth with life forms nearly as diverse as the planet has ever possessed. The global population has grown to nearly seven times as large (6 billion), and the level of consumption of resources is far greater. This human pressure now exceeds the carrying capacity of many natural resources.

Nonrenewable

Nonrenewable resources, such as fossil fuels, are replaced over geologic time scales of tens of millions of years. Human societies will eventually use up all of the economically available stock of many nonrenewable resources, such as oil. Peak oil production in the United States, for example, occurred in 1984 and has since declined significantly as the most easily accessible oil fields have been drained. Clearly, because the stock of nonrenewable resources is fixed, future generations will inherit a world depleted of those important resources. Conservation thus entails actions to use these resources most efficiently and thereby extend their life as long as possible. By recycling aluminum, for example, the same piece of material is reused in a series of products, reducing the amount of aluminum ore that must be mined. Similarly, energy-efficient products help to conserve fossil fuels since the same energy services, such as lighting or transportation, can be attained with smaller amounts of fuel. See also: Human ecology

It may be expected that the biggest challenge of resource conservation would involve nonrenewable resources, since renewable resources can replenish themselves after harvesting. In fact, the opposite is the case. Historically, when nonrenewable resources have been depleted, new technologies have been developed that effectively substitute for the depleted resources. Indeed, new technologies have often reduced pressure on these resources even before they are fully depleted. Fiber optics, for example, has substituted for copper in many electrical applications, and it is anticipated that renewable sources of energy, such as photovoltaic cells, wind power, and hydropower, will ultimately take the place of fossil fuels when stocks are depleted. Renewable resources, in contrast, can be seriously depleted if they are subjected to excessive harvest or otherwise degraded, and no substitutes are available for, say, clean water or food products such as fish or agricultural crops. Moreover, when the misuse of biological resources causes the complete extinction of a species or the loss of a particular habitat, there can be no substitute for the esthetic and moral values that many people associate with that diversity of life.

Renewable

The urgent need to conserve renewable resources, particularly biological resources, can be seen in trends associated with major ecosystems. For example, 60% of the world's most important fish stocks are now overfished. Well over one-half of the world's coral reefs are at risk of degradation from human activities. The world has lost nearly half of its original forest cover, and each year an additional 12 million hectares (29.7 million acres) are deforested. These pressures of overharvesting and habitat loss, combined with other pressures such as pollution and the introduction of exotic species (which often outcompete or otherwise threaten native species), are now depleting the very building blocks of living natural resources—the diversity of genes, species, and ecosystems that constitute living systems. See also: Ecosystem; Reef

The diversity of life is threatened with a massive extinction that could rival the loss of diversity that took place some 65 million years ago around the time that dinosaurs became extinct. Since the 1600s, nearly 500 animal and 650 plant species (mostly vertebrates and flowering plants) are known to have become extinct, and many more species undoubtedly became extinct before they were even identified. The rate of extinctions in groups such as birds and mammals has increased dramatically during this period. Not all species extinctions are necessarily caused by humans. Species went extinct long before humans appeared on the planet, but the background rate of natural extinction is estimated to be nearly 100 times slower than current rates. If the current rate of loss of closed tropical forest (about 1% globally per year) continues until 2030, the number of species these habitats will support will be reduced by 5–10%. This could amount to an additional tens of thousands of extinctions in groups of organisms such as plants.

Current overuse and misuse of renewable living resources cannot be sustained and poses significant economic costs to societies. A critical element of ensuring a sustainable biosphere—one that continues to provide the goods and services from living systems upon which society depends—is thus the conservation of natural resources. “Conservation” is sometimes used synonymously with “protection.” More appropriately, however, it refers to the protection and sustainable use of resources. Critical elements of the effective conservation of natural resources include sustainable resource management, establishment of protected areas, and ex situ (off-site) conservation.

Resource management

Some of the most pressing resource conservation problems stem directly from the mismanagement of important biological resources. Many marine fisheries are being depleted, for example, because of significant overcapacity of fishing vessels and a failure of resource managers to closely regulate the harvest. In theory, a renewable resource stock could be harvested at its maximum sustainable yield and maintain constant average annual productivity in perpetuity. In practice, however, fishery harvest levels are often set too high and, in many regions, enforcement is weak, with the result that fish stocks are driven to low levels. A similar problem occurs in relation to the management of timber resources. Short-term economic incentives encourage cutting as many trees as quickly as possible. Without effective resource management policies and enforcement, sound stewardship of forest resources is difficult. See also: Fisheries ecology; Forest management

Early conservation efforts primarily involved regulation of wildlife harvests. Historically, hunters often depleted game or commercial species until they were effectively extinct (or completely extinct in the case of such species as passenger pigeons in the United States or the great auk in the north Atlantic). However, in the last half century the development and application of principles of wildlife management has led to more effective regulation of harvests. It is now rare that commercial harvest of individual species threatens a species with extinction, although, as in the case of fisheries, it is still common for some species to be

harvested at levels that substantially deplete the population. See also: Food web

A number of steps are being taken to improve resource conservation in managed ecosystems. (1) Considerable scientific research has been undertaken to better understand the natural variability and productivity of economically important resources. (2) Many national and local governments have enacted regulations for resource management practices on public and private lands. These include laws regulating management practices (for example, laws that require timber companies to leave buffers of trees standing near rivers and creeks), as well as laws protecting specific resources, such as endangered species. (3) Problems of resource mismanagement often have stemmed from the fact that local residents, who would have a greater incentive to manage for long-term production, had little rights to local resources, whereas the companies or individuals with rights to harvest resources found it economically beneficial to deplete the resource and move on to new regions. In some of these regions, programs recently have been established either to involve local communities more directly in resource management decisions or to return to them resource ownership rights. (4) Efforts are under way to manage resources on a regional or ecosystem scale using methods that have come to be known as ecosystem management or bioregional management. Since the actions taken in one location often influence species and processes in other locations, traditional resource conservation strategies were often focused too narrowly to succeed.

Protected areas

Regardless of the success in better managing resources, the fact remains that human activities now have reshaped much of the land surface to meet human needs. Human changes in land use and land cover, for example, have transformed one-third to one-half of Earth's icefree surface. This is an area equal to North America, South America, and Africa combined. Clearly, without significant management interventions, many species that once lived in these transformed regions are likely to become extinct. One of the most effective strategies to protect species from extinction is the establishment of protected areas designed to maintain populations of a significant fraction of the native species in a region. Worldwide, 9832 protected areas, totaling more than 9.25 million square kilometers (24 million square miles), cover about 8% of land on Earth. Although these sites are not all managed exclusively for the conservation of species, they play an essential role in protecting species from extinction.

Many problems remain, however, in ensuring effective protected-area conservation networks. For example, several regions with important biodiversity still lack effective protected-area networks. In addition, where protected areas have been designated, human and financial resources are not always available to effectively manage the areas, creating "paper parks." Particularly in developing countries, the establishment of protected areas has resulted in conflicts with local communities that had been dependent upon the areas for their livelihood. These challenges are now being addressed through international efforts, such as the International Convention on Biological Diversity, which aims to increase the financing available for protected areas and to integrate conservation and development needs.

Ex situ conservation

The most effective and efficient means for conserving biological resources is to prevent the loss of important habitats and to manage resources for their long-term productivity of goods and services. In many cases, effective conservation in the field is no longer possible. For example, some species have been so depleted that only a few individuals remain in their natural habitat. In these cases, there is no alternative to the ex situ conservation of species and genetic resources in zoos, botanical gardens, and seed banks. Ex situ collections play important conservation roles as well as serving in public education and research. Worldwide, zoos contain more than 3000 species of birds, 1000 species of mammals, and 1200 species of reptiles, and

botanic gardens are believed to hold nearly 80,000 species of plants. These collections hold many endangered species, some of which have breeding populations and thus could potentially be returned to the wild. Genebanks hold an important collection of the genetic diversity of crops and livestock.

Much can be done to better conserve the world's natural resources, but in the face of growing pressure on these resources the challenge is growing. One of the most important steps to bolster any conservation activity is to learn more about the target resource. Scientists have identified only about 1.7 million of an estimated 13 million species of plants, animals, fungi, and microbes on Earth. Many more species are described each year. Unless basic scientific information on this biodiversity is obtained, it is unlikely that conservation will be effective. See also: Land-use planning; Mineral resources; Soil conservation; Water conservation

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Additional Readings

- World Conservation Union

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