**Ecology**

Ecology, also called bioecology, bionomics, or environmental biology is the study of the relationships between organisms and their environment. Some of the most pressing problems in human affairs – expanding populations, food scarcities, environmental pollution including global warming, extinctions of plant and animal species, and all the attendant sociological and political problems – are to a great degree ecological.

The word ecology was coined by the German zoologist Ernst Haeckel, who applied the term *oekologie* to the “relation of the animal both to its organic as well as its inorganic environment.” The word comes from the Greek *oikos*, meaning “household,” “home,” or “place to live.” Thus, ecology deals with the organism and its environment. The concept of environment includes both other organisms and physical surroundings. It involves relationships between individuals within a population and between individuals of different populations. These interactions between individuals, between populations, and between organisms and their environment form ecological systems, or ecosystems.

In practice, ecology is composed of broadly overlapping approaches and further divided by the groups of species to be studied. There are many, for example, who specialize in the field of “bird behavioral ecology.” The main approaches fall into the following classes.

Evolutionary ecology examines the environmental factors that drive species adaptation. Studies of the evolution of species might seek to answer the question of how populations have changed genetically over several generations but might not necessarily attempt to learn what the underlying mechanisms might be. Evolutionary ecology seeks those mechanisms.

Physiological ecology asks how organisms survive in their environments. There is often an emphasis on extreme conditions, such as very cold or very hot environments or aquatic environments with unusually high salt concentrations.

Behavioral ecology examines the ecological factors that drive behavioral adaptations. The subject considers how individuals find their food and avoid their enemies.

Population ecology, or autecology, examines single species. One immediate question that the subject addresses is why some species are rare while others are abundant. Interactions with other species may supply some of the answers.

**Conservation**

Conservation is the study of the loss of Earth’s biological diversity and the ways this loss can be prevented. Biological diversity, or biodiversity, is the variety of life either in a particular place or on the entire Earth, including its ecosystems, species, populations, and genes. Conservation thus seeks to protect life’s variety at all levels of biological organization.

Species extinction is the most obvious aspect of the loss of biodiversity. For example, species form the bulk of the examples in a comprehensive assessment of the state of the planet published in the early 21st century by the Millennium Ecosystem Assessment, an international effort coordinated by the United Nations Environment Programme. The subject of conservation is broader than this, however. Even a species that survives extinction can lose much of its genetic diversity as local, genetically distinct populations are lost from most of the species’ original range. Furthermore, ecosystems may shrink dramatically in area and lose many of their functions, even if their constituent species manage to survive. Conservation is involved with studying all these kinds of losses, understanding the factors responsible for them, developing techniques to prevent losses, and, whenever possible, restoring biodiversity.

Conservation is a crisis discipline, one demanded by the unusual rates of loss; it is also a mission-driven one. By analogy, ecology and conservation have the same relationship as physiology and medicine. Human physiology studies the workings of the human body, whereas medicine is mission-oriented and aims to understand what goes wrong and how to treat it. The major parts of this article thus deal first with the “pathology” of extinction – why and how biodiversity is lost – and second with the “treatment” methods to prevent these losses.

Conservation is often considered a purely biological topic, as exemplified by major scientific journals with titles such as Conservation Biology and Animal Conservation as well as college textbooks with such titles as Principles of Conservation Biology and Essentials of Conservation Biology. However, because the underlying cause of the loss of biodiversity is increasing human activity, conservation must inevitably involve human interactions. Many of the techniques to prevent the loss of biodiversity involve issues of economics, law, social sciences, and religion – all of which are covered by the journals and textbooks cited above.

**Ecosystem**

Ecosystem is the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space.

An ecosystem can be categorized into its abiotic constituents, including minerals, climate, soil, water, sunlight, and all other nonliving elements, and its biotic constituents, consisting of all its living members. Linking these constituents together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem.

The fundamental source of energy in almost all ecosystems is radiant energy from the Sun. The energy of sunlight is used by the ecosystem’s autotrophic, or self-sustaining, organisms. Consisting largely of green vegetation, these organisms are capable of photosynthesis – i.e., they can use the energy of sunlight to convert carbon dioxide and water into simple, energy-rich carbohydrates. The autotrophs use the energy stored within the simple carbohydrates to produce the more complex organic compounds, such as proteins, lipids, and starches, that maintain the organisms’ life processes. The autotrophic segment of the ecosystem is commonly referred to as the producer level.

Organic matter generated by autotrophs directly or indirectly sustains heterotrophic organisms. Heterotrophs are the consumers of the ecosystem; they cannot make their own food. They use, rearrange, and ultimately decompose the complex organic materials built up by the autotrophs. All animals and fungi are heterotrophs, as are most bacteria and many other microorganisms.

Together, the autotrophs and heterotrophs form various trophic (feeding) levels in the ecosystem: the producer level, composed of those organisms that make their own food; the primary consumer level, composed of those organisms that feed on producers; the secondary consumer level, composed of those organisms that feed on primary consumers; and so on. The movement of organic matter and energy from the producer level through various consumer levels makes up a food chain. For example, a typical food chain in a grassland might be grass (producer) → mouse (primary consumer) → snake (secondary consumer) → hawk (tertiary consumer). Actually, in many cases the food chains of the ecosystem overlap and interconnect, forming what ecologists call a food web. The final link in all food chains is made up of decomposers, those heterotrophs that break down dead organisms and organic wastes.

**Tropical rainforest**

Tropical rainforest, also spelled tropical rain forest is a luxuriant forest, generally composed of broad-leaved trees and found in wet tropical uplands and lowlands around the Equator.

Rainforests are vegetation types dominated by broad-leaved trees that form a dense upper canopy (layer of foliage) and contain a diverse array of vegetation. Contrary to common thinking, not all rainforests occur in places with high, constant rainfall; for example, in the so-called “dry rainforests” of northeastern Australia the climate is punctuated by a dry season, which reduces the annual precipitation. Nor are all forests in areas that receive large amounts of rainfall true rainforests; the conifer-dominated forests in the extremely wet coastal areas of the American Pacific Northwest are temperate evergreen forest ecosystems. Therefore, to avoid conveying misleading climatic information, the term *rainforest* is now preferred over *rain forest*.

Tropical rainforests represent the oldest major vegetation type still present on the terrestrial Earth. Like all vegetation, however, that of the rainforest continues to evolve and change, so modern tropical rainforests are not identical with rainforests of the geologic past.

Tropical rainforests grow mainly in three regions: the Malesian botanical subkingdom, which extends from Myanmar (Burma) to Fiji and includes the whole of Thailand, Malaysia, Indonesia, the Philippines, Papua New Guinea, the Solomon Islands, and Vanuatu and parts of Indochina and tropical Australia; tropical South and Central America, especially the Amazon basin; and West and Central Africa. Smaller areas of tropical rainforest occur elsewhere in the tropics wherever climate is suitable. The principal areas of tropical deciduous forest (or monsoon forests) are in India, the Myanmar–Vietnam–southern coastal China region, and eastern Brazil, with smaller areas in South and Central America north of the Equator, the West Indies, southeastern Africa, and northern Australia.

The flowering plants (angiosperms) first evolved and diversified during the Cretaceous Period about 100 million years ago, during which time global climatic conditions were warmer and wetter than those of the present. The vegetation types that evolved were the first tropical rainforests, which blanketed most of the Earth’s land surfaces at that time. Only later – during the middle of the Paleogene Period, about 40 million years ago – did cooler, drier climates develop, leading to the development across large areas of other vegetation types.

**Desertification**

Desertification, also called desertization, is the process by which natural or human causes reduce the biological productivity of drylands (arid and semiarid lands). Declines in productivity may be the result of climate change, deforestation, overgrazing, poverty, political instability, unsustainable irrigation practices, or combinations of these factors. The concept does not refer to the physical expansion of existing deserts but rather to the various processes that threaten all dryland ecosystems, including deserts as well as grasslands and scrublands.

Roughly half of Earth’s ice-free land surface – approximately 52 million square km (about 20 million square miles) – Is drylands, and these drylands cover some of the world’s poorest countries. The United Nations Environment Programme (UNEP) notes that desertification has affected 36 million square km (14 million square miles) of land and is a major international concern. A 2007 report by the United Nations University maintains that the lives of 100 to 200 million people are affected by desertification. The report also notes that this phenomenon may cause the displacement of about 50 million people by 2017, making it one of the most severe environmental challenges facing humanity.

In general, desertification is caused by variations in climate and by unsustainable land-management practices in dryland environments. By their very nature, arid and semiarid ecosystems are characterized by sparse or variable rainfall. Thus, climatic changes such as those that result in extended droughts can rapidly reduce the biological productivity of those ecosystems. Such changes may be temporary, lasting only a season, or they may persist over many years and decades. On the other hand, plants and animals are quick to take advantage of wetter periods, and productivity can rapidly increase during these times.

To better understand how climatic changes and human activities contribute to the process of desertification, the consequences listed above can be grouped into four broad areas:

1) irrigated croplands, whose soils are often degraded by the accumulation of salts;

2) rain-fed croplands, which experience unreliable rainfall and wind-driven soil erosion;

3) grazing lands, which are harmed by overgrazing, soil compaction, and erosion;

5) dry woodlands, which are plagued by the overconsumption of fuelwood.

**Global warming**

Global warming is the phenomenon of increasing average air temperatures near the surface of Earth over the past one to two centuries. Climate scientists have since the mid-20th century gathered detailed observations of various weather phenomena (such as temperatures, precipitation, and storms) and of related influences on climate (such as ocean currents and the atmosphere’s chemical composition). These data indicate that Earth’s climate has changed over almost every conceivable timescale since the beginning of geologic time and that the influence of human activities since at least the beginning of the Industrial Revolution has been deeply woven into the very fabric of climate change.

Giving voice to a growing conviction of most of the scientific community, the Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP). In 2013 the IPCC reported that the interval between 1880 and 2012 saw an increase in global average surface temperature of approximately 0.9 °C (1.5 °F). The increase is closer to 1.1 °C (2.0 °F) when measured relative to the preindustrial (i.e., 1750–1800) mean temperature. The IPCC stated that most of the warming observed over the second half of the 20th century could be attributed to human activities. It predicted that by the end of the 21st century the global mean surface temperature would increase by 0.3 to 5.4 °C (0.5 to 9.7 °F) relative to the 1986–2005 average. The predicted rise in temperature was based on a range of possible scenarios that accounted for future greenhouse gas emissions and mitigation (severity reduction) measures and on uncertainties in the model projections. Some of the main uncertainties include the precise role of feedback processes and the impacts of industrial pollutants known as aerosols which may offset some warming.

Many climate scientists agree that significant societal, economic, and ecological damage would result if global average temperatures rose by more than 2 °C (3.6 °F) in such a short time. Such damage would include increased extinction of many plant and animal species, shifts in patterns of agriculture, and rising sea levels. The IPCC reported that the global average sea level rose by some 19–21 cm (7.5–8.3 inches) between 1901 and 2010 and that sea levels rose faster in the second half of the 20th century than in the first half. It also predicted, again depending on a wide range of scenarios, that by the end of the 21st century the global average sea level could rise by another 29–95 cm (11.4–37.4 inches) relative to the 1986–2005 average and that a rise of well over 1 metre (3 feet) could not be ruled out.

**Greenhouse effect**

Greenhouse effect is a warming of Earth’s surface and troposphere (the lowest layer of the atmosphere) caused by the presence of water vapour, carbon dioxide, methane, and certain other gases in the air. Of those gases, known as greenhouse gases, water vapour has the largest effect.

The origins of the term greenhouse effect are unclear. French mathematician Joseph Fourier is sometimes given credit as the first person to coin the term greenhouse effect based on his conclusion in 1824 that Earth’s atmosphere functioned similarly to a “hotbox” – that is, a heliothermometer (an insulated wooden box whose lid was made of transparent glass) developed by Swiss physicist Horace Bénédict de Saussure, which prevented cool air from mixing with warm air. Fourier, however, neither used the term greenhouse effect nor credited atmospheric gases with keeping Earth warm. Swedish physicist and physical chemist Svante Arrhenius is credited with the origins of the term in 1896, with the publication of the first plausible climate model that explained how gases in Earth’s atmosphere trap heat. Arrhenius first refers to this “hot-house theory” of the atmosphere – which would be known later as the greenhouse effect – in his work Worlds in the Making (1903).

The atmosphere allows most of the visible light from the Sun to pass through and reach Earth’s surface. As Earth’s surface is heated by sunlight, it radiates part of this energy back toward space as infrared radiation. This radiation, unlike visible light, tends to be absorbed by the greenhouse gases in the atmosphere, raising its temperature. The heated atmosphere in turn radiates infrared radiation back toward Earth’s surface.

Without the heating caused by the greenhouse effect, Earth’s average surface temperature would be only about −18 °C (0 °F). On Venus the very high concentration of carbon dioxide in the atmosphere causes an extreme greenhouse effect resulting in surface temperatures as high as 450 °C (840 °F).

Although the greenhouse effect is a naturally occurring phenomenon, it is possible that the effect could be intensified by the emission of greenhouse gases into the atmosphere as the result of human activity. This global warming could alter Earth’s climates and thereby produce new patterns and extremes of drought and rainfall and possibly disrupt food production in certain regions.

**Acid rain**

Acid rain, also called acid precipitation or acid deposition is precipitation possessing a pH of about 5.2 or below primarily produced from the emission of sulfur dioxide (SO2) and nitrogen oxides (NOx; the combination of NO and NO2) from human activities, mostly the combustion of fossil fuels. In acid-sensitive landscapes, acid deposition can reduce the pH of surface waters and lower biodiversity. It weakens trees and increases their susceptibility to damage from other stressors, such as drought, extreme cold, and pests. In acid-sensitive areas, acid rain also depletes soil of important plant nutrients and buffers, such as calcium and magnesium, and can release aluminum, bound to soil particles and rock, in its toxic dissolved form. Acid rain contributes to the corrosion of surfaces exposed to air pollution and is responsible for the deterioration of limestone and marble buildings and monuments.

The phrase acid rain was first used in 1852 by Scottish chemist Robert Angus Smith during his investigation of rainwater chemistry near industrial cities in England and Scotland. The phenomenon became an important part of his book Air and Rain: The Beginnings of a Chemical Climatology (1872). It was not until the late 1960s and early 1970s, however, that acid rain was recognized as a regional environmental issue affecting large areas of western Europe and eastern North America. Acid rain also occurs in Asia and parts of Africa, South America, and Australia. As a global environmental issue, it is frequently overshadowed by climate change. Although the problem of acid rain has been significantly reduced in some areas, it remains an important environmental issue within and downwind from major industrial and industrial agricultural regions worldwide.

Nitrate and sulfate concentrations in precipitation over the eastern United States are strongly correlated with pH – the lower the pH of rain, the higher the concentrations of nitrate and sulfate. Such low pH values and increased nitrate and sulfate concentrations were observed in the rains of western Europe and North America until the late 20th century. The pH values of precipitation in these regions have increased significantly since then because of strict air quality regulations. Other parts of the world that have industrialized since the late 20th century without enacting adequate air pollution controls, such as China, experienced similar pH declines in precipitation.

**Pollution**

Pollution, also called environmental pollution is the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. The major kinds of pollution are (classified by environment) air pollution, water pollution, and land pollution. Modern society is also concerned about specific types of pollutants, such as noise pollution, light pollution, and even plastic pollution.

Although environmental pollution can be caused by natural events such as forest fires and active volcanoes, use of the word pollution generally implies that the contaminants have an anthropogenic source – that is, a source created by human activities. Pollution has accompanied humankind ever since groups of people first congregated and remained for a long time in any one place. Indeed, ancient human settlements are frequently recognized by their pollutants—shell mounds and rubble heaps, for instance. Pollution was not a serious problem as long as there was enough space available for each individual or group. However, with the establishment of permanent settlements by great numbers of people, pollution became a problem, and it has remained one ever since.

Cities of ancient times were often noxious places, fouled by human wastes and debris. Beginning about 1000 CE, the use of coal for fuel caused considerable air pollution, and the conversion of coal to coke for iron smelting beginning in the 17th century exacerbated the problem. In Europe, from the Middle Ages well into the early modern era, unsanitary urban conditions favoured the outbreak of population-decimating epidemics of disease, from plague to cholera and typhoid fever. Through the 19th century, water and air pollution and the accumulation of solid wastes were largely problems of congested urban areas. But, with the rapid spread of industrialization and the growth of the human population to unprecedented levels, pollution became a universal problem.

By the middle of the 20th century, an awareness of the need to protect air, water, and land environments from pollution had developed among the general public. In particular, the publication in 1962 of Rachel Carson’s book Silent Spring focused attention on environmental damage caused by improper use of pesticides such as DDT and other persistent chemicals that accumulate in the food chain and disrupt the natural balance of ecosystems on a wide scale.

The presence of environmental pollution raises the issue of pollution control. Great efforts are made to limit the release of harmful substances into the environment through air pollution control, wastewater treatment, solid-waste management, hazardous-waste management, and recycling.

**animal Migration**

Migration is the regular, usually seasonal, movement of all or part of an animal population to and from a given area. Familiar migrants include many birds; hoofed animals, especially in East Africa and in the Arctic tundra; bats; whales and porpoises; seals; and fishes, such as salmon.

The migration cycle is often annual and thus closely linked with the cyclic pattern of the seasons. The migration of most birds and mammals and many of the fishes are on a yearly cycle. In many cases (e.g., salmon and eels), animals with a relatively long life span return to their place of birth in order to reproduce and eventually die. In other cases, as in certain invertebrates, where the animal has a relatively brief life span and reproduces rapidly, migrations may not occur in every generation. The daily movements of certain fishes and invertebrates have also been called migrations because of their regular occurrence. This type of movement, however, is not to be confused with migration in the strict sense.

Most migrations involve horizontal travel. The distance traversed may be a few miles or several thousands of miles. Some migrations take a vertical direction and involve no appreciable horizontal movement. Certain aquatic animals, for example, move from deep water to the surface according to the season. Certain birds, mammals, and insects migrate altitudinally in mountainous areas, going from the upper zones, where they breed, to the foothills or plains during seasons when the weather is severe and unfavourable. Such vertical travels involve essentially the same type of environmental change as horizontal, or latitudinal, migrations over long distances.

A seasonal change of habitat, analogous to migration, is made by some Polychaeta (sandworms). Along the coast of Europe, clam worms (*Nereis*) live during the colder months in rock crevices and among algae. During the summer, however, they become planktonic and swim out some distance from the coast, where reproduction occurs. In the South Pacific, near Samoa and Fiji, the palolo worm (*Palola siciliensis*) lives among coral reefs, where it develops posterior segments filled with genital (reproductive) cells. These are cast off, and the worm rises to the surface. The phenomenon occurs regularly on the first day of the last quarter of the October–November moon.