

B.I.7

Loss of biodiversity

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The word biodiversity is a very recent addition to our vocabulary. Originating from the National Forum on BioDiversity, hosted by the US National Academy of Sciences and the Smithsonian Institute in 1986, the concept of biodiversity has spread beyond scientific circles and is now recognised by many people and cultures around the world.

The term is really self-explanatory, being simply a contraction of the words ‘biological diversity’, and it is used to refer to the variability and complexity among living organisms and ecosystems on the Earth. The fact that the word has spread so quickly reflects our sudden appreciation that biodiversity is now rapidly declining worldwide as a result of human activities.

Biodiversity is generally considered on three levels: genetic diversity (diversity within species), species diversity (diversity between species) and ecosystem diversity.

The value of biodiversity

The reasons put forward for protecting biodiversity can be grouped under two headings: *use-values* and *non-use values*.

Use values

The biological success of the humankind, especially since the introduction of farming, has involved the exploitation of biodiversity. Consider the amazing range of different species and varieties of plants and animals that are grown to provide food for human populations, to say nothing of the trees used for paper products and building materials and the plants used for medicines, fibres, dyes, pesticides, flavouring agents and oils. Fungi, yeasts and bacteria play essential roles in bread making, brewing, and the production of dairy products like yoghurt and cheese. And insects, as well as some birds and mammals, play a vital part as pollinators in our agricultural systems.

There are also other less direct ways that different plants, animals and microbes are useful to humankind – for example in the maintenance of atmospheric quality, the disposal of wastes, the recycling of nutrients, the generation of soils and the control of pests. It is also often pointed out that biologically diverse ecosystems harbour rich gene pools, many components of which might well be found to be beneficial for humans in one way or another at some time in the future.

Non-use values

* Born and raised in Canberra, Alice Thompson was brought up with an appreciation of, and interest in the environment, leading her to study at the Australian National University, majoring in Geography/Human Ecology and Population Studies, and her involvement in the Nature and Society Forum (NSF). She now lives in Sydney where she currently pursues a career in Government working for the NSW Office of the Australian Bureau of Statistics (ABS). Before joining ABS Alice was employed by NSF as a Research Officer to prepare reports on important ecological issues in Australia.

The non-use reasons for protecting biodiversity are essentially ethical and aesthetic. There is a strong body of opinion that it is morally wrong to cause the extinction of other forms of life unnecessarily. And for many people biodiversity provides an endless source of interest, enjoyment and wonderment, and it is a great source of inspiration for different kinds of creativity.

Explaining patterns of diversification

Over evolutionary time there has been a clear trend of increasing biodiversity, in both marine and terrestrial environments. Over the past 500 million years this increase has proceeded in a somewhat punctuated fashion. Periods of great diversification have been followed by periods of relative stability, and sometimes even decline in biodiversity.

Not all groups of organisms have diversified at the same time. For example, the extraordinary diversification of mammals over the past 60 million years has been far more spectacular than the diversification among reptiles in the same period.

The fossil record indicates that all species have a finite span of existence over geological time, and it is believed that roughly 99% of all species that ever existed on Earth have become extinct. The Global Biodiversity Assessment estimates the average life span of fossil species to be between 1 million and 10 million years. This would mean that on average around two to three species would be likely to become extinct each year from natural processes worldwide.

Rates of extinction have varied greatly over time, ranging from mass extinctions where many species have been lost in a relatively short period, to background rates of extinction, with a gradual loss of species over time. There have been five periods of mass extinctions. The most severe episode occurred around 250 million years ago, when around 96% of marine animal species disappeared, with terrestrial organisms also significantly affected. The latest mass extinction took place about 65 million years ago when all the dinosaur species disappeared, as well as 10% of families of terrestrial organisms and 15% of families of marine organisms.

Even so, over the past 66 million years mass extinction has accounted for only around 4% of total extinctions. Seventy five to 95% of animal species alive at the beginning of the period are believed to have become extinct.

On a geological timescale, the rates of recovery of biodiversity following mass extinction are comparably rapid, although it takes around 5-10 million years for some communities to properly recover and re-establish, and when this happens the pattern of biodiversity is often quite different from that which prevailed before the extinction event.

The rate of background extinctions has not been constant either. At present the average rate of background extinction is very low. In fact it is so low that there is no documented case over the past hundred years of the extinction of any plant or animal species caused by non-human agencies like competition, disease or environmental factors.

Current Concerns

There are now believed to be some 7 million to 15 million species of animals, plants, fungi and micro-organisms (excluding bacteria and viruses) on Earth. Of these, around 400 000 are plant species and around 50 000 are vertebrates.

Since 1600, around 484 animals and 654 plant species are recorded as having become extinct, and it is certain that countless other species have also disappeared without being documented. Within this period, the actual recorded rate of extinctions has dramatically increased, with three times as many species of birds and mammals recorded as becoming extinct since 1810 as were recorded between 1600 and 1810. Over half of the known extinctions of the past 200 years occurred worldwide in the 20th century. They have been particularly numerous on islands, island archipelagos, and in fresh water ecosystems. About 75% of extinctions among animals occurred on islands.

Even when we take into account the many uncertainties surrounding the comparison of past and recent rates of extinction, current rates far exceed the natural background rates that appear in the fossil record. Over the past 250 million years, approximately 1 species became extinct per year. It has been estimated that around 50 species are now being lost every day, some of which have never been described. According to one estimate 140 000 species are now becoming extinct every year. At this rate we will wipe out half the existing species in 70 years¹. Over 34 000 species of plants face extinction, and among animals, mammals are now recognised to be much more endangered than birds

It is feared that climate change resulting from an enhanced greenhouse effect will further increase the rate of extinction.

Endangered Australia

Australia is one of the twelve most biologically diverse countries in the world, due to its size, lengthy isolation and many climatic zones. However, there is still limited knowledge about the level and extent of this biodiversity, and it has been suggested that only about 15 per cent of Australian species have been described.

At present the Australian continent has the highest record of recent mammal extinctions in the world, with 10 out of 144 species of marsupial and 8 out of 53 species of native rodent becoming extinct over the past 200 years. Two hundred and sixty four of Australia's 1247 bird species and subspecies are estimated to be extinct or at risk.

The 1996 State of the Environment Report found that the loss of biodiversity was perhaps the most serious local environmental problem facing Australia today.

Threats to biodiversity

Species decline can result from a number of factors and it is difficult to identify the primary cause in individual cases, partly because there are usually several threatening processes operating simultaneously. Box 12.1 describes the major categories of threats and causes of species decline and extinction.

Box 12.1

Main categories of species decline

Habitat destruction

Loss of habitat is a key factor in population extinction, especially on small spatial scales. It is largely a result of vegetation clearance for pastoral development, cultivation and settlement, although forestry and mining operations, fire and pollution also significantly contribute to loss of habitats around the world.

Changes in habitat quality

This is a less extreme form of environmental change, although it can lead to significant decline in animal and plant populations. An example is loss of biodiversity as a result of climate change, which in the near future may well be too rapid to allow adaptation in many species. Alteration of habitats by chemical pollution is another major factor leading to the decline of species around the world.

Changes in the Australian landscape through the repeated and deliberate firing of vegetation by Aboriginals is considered by some to have contributed to the extinction of several large vertebrate species (megafauna).

Habitat fragmentation

The fragmentation of habitats through rural and urban developments can cause a previously continuous and stable population structure to disintegrate, with local populations becoming so small that they are at risk of extinction. The disruption of habitats interferes with the usual foraging and breeding behaviour of species that are adapted through evolution to a more continuous habitat.

Together, these three habitat changes account for over 90% of cases of species decline and extinction

Persecution and overexploitation – This can result from commercial or subsistence activities, and it represents a significant threat to many species of animals, particularly large vertebrates. It includes hunting for meat, hides or fur and collecting wild species for the pet trade and plants for horticulture.

During the Pleistocene epoch (from 1.8 million to 12 000 years ago), the extinction of large mammals (megafauna) and flightless birds closely coincided with the arrival of humans in North America, Madagascar, Australia and New Zealand. While climate change is likely to have been a significant factor in the extinction of some of these species, most authorities believe that predation and overexploitation by humans greatly contributed to their demise. This category of threat also includes the deliberate eradication of species considered to be pests, as well as species killed as incidental catches in aquatic environments.

The introduction of exotic species

The spread of exotic, or non-indigenous, species is second only to habitat destruction in harming native communities. They can reduce biodiversity in an area by competing with, or preying upon native species, The human-enhanced spread of infectious diseases and parasites is also a major threat to many animal and plant species.

It is noteworthy that while human activities have resulted in the extinction of large number of species of animals and plants, they have also actually brought about an increase in biodiversity within some species. A whole range of novel genetic forms of life have come into existence that would never have seen the light of day were it not for humankind, and this happened long before the development of the genetic engineering of the modern era.

In the case of animals, selective breeding has given rise to a fantastic range of varieties of cattle, sheep, goats, pigs and poultry. The effects are particularly striking in the case of dogs, in which the criteria for selection have not usually been related to the animal's food value. It is true that some breeds of dog, such as sheep and cattle dogs, are the result of deliberate selection for behaviour of practical value to humans. But many others, like the Pekinese, Chihuahua, Toy Poodle and Great Dane, simply reflect the frivolous whims of generations of dog-fanciers.

The number of new genetic varieties of plant species brought into being through human activities as sources of food and as garden plants is astronomical.

Most of these novel genetic forms both of plants and animals are not only the product of human cultural intervention, but they are also dependent on human culture for their continued survival. They would quickly disappear if humankind were suddenly to vacate the scene.

Action – responses to the loss of biodiversity

In the face of declining species and rapidly degrading habitats around the world, numerous multi-lateral treaties and international agreements have arisen over the past three decades. While many of these treaties have been commended for their global coverage and innovative approaches, most only deal with biodiversity in part, and they have evolved in a piecemeal and uncoordinated manner.

It was not until 1992 that international negotiations for a legally binding instrument to conserve the components of biological diversity were initiated. The Convention on Biological Diversity, opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development, was developed in response to global concern over the loss of genes, species and ecosystems, and to the growing recognition of the immeasurable value of biological diversity to present and future generations. This was the first comprehensive international agreement to address the loss of biodiversity. The primary objectives of the Convention are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

The Convention entered into force on 29 December, 1993, with 168 signatory countries. All signatory countries take responsibility for the conservation and sustainable use of their own biological diversity, and are also required to cooperate in matters of mutual or shared interest. The Convention promotes partnerships between countries, through scientific, technical and financial transfers. A financial mechanism requires developed countries to provide new and additional financial resources to assist developing countries meet their obligations under the Convention.

Australia is a signatory to this Convention and is party to many other international and regional agreements that are relevant to the conservation of biodiversity.

At a national level, the protection of biodiversity and maintenance of essential ecological processes and life-support systems is one of three core objectives of the National Strategy for Ecologically Sustainable Development (1992).

However, until recently there was no broad legislation in Australia to conserve and maintain biodiversity. Instead, many laws relating to the management of flora and fauna have been passed over the past century, but like early international conservation attempts, they have occurred in a piecemeal manner, with few specifically targeting biodiversity. The States and Territories have been largely responsible for the management of species and protected areas, and are party to a number of state and national strategies for the conservation of natural biological resources.

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) has provided a single national scheme for the protection of the environment and the conservation of biodiversity. Most importantly, this Act aims to promote a partnership approach to environmental protection and biodiversity conservation through bilateral agreements with States and Territories, conservation agreements with landholders, recognition and promotion of the role of indigenous people and involvement of local communities the community in management planning.

Largely as an outcome of the activities of community-based environmental groups, public awareness of the biodiversity issue has gained momentum over the past few decades, and it has now emerged as an issue of key concern for many Australians. These groups include large international organisations, like Greenpeace and World Wide Fund for Nature (WWF) and national organisations such as the Australian Conservation Foundation (ACF) and the National Parks Associations.

Many groups regularly monitor the environment providing information that has contributed to our knowledge and understanding of the diversity of organisms and ecosystems. Unfortunately the activities undertaken by these community groups are often costly and time consuming, and most of the input is on a voluntary basis.

There are now several community-government initiatives involving collaboration between community groups, conservation organisations and government bodies. Examples are Greening Australia, and the One Billion Trees campaign, which arose in response to the loss of native vegetation. There have also been many community networks established, like the Community Biodiversity Network and the National Threatened Species Network, which aim to achieve increased community support and involvement in the protection of threatened species and their habitats. Landcare has been a crucial community-government initiative that has provided a mechanism for the conservation of biodiversity alongside agricultural and pastoral production.

It remains to be seen whether these encouraging developments in Australia and overseas will be sufficient to stem the tide of human-induced extinction of animal and plant species.

Further Reading

For further information see:

The Australian Academy of Science's Nova website:

- (1) www.science.org.au/nova/010/010key.htm
- (2) www.science.org.au/nova/091/091key.htm
- (3) www.science.org.au/nova/099/099key.htm

and:

- (4) The website of the Australian Museum
www.amonline.net.au/biodiversity
- (5) E.O. Wilson 1989 *Biodiversity*. National Academies Press, Washington DC.
- (6) Ron Nielsen. 2005. *The little green book* Scribe Publications, Melbourne.

ⁱ Ron Nielsen. 2005. *The little green book* Scribe Publications, Melbourne. pp 442-43. The main causes of this loss of biodiversity are habitat destruction through various bioharvesting activities of humankind, including farming, fishing and logging. Other causes include the release of exotic species into the environment and construction of buildings and roads and the destruction of forests and other natural ecosystems in preparation for farming monocultures.