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Biodiversity Loss and Its Causative Factors

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Abstract: Wild life conservation is the practice of protecting wild plant and animal species and their habitats. Several endangered species face the risk of extinction due to negative effects of human activity on wildlife. The causal factors include- overhunting, destruction of habitats and presence of toxic chemicals in water, air and soil. The extinction of animals and plant species is an irreparable loss with potentially serious environmental and economic consequences for developing and developed countries alike. Since many types of plants and animals have specific habitat requirements, climatic changes could cause disastrous loss of wildlife species. A slight drop or rise in temperature and rainfall can translate into large seasonal changes which are likely to affect diverse living species of plant and animals. There is global concern to assess the diverse factor underlying genetic makeup and wild populations. Several case studies have helped people to restore biodiversity. Thus, biodiversity conservation is a priority area of research for achieving sustainable development and mankind.

Keywords: Biodiversity, genetic diversity, habitat loss, ecological footprint, sustainable development, climate change.

Introduction

All over the globe, human beings are dependent upon natural resources (wild and domesticated plants and animals, fossil fuels and mineral wealth) for food, clothes, medicines shelter, air, water and climate modifications. These processes which help sustain human life on earth are called ecosystem services. However, due to human population boom, we have physically altered half of earth's land surface as well as aquatic resources. In the oceans, stocks of most major fisheries are shrinking because of overharvesting. Some of the greatest concentrations of biodiversity are found in the tropics. Unfortunately, tropical forests are being cleared at an alarming rate to support increasing human populations. The rates of deforestation in the tropics are among the highest in the world. Some of the most productive and diverse aquatic areas (coral reefs and estuaries) are being severely stressed. Humans are in the process of doing more damage to the biosphere and pushing more species toward extinction than the large asteroid that may have triggered the mass extinctions at the close of Cretaceous period (65 million years ago). At present, the rate of species loss may be 1000 times higher than at any time in the past. Many species that are threatened could potentially provide crops, fibers and medicines for human use, making biodiversity a crucial natural resource. Many researchers are enthusiastic about the potential bioprospecting for the development of new medicines, foods, petroleum substitutes, industrial chemicals and other products. However, because many million species may become extinct before we even know about them, we stand to lose irretrievably the valuable genetic potential held in their unique libraries of genes.

Major threats to Biodiversity

Four major threats to biodiversity include – habitat destruction, introduced or invasive species, over exploitation and disruption of interaction networks such as food webs.

(i) Habitat destruction

Massive destruction of habitats has been brought about by agriculture, urban development, deforestation, mining and pollution. When no alternative habitat is available or a species is unable to move, habitat loss may mean extinction. Forest fragmentation is occurring at a rapid rate in the tropics, leaving small forest islands. During the last few decades, habitat fragments have lost 10 to 60% of their plant species. Habitat loss is also a major threat to marine biodiversity, especially along continental coasts and around coral reefs. About 90% of coral reefs (earth's most species rich aquatic communities) have been damaged by human activities. At the current rate of destruction of coral reefs, one third of marine fish species could be lost in the next 30 years.

(ii) Invasive species

Introduced species (also called invasive, non-native or exotic species) are those that humans move (either intentionally or accidentally) from the species native locations to new geographical areas. The modern ease of travel by ship and airplane has accelerated the transplant of species across continents. Such transplanted species spread through a new regions at exponential rates because these lack predators and pathogens in the new territories. Introduced species proliferate quickly in their new locales and disrupt their adopted community often by preying on native organisms or outcompeting them for resources. For example, the brown tree snake was accidentally introduced to the island of Guam through a military dump up operation after world war II. Since then, 12 species of birds and 6 species of lizards on which these snakes prey have become extinct in Guam. Another accidental introduction is the zebra mussel which was introduced in the Great lakes of North America in 1988 through ships arriving from Europe. In the U.S., zebra mussels have attained high population density and disrupted freshwater ecosystems, thereby threatening native aquatic species. Further, humans have deliberately introduced many species with good intentions but disastrous results. For example, a Japanese plant called Kudzu was introduced in the southern U.S.A. to help control soil erosion. However, this plant has taken over vast expanses of landscape and has eliminated several native plant species. Introduced species are a worldwide problem, contributing to about 40% of extinctions recorded so far.

(iii) Overexploitation

Overexploitation refers to human harvesting of wild plants or animals at rates exceeding the ability of populations of these species to rebound. This process includes commercial fishing, hunting, collecting and trading of animals. It is possible for overexploitation to endanger plants or animals which produce valuable commercial products. The African elephant is a classic example of the impact of overhunting largely because of the trade in ivory and elephant populations have been declining in most of Africa during the last 50 years. Species with restricted habitats, such as small islands, are vulnerable to overexploitation. Humans had hunted great auk to extinction on the islands in the Atlantic oceans. This flightless seabird was hunted for its feathers, eggs and meat.

(iv)Disruption of interaction networks

Ecosystem dynamics depend on the networks of interspecific interactions within biological communities. Extinction of one species can doom other species of a community particularly when extinction involves a keystone species or an ecosystem engineer species i.e. species which has a highly specialized relationship with other species. Foundation species or ecosystem engineers exert their influence not through their tropic interactions but by causing physical changes in the environment that affect the structure of the community. Foundation species act as facilitators that have positive effects on the survival and reproduction of some of the other species in the community. For example, the black rush *Juncus* species help prevent salt build up by shading the soil surface which reduces evaporation. This was shown experimentally by removal of *Juncus* from study plots in the salt marsh which led to death of three other plant species. In another field experiment in U.S.A., *Albizzia procera*, a non-native plant that thrives on nitrogen poor soils was used to improve roadside area after removal of original forests. The rapid buildup of organic material from dense strands of *Albizzia procera* enabled indigenous plants to recolonise the area and overgrow the introduced plant in a relatively brief time.

Loss of genetic diversity in small populations

A species is designated as endangered when its population is small. A small population is prone to inbreeding and genetic drift draws a population to extinction vortex. The key factor driving the extinction vortex is the loss of genetic variation necessary to enable evolutionary responses to environmental change such as new strains of pathogens. In a case study of greater prairie chicken in the U.S.A., researchers observed that population collapse were mirrored in a reduction in fertility as measured by the hatching rates of eggs. Comparisons of DNA samples from the collapsing population with DNA from feathers in the museum specimens showed that the genetic variation had declined in the investigated population. In 1992, researchers began experimental translocations of prairie chicken from distant populations in an attempt to increase genetic variation. After translocation, the viability of eggs rapidly improved and the population rebounded. The study showed that lack of genetic variation had started the prairie chicken population down the extinction vortex.

Loss of genetic diversity due to modern agricultural practices

To increase food production, the Green Revolution fostered the development of inbred strains of high-yield varieties (HYV) of crop plants. This approach was very successful and it is estimated that over one billion people worldwide now derive all or part of their food supply from these new crops (HYV). However, this program has a dark side. In many countries, as farmers switched to HYV, they abandoned the traditional varieties or cultivars of crop plants which contained a high degree of genetic diversity. For example, 50 years ago farmers in our country used to grow more than 30,000 varieties of rice. Now it is estimated that 50 – 75 % of all rice fields are planted with just 10 varieties. This dramatic loss of genetic variation has generated some controversies. Accordingly, Green Revolution represents short-term gains but long-term losses. It is not clear whether climate change will adversely affect high yielding varieties and may perhaps reduce the food supply.

In the U.S.A., about 7100 apple varieties were used to be grown in 1900 but only 15 % of these varieties can be found now. Just fifteen varieties of apples account for 90 % of apples now sold in the U.S.A. Modern varieties may be better adapted for current horticultural practices but many old varieties contained useful genes that can still play a vital role in survival functions such as resistance to disease, cold or drought.

Protected areas for biodiversity

Conservation biologists have applied their understanding of community and ecosystem dynamics in establishing protected areas to slow the loss of biodiversity. Currently, governments have set aside about 7 % of the world's land in various forms of reserves. Biodiversity hotspots are good choices for nature reserves. A biodiversity hotspot is a relatively small area with an exceptional concentration of endemic species and a large number of endangered and threatened species. Designating an area as a biodiversity hotspot is often biased towards saving vertebrates and plants, with less attention paid to invertebrates and microorganisms.

Effects of pollution on Biodiversity

Humans release an immense variety of synthetic toxic chemicals in the environment without realizing its ecological consequences. Organisms acquire toxic substances from the environment along with the nutrients and water. Some chemicals are metabolized or excreted while others accumulate in specific tissues such as fat. For example, in the decade after World War II, use of DDT grew rapidly but its ecological consequences were not understood. DDT had been used to control insects such as mosquitoes and agricultural pests. By 1950's scientist learned that DDT persists in the environment and is transported by water to areas far from where it is applied. One of the first sign that DDT was a serious environmental problem was a decline in the populations of several bird species such as pelicans and eagles which feed on the top of food web. The accumulation of DDT in the tissues of these birds interfered the deposition of calcium in their egg shells. When the birds tried to incubate their eggs, the weight of the parents broke the shells of affected eggs, resulting in massive declines in the bird's reproductive rates. Rachel Carson's book Silent spring brought this problem to public attention and DDT was banned in U.S.A. in 1960's. In the subsequent decades, a dramatic recovery in the populations of the affected bird species followed. The history of DDT illustrates the importance of understanding the ecological connections between diseases and communities i.e. malaria versus bird communities. Despite this fact, DDT is still used in much of the tropics to control mosquitoes that spread malaria and other diseases.

Climate warming and its effects on Biodiversity

Human activities release a variety of gaseous waste products to the environment. People once thought that the vast atmosphere could absorb these materials indefinitely. However, we now know that such additions can cause fundamental changes to the atmosphere and its interactions with the rest of biosphere. Rising concentrations of long-lived greenhouse gases such as CO_2 are changing the earth's heat budget. Much of the solar radiation that strikes the planet is reflected back into space. Although CO_2 and other greenhouse gases in the atmosphere are transparent to visible light, they intercept and absorb much of the infrared radiation emitted by earth, followed by re-reflecting some of it back towards the earth. This process retains some of the solar heat which is known as greenhouse effect. The marked increase in the concentration of atmospheric CO_2 over the past 150 years concerns scientists because of its links to increased global temperatures. Fossil fuel burning also contributes to the warming. Most scientists are convinced that such warming is already occurring and will increase rapidly during the current century.

Global warming is making hot days hotter, rainfall and flooding heavier, hurricanes stronger and droughts more severe. This intensification of weather and climate extremes will be the most visible impact of global warming in our everyday lives. Climate warming is also causing changes to the landscape of our world, adding stress to wildlife species and their habitat. Many types of plants and animals have specific habitat requirements. Climate change could cause disastrous loss of wildlife species. A slight rise or drop in the average rainfall will translate into large seasonal changes. Hibernating mammals, reptiles, amphibians and insects are likely to be harmed and disturbed. The ecosystems where the largest warming has already occurred are those in the far north, particularly northern coniferous forests and tundra. As snow and ice melt and uncover darker more absorptive surfaces, these systems reflect less radiation back to the atmosphere and warm further. Arctic sea ice in the summer of 2010 covered the smallest area on record. Climate models suggest that there may be no summer ice within a few decades, thereby decreasing habitat for polar bears, seals and seabirds. Higher temperatures also increase the likelihood of fires. In the boreal forests of North America and Russia, fires have burned twice the usual areas in recent times.

Global models predict that by the end of the 21st century, the atmospheric CO_2 concentration will be more than double, increasing average global temperature by about 3 °C. Supporting these models is the correlation between CO_2 levels and temperatures in the prehistoric times. One way climatologists estimate past CO_2 concentration is to measure CO_2 levels in bubbles trapped in glacial ice. Prehistoric temperatures are inferred by several methods i.e. (a) chemical isotopes in the sediments and corals; and (b) analysis of past vegetation based on fossils. A warming trend would also alter the geographical distribution of precipitation making agricultural areas more drier affecting food supply.

Depletion of atmospheric ozone

Life on earth is protected from the damaging effects of ultraviolet (UV) radiation by a layer of ozone located in the stratosphere 17 – 25 km above earth's surface. However, satellite studies on the atmosphere show that the spring time ozone layer over Antarctica has thinned substantially since mid 1970's. The destruction of ozone results primarily from the accumulation of chlorofluorocarbons (CFCs) used in manufacturing and refrigeration. In the stratosphere, chlorine atoms released from CFCs react with ozone, reducing it to molecular O_2. Subsequent reactions release the chlorine, allowing it to react with other ozone molecules in a catalytic chain reaction. The ozone levels have decreased 2 to 10 % during the last two decades.

The consequences of ozone depletion for life on earth may be severe for plants, animals and microorganisms. Scientists expect effects on crops and natural communities such as phytoplankton that are responsible for a large proportion of earth's primary production. To study the consequences of ozone depletion, ecologists have conducted field experiments in which they used filters to decrease or block the UV radiation in the sunlight. One such experiment performed on a scrub ecosystem near the tip of South America showed that when the ozone hole passed over the area, the amount of UV radiation increased, causing more DNA damage in plants that were not protected by filters. Scientists have shown similar DNA damage and a reduction in phytoplankton growth when the ozone hole opens over the southern ocean each year. The partial destruction of earth's ozone shield is one more example of how much humans have been able to disrupt the ecosystem dynamics and the biosphere.

Sustainable development and biodiversity conservation

Ecologists have used the concept of sustainability as a tool to establish long term conservation priorities. We need to understand the interconnections of the biosphere if we are to protect species from extinction. By sustainable development, we mean economic development that meets the needs of people today without limiting the ability of future generations to meet their needs. There is need to define and acquire the basic ecological information needed to develop, manage and conserve earth's biological resources as responsibly as possible. This includes studies on interaction between climate and ecological processes and biodiversity and the ways in which productivity of natural and artificial ecosystems can be sustained. For this, we must connect life sciences with social sciences, economics and the humanities. Ecological footprint is a method to estimate the human carrying capacity of earth by calculating the aggregate land and water area in various ecosystem of a nation. People living in developed or wealthier nations have a larger ecological footprint than do people living in developing or poor nations. By reducing our orientation towards short-term gain, we can learn to value the natural processes and biodiversity that sustain us.

Several studies indicate that the functioning of ecosystems, and hence their capacity to perform ecological services is linked to conservation of biodiversity. As human activities reduce biodiversity, we may be reducing the capacity of earth's ecosystems to perform processes critical to our survival. Perhaps, it is because we do not attach a monetary value to the services of natural ecosystems. Ecologists have estimated the dollar value of earth's ecosystem services at $ 33 trillion per year which is nearby twice the gross national product of all the countries on earth (i.e. $ 18 trillion). We must work out the trade-off between cost and benefit of several development works such as building a dam or clearing forests. Thus, a combination of scientific and people's (shareholder of that region) efforts can make a significant difference in creating a truly sustainable world.

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References

Baker CS and Palumbi SR. (1994) Which whales are hunted? A molecular genetic approach to monitoring whales. Science 265: 1538 – 1539.

Dobson A and Lyles A. (2000) Black-footed ferret recovery. Science 288 – 985.

Dobson AP, Bradshaw AD and Baker AJM. (1997) Hopes for the future restoration ecology and conservation Biology. Science 277: 515 – 522.

Frankham R. (1995) Conservation Genetics. Ann. Rev. Genet. 29: 305 – 327.

Hedrick PW. (2001) Conservation Genetics? Where are we now? Trends. Ecol. 16: 629 – 636.

Johnson WE, Onorato DP, Roelke ME, Land ED, Cunningham M, Belden RC, McBride R, Jansen D, Lotz M, Shindle D, Howard J, Wildt DE, Penfold LM, Hostetler JA, Oli MK, O'Brien SJ. (2010) Genetic restoration of the Florida Panther. Science 329: 1641 – 1644.

Krebs CJ. (2001) Ecology. Benjamin Cummings.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GA, Kent J. (2001) Biodiversity hotspots for conservation priorities. Nature 403: 853 – 858.

Westemeier RL, Brawn JD, Simpson SA, Esker TL, Jansen RW, Walk JW, Kershner EL, Bouzat JL, Paige KN. (1998) Tracking the long term decline and recovery of an isolated population. Science 282: 1695 – 1698.

Wilson ED. ed. (1988) Biodiversity. Washinton, D.C., National Academy of Sciences.

Zhang Z-P, Zhong Y, Han Z-B, Zhou L, Su H-S, Wang J, Liu Y, Cheng M-S. Synthesis, Molecular Docking Analysis and Biological Evaluations of Saccharide-Modified Thiadiazole Sulfonamide Derivatives. International Journal of Molecular Sciences . 2021; 22(11):5482. https://doi.org/10.3390/ijms22115482. Chicago/Turabian Style. Zolotoordynskoe obozrenie=Golden Horde Review. Journal of Food Quality and Hazards Control. Register Journal. Visitors Counter. Today. 1484. Yesterday. 1823.Â International Journal of Zoological Investigations (IJZI) is a peer reviewed six monthly open access journal that publishes original research papers as well as review articles in all areas of Zoology. Journal is indexed by. Google. Â© 2013-2020, Open Academic Journals Index. All rights reserved. Privacy PolicyTerms and ConditionsContact Us. International Journal of Zoological Investigations- International Journal of Zoological Investigations (IJZI) is a peer reviewed six monthly open access journal that publishes original research papers as well as review articles in all areas of zoology mainly: Ã¢â,¬Â¢ Cell biology Ã¢â,¬Â¢ Toxicology Ã¢â,¬Â¢ Environmenta.Â Department of Zoology, DDU Gorakhpur University, Gorakhpur 273009, India. Email id : editor_ijzi@hotmail.com.