INTRODUCTION

Biodiversity, the variety of living things also makes the world a more beautiful and exciting place to live.

The convention on Biological Diversity defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes in which they are a part; this includes diversity within species, between species and of ecosystems.

Genetic species – includes the variation between individuals and between populations within a species.

Species diversity – refers to the different types of animals, plants and other life forms within a region.

Ecosystem diversity - means the variety of habitats found in an area.

The 158 states that signed the convention on Biological Diversity at the UN Conference on Environment and Development in Rio de Janeiro in 1992 agreed that there was a general lack of information on and knowledge of biodiversity, and that there was an urgent need to develop scientific, technical and institutional capacities to provide the basic understanding on which to plan and implement appropriate measure.

BIODIVERSITY HOT SPOTS

Most of the world biodiversity concentrations are near the equator, especially tropical rainforests and coral reefs. Only 10 to 15% live in N/America and Europe.

Ares isolated by water, deserts or mountains can also have high concentration of unique species and biodiversity.

Rainforests are experiencing biodiversity loss at rates greater than most other habitat types. The primary cause of rainforest loss is deforestation for timber, cattle grazing, and farming.

Over 200,000 square miles of the Amazon rainforest have already been lost to deforestation, with another 7-10,000 square miles being destroyed each year. Scientists have only studied a fraction of the plants, animals, and insects that live in the rainforests, and estimate that there may be thousands of species not known to science at all. We have almost certainly driven to extinction already many species that we will never know about.

Another cause of rainforest biodiversity loss is climate change. Rainforests are delicately balanced ecosystems that can be substantially affected by even small changes in climate. The first documented victim of climate change in a rainforest was the Golden Toad (see below).

Wetlands are another habitat being lost at great pace. In the 1600s, the United States is estimated to have had approximately 220 million acres of wetland; in 1997, it had 105 million acres, less than half as many. The majority of those lost were drained, filled, and converted to other uses, such as farmland and later, parking lots.

Wetlands are very important to humans for a number of reasons, including storm mitigation and water filtration. Marshes and swamps serve as barriers when storms such as hurricanes come through, substantially decreasing wind speeds and absorbing storm surges. And all wetlands filter fresh water that runs through them, removing pollutants and making it safe for human consumption.

Coral reefs are extremely sensitive to changes in ocean temperature, and "coral bleaching" results when temperatures get too high; this phenomenon will eventually kill corals if the temperature does not return to suitable levels. As of 2004, 20% of the world's coral reefs were effectively dead, with no prospect of recovering. Research indicates that much of this destruction is due to human activity, including rising sea water temperatures.

HOW DO WE BENEFIT FROM BIODIVERSITY?

We benefit from other organization in many ways, some of which we don't appreciate until a particular species or community disappears. Even seemingly obscure and insignificant organisms can play irreplaceable roles in ecological systems or be the source of genes or drugs that someday may be indispensable. The benefits include:

Food

All of our food comes from other organisms. Many wild plant species could make important contributions to human food supplies either as they are or as a source of genetic material to improve domestic crops. Noted ecologist Norman Myers estimates that as many as 80,000 edible wild plant species could be utilized by humans.

Drugs and Medicines

Living organisms provide us with many useful drugs and medicines.

The United Nations Development Programme estimates the value of pharmaceutical products derived from developing world plants, animals and microbes to be more than $30 billion per year.

Table 2. *Some Natural Medicinal Products.*

Product	Source	Use
Penicillin	Fungus	Antibiotic
Bacitracin	Bacterium	Antibiotic
Tetracycline	Bacterium	Antibiotic
Erythromylin	Bacterium	Antibiotic
Quinine	Chincona bark	Malaria treatment

Diosgenin	Mexican yam	Birth-control drug
Cortisone	Mexican yam	Anti-inflammation treatment
Cytarabine	Sponge	Leukemia cure
Bee venom	Bee	Arthritis relief
Reserpine	Rauwolfia	Hypertension drug
Allantoin	Blowfly larva	Wound healer
Aspirin	Willow tree	Malaria drug
Vincristine	Periwinkle plant	Anticancer drugs

More than half of all prescriptions contain some natural products. The United Nations Development Program estimates the value of pharmaceutical products derived from developing world plants, animals, and microbes to be more than $30 billion per year. Consider the success story of vinblastine and vincristine. These anticancer alkaloids are derived from the Madagascar periwinkle (Catharanthus roseus). They inhibit the growth of cancer cells and are very effective in treating certain kind of cancer.

Ecological Benefits

Human life is inextricably linked to ecological services provided by other organisms. Soil formation, waste disposal, air and water purification, nutrient cycling, solar energy absorption, and food production all depend on biodiversity. Total value of these ecological services is at least $33 trillion per year, or more than double total world GNP. In many environments, high diversity may help biological communities withstand environmental stress better and recover more quickly than those with fewer species.

Aesthetic and Cultural Benefits

Millions of people enjoy hunting, fishing, camping, hiking, wildlife watching, and other nature-based activities. These activities provide invigorating physical exercise, and contact with nature can be psychologically and emotionally restorative. In many cultures, nature carries spiritual connotations, and a particular species or landscape may be inextricably linked to a sense of identity and meaning. Observing and protecting nature has religious or moral significance for many people. Some religious organizations call for the protection of nature simply because it is God creation.

WHAT THREATENS BIODIVERSITY?

Extinction, the elimination of species, is a normal process of the natural world. Indeed, as one biologist puts it: extinction is a fundamental part of nature – more than 99 percent of all species that ever lived are now extinct (Jablonski, 2004: 589). In undisturbed ecosystems, the rate of extinction appears to be about one species lost every decade. Ecologist E. O. Wilson estimates that we are losing 10,000 species or subspecies a year. That makes more than 27 per day!

Natural Causes of Extinction

Studies of the fossil record suggest that more than 99 percent of all species that ever existed are now extinct. Most of the species were gone before humans came on scene. Periodically, mass extinctions have wiped out vast numbers of species and even whole families (Table 2).

The best studied of these events occurred at the end of the Cretaceous Period when dinosaurs disappeared, along with at least 50 percent of existing species. Current theories

suggest that these catastrophes were caused by climate change, perhaps triggered when large asteroids struck the earth.

Table 2: Mass extinction

HISTORIC PERIOD	TIME BEFORE PRESENT	EFFECTS
Ordovician	444 million	25% of all families extinct
Devonian	370 million	19% of all families extinct
Permian	250 million	54% of families, 90% OF SPECIES EXTINCT
Triassic	210 million	23% of families, half species extinct
Cretaceous	65 million	17% of families, half of species extinct (Including dinosaurs but not mammals)
Quaternary	Present	1/3 to 2/3 of all species extinct if present trends continue.

Species Loss as Natural Process

New species are constantly being added to the planet through mutation and natural selection. This is a natural process that has been going on since the beginning of life on earth.

By the same process, species are constantly becoming extinct. There are a number of biological causes of species loss. Biological causes of extinctions can be thought of as changes in relationships; predator-prey relationships or relationships among competitors. Some examples of relationship changes include the following:

- Population fluctuations of predatory species leading to extinctions of prey species.

- New diseases resulting from genetic mutations of existing pathogens producing species extinctions.

- Existing competitors becoming more effective.

- New competitors emerge from existing species which were not competitors in the past, this can result from evolutionary changes in other organism.

HUMAN-CAUSED REDUCTIONS IN BIODIVERSITY

Habitat Destruction and Modification

Human disturbance of natural habitat is the largest single cause of loss of biological diversity. Over the past 10,000 years, billions of hectares of forests, woodlands, and grasslands have been converted to commercial forests, croplands, or grazing lands. Habitat loss and degradation was the most pervasive threat to birds, mammals and plants, according to the 2004 IUCN Red list, affecting 86 percent of all threatened birds, 86 percent of the threatened mammals assessed and 88 percent of threatened amphibians (IUCN, 2004).

Fragmentation

In addition to loss of absolute habitat area, a serious problem is habitat fragmentation - the reduction of habitat into smaller and smaller, more scattered patches. Fragmentation reduces biodiversity because many species, such as bears and large cats, require large territories to subsist. Other species, such as forest interior birds, reproduce successfully only in deep forest or other habitat far from edges and human settlement.

Fragmentation also divides populations into isolated groups. Small, isolated populations are vulnerable to catastrophic events, such as a single storm or disease outbreak.

Very small populations may not have enough breeding adults to be viable even under normal circumstances.

Hunting and Fishing

Over harvesting is responsible for depletion or extinction of many species. A classic example is the extermination of the American passenger pigeon (Ectopistes migratorius). Even though it inhabited only eastern North America, 200 years ago, this was the world's most abundant bird with a population of between 3 and 5 billion. This species once accounted for about one-quarter of all birds in North America. In 1830, John James Audubon saw a single flock of passenger pigeons estimated to be ten miles wide, hundreds of miles long, and thought to contain perhaps a billion birds. In spite of this vast abundance, market hunting and habitat destruction caused the entire population to crash in only about 20 years between 1870 and 1890. The last known wild bird was shot in 1900, and the last existing passenger pigeon, a female named Martha, died in 1914 in the Cincinnati Zoo.

Fish stocks have been seriously depleted by over harvesting in many parts of the world, mostly because of a huge increase in fishing fleet size and efficiency in recent years. Defenders of wildlife estimates that poachers kill a million metric tons of game for the bush meat trade every year, helping to reduce chimpanzee populations by 95 percent and vastly reducing gorilla and orangutan populations.

Commercial Products and Live Specimens

Despite international bans on trade in products from endangered species, smuggling of furs, hides, horns, live specimens, and folk medicines amounts to millions of dollars each year. The trade in wild species for pets is an enormous business.

Predator and Pest Control

Some animal populations have been greatly reduced, or even deliberately exterminated, because they are regarded as dangerous to humans or livestock, or because they compete with our use of resources. Every year, U.S government animal control agents trap, poison, or shoot thousands of coyotes, bobcats, prairie dogs, and other species considered threats to people, domestic live stocks, or crops.

Exotic Species Introductions

Aliens introduced into habitats where they are not native are one of the greatest threats to biodiversity worldwide. Exotics can be thought of as biological pollution. Freed from the predators, parasites, pathogens, and competition that kept them in check in their native home, formerly mild-mannered species can turn into super-aggressive "weedy" invaders in a new habitat.

Accidental introductions of new species can present major problems, too. Mosquitoes were accidentally introduced into Hawaii in 1826 when they arrived on sailing ships. The mosquito carried several diseases of birds to which the native bird populations were particularly susceptible.

Pollution

We have known for a long time that toxic pollutants can have disastrous effects on local populations of organisms. A pesticide-linked decline of fish-eating birds and falcons was documented in the 1970s. Marine mammals, alligators, fish and other declining suggest complex interrelations between pollution and health.

Genetic Assimilation

Some rare and endangered species are threatened by genetic assimilation because the crossbreed with closely related species that are more numerous or more vigorously.

EFFECTS OF BIODIVERSITY LOSS

Biodiversity may not seem very important for humans, but it is! The living organisms of the world are critical to many aspects of human life, all of which will be affected as biodiversity is lost.

Energy

Wood and wood-based charcoal provide a large percentage of energy used for heating and cooking around the world, especially in rural or developing areas. Loss of biodiversity will reduce the amount of wood and the variety available for these purposes.

Food supply

Many communities rely on the biodiversity around them for food, especially when natural disasters strike. In many developing regions where drought or flooding are frequent dangers, it is important for people to have secondary food sources to turn to that are adapted to these conditions and are available when the need arises. In addition, having monoculture crops can be extremely dangerous when a pest or disease arises that affects that crop. The Irish potato famine, which was caused by a fungus that specifically infects potatoes, is a good example. It killed between 500,000 and 1 million people and caused several million more to evacuate Ireland. For many of those people, potatoes were their sole source of food.

Environmental Buffers

Coral reefs and wetlands such as mangroves and marshes provide excellent barriers against storms and flooding. Coastal communities are especially vulnerable to the effects of these natural disasters, and removal and conversion of wetlands worldwide has worsened conditions during times of flood.

Medicines

Many important drugs are derived from biodiversity, and of these a large percentage cannot be manufactured artificially; they must come from the source organism. Examples include the antibiotic penicillin, which comes from a fungus, and digitalis, used to treat heart conditions, which comes from the foxglove plant. There are likely thousands of microorganisms and plants that have potential medical uses which have not yet been discovered.

Pest Control

Almost all species have natural predators, other organisms that eat them, infect them, and otherwise control their abundance. As we exterminate species, there is no way of knowing what other creatures we may be allowing to thrive in their absence.

Pollination

Plants require pollination to produce seeds and fruit, and many of the plant-based foods we enjoy consuming need to be pollinated by insects or birds. Pollinators are beginning to decline in abundance globally, resulting in fewer seeds or fruit, or seeds that are less viable to produce the next generation of plants.

Erosion Control

Plants are excellent at preventing erosion. Their roots hold soils in place and stabilize slopes and fields alike. As deforestation occurs, mudslides become more frequent and fresh water quality declines as soils are washed into rivers and lakes.

Livelihoods

Millions of people world-wide make their livings from biodiversity. People who farm, fish, or create crafts or furniture from natural sources will be in danger of losing their livelihoods if the species they depend on begin to decline. In some cases this is paradoxical, since over fishing and over hunting contribute to the very loss that will eventually make the fishers and hunters unable to support themselves.

Clean Water

Watershed destruction and deforestation lead to decreased quality of drinking water, which has greatest effects in rural and developing areas. Wetlands also serve water-filtering purposes that are lost when they are destroyed or converted.

Spiritual

Many people around the world value various ecosystem components in their religious and spiritual belief systems. As this biodiversity is lost, it will affect culture and quality of life of many.

Raw Materials

Many raw materials and resources come from the biological world, including wood for building, fabrics and fibers such as cotton, hemp, and raffia, dyes, resins, gums, rubbers, and oil.

PROTECTING BIODIVERSITY

1.   Using Geographical Information System (GIS) to Protect Biodiversity

A GIS includes computer programs that map, manage, and analyze information about the environment together with environmental data when scientists overlay, integrate, or model information such as species distribution, habitat and land cover areas, or water resources, computer mapping software and data provide efficient tools for investigation. One of the most important conservation biology projects using GIS today is the Gap Analysis Program (GAP). The idea behind GAP is that many biologically diverse biomes and habitats are not sufficiently protected. They represent "gaps" in conservation programs. To preserve long term biodiversity, scientists in this program hope to fill as many of those gaps as possible by identifying and preserving important areas.

2.   Hunting and Fishing Laws:

By the 1890s, most states had enacted some hunting and fishing restrictions. The general idea behind these laws was to conserve the resource for future human use rather than to preserve wildlife for its own sake. The wildlife regulations and refuges established since that time have been remarkably successful for many species.

3.   The Endangered Species Act

Simply identifying species at risk can initiate protection. Globally, the World Conservation Union maintains a "Red List" of threatened species, and increasingly, countries are developing their own lists. In North America, the U.S Endangered Species Act (ESA) of 1973 and the committee on the status of endangered wildlife in Canada in 1976 represented powerful new approaches to wildlife protection.

Endangered Species: are those considered in imminent danger of extinction, while **Threatened Species** are those that are likely to become endangered – at least locally- within the foreseeable future. Bald eagles, gray wolves, brown bears, and sea otters, for instance, together with a number of native orchids and other rare plants, are considered locally threatened even though they remain abundant in other parts of their former range.

Vulnerable species: are naturally rare or have been locally depleted human activities to a level that puts them at risk.

The ESA regulates a wide range of activities involving endangered species, including "taking" (harassing, harming, pursuing, hunting, shooting, trapping, killing, capturing, or collecting) species either accidentally or on purpose, and importing, exporting, selling, or possessing endangered species, parts, or products. Violators of the ESA are subject to fines up to $100,000 and one year imprisonment, as well as loss of vehicles and equipment used in the violation.

Table 3: Endangered and Threatened species, U.S and Foreign, listed by USFWS

Mammals	357
Birds	279
Reptiles	123
Amphibians	31

Fish	153
Invertebrates	203
Plants	746

Source: Data from U.S fish and wildlife service, 2002.

3.   Recovery Plans:

Once a species is officially listed as endangered, the U.S fish and wildlife service must prepare a recovery plan detailing how populations will be rebuilt to sustainable levels. Negotiating the costs, politics, local economic interests, and biological species requirement can take years. Some recovery plans have been gratifyingly successful. The American alligator was listed as endangered in 1967 because hunting (for meat, skins, and sport) and habitat destruction had reduced populations to precarious levels. Protection has been so effective that the species is now plentiful throughout its entire southern range.

4.   Re-introduction

An endangered species can be restored by re-introducing it to its former habitat once the major threats to its survival have been removed. Re-introduction is expensive, so it has been attempted for only a few species. It usually requires raising animals in captivity and intensive management after release. For the falcon, re-introduced populations rebounded because the principal threat DDT had been removed from its food chain. In a major triumph for endangered species activists, the bird was removed from the endangered species list in 2001.

5.   Private and Critical Habitat

Private land is essential in endangered species protection. Eighty percent of the habitat for more than half of all listed species is on non-public property. The U.S supreme court has ruled that destroying habitat is as harmful to endangered species as directly taking (taking) them. The US fish and wildlife service has been negotiating agreements called Habitat Conservation Plans (HCP) with private land owners. Under these plans, land-owners are allowed to harvest resources or build on part of their land as long as the species benefits overall. By improving habitat in some areas, funding conservation research, removing predators and competitors, or other steps that benefit the endangered species, developers are allowed to destroy habitat or even "take" endangered species.

6.   Re-authorizing the endangered species acts:

The ESA officially expired in 1992. Since then, Congress has debated many alternative proposals, ranging from outright elimination to substantial strengthening of the act. Many people believe that the law puts the welfare of plants and animals above that of humans. On the other hand, much of the public also supports the ESA and the goal of protecting natural beauty and biodiversity.

7.   International Wildlife Treaties:

The 1975 Convention on International Trade in Endangered Species (CITES) was a significant step toward worldwide protection of endangered flora and fauna. It regulates trade in living specimens, but has not been foolproof.

8.   Imparting Environment Education:

Educating people from all walks of life regarding eco-friendly practices goes a long way in conservation of plant and genetic biodiversity.

9.   Population Control

Effective population control measures have to be taken as a top-priority issue in the national agenda by involving people of all political parties, religious faiths and social organizations. Suitable incentives and disincentives should be in built into the strategies specially formulated for this purpose.

10.   Reviewing the Agricultural Practice

We should refrain from temptation of high yields and making a fast buck at the cost of sustainable development. We should try to infuse diversity in our agricultural practices by restoring to mixed cropping, polyculture and tolerance to wild, plants and other life forms around our agricultural fields.

11.   Controlling Urbanization

Ever increasing urbanization and expansion of urban settlements should be controlled. Biological diversity should be infused into the urban localities.

12.   Enacting, Strengthening and Enforcing Environmental Legislations

Existing environmental laws against ecologically unsound practices should be strengthened and enforced ruthlessly.

13.   Conserving Biodiversity in Seed-Banks and Gene Banks

Most of the plants species form seeds with variable periods of dormancy after which they can be germinated to yield daughter plants. The seeds can be stored in seed-banks or gene banks or germ plasm banks. The germ plasm of a plant is any of its parts from which new plants can be generated.

14. Restoration of Biodiversity

By restoring both the extent and quality of important habitats, restoration programme provides refuge for species and genetics resources that might be lost otherwise. The techniques to restore ecosystem include; vegetation planting to control erosion, fertilization of existing vegetation to encourage growth, removal of contaminated soil etc.

15. Biodiversity Inventories

Current scientific understanding of ecological processes has to be strengthened by adequate research efforts aimed at improving methodologies, distributional and status information. Strategies based on sound information will ultimately provide the basis for pragmatic policies and management decisions.

16. Conserving Biodiversity in Protected Habitat

The two basic approaches to the wildlife conservation in protected habitats are as follows.

(a). Ex-situ conservation: It means the wildlife conservation in captivity under human care. In this, the endangered plant and animals are collected and bred under controlled conditions in gardens, zoos, sanctuaries etc.

(b). In-situ conservation: This involves setting aside large portions of earth surface for wildlife. However, many protected habitats are used for logging, tourism and profitable activities.

REFERENCES

Arvind Kumar (2004). A textbook of Environmental Science pp 127-132.

Daniel B. Botkin & Edward A. Keller (1998) Environmental science Earth as a living planet pp 129-139.

Gareth Jones (2004). People and Environment, pp 208-220

Gtylermiller J.R. (2006) Miller Environment Science, pp 607 – 629

Jablonski, D (2004) Extinction: past and present. Nature, 427:589

Nick Middleton (2008). The Global Casino: An Introduction to Environmental Issues pp 296-317

Rainforest facts (1996). Pp 1-23.

Thomas M. Smith and Robert Leo Smith (2006). Elements of Ecology, pp 602-629.

Williams P. Cunningham (2004). Principles of Environmental Science, pp 107-121