Plant Biodiversity

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Abstract

An overview of plant biodiversity is provided in this chapter. Details of genetic diversity, species diversity and ecosystem diversity are given. Hotspots of biodiversity and their details have also been given. Threats to biodiversity and methods of conservation are described.

Keywords

Plant biodiversity • Genetic diversity • Species diversity • Ecosystem diversity • Hotspots of biodiversity • Biodiversity conservation

6.1 Introduction

Planet Earth is endowed with a rich variety of life forms, and the teeming millions of these living organisms have been well knit by the laws of nature. The interdependence of the various life forms starting from the unicellular primary producers to the complexly built higher plants and animals is a unique feature of this green planet.

The word *biodiversity* was coined by Walter G. Rosen in 1986, and it is highly popularised during the recent times. Biodiversity, as this assemblage of life forms is referred to, has now been acknowledged as the foundation for sustainable livelihood and food security. Scientists have estimated that more than 50 million species of

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plants and animals, including invertebrates and microorganisms, occur on Earth and hardly two million of them have been described by man so far. Scientists are also aware of the immense potentials of the various life forms especially in the context of recent advances made in science and technology. The incessant human assault on forests has left indelible scars on nature. One result of the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil, in June 1992 was a *Convention on Biological Diversity* which was signed by 187 countries.

6.1.1 Definition

Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organised at many levels ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes and their relative richness and abundance.

6.2 Why Biodiversity Is Significant?

Broadly speaking biological diversity satisfies human needs in two different ways, direct and indirect. Much of the world's agricultural and pharmaceutical needs – from developing hybrid seeds to herbal cures – come from prime forests.

Biodiversity will not only help in increasing agricultural productivity but also in developing disease-resistant varieties. It was evident in the early 1970s that the epidemic called grassy stunt virus, which destroyed more than 1,60,000 ha of rice in Asia, could be controlled from a single sample of wild rice *Oryza nivara* from Central India, which was found to be the only known genetic source of resistance to the grassy stunt. Besides 20 major genes from wild for disease and pest resistance are used in rice improvement programmes.

Besides food and other basic needs, human health has gained priority in welfare programmes. Once, all medicines used to come from plant and animal resources. Worldwide medicines from plants are now worth 40 billion dollars a year. Even now 80 % of the people in the developing countries depend upon traditional medicines.

Indirect benefits include nutrient trapping, maintaining water cycles, soil production and protection of soil, absorption and breakdown of pollutants, provision of recreational, aesthetic, scientific, spiritual, etc.

It is estimated that more than 25 % of all medicines available today are derived from tropical plants. Over 40 % of all pharmaceuticals available in the USA depend on natural sources.

In 1960, a child contracting leukemia had one chance in five of survival. Since then scientists have developed a drug – vincristine – from a plant of the tropical forests. *Catharanthus roseus* (Syn. *Vinca rosea*), now allows a leukemia sufferer four chances in five of survival. The National Cancer Institute near Washington DC has screened 29,000 plant species for potential use against cancer. About 3,000 show preliminary promise, and at least 5 may come to rival vincristine. The institute believes that mass extinctions of species could represent a serious setback to the future of anticancer campaigns.

Among other medical products, the 'pill' that is swallowed by 80 million women each day contains sex hormone combinations derived from a Mexican forest yam (*Dioscorea mexicana*). Over-the-counter sales of the pill are now worth one million dollars a year.

6.3 Biodiversity in the World

6.3.1 Genetic Diversity

Genetic diversity refers to intraspecific diversity and is often measured in terms of total DNA content, genome size in terms of base pair numbers, number of genes and by some on the chromosome number, size and morphology.

Genetic diversity studies have been done not only on wild taxa but also on taxa that are domesticated/cultivated by humans. In fact more attention has been paid to the latter groups of taxa, particularly on agricultural and horticultural plants. Agriculture today is characterised by a sharp reduction in the diversity of cultivated plants. Out of an estimated total of 30,000 edible plant species, only 30 'feed the world', with the three major crops being maize (*Zea mays*), wheat (*Triticum aestivum*) and rice (*Oryza sativa*) (FAO 1996). Genetic resources can be defined as all materials that are available for improvement of a cultivated plant species (Haussmann et al. 2004). Plant genetic resources are the biological basis of food security and, directly or indirectly, support the livelihoods of every person on Earth. Plant genetic resources for food and agriculture (PGRFA) consist of diversity of seeds and planting material of traditional varieties and modern cultivars, crop wild relatives and other wild plant species. These resources are used as food, feed for domestic animals, fibre, clothing, shelter and energy. The conservation and sustainable use of PGRFA are necessary to ensure crop production and meet growing environmental challenges and climate change. The erosion of these resources poses a severe threat to the world's food security in the long term.

Countries are fundamentally interdependent with regard to plant genetic resources and in particular for crop genetic resources which have been systematically developed, improved and exchanged without interruption over millennia. Food and agriculture production are dependent on genetic resources domesticated elsewhere and subsequently developed in other countries and regions. Continued access to plant genetic resources and a fair and equitable sharing of the benefits arising from their use are therefore essential for food security.

Much of the spectacular success in plant variety development of the rich industrialised countries in the north are attributed to the richness of genetic diversity at the centres of origin and primary diversity of economic species located in the poorer developing countries of the south. While the genetic indebtedness of the north to the south is widely recognised, sharing of economic benefits accruing from genetic wealth is still a matter of debate and discussion.

The advent of the era of molecular biology and recombinant DNA research has brought home the point that all forms of genetic diversity have potential commercial value and therefore needs protection. The basic feedstock for biotechnology industry is biodiversity. This is why in the global biodiversity convention, the linkages between the two have been stressed.

Worldwide 1,308 gene banks are registered in the WIEWS (World Information and Early Warning System on PGR) database (http://apps3.fao.org/wiews) and conserve a total of 6.1 million accessions, including major crops, minor or neglected crop species, as well as trees and wild plants. Of the 30 main crops, more than 3.6 million accessions are conserved ex situ.

6.3.2 Species Diversity

On this planet Earth there are about 30 million insects; 15,210 mammals, reptiles and amphibians; 9,225 birds; 21,000 fishes; about 4,80,000 plants; and 3 million other invertebrates and microorganisms. Many among them have not been identified. For example, out of 30 million insects only 7,51,000 have been identified. Figures for other organisms identified are (total number of species in brackets): mammals, reptiles, and amphibians 14,484 (15,210); birds 9,040 (9,225); fish 19,056 (21,000); plants 3,22,311 (4,80,000); and other invertebrates and microorganisms 2,76,594 (3,000,000), making a total of 1,392,485 (33,525,435) (Table 6.1). The number of angiospermous species in different countries is given in Table 6.2.

Most of the 1,700 million hectares of tropical forests, rich in biodiversity, are located in poor countries. While such forests covered barely 7 % of the land surface, they harbour half of the species of the world's flora and fauna. For instance, in a 15-ha patch of rainforest in Brunei, 700-odd species of trees have been identified, as many as in all of North America.

Table 6.1 Estimated number of species in the world

Group	Total number of species	Number of identified species	Percentage of the identified over the total species
Mammals, reptiles and amphibians	15,210	14,484	95
Birds	9,225	9,040	98
Fish	21,000	19,056	90
Plants	4,80,000	3,22,311	67
Insects	300,00,000	7,51,000	3
Other invertebrates and microorganisms	30,00,000	276,594	9
Total	335,25,435	1,392,485	4

Table 6.2 Number of angiospermous species in different countries

Country	Angiospermous species
Brazil	55,000
Columbia	45,000
Ecuador	29,000
China	27,000
Mexico	25,000
Australia	23,000
South Africa	21,000
Indonesia	20,000
Venezuela	20,000
Peru	20,000
India	17,000

Species Richness Species richness has become an important component of biodiversity assessment. Now it is very commonly used as a synonym of species diversity. Similarly, global biodiversity is very often considered in terms of global number of species in each of the different taxonomic groups. In other words, measures of biodiversity for particular areas, habitats or ecosystems are often largely reduced to a straightforward measure of species richness (Krishnamurthy 2003). Although species richness data may provide relatively little ecologically significant information, in practice such data are the most easily derived. Thus, they are perhaps the most useful indices for comparisons of diversity on a larger geographical scale. Moreover, at present species richness data are the only type of information available for most areas of the world. Such data are also important for prioritising conservation strategies since they allow identification of geographic regions of the world with exceptional or with very poor diversity.

One of the major limitations with species diversity measures is that they treat all species (even within a specific group of organisms) equally, i.e. they take no account of differences between species in relation to their place in a natural hierarchical system. A taxic diversity approach, therefore, is based on the view that 'individual species vary enormously in the contribution they make to diversity because of their taxonomic position'. Taxonomically isolated species or species of taxonomically isolated genera are of very great value (e.g. *Ginkgo biloba*) in diversity assessment in an area. An area containing taxonomically diverse species is considered to have greater diversity than an area with closely related species in equal numbers.

Species Abundance As just mentioned, simple species richness data may have very limited ecological value. More meaningful are measures of species abundance, especially relative abundance of different species in an area. In general, as remarked earlier, the more equally abundant the various species in an area or ecosystem, the more diverse it is considered. Species abundance data will provide meaningful interpretation of population size of any species in any area. Population is the basic unit of studying genetic diversity in a species taxon.

6.3.3 Ecosystem Diversity

The wide variety in physical features and climate situations have resulted in a diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems, which harbour and sustain the immense biodiversity.

6.3.3.1 Forest Ecosystem

A forest ecosystem is a natural woodland unit consisting of all plants, animals and microorganisms (biotic components) in that area functioning together with all the nonliving physical (abiotic) factors of the environment.

6.3.3.1.1 Types of Forests

Forests can be classified in different ways and to different degrees of specificity. One such way is in terms of the 'biome' in which they exist, combined with leaf longevity of the dominant species (whether they are evergreen or deciduous). Another distinction is whether the forests are composed predominantly of broadleaf trees, coniferous (needle-leaved) trees or mixed.

Boreal forests occupy the subarctic zone and are generally evergreen and coniferous.

Temperate zones support both broadleaf deciduous forests (e.g. temperate deciduous forest) and evergreen coniferous forests (e.g. temperate coniferous forests and temperate rainforests). Warm temperate zones support broadleaf evergreen forests, including laurel forests.

Tropical and subtropical forests include tropical and subtropical moist forests, tropical and subtropical dry forests and tropical and subtropical coniferous forests.

Physiognomy classifies forests based on their overall physical structure or developmental stage (e.g. old growth vs. second growth).

Forests can also be classified more specifically based on the climate and the dominant tree species present, resulting in numerous different forest types (e.g. ponderosa pine/Douglas-fir forest). A number of global forest classification systems have been proposed, but none has gained universal acceptance. UNEP-WCMC's forest category classification system is a simplification of other more complex systems (e.g. UNESCO's forest and woodland 'subformations'). This system divides the world's forests into 26 major types, which reflect climatic zones as well as the principal types of trees. These 26 major types can be reclassified into 6 broader categories: temperate needle leaf, temperate broadleaf and mixed, tropical moist, tropical dry, sparse trees and parkland and forest plantations. Each category is described as a separate section below.

6.3.3.1.1.1. Temperate Needle Leaf Forests

Temperate needle leaf forests mostly occupy the higher latitude regions of the Northern Hemisphere, as well as high altitude zones and some warm temperate areas, especially on nutrient-poor or otherwise unfavourable soils. These forests are composed entirely, or nearly so, of coniferous species (Coniferophyta). In the Northern Hemisphere pines (*Pinus*), spruces (*Picea*), larches (*Larix*), firs (*Abies*), Douglasfir (*Pseudotsuga*) and hemlocks (*Tsuga*) make up the canopy, but other taxa are also important. In the Southern Hemisphere, most coniferous trees (members of the Araucariaceae and Podocarpaceae) occur in mixtures with broadleaf species and are classed as broadleaf and mixed forests.

6.3.3.1.1.2. Temperate Broad Leaf and Mixed Forests

Temperate broad leaf and mixed forests include a substantial component of trees in the Anthophyta. They are generally characteristic of the warmer temperate latitudes but extend to cool temperate ones, particularly in the Southern Hemisphere. They include such forest types as the mixed deciduous forests of the USA and their counterparts in China and Japan; the broadleaf evergreen rainforests of Japan, Chile and Tasmania; the sclerophyllous forests of Australia, central Chile, the Mediterranean and California; and the southern beech *Nothofagus* forests of Chile and New Zealand.

6.3.3.1.1.3. Tropical Moist Forests

There are many different types of tropical moist forests, although most extensive are the lowland evergreen broad leaf rainforests, for example, várzea and igapó forests and the terra firma forests of the Amazon basin; the peat swamp forests and dipterocarp forests of Southeast Asia; and the high forests of the Congo Basin. Forests located on mountains are also included in this category, divided largely into upper and lower montane formations on the basis of the variation of physiognomy corresponding to changes in altitude.

6.3.3.1.1.4. Tropical Dry Forests

Tropical dry forests are characteristic of areas in the tropics affected by seasonal drought. The seasonality of rainfall is usually reflected in the deciduousness of the forest canopy, with most trees being leafless for several months of the year. However, under some conditions, e.g. less fertile soils or less predictable drought regimes, the proportion of evergreen species increases and the forests are characterised as 'sclerophyllous'. Thorn forest, a dense forest of low stature with a high frequency of thorny or spiny species, is found where drought is prolonged and especially where grazing animals are plentiful. On very poor soils, and especially where fire is a recurrent phenomenon, woody savannas develop (see Sect. 6.3.3.1.1.5).

6.3.3.1.1.5. Sparse Trees and Parklands

Sparse trees and parkland are forests with open canopies of 10–30 % crown cover. They occur principally in areas of transition from forested to non-forested landscapes. The two major zones in which these ecosystems occur are in the boreal region and in the seasonally dry tropics. At high latitudes, north of the main zone of boreal forest or taiga, growing conditions are not adequate to maintain a continuous closed forest cover, so tree cover is both sparse and discontinuous. This vegetation is variously called open taiga, open lichen woodland and forest tundra. It is species poor, has high bryophyte cover and is frequently affected by fire.

6.3.3.1.1.6. Forest Plantations

Forest plantations, generally intended for the production of timber and pulpwood, increase the total area of forest worldwide. Commonly monospecific and/or composed of introduced tree species, these ecosystems are not generally important as habitat for native biodiversity. However, they can be managed in ways that enhance their biodiversity protection functions and they are important providers of ecosystem services such as maintaining nutrient capital, protecting watersheds and soil structure as well as storing carbon. They may also play an important role in alleviating pressure on natural forests for timber and fuel wood production.

6.3.3.2 Grasslands

Grasslands, which are also known at steppes, prairies, pampas and savannas in various parts of the world, are vegetation types with predominance of grass and grass-like species.

Grasslands are an important part of the Earth's many ecological communities, originally covering as much as 25 % of the Earth's surface. They have provided expansive grazing land for both wild and domesticated animals and offered flat areas that have been ploughed to grow crops. Grasslands occur in areas with hot summer temperatures and low precipitation. Areas with less rainfall are deserts and areas with more rainfall tend to be forested. There are two broad types of grasslands in the world: tropical savannah and temperate grassland.

6.3.3.2.1 Tropical Savannah

Tropical savannah occurs in Africa, Australia, South America and Indonesia. Rainfall of 50–130 cm a year is concentrated in 6–8 months with drought the rest of the year. Soils are usually very thin, supporting only grasses and forbs (flowering plants), with only scattered trees and shrubs. Differences in climate and soils create many variations in the plant communities and animal species throughout the savannah. In many areas, the grasslands have been burned to maintain a healthy grass crop for grazing animals. In some areas the savannah has been expanded by cutting the forest and burning the area each year to prevent the return of trees.

6.3.3.2.2 Temperate Grasslands

Temperate grasslands have less rainfall (25–90 cm) than tropical grasslands and a much greater range of temperatures from winter to summer than savannah. There are two broad types of grasslands in temperate latitudes: prairie and steppe.

6.3.3.2.3 Prairie Grasslands

Prairie grasslands are found across the globe. They have a variety of names in other parts of the world: pampas in South America, veldt in South Africa and puszta in Hungary. These areas have deep, rich soils and are dominated by tall grasses; trees and shrubs are restricted to river valleys, wetlands and other areas with more moisture. Over the years the native grass species on the extensive areas of level ground have been ploughed and fields seeded. Many of these grasslands have been lost to cereal crops.

6.3.3.2.4 Steppe Grasslands

Steppe grasslands receive only 25–50 cm of rainfall each year and the grasses are much shorter than those on prairie grasslands. They are also not as widespread, occurring only in Central and Eastern Europe, Northern Eurasia and Western North America.

6.3.3.3 Wetland Ecosystem

Wetlands are transitional zones that occupy intermediate position between dryland and open water. These ecosystems are dominated by the influence of water; they encompass diverse and heterogenous habitats ranging from rivers, flood plains and rain-fed lakes to swamps, estuaries and salt marshes.

Wetlands are productive ecosystems which serve as habitat for a variety of plants and animals. Wetlands perform essential functions including flood control, natural sewage treatment, stabilisation of shorelines against wave erosion, recharging of aquifiers and supporting rich biodiversity. Many wetlands serve as the winter habitats for migratory birds.

Many of the wetland areas have been drained and reclaimed for agricultural and urban expansion. Siltation problems particularly in shallow wetlands are also subjected to the stresses such as agricultural run-offs, pesticides and construction of dams and barrages.

Wetlands are found throughout the world except in Antarctica. The world has 7–9 million km^2 of wetland which is 4 to 6 % of the land surface. 56 % of the 4–6 % of land surface is found in the tropical and subtropical regions. In 1987 Matthews and Fung estimated the extent of wetlands in the world by climatic zones they found: polar/boreal 2.7 million km^2, temperate 0.7 million km^2, subtropical/tropical 1.9 million km^2, rice paddies 1.5 million km^2 and total wetland area 6.8 million km^2.

6.3.3.3.1 Major Wetland Regions of the World

South America – The Orinoco River Delta of Venezuela covers 36,000 km^2 and is dominated by brackish shoreline by mangrove forests. It enters the Caribbean.

The Llanos: Located on the western part of the Orinoco River found in western Venezuela and northern Colombia covers 450,000 km^2. It is one of the largest inland wetland areas of South America. Winter wet season with a summer dry season gives rise to yearly flooding. Dominated by savannah grasslands and scattered palms.

The Amazon River: Covers 300,000 km^2, 3,000 km long and the river floods 5–15 m high yearly. It is considered as the world's single largest river, with a flow that results in about one-sixth to one-fifth of all the fresh water in the world.

The Pantanal: One of the largest wetlands in world located in southwestern Brazil. Covers 140,000 km^2 four times the size of the Florida Everglades, with about 131,000 km^2 of that area flooded annually. It is a haven to 650–700 species of birds.

6.3.3.3.1.1. Europe

1. Mediterranean Sea Deltas: The Rhone River Delta created France's most important wetland, the Camargue. Covers about 9,000 km^2. Highly affected by a hot, dry summer and

cool, wet winters. Home to one of the world's 25 major flamingo nesting sites.

2. Coastal marshes of Northern Europe: Extensive salt marshes and mud flats are found along the Atlantic Ocean and the North Sea coastlines of Europe. Mostly grass-type marshes.
3. Rhine River Delta: It is a major transportation artery in Europe. Much of the Netherlands is on the Rhine River Delta.
4. Peatlands: About 3.46 million km^2 of northern boreal and subarctic peatland exist, more than half of the world wetlands. Predominately found in the Old World, Ireland, Scandinavia, Finland and Russia. Mostly made up of decomposed sphagnum moss.

6.3.3.3.1.2. Africa

An abundance of wetlands is found in sub-Saharan Africa such as the Congo River swamps, Inner Niger Delta, Sudd of the Upper Nile and the Okavango Delta.

Sudd of the Upper Nile: Rainforest where the Blue and White Nile meet in the southern Sudan.

Nile Delta: It used to be a huge delta; the land has been converted to farm land. It no longer floods due to the Aswan Dam.

Okavango Delta: A vast number of rivers, channels, island and lagoons are diverted to the Okavango Delta. Along the coast, there are many mangrove forests.

6.3.3.3.1.3. Australia

Wetlands are distinctive due to seasonal dryness from high evaporation rates and low rainfall. Saline wetlands and lakes are common as a result of the high evaporation rates.

6.3.3.3.1.4. New Zealand

It is one location in North Island which has all seven types of wetlands. It has lost 90 % of its wetlands. South Island receives 2–10 m annually of rain and has several types of wetlands.

6.3.3.3.1.5. Asia

Most of its wetlands have been converted for agriculture. South Asia and Southeast Asia have the biggest wetlands. Some of the major rivers are the Indus, Ganges, Chao Phraya, Mekong and Red. The Mekong begins at the Tibet Plateau and runs through China, Laos, Cambodia and Vietnam draining 625,000 km^2. It is estimated that 20 million people receive their protein from fishing in these areas.

China: Approximately 650,000 km^2 of wetlands and Pearl and Yangtze River Deltas. Of that, 250,000 km^2 have been reserved.

6.3.3.4 Coastal and Marine Ecosystem

The coastal-marine ecosystem refers to the marine region extending from the 'upper tidal limits out across the continental shelf, slope and rise'; it thus includes rocky shores, sandy beaches, kelp forests, subtidal benthos and the water column over the shelf, slope and rise. Marine ecosystems cover approximately 71 % of the Earth's surface and contain approximately 97 % of the planet's water. They generate 32 % of the world's net primary production. The coastal-marine system generally encompasses the exclusive economic zones of nations and is approximately 200 nautical miles wide with a 440,000 km long continental profile. The coastal-marine system remains largely neglected despite its very huge productivity. Hayden et al. (1984) described 21 types of oceanic and coastal-marine realms and 45 coastal provinces.

6.3.3.4.1 Mangroves

Mangroves are salt-tolerant ecosystems in tropical and subtropical regions. These ecosystems are largely characterised by assemblage of unrelated tree genera that share the common ability to grow in saline tidal zones. The evergreen broad-leaved trees of mangrove forests are highly adapted to the stresses of flooding and salinity.

Mangroves are various types of trees up to medium height and shrubs that grow in saline coastal sediment habitats in the tropics and subtropics. The remaining mangrove forest areas of the world in 2,000 were 137,760 km^2. The mangrove biome is a distinct saline woodland or shrub land habitat characterised by depositional coastal environments, where fine sediments (often with high organic content) collect in areas protected from high-energy wave action. Mangroves dominate three-quarters of tropical coastlines. The saline conditions tolerated by various mangrove species range from brackish water, to pure seawater, to water concentrated by evaporation, to over twice the salinity of ocean seawater. Healthy mangrove forests provide a vast array of important co-benefits to coastal communities around the world. These benefits include ecosystem services such as a rich cultural heritage, the protection of shorelines from storms, erosion or sea-level rise, food from fisheries, maintenance of water quality and landscape beauty for recreation and ecotourism. In a 'Blue Carbon' context, these ecosystems also store and sequester potentially vast amounts of carbon in sediments and biomass.

6.3.3.5 Desert Ecosystems

Deserts are arid regions, generally receiving less than 10 in. of precipitation a year, or regions where the potential evaporation rate is twice as great as the precipitation. Desert ecosystem is characterised by low precipitation, arid lands, with expanse of sands, rock or salt, which are largely barren except for sparse or seasonal vegetal cover.

The world's deserts are divided into four categories. Subtropical deserts are the hottest, with parched terrain and rapid evaporation. Although cool coastal deserts are located within the same latitudes as subtropical deserts, the average temperature is much cooler because of frigid offshore ocean currents. Cold winter deserts are marked by stark temperature differences from season to season, ranging from 100 °F (38 °C) in the summer to 10 °F (−12 °C) in the winter. Polar regions are also considered to be deserts because nearly all moisture in these areas is locked up in the form of ice.

Subtropical deserts include Sahara desert (3.5 million sq mi in Morocco, Western Sahara, Algeria, Tunisia, Libya, Egypt, Mauritania, Mali, Niger, Chad, Ethiopia, Eritrea, Somalia), Arabian desert (1 million sq mi in Saudi Arabia, Kuwait, Qatar, UAE, Oman, Yemen), Kalahari desert (2,20,000 sq mi in Botswana, South Africa, Namibia), Australian deserts (Gibson – 1,20,000 sq mi; Great Sandy – 1,50,000 sq mi; Simpson and Sturt Stony – 56,000 sq mi), Mojave (54,000 sq mi, USA), Sonoran (1,20,000 USA Mexico), Chihuahuan (1,75,000 sq mi in Mexico, USA) and Thar desert (over 1,75,000 sq mi in India and Pakistan). Cool coastal deserts include Namib (13,000 sq mi in Angola, Namibia, South Africa) and Atacama (54,000 sq mi in Chile). Cold winter deserts include the Great Basin and Colorado Plateau in USA; Patagonian in Argentina; Karakum in Uzbekistan and Turkmenistan; Kyzyl kum in Uzbekistan, Turkmenistan and Kazakhstan; and Iranian desert and Gobi desert in China and Mongolia, while Polar deserts include Arctic and Antarctic.

6.4 Hotspots of Biodiversity

Biodiversity hotspots are a method to identify those regions of the world where attention is needed to address biodiversity loss and to guide investments in conservation. They are first developed by Norman Myers in 1988 to identify tropical forest 'hotspots' characterised both by exceptional levels of plant endemism and by serious levels of habitat loss. Myers subsequently updated the concept in 1990, adding eight hotspots, including four in Mediterranean regions. Conservation International adopted Myers' hotspots as its institutional blueprint in 1989, and in 1996, the organisation made the decision to undertake a reassessment of the hotspots concept, including an examination of whether key areas had been overlooked. Three years later an extensive global review was undertaken, which introduced quantitative thresholds for the designation of biodiversity hotspots.

To qualify as a hotspot, a region must meet two strict criteria: it must contain at least 1,500 species of vascular plants (>0.5 % of the world's total) as endemics, and it has to have lost ≥ 70 % of its original native habitat.

Myers et al. (2000) gave the details of 25 'hotspots' of global biodiversity (Table 6.3).

Table 6.3 Hotspots of biodiversity of the world

Hotspot	Original extent	Plant species	Endemic plants
Tropical Andes	1,258,000	45,000	20,000
Mesoamerica	1,155,000	24,000	5,000
The Caribbean	263,500	12,000	7,000
Brazil's Atlantic forest	1,227,600	20,000	8,000
Choco/Darien/Western Ecuador	260,000	9,000	2,250
Brazil's Cerrado	1,783,200	10,000	4,400
Central Chile	300,000	3,429	1,605
California Floristic Province	324,000	4,426	2,125
Madagascar	494,150	12,000	9,704
Eastern arc and coastal forest of Kenya/Tanzania	30,000	4,000	1,500
Guinean forests of West Africa	1,265,000	9,000	2,250
Cape floristic province	74,000	8,200	5,682
Succulent Karoo	112,000	4,849	1,940
Mediterranean Basin	2,362,000	25,000	13,000
Caucasus	500,000	6,300	1,600
Sundaland	1,600,000	25,000	13,000
Wallacea	347,000	10,000	1,500
Philippines	300,800	7,620	5,832
Indo-Burma	2,060,000	13,500	7,000
South Central China	800,000	12,000	3,500
Western Ghats/Sri Lanka	182,500	4,780	2,180
SW Australia	309,850	5,469	4,331
New Caledonia	18,600	3,332	2,551
New Zealand	270,500	2,300	1,865

Currently, 34 biodiversity hotspots have been identified, most of which occur in tropical forests. Between them they contain around 50 % of the world's endemic plant species and 42 % of all terrestrial vertebrates but have lost around 86 % of their original habitat.

Hotspots are not formally recognised or governed areas. However, the identification of these areas as hotspots increases the likelihood of conservation investment. In addition, other designations for biodiversity conservation are likely to be present within these broad areas which may have more formal management structures. For example, the average protected area coverage of hotspots, based on IUCN protected area categories I–VI, is 10 % of their original extent.

6.5 Species Extinction

During the next 20–30 years, the world could lose more than a million species of plants and animals – primarily because of environmental changes due to humans. At 100 species per day, this extinction rate will be more than 1,000 times the estimated 'normal' rate of extinction. The list of lost, endangered and threatened species includes both plants and animals. About 10 % of temperate region plant species and 11 % of world's 9,000 bird species are at some risk of extinction. In the tropics, the destruction of forests threatens 1,30,000 species which live nowhere else. Harvard biologist E.O. Wilson estimates that the chopping down of tropical forests leads to extinction of at least 50,000 species every year – about 140 every day.

In the west during the nineteenth-century industrial revolution, forest destruction for timber industry and hunting led to extinction of several of its important wildlife species. Wolves from Scotland, bear and lynx from Switzerland, European bison from Poland, bottle-nosed dolphin from Netherlands and northern bald ibis from Spain are a few of the several species Europe has lost. These countries are now interested in spending heavily to bring back the species they have lost. It is wise to learn from the hard lessons learnt by these countries.

Presently, approximately 80 % of the world food supply is provided by fewer than two dozen species of plants and animals. In the process of depending upon such a few number of species, we are also (1) narrowing the genetic diversity of crops that we depend upon, (2) changing diverse natural areas in monocultures, (3) reducing the numbers of actual and potential ancestors of crops and domestic animals which may provide genetic material to develop new strains or races and (4) undermining the food security for a growing population.

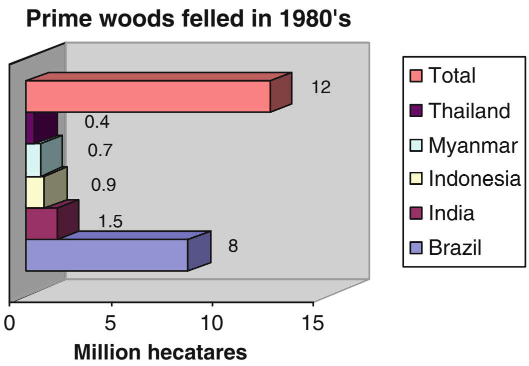
Most of the agricultural crops currently being cultivated have been selected for a particular geographic area. These cultivars may not be as productive or even viable if the climate changes and if new pests or diseases evolve. This makes even more pronounced the need to preserve genetic diversity needed to find food species, which can adopt to new conditions.

6.6 Threats to Ecosystem

Over 1.6 billion people depend directly on forests for their livelihoods across the world, and forests play a crucial role in the Earth's life support system – including the global carbon and hydrological cycles. Some areas of the world are experiencing net gains in forest cover, through the natural expansion or reforestation efforts. However, deforestation in some areas of the world continues apace, impacting livelihoods and the global climate. The UN estimates that 18 % of global carbon dioxide emissions stem from deforestation and forest degradation in developing countries. Avoiding deforestation and degradation is therefore a priority in reducing greenhouse gas emissions.

Forests cover 31 % of the world's land surface, just over 4 billion hectares. (One hectare = 2.47 acres.) This is down from the pre-industrial area of 5.9 billion hectares. According to data from the UN Food and Agriculture Organization, deforestation was at its highest rate in the 1990s, when each year the world lost on average 16 million hectares of forest – roughly the size of the state of Michigan. At the same time, forest area expanded in some places, either through planting or natural processes, bringing the global net loss of forest to 8.3 million hectares per year. In the first decade of this century, the rate of deforestation was slightly lower, but still, a disturbingly high 13 million hectares were destroyed annually. As forest expansion remained stable, the global net forest loss between 2000 and 2010 was 5.2 million hectares per year.

Mountain ecosystem takes the major negative impact of unplanned development, opening of roads, degradation of catchment areas and resultant landslides and erosion. The major threats faced by the forest ecosystem are commercial clear felling and selective clear felling; conversion for agriculture, settlements and roads; inundation for development projects like multipurpose river valley projects, shifting cultivation and conversion to monoculture; army operations; grazing; mining; fire wood collection; introduction of exotics, fire and pollution, development projects, conversion for agriculture and tree plantations; and introduction and spread of exotics.



Grasslands are one of the most threatened ecosystems. Apart from commercial pressures, they come under pressure from grazing, fire and pollution,

The lakes, marshes, river systems and other wetlands are threatened mainly by domestic pollution from untreated sewage, industrial pollutants and toxic effluents; agricultural run-offs containing residues of pesticides and chemical fertiliser; and excessive siltation from degraded catchments. Excessive withdrawal of water from the water bodies for industry, irrigation or domestic use; dredging and reclamation of water bodies; excessive fishing; and building of dams, jetties and canals are other factors adversely affecting the wetlands. A number of wetlands are reported to be seriously threatened.

Mangroves are subjected to serious threats due to their reclamation for urban development, waste disposals, oil spillage, etc. Coral reef ecosystems are threatened because of mining, blasting, dredging, collection of reef biota, coastal clearance for development, sewage disposal, discharge of effluents from industries and thermal power plants, chemical pollution and oil spillage.

The world's deserts with a high livestock population face heavy biotic pressure. Besides, expansion of mining, urbanisation and industrialisation also poses threat to this ecosystem. The expanding salt extraction has resulted in widespread disturbance in salt deserts. In the cold desert, a major destructive factor is road construction, which in turn leads to landslides and soil erosion. Other threats are overgrazing and excessive collection of fuel wood. Desertification and land degradation per se pose a potential threat to biodiversity.

Factors contributing to the loss of biodiversity are given in Table 6.4.

Table 6.4 Categories of fundamental human factors contributing to the erosion of biological activity

Factor	Example of impact on conversion
Population growth	Demographic pressure
Poverty	Hunger, deforestation, trading of species in danger of extinction, lack of popular support
Bad perception	Desire of quick results and negation of failures in the long term
Anthropocentrism	Absence of support for nonutilitarian causes
Cultural transitions	Unsustained management of resources during colonisation and quick social changes
Economy	Absence of planning as a result of the internationalisation of markets and erratic price of goods
Implementation of policies	Social crisis, wars, corruption, non-fulfilment of law

Source: Pullaiah (2012)

6.7 Conservation of Biological Diversity

Biological diversity can be preserved for posterity in two ways – in situ and ex situ. Ex situ maintenance of species is provided by botanic gardens, Zoos and aquaria and of gene pools by germplasm banks (seed stores, in vitro collections and field gene banks) and grass-root collections of plant cultivars and animal breeds. Botanic gardens probably have a greater capacity with respect to plant species. But clearly it is possible to maintain ex situ only a tiny fraction of the world's species.

Approaches to Conservation

- *In situ* Conservation
  - a) Biosphere reserves
  - b) National Parks
  - c) Wild life Sanctuaries
  - d) Wet lands
  - e) Mangroves.
  - f) Sacred groves.
  - g) Protected land scapes
  - h) Ethnobiological reserves
  - i) Reserve and Protected forests.
  - j) Preservation plots and sample plots.
- *Ex situ* Conservation
  - Whole organisms
    - i) Botanical gardens
    - ii) Arboreta
    - iii) Zoological parks.
    - iv) Aquaria
  - Part organisms (Bio-banks)
    - a) Seed pollen banks
    - b) Tissue/organ culture
    - c) Cryo preservation.
    - d) Sperm/egg/embryo.
    - e) Gene banks/Libraries.

In situ conservation is done by protecting areas rich in biodiversity. These include biosphere reserves, national parks, sanctuaries, etc. The concept of biosphere reserves is the brainchild of Man and Biosphere Programme of UNESCO. The primary objective of this concept is to save, for the present and future use, the diversity and integrity of biotic communities of plants and animals within natural ecosystems and to safeguard the genetic diversity of species on which their continuing evolution depends. Such reserves are to comprise of terrestrial and marine ecosystems and to coincide with national parks and sanctuaries.

6.7.1 In Situ Conservation

Areas of natural habitats/ecosystems protected under in situ conservation are called protected areas. Today, there are over 9,832 protected areas including 1,508 national parks, of approximately 9.25 million km^2 or about 8.2 % of the Earth's land surface. A further 40,000 smaller protected areas cover another 5 % of the land area. The goal recommended by IUCN, however, is preservation of a cross section of all major ecosystems to the extent of 13 million km^2 or about 10–12 % of the Earth's surface.

6.7.1.1 Some Biosphere Reserves of the World

1. Rainforest reserves – Albert National Park, Congo, and King George V Park, Malaysia
2. Grassland reserves – Savannah Steppe (Africa, Georgia, USA), and Prairie (Oklahoma and Montana, USA)
3. Desert reserves – Arizona Desert, South African Desert and Nevada Desert
4. Tundra reserves – Lapland Reserves, Finland

These reserves aim at conserving the biological diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of living resources.

6.7.2 In Situ Conservation of Plant Genetic Resources

Plants are the basis of life on planet Earth. Plants are the only organisms capable of using the solar energy for transforming the carbon dioxide in the air into organic substances. Consequently, plants produce food for all and reduce the global warming. Agriculture, with nurturing and utilising plant diversity, plays a key role in feeding millions and protecting our natural resources and the environment.

Plant diversity on Earth is represented by an estimated 300,000 species of higher plants. However, only about 7,000 species have been domesticated and cultivated by humans over the millennia for food and feed. Today, our nutrition anywhere in the world is supplied by a mere 30 plant species because they provide 95 % of dietary energy and protein.

While the number of cultivated plant species is relatively small and seemingly insignificant, nature has evolved an extraordinary intraspecific genetic diversity in crop plants and their wild relatives. For example, the number of rice land races in India is estimated to be 50,000 and wild rice about 200. Add to that 20 new improved varieties released each year. It is this diversity within species that allows for the cultivation of crops across different regions and in different situations such as weather and soil conditions. These invaluable and irreplaceable plant resources are called plant genetic resources (PGR). They form the basis of all crop varieties that are bred to produce more, withstand stresses and yield quality output.

Plant genetic resources for food and agriculture (PGRFA) have been systematically collected and exchanged for some 500 years. Conservation focuses explicitly on maintaining the diversity of the full range of genetic variation within a particular species or taxa. Plant genetic resources can be conserved both in situ and ex situ.

The main reasons for conserving PGRFA are to ensure the future adaptability of cultivars and wild populations, to preserve data and traits that ensure sustainable agriculture, to promote the use of genetic resources in commerce and biotechnology and to conserve genetic diversity for cultural reasons.

Ex situ conservation of genetic resources entails conservation of biological diversity components outside their natural habitats. The main storage infrastructures for such conservation techniques are gene banks; millions of accessions are now stored in hundreds of gene banks around the world for conservation and utilisation purposes.

In situ conservation of genetic resources means the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties. Common approaches for in situ conservation are Genetic reserve conservation and on-farm conservation.

6.7.3 Ex Situ Conservation

To complement in situ conservation, attention has been paid to ex situ conservation measures. Some taxa 'extinct in the wild' but conserved in the botanic gardens is given in Table 6.5.

Table 6.5 Some taxa 'extinct in the wild' but conserved in the botanic gardens (data from IUCN/WCMC and Maunder 1997)

Taxon	Native country
Anthurium leuconeura	Mexico
Arctostaphylos uva-ursi ssp. *loebreweri*	USA
Bromus verticillatus	UK
Calandrinia feltonii	Falkland Island
Ceratozamia hildae	Central America
Commidendrum rotundifolium	St. Helena
Cosmos atrosanguineus	Mexico
Erica verticillata	South Africa
Encephalartos woodii	South Africa
Franklinia alatamaha	USA
Graptopetalum bellus	Mexico
Helichrysum selaginoides	Tasmania
Lysimachia minoricensis	Minorea
Opuntia lindheimeri	USA (Texas)
Paphiopedilum delenatii	Vietnam
Sophora toromiro	Easter Island
Tecophilaea cyanocrocus	Chile
Trochetiopsis erythroxylon	St. Helena
Tulipa sprengeri	Turkey
Dombeya acutangula	Rodrigues
D. mauritiana	Mauritius
Vernonia shevaroyensis	S. India

6.8 Climate Change and Biodiversity

Levels of greenhouse gases in the atmosphere are rapidly increasing, warming the Earth's surface and lower atmosphere. Higher temperatures lead to climate change that includes effects such as rising sea levels, changes in precipitation patterns that can produce floods and droughts and the spread of vector-borne diseases such as malaria. Some areas may benefit from changes in the climate. Others, including those in least developed countries and small island developing states, may suffer greatly.

There is ample scientific evidence that climate change affects biodiversity. Climate change, according to the Millennium Ecosystem Assessment, is likely to become the dominant direct driver of biodiversity loss by the end of the century. It is already forcing biodiversity to adapt either through changing habitat, life cycles or development of new physical traits. This, in turn, will affect vital ecosystem services for all humans, such as air and water purification, pollination and production of food, decomposition and nutrient cycling, carbon sequestration, etc. Change in phenology leads to loss of synchrony between species.

Biodiversity can also help reduce the effects of climate change. The conservation of habitats, for example, can reduce the amount of carbon dioxide released into the atmosphere. Moreover, conserving mangroves can reduce the disastrous impacts of climate change such as flooding and storm surges. If we act now to mitigate greenhouse gas emissions and identify systems-based adaptation priorities, we can reduce the risk of species extinctions and limit damage to ecosystems. We can preserve intact habitats, especially those sensitive to climate change, improve our understanding of the climate change-biodiversity relationship and view biodiversity as a solution to climate change.

In marine environments, plankton species have been shifting geographically and so have fish species. In America's great estuary, the Chesapeake Bay, the southern boundary of the eel grass (*Zostera marina*) community, an important element in the ecology and productivity of the bay, has been moving steadily northward. Eel grass has a distinct upper temperature limit and as the bay has warmed the area in which it grows has decreased by 25 % as a consequence. Range shift of Edith's checkerspot butterfly (*Euphydryas editha*) moving northward and up in altitude and as the bay has warmed the area in which it grows has decreased by 25 % as a consequence population present population extinct. Tropical ecosystems are affected as well. Costa Rica's legendary Monteverde Cloud Forest is experiencing more frequent dry days as climate change raises the altitude at which clouds (virtually the sole source of moisture for cloud forests) form. It is believed that the golden toad (*Bufo periglenes*), which has not been seen in Monteverde for about 20 years, is the first species to be driven to extinction by climate change.

6.9 The Convention and Indigenous and Local Communities

The international community has recognised the close and traditional dependence of many indigenous and local communities on biological resources, notably in the preamble to the Convention on Biological Diversity. There is also a broad recognition of the contribution that traditional knowledge can make to both the conservation and the sustainable use of biological diversity, two fundamental objectives of the convention.

The Conference of the Parties has established a working group specifically to address the implementation of Article 8 (j) and related provisions of the convention. This working group is open to all parties, and indigenous and local communities' representatives play a full and active role in its work. Traditional knowledge is considered a 'cross-cutting' issue that affects many aspects of biological diversity, so it will continue to be addressed by the Conference of the Parties and by other working groups as well. In particular, in decision VII/19D, the Conference of the Parties requested the Ad Hoc Open-ended Working Group on Access and Benefit-sharing with the collaboration of the Ad Hoc Working Group on Article 8 (j) and related provisions to elaborate an international regime on access to genetic resources and benefit sharing with the aim of adopting an instrument/instruments to effectively implement the provisions in Article 15 and Article 8 (j) of the convention and the three objectives of the convention. This is an ongoing priority of the convention.

6.10 Biodiversity Prospecting

Bioprospecting is an umbrella term describing the process of discovery and commercialisation of new products based on biological resources. Bioprospecting often draws on indigenous knowledge about uses and characteristics of plants and animals. In this way, bioprospecting includes biopiracy, the exploitative appropriation of indigenous forms of knowledge by commercial actors, as well as the search for previously unknown compounds in organisms that have never been used in traditional medicine.

Natural organisms have evolved a staggering variety of chemical compounds to escape predators, capture prey, enhance reproductive success and fight infection. Some of these chemical compounds have proved to be of great value when adapted for industrial, agricultural and pharmaceutical uses. In the USA for instance, nearly 25 % of prescription medicines contain active ingredients derived from plants, while many other drugs are synthesised to replicate or improve naturally produced molecules. Today we treat leukemia with medicines derived from rosy periwinkle of Madagascar and the bark of the pacific yew tree is the source of a promising treatment for ovarian cancer.

6.11 International Organisations Involved in Biodiversity Conservation

6.11.1 IUCN: International Union for Conservation of Nature

IUCN – International Union for Conservation of Nature helps develop conservation science, manages field projects all over the world and brings together players from different domains and sectors to develop and implement policy, laws and best practice. The International Union for Conservation of Nature and Natural Resources is the most important world body of 74 sovereign states, 105 government agencies, 674 nongovernmental organisations and 32 affiliates that is concerned with the conservation of nature worldwide. The headquarters of the IUCN is situated at Gland, Switzerland. Anyone who is interested in conservation should be aware of the activities of the IUCN, its organs and publications. www.iucn.org

The Species Survival Commission (SSC) is one of the six volunteer commissions within the IUCN, with the mission to conserve biological diversity by developing and executing programmes to study, save, restore and manage wisely the species and their habitats. SSC is the source of information for IUCN on the conservation of species. On behalf of the IUCN, the SSC delivers and promotes its knowledge, advice and policies to those who can influence the implementation of conservation action. The SSC has its headquarters at the IUCN in Switzerland.

6.11.2 Conservation International

Global Conservation Fund finances the creation, expansion and long-term management of priority areas for conservation. Conservation International aims to protect life on Earth and to demonstrate that human societies will thrive when in balance with nature. It works with governments, nonprofit organisations, universities, businesses and local communities in priority regions to strengthen conservation efforts. www.conservation.org

6.11.3 World Wildlife Fund

The largest multinational conservation organisation in the world, WWF works in 100 countries and is supported by 1.2 million members in the USA and close to 5 million globally. The World

Wildlife Fund has derived a system called the ‘Global 200 Ecoregions’, the aim of which is to select priority ecoregions for conservation within each of 14 terrestrial, 3 freshwater and 4 marine habitat types. They are chosen for their species richness, endemism, taxonomic uniqueness, unusual ecological or evolutionary phenomena and global rarity. All biodiversity hotspots contain at least one of the global 200 ecoregions. www.worldwildlife.org

6.12 Biodiversity-Related Conventions

Six international conventions focus on biodiversity issues: the Convention on Biological Diversity (year of entry into force: 1993), the Convention on Conservation of Migratory Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975), the International Treaty on Plant Genetic Resources for Food and Agriculture (2004), the Ramsar Convention on Wetlands (1971) and the World Heritage Convention (1972). Each of the biodiversity-related conventions works to implement actions at the national, regional and international level in order to reach shared goals of conservation and sustainable use. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem based) and operational tools (e.g. programmes of work, trade permits and certificates, multilateral system for access and benefit sharing, regional agreements, site listings, funds).

The six biodiversity-related conventions are as follows.

6.12.1 Convention on Biological Diversity

The objectives of the CBD are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising from commercial and other utilisation of genetic resources. The agreement covers all ecosystems, species and genetic resources.

The Convention on Biological Diversity (CBD) was formed at a meeting in Rio de Janeiro in 1992 and came into force, with a membership of 133 countries, in December 1993. CBD aims to protect the world’s biological resources from further erosion or at least to slow that rate of erosion down. Till CBD came into force, living organisms were considered a common heritage of the humankind, but CBD accepts them as a sovereign property of the nation states. CBD is to promote conservation of biological diversity, a sustainable use of its components and equitable sharing of the resultant benefits. Thus, there is a difference in the objectives of the IUCN and the CBD, though basically both strive to conserve the world’s biological resources.

The Convention on Biological Diversity has three main goals:

1. Conservation of biological diversity (or biodiversity)
2. Sustainable use of its components
3. Fair and equitable sharing of benefits arising from genetic resources

2010 was the International Year of Biodiversity. The Secretariat of the Convention on Biological Diversity is the focal point for the International Year of Biodiversity. The 11th Conference of Parties (COP) to the Convention on Biological Diversity was held in Hyderabad. On 22 December 2010, the UN declared the period from 2011 to 2020 as the UN Decade on Biodiversity. They, hence, followed a recommendation of the CBD signatories during COP10 at Nagoya in October 2010.

6.12.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The CITES aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Through its three appendices, the convention accords varying degrees of protection to more than 30,000 plant and animal species.

CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES has established the international legal framework for the prevention of trade in endangered species and for an effective regulation of trade in others. Member states respect the recommendations of CITES presented in CITES Appendices and implement restriction on the trade of the listed species. CITES Appendix I lists species that are threatened while Appendix II includes the species that may become threatened with extinction if trade is not regulated. Those in Appendix III are species that require watching. Depending upon the need, species may be shifted from one to another Appendix. The CITES Appendices are periodically reviewed, the latest being the outcome of the Tenth Conference of the Parties (all those concerned with trade, governments, NGOs and conservation experts) in June 1997 in Harare, Zimbabwe.

Recently, CITES and TRAFFIC together resolved to work closely with traditional medicine communities to (a) eventually eliminate illegal trade in endangered species of medicinal plants, (b) ensure that the appropriate national legislation is in place to control trade in parts and derivatives of CITES listed species, (c) strengthen enforcement efforts, (d) promote forensic identification techniques and (e) investigate the use of substitutes and artificial propagation. www.cites.org.

Trade Records Analysis of Fauna and Flora in Commerce (TRAFFIC) is the body that monitors the volume of trade in endangered species and works in co-ordination with CITES and SSC, to assess the impact of trade, the objective being to manage trade sustainably.

6.12.3 Convention on the Conservation of Migratory Species of Wild Animals

CMS or the Bonn Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. Parties to the CMS work together to conserve migratory species and their habitats by providing strict protection for the most endangered migratory species, by concluding regional multilateral agreements for the conservation and management of specific species or categories of species and by undertaking co-operative research and conservation activities.

6.12.4 The International Treaty on Plant Genetic Resources for Food and Agriculture

The objectives of the Treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. The Treaty covers all plant genetic resources for food and agriculture, while its multilateral system of access and benefit sharing covers a specific list of 64 crops and forages. The Treaty also includes provisions on Farmers' Rights

6.12.5 Convention on Wetlands (Popularly Known as the Ramsar Convention)

The Ramsar Convention provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention covers all aspects of wetland conservation and wise use, recognising wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities.

The Ramsar List of Wetlands of International Importance now includes 2,122 sites (known as 'Ramsar Sites') covering 205,366,160 ha (507,470,800 acres) up from 1,021 sites in 2000. The nation with the highest number of sites is the UK at 169; the nation with the greatest area of listed wetlands is Canada, with over 130,000 km^2

(50,000 sq mi), including the Queen Maud Gulf Migratory Bird Sanctuary at 62,800 km^2 (24,200 sq mi). The Ramsar definition of wetlands is fairly wide, including 'areas of marine water the depth of which at low tide does not exceed six meters' as well as fish ponds, rice paddies and salt pans. Presently there are 168 contracting parties, up from 119 in 1999 and from 21 initial signatory nations in 1971. The state parties meet every 3 years as the Conference of the Contracting Parties (CCP), the first held in Cagliari, Italy, in 1980. Amendments to the original convention have been agreed to in Paris (in 1982) and Regina (in 1987).

6.12.6 World Heritage Convention (WHC)

The primary mission of the WHC is to identify and conserve the world's cultural and natural heritage, by drawing up a list of sites whose outstanding values should be preserved for all humanity and to ensure their protection through a closer cooperation among nations.

The 156 biodiversity World Heritage sites cover a total land area of 1.1 million km^2, i.e. nearly 0.8 % of the global land surface, or 6.6 % of the total extent of the world's terrestrial protected areas. Generally speaking, biodiversity World Heritage sites are very large protected areas, often involving multiple component parts in serial sites. The existing network of biodiversity World Heritage sites encompasses many outstanding protected areas that represent a wide range of global biodiversity conservation priorities. Biodiversity World Heritage sites 'represent' 31 (89 %) of the 35 biodiversity hotspots and all five high-biodiversity wilderness areas, 97 (68 %) of the 142 Global 200 terrestrial priority ecoregions, 72 (31 %) of the 234 Centres of Plant Diversity and 83 (38 %) of 218 Endemic Bird Areas

References

FAO (1996) Report on the state of the world's plant genetic resources for food and agriculture. Prepared for the international technical conference on Plant Genetic Resources, Leipzig, 17–23 June 1996, Rome

Hausmann BIG, Parzies HK, Presterl T, Sušić Z, Miedaner T (2004) Plant genetic resources in crop improvement. Plant Genet Res 2:3–21

Hayden BP, Ray GC, Dolan R (1984) Classification of coastal and marine environments. Environ Conserv 11:199–207

Krishnamurthy KV (2003) An advanced textbook on biodiversity: principles and practices. Oxford & IBH Publishing Co., New Delhi

Myers N (1988) Threatened biotas: 'hotspots' in tropical forests. Environmentalist 8:187–208

Myers N (1990) The biodiversity challenge: expanded hotspots analysis. Environmentalist 10:243–256

Myers N, Mittermeirs RA, Mittermier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403(6772):853–858

Pullaiah T (2012) An overview on biodiversity and conservation perspectives. Bioherald 29:1–14