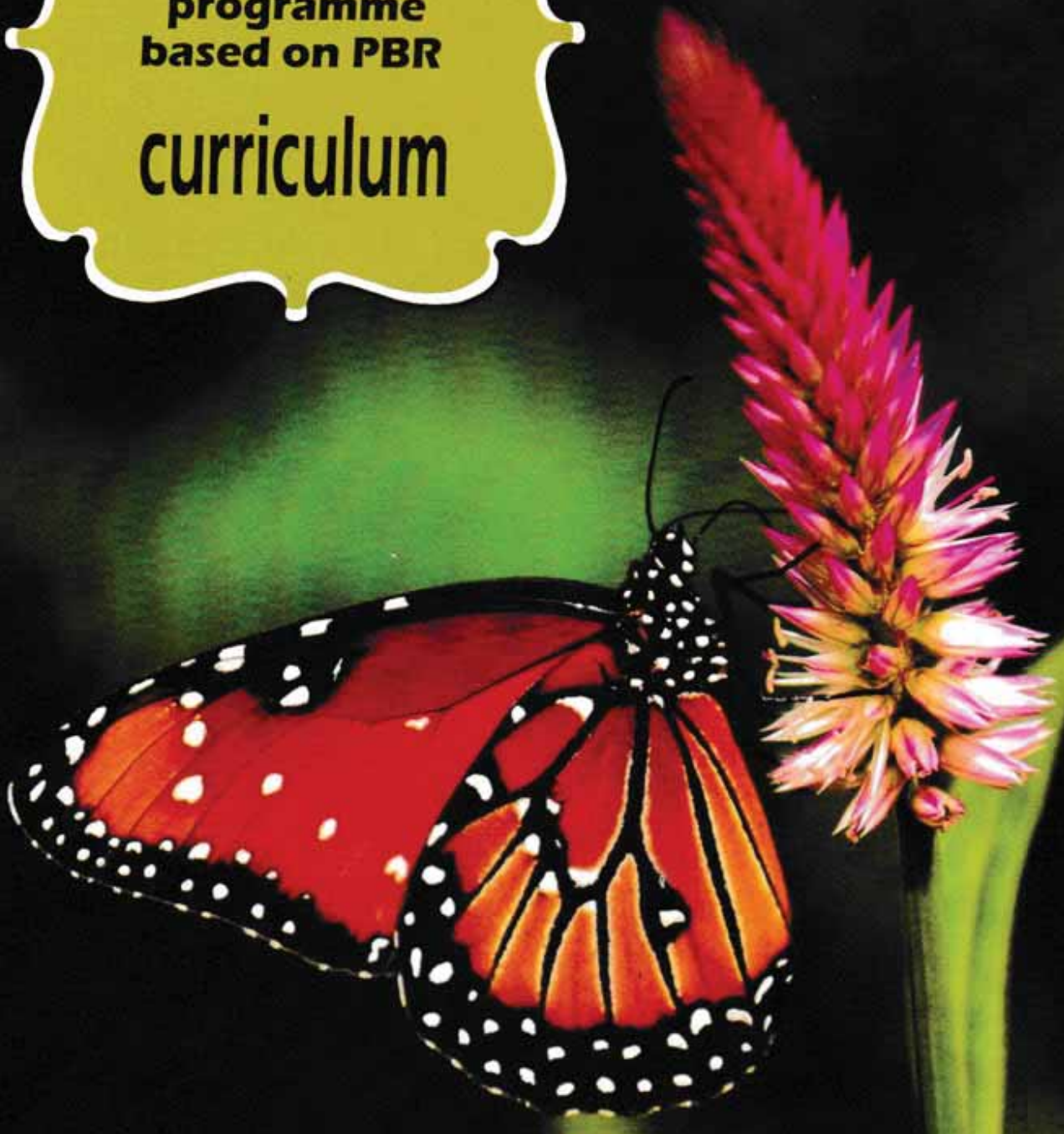
Awareness and Familiarization programme based on PBR

curriculum



KERALA STATE BIODIVERSITY BOARD
L-14, Jai Nagar, Medical College P.O
Thiruvananthapuram-695011
Phone: 0471-2554740 Fax-0471-2448234
www.keralabiodiversity.org keralabiodiversity@gmail.com

HANDBOOK

AWARENESS AND FAMILIARIZATION PROGRAMME BASED ON PBR

C U R R I C U L U M

KERALA STATE BIODIVERSITY BOARD

L-14, Jai Nagar, Medical College (P.O), Thiruvananthapuram – 695 011
Tele fax: 0471-2448234; Ph: 0471-2559134; Mobile: 9846921737
E-mail: keralabiodiversity@gmail.com; Webite: www.keralabiodiversity.org

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CHAPTER I

BIODIVERSITY

Biodiversity in general

The term 'Biodiversity' or "Biological Diversity" was first coined by Walter G. Rosen in 1985. According to Article 2 of the Convention on Biological Diversity, "Biological Diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD, 1992). Biological diversity is the total variety of life on our planet. Total number of races or species i.e. the sum total of various types of microbes, plants and animals present in a system is referred to as *Biological diversity* or simply as *Biodiversity*.

WHAT IS BIODIVERSITY

Biodiversity is the variety and variation of all species of plants, animals, fungi, and microbes, including their genetic makeup, their ecological roles, and their interrelationships in biological communities throughout the world ecosystems. Biodiversity is therefore the natural biological capital for our life support system on the planet Earth.

LEVELS OF BIODIVERSITY

Biodiversity is usually analyzed at three levels- genetic, species and ecosystem.

1. **Diversity of genetic organization within a species:**

Each species varying from lower forms to higher, store an immense amount of genetic information. The variation of genes, not only of numbers but of structure also, is of great value as it enables a population to adapt to its environment and to respond to the process of natural selection. If a species has more genetic variation, it can adapt better to the changed environmental conditions. Lower diversity in a species leads to genetic uniformity of genetically similar crop plants. This homogeneity is desirable in producing uniform quality of grain. But genetic uniformity restricts adaptability of a species to environmental stress as all the plants have same level of resistance.

India has high genetic diversity and is regarded as a Vavilov's centre of high crop genetic diversity-so named after the Russian agro-botanist N.I. Vavilov, who identified eight such centres of origin of cultivated plants around the world in 1950's.

2. **Diversity of species composition within a community**: it refers to the variations prevailing among different type of organisms, which are found in a particular habitat. So, variety of species for a particular region is considered to be species diversity.

Species diversity can be measured in terms of

Species richness: refers to the number of various species in a defined area.

Species abundance: refers to the relative numbers among species. For example the number of species of plants, animals and micro-organisms may be more in an area than that recorded in another area.

Taxonomic or Phylogenetic diversity: refers to the genetic relationships between different groups of species.

Kinds of species present in area are also important. When taxonomically unrelated species are present in an area, the area represents greater species diversity as compared to an area represented by taxonomically related species. Species diversity is not evenly distributed across the globe. The overall richness of species is concentrated in equatorial regions and tends to decrease as one moves from equatorial to polar regions. In addition biodiversity in land ecosystems generally decreases with increasing altitude. The other factors that influence biodiversity are amount of rainfall and nutrient level in soil. In marine ecosystems, species richness tends to be much higher in continental shelves.

3. **Community/ Ecosystem diversity**: Ecosystem diversity encompasses the broad differences between ecosystem, and the diversity of the habitats and ecological processes occurring within each ecosystem type. It is considered as the variation of habitat occurring within a region eg. river, fresh water etc.

Great Indian Hornbill (*Buceros bicornis*)

India has very diverse terrestrial and aquatic ecosystems ranging from ice capped Himalayas to deserts, from arid to scrub to grassland to wetlands, and tropical rainforests, from coral reefs to the deep sea. Each of these comprises a great variety of habitats and interactions between and within biotic and abiotic components. The most diverse areas are the Western Ghats and the North Eastern Regions. Majority of species found in these ecosystems are endemic.

IMPORTANCE OF BIODIVERSITY

Biodiversity is a valuable natural resource for the survival of mankind. Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play.

A healthy biodiversity system offers a number of natural services to mankind.

Ecosystem services such as

- Protection of water resources
- Soil formation and protection
- Nutrient storage and recycling
- Pollution breakdown and absorption
- Contribution to climate stability
- Maintenance of ecosystems
- Recovery from unpredictable events

Biological resources such as

Food

Medicinal resources and pharmaceutical drugs

Wood products

Ornamental plants

Breeding stocks, population reservoirs

Future resources

Diversity in genes, species and ecosystems

Social benefits such as

Research, education and monitoring

Recreation and tourism

Cultural values

"At least 40 percentage of the world's economy and 80 percentages of the needs of the poor are derived from biological resources. In addition, the richer the diversity of life, the greater the opportunity for medical discoveries, economic development and adaptive responses to such new challenges as climate change"

CHAPTER II

BIODIVERSITY AT GLOBAL LEVEL

Global biodiversity is the measure of biodiversity on planet Earth and is defined as the total variability of life forms. Biodiversity has grown and shrunk in earth's past due to (presumably) abiotic factors such as extinction events caused by geologically rapid changes in climate. Climate change which occurred 299 million years ago was one such event. A cooling and drying resulted in catastrophic rainforest collapse and subsequently a great loss of diversity, especially of amphibians. Habitat change is the most important factor currently affecting biodiversity, as some 40% of forests and ice-free habitats have been converted to cropland or pasture. Other factors are: overexploitation, pollution, invasive species, and climate change.

MEGABIODIVERSITY COUNTRIES

The megadiverse countries are a group of countries that harbor the majority of the Earth's species and are therefore considered extremely biodiverse. Conservation International has identified 17 mega diverse countries in 1998. All are located in, or partially in, tropical or subtropical regions.

The Mega diversity Countries account for at least two thirds of all non-fish vertebrate species and three quarters of all higher plant species. This classification primarily aims to demonstrate how a small number of countries hold a large portion of global diversity and therefore have a responsibility for conservation and biodiversity management.

The Mega diversity Country concept is based on four premises

1. The biodiversity of each and every nation is critically important to that nation's survival, and must be a fundamental component of any national or regional development strategy;
2. Biodiversity is by no means evenly distributed on our planet, and some countries, especially in the tropics, harbour far greater concentrations of biodiversity than others;
3. Some of the most species rich and biodiverse nations also have ecosystems that are under the most severe threat;

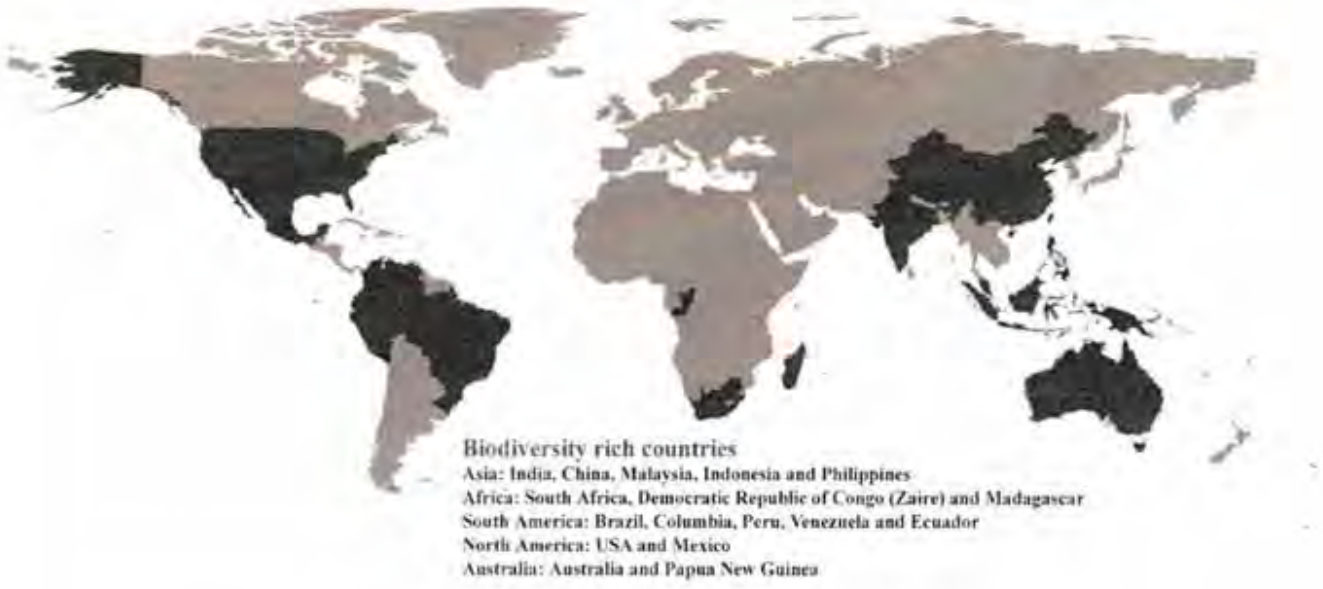


Fig. 1. Biodiversity rich Countries

Table 1. Approximate Number of Species at Global level (Source: Threats to Biodiversity)

Group	No. of described Species
Bacteria and blue green algae	4,760
Fungi	46,983
Algae	26,900
Bryophytes	17,000
Gymnosperms	750
Angiosperms	250,000
Protozoans	30,800
Sponges	5,000
Corals and Jellyfishes	9,000
Roundworms and earthworms	24,000
Crustaceans	38,000
Insects	751,000
Other Arthropods and minor Vertebrates	132,461
Molluscs	50,000
Starfish	6,100
Fishes (teleost)	19,056
Amphibians	4,184
Reptiles	6,300
Birds	9,198
Mammals	4,170
Total	**1,435,662**

4. To achieve maximum impact with limited resources, conservation efforts must concentrate heavily (but not exclusively) on those countries richest in diversity and endemism and most severely threatened; resources invested in them for conservation should be roughly proportional to their overall contribution to global biodiversity.

BIODIVERSITY HOTSPOTS

The concept of "**Hotspots**" was proposed by Norman Myers in 1990 through his two articles published in "The Environmentalist" in 1988 and 1990. According to Myers a region must meet two strict criteria-

It must have at least **1,500 vascular plants as endemics** — it must have a high percentage of plant life found nowhere else on the planet.

It must have **30% or less of its original natural vegetation.** In other words, it must be **threatened.**

Around the world, 34 areas qualified under this definition. They support more than half of the world's plant species as endemics — i.e., species found no place else — and nearly **43% of bird, mammal, reptile and amphibian species as endemics.**

Fig. 2. Biodiversity Hotspots of the World

Atlantic Forest
Carrebean Islands
Chilean Winter Rain forest
Eastern Afro Montane
Horn of Africa
Japan
Maputaland
Mountains of Central Asia
New Zealand
South West Australia
Tropical Andes
Western Ghats and Sri Lanka
California Floristic Province
Cauccusus
Costal Forests of Eastern Africa
Gunean Forests of Wes Africa
Indo-Burma
Madagascar & Indian Ocean Islands
Meditaréan Basin
Mountains of South West China
Philippines
Succulent Karoo
Choco-Magdalena
Cape Floristic Region
Cerrado
East Melanesian Islands
Himalaya
Irano-Anattolean
Madrian Pine Oak Forest
Mesoamerica
New Caledonia
Polynesia-Micronesia
Sundaland
Wallacea

CHAPTER III

BIODIVERSITY AT NATIONAL LEVEL

India, located in south Asia, between latitude 8° 4' and 38° N and longitudes 69° and 97° E, extends over a total geographical area of about 3029 million hectares, bounded by Himalayas in the North, the Bay of Bengal in the East, the Arabian Sea in the West and Indian Ocean in the South. The wide variety in physical features and climatic situation has resulted in a diversity of ecological habitats. The Indian region having a vast geographical area is quite rich in biodiversity with noticeable percentage of endemic diversity.

India is one of the megadiverse countries with 2.4% of the world land area, accounts for 7-8% of all recorded species of the world, including about 91,000 species of animals and 45,500 species of plants that have been documented in its ten bio-geographic regions. It is home to 8.58% of mammals, 13.66% of birds, 7.91% of reptiles, 4.66% of amphibians and 11.72% fishes. There are no clear estimates about the marine biota though the coastline is approximately 7516 km long with a shelf zone of 4,52,460 sq.km and extended economic zone of 20, 13, 410 sq.km. Sea weeds, fish, crustaceans, molluscs, corals, reptiles and mammals are seen here.

The Western Ghats in Peninsular India, which extends in the southern state are a treasure house of species diversity. The area harbours more than 7388 species of flowering plants of which 1261 are endemic to western ghats. Much of the world's spices such as black pepper and cardamom have their origins in the Western Ghats. The region also harbors over 500 bird species, about 120 mammalian species, 225 species of reptiles and 220 species of amphibians. Over 60% of the reptiles and amphibians are completely endemic to the hotspot. Remarkable as this diversity is, it is severely threatened today. The highest concentration of species in the Western Ghats is believed to be the Agasthyamalai Hills in the extreme south.

BIOGEOGRAPHICAL CLASSIFICATION

India, is one among the 17 mega biodiversity countries in the world and is divided into 10 bio-geographic regions and four of the 34 globally identified biodiversity hotspots are located in India. . The wide variety in physical features and climatic conditions have resulted in a diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and deserts which harbor and sustain immense biodiversity. Biogeographically India is situated at

Comparative table of faunal and floral diversity in world and India

Taxonomic group	Number of species		
	World	India	Percentage in India
Protista (Protozoa)	31,250	3500	11.20
Animalia	1,53,122	13,033	8.51
Mesozoa	71	10	14.08
Porifera	5000	500	10.00
Cnidaria	10,105	1042	10.31
Ctenophora	100	12	12.00
Platyhelminthes	17,511	1,650	9.42
Rotifera	2500	330	13.20
Gastrotricha	3000	100	3.33
Kinorhyncha	100	10	10.00
Nematoda	30,028	2902	9.66
Acanthocephala	800	229	28.63
Sipuncula	145	35	24.14
Mollusca	66,535	5169	7.77
Echiura	127	43	33.86
Annelida	17,000	1000	5.88
Onychophora	100	1	1.00
Arthropoda	11,81,398	74,175	6.28
Crustacea	60,000	3549	5.91
Insecta	10,20,007	63,423	6.22
Arachnida	73,451	5850	7.96
Pycnogonida	600	17	2.83
Chilopoda	8000	101	1.26
Diplopoda	7500	162	2.16
Symphyla	120	4	3.33
Merostomata	4	2	50.00
Phoronida	11	3	27.27
Bryozoa (Ectoprocta)	4000	200	5.00
Entoprocta	60	10	16.67
Brachiopoda	300	3	1.00
Chaetognatha	111	30	27.03
Tardigrada	514	30	5.84
Echinodermata	6600	779	11.80
Hemichordata	120	12	10.00
Chordata	64,669	5,665	8.76
Protochordata	2106	119	5.65
Pisces	32,120	3,022	9.41
Amphibia	6771	342	5.05
Reptilia	9230	526	5.70
Aves	9026	1,233	13.66
Mammalia	5416	423	7.81
Total (Animalia)	13,99,189	92,873	6.64
Grand total (Protista + Animalia)	14,30,439	96,373	6.74

Source: ZSI (2014)

Plant group	Number of species described		
	India	Word (Estimated)	Percentage in India
Algae	7244	40800	17.75
Bryophytes	2504	14500	17.27
Pteridophytes	1267	12000	10.56
Gymnosperms	74	650	11.38
Angiosperms	17926	250000	7.17
Total	**29015**	**317950**	**9.13**

Source: BIS 2013

the tri junction of three realms- Afro tropical, Indo-Malayan and Paleo-arctic realms and therefore has characteristic elements from each of them.

The major bio-geographical regions of India are Trans- Himalaya, Himalaya, Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plain, Coast, North-East region and Islands.

BOTANICAL REGIONS OF INDIA

The country has been divided into the following floristic regions,

Western Himalayas: extends from Kumaon to Kashmir and the rainfall is upto 200 cm. Corresponds to 3 climatic belts – Submontane zone, Temperate zone and Alpine zone.

Eastern Himalayas: includes the regions of Sikkim and NEFA, characterized by more rainfall, less snow and higher temperature. Further divided into 3 zones attitudinally- Tropical zone, Temperate zone and Alpine zone.

Indus Plains: include arid and semi arid regions of Punjab, Rajasthan, Kutch, part of Gujarat and Delhi. Vegetation is of tropical thorn forest type.

Gangetic Plains: extends over UP, Bihar, Bengal and part of Orissa. Vegetation is of chiefly tropical moist, deciduous and dry deciduous type. The common plants are *Dalbergia sissoo*, *Acacia* etc.

Central India: comprises Madhya Pradesh, part of Orissa and Gujarat. Vegetation is thorny, mixed deciduous and teak type. Chief plants are *Tectona grandis, Madhuca.*

Malabar (West Coast): include western coast of Indian from Gujarat to Cape Comorin and has heavy rainfall. The forests are tropical evergreen in extreme west, semi evergreen towards interior subtropical or montane temperate evergreen forests in Nilgiris and mangroves near Bombay and Kerala coast.

Deccan Plateau: extends all over Peninsular India and has rainfall upto 100 cm.

Assam: characterized by heavy rainfall (220 to 1000cm) and the vegetation is either dense evergreen forest or sub tropical. The evergreen forests trees like *Dipterocarpus, Mesua ferrca, Shorea robusta, Ficus elastic* etc are seen here.

Andamans: possess varied type of vegetation with mangroves and beach forests of tall trees in the interior.

BIODIVERSITY AT LOCAL LEVEL

Biodiversity at local level can be explained by demarcating the points, places, zones which are rich in biodiversity and can be compositional i.e. rich in plants and animals of same habitat and genetic make up. Local level biodiversity can be studied based on the following,

1. Richness of species at a given place
2. Physical characteristics of the habitat and vegetation in the area
3. Changes in species composition across different habitats
4. Local diversity based on climatic, geographical, ecological and other processes
5. Rate of change across gradients and conditions.

Mega diversity concept covers the broad aspects of biodiversity emphasizing more on species richness, threatened taxa and endemic species. Conservation International identified 17 megadiverse countries in the world and India harbours 4 hotspots- Himalaya, Western Ghats and North-East and Nicobar Islands. Megadiverse countries hold largest fraction of the world's species with a high concentration of endemic species.

The concept of "Mega diversity" was first developed by Russell Mittermeier in 1988, as a way to prioritise conservation action. This country-based method raises national awareness for biodiversity conservation in nations with high biological diversity, with many species unique to a specific country. This concept complements that of biodiversity hotspots and high-biodiversity wilderness areas to achieve significant coverage of the world's biological resources and was first proposed in 1988. The Megadiversity country concept is based on four premises:

1. The biodiversity of each and every nation is critically important to that nation's survival, and must be a fundamental component of any national or regional development strategy;

2. Biodiversity is by no means evenly distributed on our planet, and some countries, especially in the tropics, harbour far greater concentrations of biodiversity than others;

3. Some of the richest and most diverse nations also have ecosystems that are under the most severe threat;

4. To achieve maximum impact with limited resources, we must concentrate heavily (but not exclusively) on those countries richest in diversity and endemism and most severely threatened; investment in them should be roughly proportional to their overall contribution to global biodiversity.

BIODIVERSITY IN INDIA

The mega biodiverse countries are United States of America, Mexico, Colombia, Ecuador, Peru, Venezuela, Brazil, Democratic Republic of Congo, South Africa, Madagascar, India, Malaysia, Indonesia, Philippines, Papua New Guinea, China, and Australia.

BIODIVERSITY HOTSPOTS IN INDIA

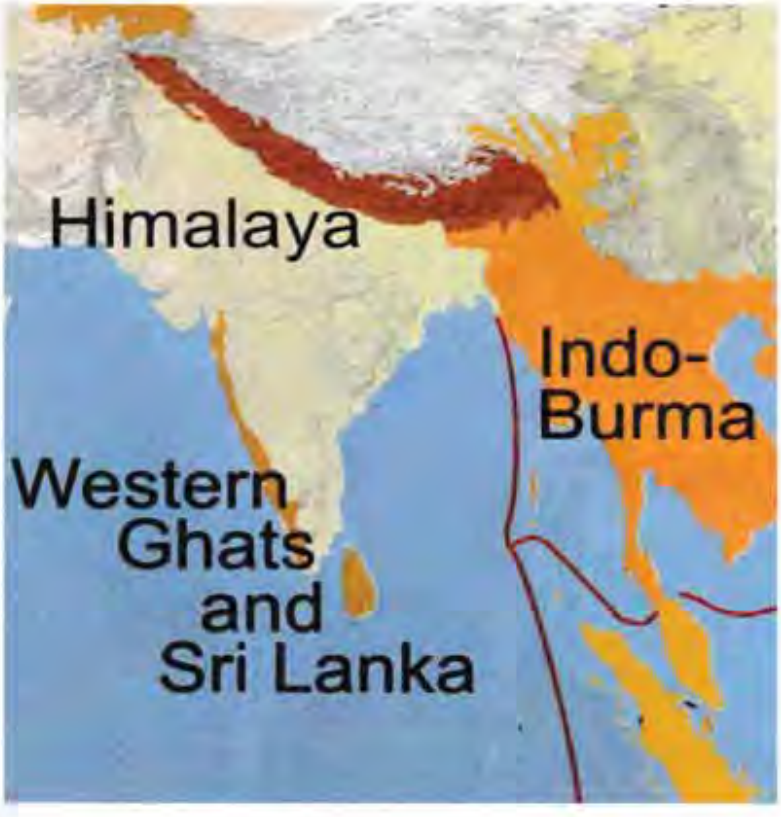
India harbour four of 34 "**Global Biodiversity Hotspots**" - unique, biologically rich areas which are facing severe conservation threats. Urgent measures are necessary to protect the unique biota of the area.

Himalaya: the Himalaya hotspot is home to the world's highest mountains, including Mt. Everest. The mountains rise abruptly, resulting in a diversity of ecosystems that range from alluvial grasslands and subtropical broadleaf forests to alpine meadows above the tree line. Vascular plants have been recorded at more than 6000 meters. The hotspot is home to important populations of numerous large birds and mammals, including vultures, tigers, elephants, rhinos, and wild water buffalo.

North-East: The hotspot holds remarkable endemism in flora and fauna, most of which are threatened with extinction due to overharvesting and habitat loss.

Nicobar Island: is the part of hotspot Sundaland and has some of remarkable island ecosystems of world. The islands are fringed by spectacular reefs. The Nicobar islands are characterised by absence of large mammals and is nesting place for four species of turtles

Western Ghats: is the part of the hotspot Western Ghat and Srilanka, faced with tremendous population pressure, the forests of the Western Ghats and SriLanka have been dramatically impacted by the demands for timber and agricultural land. Remaining forests of the Western ghats are heavily fragmented. The region is home to a rich endemic assemblage of plants, reptiles and amphibians, as well as important populations of Asian elephants, Indian tigers and the endangered lion tailed macaque.



Biodiversity Hotspots

"The most remarkable places on Earth are also the most threatened."

CHAPTER IV
THREATS TO BIODIVERSITY

The negative impacts of anthropogenic actions have become so great that we are losing biodiversity more quickly now than at any other time in earth's recent history. Scientists have assessed more than 47,000 species and found that 36 percent of these are threatened with extinction, the state whereby no live individuals of a species remain. Also, the current extinction rates are 50 to 500 times higher than those observed from fossil records or the so-called back ground rates.

The earth is currently experiencing a sixth major extinction event, one greater than that which resulted in the extinction of the dinosaurs. Unlike past extinction events, which were caused by natural disasters and planetary changes, current extinction is driven by human actions.

Following are the major threats to biodiversity

Habitat loss: occurs when natural environment is transformed or modified to serve human needs and is the most significant cause of biodiversity loss globally. Human activities that destroy habitats include deforestation, filling wetlands and damming rivers. Habitat loss can also cause fragmentation, which occurs when parts of a habitat (the local environment in which an organism is usually found) become separated from one another because of changes in a landscape, such as the construction of roads. Fragmentation makes it difficult for species to move within a habitat, and poses a major challenge for species requiring large tracts of land.

Poaching: is another threat to wildlife. It is the illegal hunting, killing or capturing of wild animals for the economic benefits. Large mammals such as the tiger, rhinoceros and the elephant are victims of hunting and poaching.

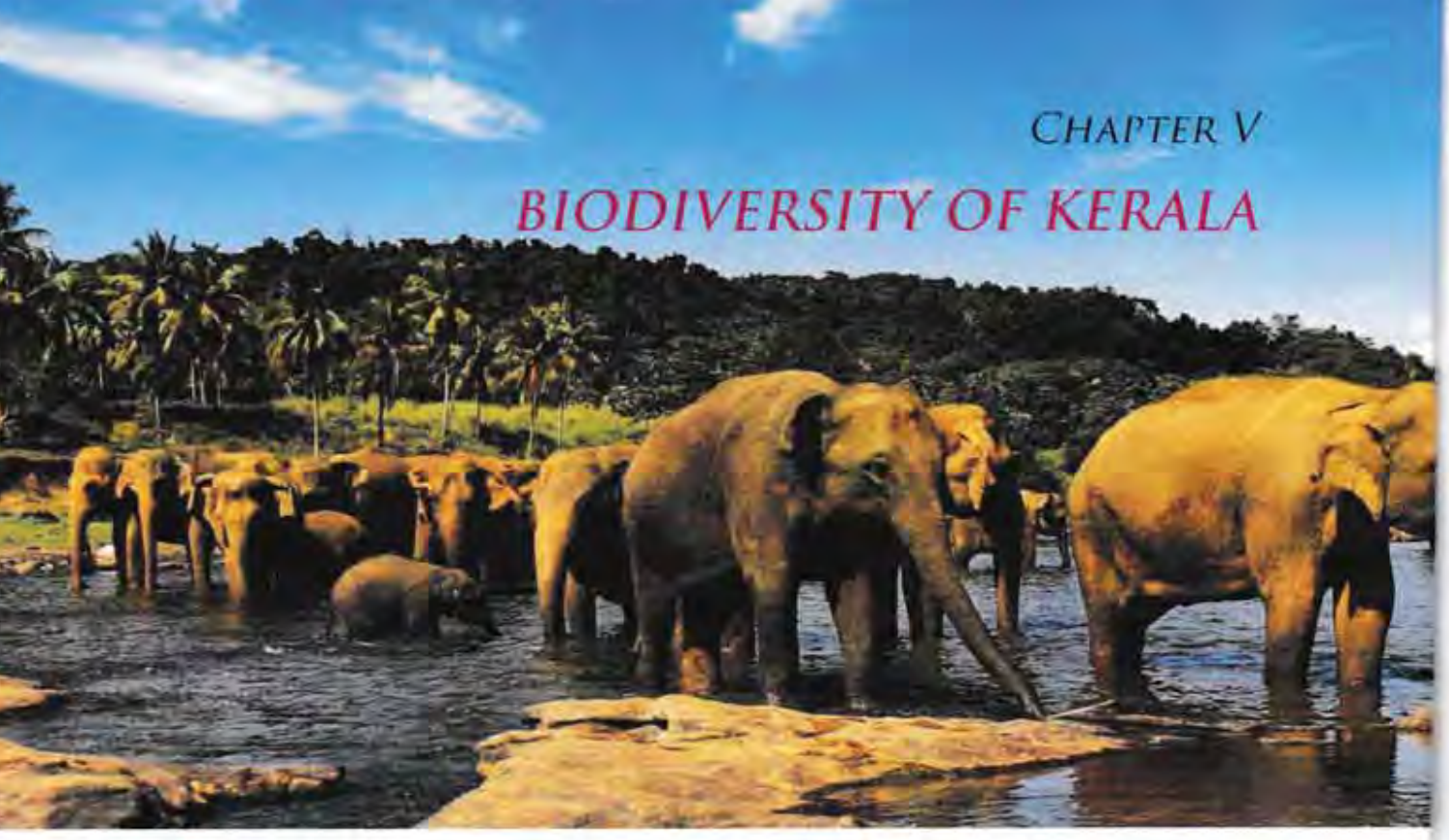
Climate change due to the build up of green house gases is a growing threat to biodiversity. Climate change alters the climate patterns and ecosystems in which species have evolved and on which they depend. This forces species to either move in order to find favourable conditions in which to live, or to adapt to their new climate. While some species may be able to keep up with the changes created by climate change, others will be unable to do so. Biodiversity in the Polar Regions and mountain ranges is especially vulnerable to climate change.

Over exploitation or unsustainable use: happens when biodiversity is removed faster than it can be replenished and, over the long term, can result in the extinction of species.

Invasive Alien Species: species that have spread outside of their natural habitat and threaten biodiversity in their new area are a major cause of biodiversity loss. These new species act as predators, parasites, vectors (or carriers) of disease or direct competitors for habitat and food.

In many cases invasive alien species do not have any predators in their new environment, so their population size is often not controlled. Some IAS thrives in degraded systems and can thus work in conjunction with or augment other environmental stressors. IAS may also cause economic or environmental damage, or adversely affect human health. The introduction of invasive alien species can be either intentional, as with the introduction of new crop or livestock species, or accidental such as when species are introduced through ballast water or by stowing away in cargo containers. Some of the main vectors (carriers) for IAS are trade, transport, travel or tourism, which have all increased hugely in recent years.

Pollution: is also a driver of biodiversity loss. Pollution, in particular from nutrients, such as nitrogen and phosphorus, is a growing threat on both land and in aquatic ecosystems. While the large-scale use of fertilisers has allowed for the increased production of food, it has also caused severe environmental damage, such as eutrophication.



CHAPTER V

BIODIVERSITY OF KERALA

Kerala, the southern most State of India lies between 8°18' and 12°48' latitude and 74°52' and 72°22' longitude. The total geographic area of the State is 38,86,300 ha. Kerala is bordered by Tamil Nadu and Karnataka at its east and north-east; Arabian Sea at its west, and Indian Ocean at its south. Arising abruptly from the narrow Konkan and Malabar coast, Western Ghats or the Sahyadri Hills traverse 1600 km north south between the river Tapti in Gujarat and Kanyakumari in Tamil Nadu covering an area approximately 1, 60, 000 sq. km. The Kerala State is located in the tropical region of Indian Peninsula and extends to an area about 38, 863 km^2 and has a coast line of about 560 km and from the sea level it rises to about 2694 m above the mean sea level (msl).

Physiographically Kerala is divided into three zones – highlands (altitude between 75-2694 m above msl, cover almost 48% of the total land area), midlands (cover the foothills and plains with an altitudinal range of 8-75 m above msl and 42 % of the total land mass) and lowlands (cover the foothills and plains with an altitudinal range of 8-75 m above msl and 42 % of the total land mass).

The diversity in geographical set up is reflected in the climate as well. South-West monsoon, which is the major monsoon in Kerala begins sometime in June-July and continues till August-September. Southwest monsoon is the main rainy season in Kerala. This season (*Edavappathi* - as the rains starts by the middle of the Malayalam month Edavam) begins by the end of May or early June with the outset of the southwest monsoon winds. The next few months are periods of torrential rain. The next season known as retreating or reverse monsoon (*Thulavarsham* - as it rains during the Malayalam month of Thulam) are in the months of October and November and sometimes lasts till December.

Soils of Kerala are acidic, kaolintic and gravelly with low water holding capacity and high phosphate fixing capacity. They are red loam, laterite, coastal alluvium, riverine alluvium, onaatukkara alluvium, kuttanad alluvium and forest loam.

The Western Ghats is one of the 34 biodiversity hotspots and one among the eight hottest hotspots in the world. Among the states located within the Western Ghats region, Kerala possess rich biodiversity with highlands having high forest biodiversity, midlands with high agro-biodiversity and lowlands and wetlands with aquatic biodiversity. Thus Kerala is a repository for all three levels of biodiversity.

Ecosystem diversity: Kerala is bestowed with vast diversity in ecosystem by virtue of its geographical location, bio-geographical reason and climatic conditions. The ecosystem diversity of three physiographic zones of Kerala is as follows,

1. **Eco system Diversity in Lowlands**: Lowlands are the areas up to 7m above msl and include sea, backwaters, mangroves, estuaries and wetlands. Kole lands, unique wetland ecosystem in Kerala and sacred groves are the repositories of many of the plant and animal species including threatened and endemic groups. Example Kole wetlands of Thrissur. Increase in population density and developmental activities resulted in the disappearance of many of the traditional varieties of agricultural crops, fruits, medicinal plants, spices etc. Habitat alteration, pollution and unscientific agronomic practices accelerated the process of biodiversity depletion of an area.

2. **Ecosystem Diversity in Midlands**: Midlands are areas from 8-75 m above msl. This zone is characterized by dense population and agro biodiversity. The common cultivation in this zone includes traditional crops such as rice, coconut, fruits, vegetables, cash crops etc. Changes in socio-economic factors, intense cultivation of cash crops such as cocoa, pine apple, rubber etc. not only affects the agro biodiversity but also exerts its adverse impacts to biodiversity of that region. Farming of different hybrid and genetically modified varieties led to the disappearance of many of the local varieties o f rice, coconut, cattle, chicken etc. Rapid habitat fragmentation and reclamation of agricultural fields resulted in serious biodiversity loss.

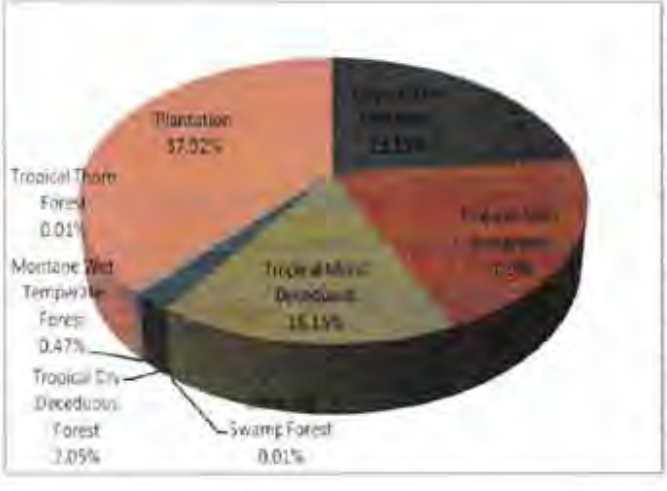
3. **Ecosystem Diversity in Highlands**: of the total area under highland sector, almost half is under forest cover and the remaining is mountainous ranges with scattered human population. Common cultivation in this zone include rubber, pepper, coconut etc. unlike other physiographic regions, degradation rate is very slow in these region.

Forests

Forests are considered as rich repositories of biodiversity. The Kerala forest include tropical wet evergreen (23.19%), tropical semi evergreen (20.2%), tropical moist deceduous (16.15%), littoral and swamp forest (0.01%), tropical dry deciduous forest (2.05%), montane wet temperate forest (0.47%), tropical thorn forest (0.01%) and plantation (37.92%). Forests also possess varied diversity of endemic plants and animals. Even though the long term forest plantations such as teak supports the endemic biodiversity, short term plantations are not suitable for the endemic diversity of the region.

The natural forests harbor many of the endemic groups. The moist deciduous forests and evergreen forests support luxuriant growth of trees and animals such as elephants, gaur, deer etc. The Kerala forests are mainly categorized as evergreen, deciduous, sholas, grasslands and mangroves.

Evergreen forests: Tropical evergreen forest abounds in the Andamans and Western Ghats. They are usually seen on the slopes and tops of hills. Semi-evergreen forests (west coast semi-evergreen forests) are generally considered as a transitional stage between evergreen and moist deciduous forests. It is also found in localities where the evergreen forests are subjected to high disturbances. These forests occur between 600 to 800 m and in some places it extends up to 900 m. Animal species such as lion tailed macaque, Nilgiri langur, Nilgiri marten, small Travancore flying squirrel, brown mongoose, Malabar civet, and many birds such as the great Indian hornbill and the Bourdillon's great eared night jar occupy specific niches in these forests.



Forest types and their percentage in Kerala

Deciduous forests: Moist deciduous forests are divided into primary climax or secondary moist deciduous

forests. The primary moist deciduous forests generally occupy the rainfall zone of 1500 to 1800 mm, as a transition between wet evergreen and dry deciduous forests. The secondary moist deciduous forests occur within the potential area of wet evergreen formations, where the rainfall is more than 2000 mm. Secondary dry deciduous forests are inferior climax forests predominated by poorly shaped, small sized trees. Sandal is also seen in such forests.

Shola forests: These patches of shola forest are found mainly in the valleys and are usually separated from one another by undulating montane grassland. Some early researchers suggested that the floristic composition represents a stable final state or climax vegetation. This stability being maintained by climatic conditions such as frost allows the grass to grow but kill off any forest seedlings.

Grasslands: Grasslands in Kerala are generally found above 1500 m. The grasslands, which are also called as 'shrub-savanna' are characterised by herbaceous and shrubby species mixed with grasses. The grasslands below 1800 m that are adjacecnt to medium or high elevation evergreen forests, are often found with sparse trees, represented by *Wendlandia thrysoidea, Glochidion spp. Terminalia chebula, Emblica officinalis, Careya arborea, Briedelia crenulata*; in some places a dwarf palm Phoenix is found in patches. At this elevation range, grasses are tall, and reach a height up to 1.5 m. They are commonly represented by *Androprogon lividus, Arundinella purpurea, Agrostis peninsularis, Chrysopogon zeylanicus, Eulalia phaeothrix, Sehima nervosum, Heteropogon contortus, Eulalia sp. Themeda sp, Ischaemum indicum, and Tripogon bromoides*. In cattle grazed and frequently burnt areas, unpalatable Cymbopogon flexuous and Pteridium, a fern are frequent. The grasses in this zone are mixed with other herbs like *Crotalaria, Desmodium, Hypericum, Knoxia, Leucas, Lobelia, Osbeckia etc. Phlebophyllum kunthianum*, a monocarpic shrub species, often dominates the grass land landscape.

Mangroves: Mangroves are wetland ecosystems formed by the assemblage of specialized plants and animals adapted to semi saline swamps along coasts. Mangrove forests of Kerala are highly localized, but the species diversity of these mangroves and its associates are comparatively rich. It is confined

to the upper reaches of estuaries, lagoons, backwaters and creeks. In Kerala mangroves are distributed in all the districts except Idukki, Pathanamthitta, Palakkad and Wayanad. Maximum extent is reported from Kannur district. The total extent of mangrove forests in the state is estimated to be less than 50km2. Mangroves play an important role in the economy of coastal people through various ways. Mangroves provide excellent habitat for migratory birds, serve as breeding ground for many species of fishes and prawns, helps in controlling pollution, retting of husks etc.

Tribals are the integral component of natural forest. They rely exclusively on forest produce for their livelihood. Now a days their life style has changed. The traditional knowledge and the familiarity with forest of tribal population is an asset in biodiversity conservation programs. Documentation of traditional knowledge of tribals is a key process in biodiversity conservation programs.

DIVERSITY OF FLORA AND FAUNA

Kerala is a home for rich diversity of flora and fauna. Many research institutions (KFRI, TBGRI), Universities and other educational institutions actively engage in the documentation of flora diversity of Kerala and have accumulated considerable wealth of knowledge on biodiversity of the State.

Floral diversity: The floral diversity of Kerala can be categorized into three -Wild and Indigenous, Indigenous and Cultivated and Exotic. Wild and indigenous floral elements are found in natural forests and other natural ecosystems. They offer a variety of products and services to mankind, including medicines and non wood forest produces. The natural forests are also rich in different types of traditionally used wood items.

Indigenous and cultivated plant varieties were once common in our agricultural fields and homesteads. These areas were also rich with a variety of indigenous rice, coconut, areca nut, pepper, ginger, turmeric, tapioca, plantains etc. In the

last few decades many of these varieties have been neglected or ignored with the introduction of high-yielding hybrid varieties. In addition to this weeds and pests introduced into the state along with exotic crops replaced many indigenous varieties. Thus, the agro-biodiversity in the state has become a mixture of both indigenous and exotic species.

Flora of Kerala comprises of a total of 11,840 taxa of plants (SoE, 2007). Among them, angiosperms comprises the dominant group, composed of 7388 species, of which about 5584 are endemic to Western Ghats. 377 are exotic naturalised and 1427 are cultivated or planted. The flora comprises of 866 species of algae, 4800 species of fungi, 520 species of lichens, 350 species of bryophytes, 332 species of pteridophytes, 4 species of gymnosperms and 4968 species of angiosperms or flowering plants. Habitat wise, algal species are mostly confined to aquatic or damp conditions whereas the other plant groups in the State are mostly terrestrial in habit. Apart from this there are hundreds of cultivated species either on plantations or crop levels or as garden plants, ornamentals, etc. There are also 850 species and varieties of cultivars growing in the State with their origin in mostly tropical parts of the globe. Due to various reasons, many of them are in various threat categories of IUCN Red List of flora and fauna prepared at global level.

Total number of plant taxa in different groups recorded from Kerala

Sl. No	Plant groups	No. of Taxa
1	Algae	866
2	Fungi	4800
3	Lichens	520
4	Bryophytes	350
5	Pteridophytes	332
6	Gymnosperms	4
7	Angiosperms	4968
	Total	**11840**

Faunal diversity: include both wild and domesticated animals. Natural forests are rich in wild animal diversity. Kerala Forest Research Institute and Kerala Forest and Wild life Department have documented information regarding many of the wild fauna of Kerala. Faunal diversity is mainly concentrated in highland regions as it forms the part of Western Ghats compared to that of midlands and lowlands.

Fishes: Kerala is blessed with numerous water bodies such as 44 rivers, back waters, estuaries, lakes, ponds and vast stretch of 560 km coastline. The known fish fauna of Western Ghat comprises 288 species with 41% endemic to this region. 250 species of fresh water fishes have been recorded from Kerala. *Sahyadria denisonii* locally known as Miss Kerala fetch 20 dollars per kilogram in international market. Our water bodies are rich in native ornamental fish varieties such as barbs, loaches, panchax etc. Kerala is a treasure house of aquatic biodiversity and World Bank report identified riverine ecosystems as a

hotspot of freshwater biodiversity. Chalakkudy river system and Periyar river in Kerala contribute major share to the diversity of fresh water fishes and endemism is another peculiarity of fresh water fishes in Kerala. Out of the 250 species, 58 species are endemic to Kerala. Some of the endemic fresh water fishes are *Lepidopygopsis typus*, *Crossocheilus periyarensis*, *Horrabagrus nigricollaris*, *Garra surendernathinii* etc.

Habitat destruction, unscientific fishing practices, sand mining, pollution, introduction of exotic species etc. are the major threats to native fishery stock of Kerala. Migratory fishes are severely threatened by dam construction. Introduction of exotic species such as carps, tilapia, guppy, gambusia will gradually eliminate indigenous species from many of the water bodies. Reclamation of wetlands, modification/alteration of flood plains of rivers especially rice fields led to the decline in fish population. Long term management and conservation programs are necessary for the revival of native fishery sector in Kerala.

Amphibians: are the group of animals capable of reflecting even subtle changes in the environment and are reckoned as indicators of environmental health. Out of the 113 species of amphibians recorded from Kerala, 16 species are identified as endemic. Many of the amphibian species are endemic to Western Ghats also. Kerala is a home to wide variety of leg less amphibians, caecilians. The resemblance of this animal to snake put them in danger and killing. There is a need of exploration and complete documentation of amphibian species of Kerala because so many of them remain undiscovered in the forests and sacred groves. Frogs, a major group of amphibians are under threat due to habitat destruction and modification in the high land regions, changes in land use pattern and indiscriminate use of pesticides in the midland and lowland regions.

Reptiles: Life and culture of Keralites are joined together with reptiles especially the snake worship, an age old tradition in which snakes forms the major deity. Of the total 171 species of reptiles, 14 are endemic to our state. The major representatives of reptilian fauna include turtles, lizards, geckos, snakes, and monitors. The highly poisonous and nest building King-cobra and the non-poisonous blind snake enrich our reptilian fauna.

Habitat alteration in the midlands and lowlands pose threat to reptiles. Apart from this, snakes are being killed in large numbers attributing its poisonous nature, even though four species of snakes are poisonous in Kerala such as king cobra, cobra, krait and viper, turtles are killed for their meat, snakes for skin etc.



Among tortoises, star tortoises restricted to the rain shadow region of Chinnar wild life sanctuary and cane turtles are on the verge of extinction. The salt water crocodile once common in the wetlands of Kuttanadu region has become extinct from Kerala

Birds: Kerala is rich in avi fauna. A total of 512 species of birds has been recorded from Kerala, of which 6 are endangered. Destruction of natural forests and wetlands led to the decline of avifauna. Apart from this, increased load of pesticides in food grain resulted in the decrease of birds (house sparrow), poaching exert severe threat to species like ducks etc. Decline in bird population, an integral component in an ecosystem, would affect the existence of other living beings.

KEY STONE SPECIES

A keystone species is a plant or animal that plays a unique and crucial role in the way an ecosystem functions. Without keystone species, the ecosystem would be dramatically different or cease to exist altogether.

Elephas maximus indicus (Elephant), Asterias rubens (Star fish), Crocodilus palustris (Crocodile), Apis indica (Honey bee) are examples to keystone species.

Mammals: the diversity of mammals, which occupy the epitome of evolutionary ladder, plays a crucial role in maintaining ecological balance. So far, 145 species of mammals have been documented from our state. Tigers represent the flagship species of forest ecosystem. 'Project Tiger', a conservation program for this endangered animal also conserve other species of the ecosystem. Slender loris, rusty cat, civet cat, palm civet etc are seen in the highland and midland regions of Kerala. Many mammalian species are endemic to Western Ghats. Species such as Lion Tailed Macaque, Nilgiri Langur, Nilgiri Tahr and Nilgiri Marten are protected in wild life sanctuaries.

The forest belt of Kerala has now become fragmented in patches surrounded by human settlements. Habitat loss and scarcity of food forced many mammals to frequent human occupied areas close to forests, leading to man and wildlife conflicts. Poaching exert severe threat to mammals for example elephants are poached for their tusks. Except for insects, invertebrates remain a lesser studied category. However scientific information is available for about 6000 species of insects in Kerala.

Agri and Homestead Biodiversity: Genetic resources of crops/livestock include both wild and domesticated gene pools. They are the reservoirs of valuable genes, which could be of immense help in the genetic improvement of domesticated varieties of crops and breeds of animals. These also include hundreds of races, subspecies, local varie-

ENDEMIC SPECIES

An 'Endemic Species' is one that is only found in that region and nowhere else in the world.
Fishes: 58; Amphibians: 16; Reptiles: 14; Birds: 16

ties and breeds of various species. They can be domesticated varieties or breeds directly used by the mankind or wild relatives of crop plants or domesticated animals.

Wild plants and animals are diversifying for thousands of years due to the changes in the ecosystem in which they live. While some of them are cultivated or domesticated, some of the obsolete varieties (in the case of plants) and breeds (in the case of animals and birds) are sources of important genetic material to improve the strains or breeds presently grown.

Plant genetic resources represent the sum total of diversity accumulated through years of diversification under domestication and natural selection. This assemblage of genetic diversity of economic plants and their wild relatives, including the medicinal and aromatic plants, presents an enormous wealth of genetic variation for use in crop improvement programmes and for catering to the unknown needs of the future. A gene pool of crop plants and livestock along with their local breeds, wild relatives, land races, bio-control agents and those offering vital ecosystem services such as pollination and nutrient recycling all form a part of agrobiodiversity. Degradation of native agri-ecosystems by introduction of exotic/ improved varieties, application of commercial synthetic fertilisers, reclamation of agricultural lands for non agricultural purposes, mechanised farming cultivation of hybrid varieties led to the loss of indigenous agri and domesticated biodiversity.

The faunal component of agri- and domesticated biodiversity has also changed substantially from that of the past. Apart from forest areas, non-forest areas are also rich in biodiversity. The domesticated biodiversity include cow, goat, hen, duck, cat, dog, fish etc. Many species of ornamental plants, birds and fishes have also been introduced from other states and countries. Hybrids also contribute to the domesticated biodiversity. One of the important endemic cattle breed of Kerala is Vechur cow. The introduction of high yielding exotic varieties replaced our indigenous breeds having high disease tolerance.



CHAPTER VI
USES OF BIODIVERISTY

Domestication of livestock species, migrations, selection, adaptation, mutation, selective breeding, have created an enormous diversity of local breeds.

Native livestock and poultry breeds are resistant to parasites or disease, or adapted to humidity, drought or extremes of heat and cold.

Indigenous breeds can survive in local conditions where newer breeds would perish.

Domestic animal diversity, is essential to sustain and enhance the productivity of agriculture.

Local animals of Kerala are small sized, adaptated to the hot humid climate

Need for conserving native breeds/ varieties

- To preserve the valuable genetic resource and thereby sustain biodiversity.
- As an insurance against the adverse changes in climate such as global warming, abiotic stresses, wider gene pool of resistance to disease in future.
- Preserve the raw material for studies and research in the future

Uses of Floral Diversity

Rice occupies the prime position among food crops and over 300 varieties are being cultivated in Kerala including indigenous and high yielding hybrid varieties. Four wild varieties of rice are also found in Kerala. Rice varieties such as Njavara, Chennellu, Champavu, Karutha, Varinellu etc are well known for their medicinal properties and Gandhakassala, Jeerakassala and Neycheera are well known for flavoured rice varieties.

Tuber crops forms the major food item and under this section are tapioca, sweet potato, yam, arrow root, elephant foot yam. Edible fruit plants include mango tree, jack tree, gooseberry etc. Ginger, turmeric, cocoa, cinnamon, cardamom, clove etc .forms the important spices cultivated in Kerala. 23 varieties of ginger, 34, varieties of turmeric, 9 varieties of cardamom and 44 varieties of pepper are now cultivated in our state.

Indian copal tree and black dammer tree are used for the extraction of gums and resins. Trees such as sandal and plants like chambaka, vetiver and lemon grass are used for the extraction of perfumes. For the production of natural dyes indigo plant, turmeric, red sandal wood etc are used. Cane and bamboo support the livelihood of rural population in addition to the raw material in paper industry. These are used for making house hold articles and handicrafts. For the production of medicinally important oils trees like Neem, Indian beech etc are used.

> *"The world is currently undergoing a very rapid loss of biodiversity comparable with the great mass extinction events that have previously occurred only five or six times in the Earth's history."*
>
> **– World Wildlife Fund**

In the traditional Indian Systems of Medicines such as Ayurveda and Sidhha, more than 700 plants are used. In addition to the use in Indian Systems of Medicine, chemicals separated from these plants are used in modern medicine such as allopathy. Fungi, the most diverse group next to insects, help in degradation of biological material thereby play a key role in environmental sanitation. For the germination of orchid seeds fungi is inevitable and some of the fungi are edible also.

Uses of Faunal Diversity: wildlife and their products serve mankind in many ways. Fish and meat form important ingredient in our food. Animals play an important role in ecological equilibrium. Birds and bees are pollinators of the world. In addition we depend on the animal community for satisfying many of our needs such as food, cloth, sports entertainment, health etc.

DEPLETION OF BIODIVERSITY AND CONSERVATIVE MEASURES

Need for conserving biodiversity: Biodiversity provides the base for the livelihoods, culture and economies of several hundred millions of people, including farmers, fisher folk, forest dwellers and artisans. It provides raw material for a diverse medicinal and health care systems. It also provides the genetic base for the continuous up-gradation of agriculture, fisheries, and for critical discoveries in scientific, industrial and other sectors. The rapid erosion of biodiversity in the last few decades has impacted on the health of the land, waterbodies and people. Biodiversity is a wealth to which no value can be put. The very survival of the human race is dependent on conservation of biodiversity. There are several strategies which are adapted for conservation of Biodiversity.

In-situ Conservation: Conserving the animals and plants in their natural habitats is known as *in situ* conservation. The established natural habitats are- national parks and sanctuaries, biosphere reserves, reserved and protected forests. In Kerala, 2 Biosphere reserves (Nilgiri Biosphere reserve and Agasthyamala Biosphere reserve), 6 national parks (Eravikulam National Park, Periyar National Park, Silent Valley National Park, Mathikettan Chola National Park, Anamudi Shola, Pampadum Shola National Park) and 16 wild life sanctuaries (Periyar WLS, Neyyar WLS, Peechi-Vazhani WLS, Muthanga WLS, Parambikkulam WLS, Idukki WLS, Peppara WLS, Thattekkadu Bird Sanctuary, Chimmony WLS, Shenduruney WLS, Chinnar WLS, Aaralam WLS, Mangalavanam bird Sanctuary, Kurinjimala Sanctuary, Ranipuram WLS) was created. The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles and elephants.

Ex-situ Conservation: Ex-situ conservation of plants and animals preserve/ or protect them away from their natural habitat. This could be in zoological parks and botanical gardens or through the forestry institutions and agricultural research centres. This work is being done by institutions such as the National Bureau of Plant Genetic Resources, New Delhi, the National Bureau of Animal Genetic Resources, etc. Seed banks, botanical, horticultural and recreational gardens are important centres for ex situ conservation. Ex-situ conservation measures complement in-situ conservation.

DOCUMENTATION AND CONSERVATION OF GENETIC RESOURCES

The lives of local communities are closely interwoven with their environment, and are dependent upon their immediate resources for meeting their needs. These communities have a vast knowledge about local flora and fauna which is very important for biodiversity conservation. Much of this knowledge is orally passed on from generation to generation. Such indigenous knowledge needs to be recorded and preserved before it is lost.

CHAPTER VII

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The Convention on Biological Diversity (CBD) is an international treaty that promotes international cooperation to manage, conserve and foster the sustainable use of the world's biological resources.

Conservation of biological diversity was first highlighted in June of 1972 at the United Nations Conference on the Human environment. Although species extinction is a part of the evolutionary process, species are more threatened today due to human influence. This has considerable implications, not only for the ecosystem, but also for social and economic development. The convention on biological Diversity takes a proactive approach to ensure biodiversity, while providing for human needs through sustainable development.

United Nations Conference on Environment and Development was conducted at Rio de Janeiro, Brazil on June 5, 1992. A historic set of agreements was signed at the "Earth Summit", including two binding agreements, the Convention on Climate Change, which targets industrial and other emissions of greenhouse gases such as carbon dioxide, and the Convention on Biological Diversity, the first global agreement on the conservation and sustainable use of biological diversity. The biodiversity treaty gained rapid and widespread acceptance. Over 150 governments signed the document at the Rio conference, and since then more than 175 countries have ratified the agreement. The treaty come into force on December 29, 1993. The convention reflects an awareness of the importance of biological diversity to mankind. The Convention's ultimate authority is the Conference of the Parties (COP), consisting of all governments and regional economic integration organizations that have ratified the treaty.

The Convention on Biological Diversity (CBD) was inspired by the world community's growing commitment to sustainable development. It represents a dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources.

Convention on Biological Diversity

The Convention is comprehensive in its goals and deals with an issue so vital to humanity's future that it stands as a landmark in international law. It recognizes for the first time that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process. The agreement covers all ecosystems, species, and genetic resources. It links tradi-

tional conservation efforts to the economic goal of using biological resources sustainably. It sets principles for the fair and equitable sharing of the benefits arising from the use of genetic resources, commercially. It also covers the rapidly expanding field of biotechnology, addressing technology development and transfer, benefit-sharing and biosafety. Importantly, the Convention is legally binding; countries that join it are obliged to implement its provisions. The Convention reminds decision-makers that natural resources are not infinite and sets out a new philosophy for the 21st century, that of sustainable use. While past conservation efforts were aimed at protecting particular species and habitats, the Convention recognizes that ecosystems, species and genes must be used for the benefit of humans.

The main objectives of CBD are:

1. Conservation of biological diversity
2. Sustainable use of biodiversity components
3. Fair and equitable sharing of benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources
4. CBD have framed by Conference of Parties (COP) include 42 Articles.

Important articles are listed below:

Article 1 Objectives of the convention

Article 6 Specifies about the general measures for conservation and sustainable use of bioresources-to develop natural strategies, plans or programmes for the conservation of biodiversity.

Article 7 Specifies the identification and monitoring components of biological diversity important for its conservation

Article 8 Specifies the protection of ecosystems, natural habitats and maintenance of viable populations of species in natural surroundings- *in situ* conservation

Article 9 Specifies adopting measures for the recovery and rehabilitation of threatened species and for their introduction into their natural habitat- *ex situ* conservation

Article 12 and 13 Specifies establish and maintain programmes for scientific and technical education and training measures and conducting public awareness programmes for conservation of biodiversity

The Convention on Biological Diversity, identifies a common problem, sets overall goals and policies and general obligations, and organizes technical and financial cooperation. However, the responsibility for achieving its goals rests largely with the countries themselves. Under the convention the states has to develop national biodiversity strategies and action plans, and to integrate these into broader national plans for environment and development. This is particularly important for such sectors as forestry, agriculture, fisheries, energy, transportation and urban planning.

Other treaty commitments include:

- Identifying and monitoring the important components of biological diversity that needs to be conserved and used sustainably.

- Establishing protected areas to conserve biological diversity while promoting environmentally sound development around these areas.

- Rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species in collaboration with local residents.

- Respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.

- Preventing the introduction of, controlling, and eradicating alien species that could threaten ecosystems, habitats or species.

- Controlling the risks posed by organisms modified by biotechnology.

- Promoting public participation, particularly when it comes to assessing the environmental impacts of development projects that threaten biological diversity.

- Educating people and raising awareness about the importance of biological diversity and the need to conserve it.

Some of the major challenges to implementing the Convention on Biological Diversity and promoting sustainable development are:

Meeting the increasing demand for biological resources caused by population growth and increased consumption, while considering the long-term consequences of our actions.

Increasing our capacity to document and understand biodiversity, its value, and threats to it.

Building adequate expertise and experience in biodiversity planning.

Improving policies, legislation, guidelines, and fiscal measures for regulating the use of biodiversity.

Adopting incentives to promote more sustainable forms of biodiversity use.

Promoting trade rules and practices that foster sustainable use of biodiversity.

Strengthening coordination within governments, and between governments and stakeholders.

Securing adequate financial resources for conservation and sustainable use, from both national and international sources.

Making better use of technology.

Building political support for the changes necessary to ensure biodiversity conservation and sustainable use.

Improving education and public awareness about the value of biodiversity.

Following the ratification of CBD and after widespread consultations, India enacted the Biological Diversity Act in 2002 and notified the Rules in 2004, to give effect to the provisions of the CBD, including those relating to its third objective on Access and Benefit Sharing (ABS). India was one of the first few countries to enact such legislation. The Act is to be implemented through a three-tiered institutional structure: National Biodiversity Authority (NBA), State Biodiversity Boards (SBBs), Biodiversity Management Committees (BMCs) at the local level, in line with the provisions for decentralized governance contained in the Constitution. The Biological Diversity Act is a path-breaking and progressive legislation which has the potential to positively impact biodiversity conservation in the country.

CHAPTER VIII

NATIONAL BIODIVERSITY AUTHORITY, ACT AND RULES, FUNCTIONS

The government of India established The National Biodiversity Authority (NBA) in 2003 at Chennai in accordance with Biological Diversity Act, 2002. The NBA is a statutory, autonomous body which does advisory function for the Government of India regarding conservation of biological diversity and related matters.

General functions of the authority is to advise the Central Government:-

1. on any matter concerning conservation of bio-diversity, sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resource and knowledge ,
2. coordinate the activities of the State Bio-diversity Boards ,
3. provide technical assistance and guidance to the State Bio-diversity Boards ,

Other objectives:

4. To regulate access to biological resources of the country with the purpose of securing equitable sharing of benefits arising out of the use of biological resources and associated knowledge relating to biological resources
5. To conserve and sustainable use biological diversity
6. To respect and protect knowledge of local communities related to biodiversity
7. To secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources
8. Conservation and development of areas of importance as biological diversity heritage sites
9. Protection and rehabilitation of threatened species
10. Involvement of institutions of state governments in the broad schemes of the implementation of biological diversity act.

Biological Diversity Act 2002 and Biological diversity Rule 2004

The act is known as Biological Diversity Act 2002 and the Rule, Biodiversity Rules 2004. The acts came into force on 15th April 2004.

Important Sections:

Section 3: Specifies certain persons not to undertake biodiversity related activities without prior approval of NBA and to obtain any biological resource occurring in India or knowledge associated thereto for research or for commercial utilisation or for bio-survey and bio-utilisation.

Section 4: Specifies, results of research not to be transferred to certain persons (not a citizen of India or citizen of India but not resident of India) without prior approval of NBA.

Section 6: Specifies application for Intellectual Property Rights (IPR) not to be made without approval of NBA.

Section 7: Defines no person who is a citizen of India or a body, corporate , association or organisation which is registered in India shall obtain any biological resource for commercial utilisation except after giving prior information to the State Biodiversity Board concerned.

Section 8: Specifies on the formation of administrative setup of National Biodiversity Authority.

NBA consists of has following members for its day to day functioning:

a. Chairperson- appointed by the Central government, an eminent person having adequate knowledge and experience in the conservation and sustainable use of biological diversity and matters relating to equitable sharing of benefits out from biodiversity. He is the chief executive of the authority. His term of office is three years and is eligible for reappointment.

b. Three ex officio members, appointed by central Government, one representing from Ministry dealing with tribal affairs and two dealing with environment and forest, Additional Director or Director general of forests.

c. Seven additional ex officio members appointed by the central government representing following ministries

    i. Agricultural research and education

    ii. Biotechnology

    iii. Ocean development

    iv. Agriculture and co-operation

    v. Indian systems of medicines and homeopathy

    vi. Science and technology

    vii. Science and industrial research

The term of office of ex officio members is three years.

Section 19. Specifies, certain activities that require prior permission from NBA

Section 20. No transfer of biological resource knowledge to non Indians without NBA's approval

Section 21. Determination of equitable benefit sharing by NBA

Section 22. Establishment of State Biodiversity boards and their functions

Section 36. States the duties of Central and State Government concerned with conservation of biodiversity.

a) Central government should develop national strategies, plans, programmes for the conservation, promotion and sustainable use of biological diversity, identification and monitoring of areas rich in biological resources, promotion of in situ and ex situ conservation, incentives for research, training and public education to increase awareness with respect of biodiversity

b) If central government identifies an area of biological diversity and the habitat as threatened by overuse or abuse or neglect, it shall issue directives to concerned State Government to take ameliorative measures

c) Take necessary step to assess the environmental impact on biodiversity

d) To regulate, manage or control the risk associated with the release of modified living organism by modern science and technology

e) Take necessary steps to respect and protect the knowledge of local people relating biological diversity.

Section 41. Formation of Biodiversity Management Committees at local level

Important rules

Biodiversity rules came into force on 15th April 2004

Rule 9: States the power of Secretary of the authority- the secretary is responsible for co-ordinating and convening the meetings of the authority and maintenance of records and proceedings.

Rule 12: general functions of NBA. Advice the central government on any matter concerning conservation of biodiversity sustainable use of its components and fair and equitable sharing arising out of the use of biological resources.

Rule 22: Constitution of Biodiversity management committee (BMC) at every local self government level.

The National Biodiversity Authority (NBA) was established in 2003 to implement India's Biological Diversity Act (2002). The NBA is a Statutory, Autonomous Body and it performs facilitative, regulatory and advisory function for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources.

KERALA STATE BIODIVERSITY BOARD

According to Section 22 of Biological Diversity Act 2002, every State Government should set up a State Biodiversity Board to conserve the biological diversity at State level. Kerala State Biodiversity Board (KSBB) was established in February 2005 by the Government of Kerala in accordance with the provisions under sections 22-25 of Biological Diversity Act 2002, Rules 2004 and Kerala Biological Diversity Rules 2008. The Board functions under the environment Department, Govt. of Kerala

The Board is headed by a Chairman, a Member Secretary and five ex officio members related to Environment, Agriculture, Forest, Science & Technology and Fisheries.

Rule 16 of Kerala biological diversity Rule 2008 specifies the procedure for access to collection of biological resources for certain purposes.

Rule 19 and 20 of Kerala Biological diversity Rule 2008 defines the establishment, constitution and duties of Biodiversity management Committees at Local Self Government (LSG) level

BIODIVERSITY MANAGEMENT COMMITTEE (BMC)

The best way of making people aware of science is to get them to practice it. An excellent opportunity of taking the practice of science right down to the grassroots has recently opened up with the passage of the Biological Diversity Act. This Act provides for the establishment of **Biodiversity Management Committees** in all local bodies, Panchayats /Municipalities/corporation throughout the country.

1) Every local self government (Grama panchayath/Municipality/ Corporation) should constitute a Biodiversity Management Committee (BMCs) within its area of jurisdiction.
2) The Biodiversity Management Committee as constituted under the Section 41 should consist of a Chairperson and not more than six persons nominated by the local body, of whom not less than one third should be women and not less than 18% should belong to the Scheduled Castes/ Scheduled Tribes.
3) The Chairperson of the Biodiversity Management Committee shall be elected from amongst the members of the committee in a meeting to be chaired by the Chairperson of the local body. The Chairperson of the local body shall have the casting votes in case of a tie.

4) The Chairperson of the Biodiversity Management Committee shall have tenure of three years.
5) The local Member of Legislative Assembly/ Member of Legislative Council and Member of Parliament would be special invitees to the meetings of the Committee.
6) The main function of the BMC is to prepare People's Biodiversity Register in consultation with local people. The Register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them.
7) The other functions of the BMC are to advice on any matter referred to it by the State Biodiversity Board or Authority for granting approval, to maintain data about the local vaidyas and practitioners using the biological resources.
8) The Authority shall take steps to specify the form of the People's Biodiversity Registers, and the particulars it shall contain and the format for electronic database.
9) The Authority and the State Biodiversity Boards shall provide guidance and technical support to the Biodiversity Management Committees for preparing People's Biodiversity Registers.
10) The People's Biodiversity Registers shall be maintained and validated by the Biodiversity Management Committees.
11) The Committee shall also maintain a Register giving information about the details of the access to biological resources and traditional knowledge granted, details of the collection fee imposed and details of the benefits derived and the mode of their sharing.
12) BMC may decide the terms on which it would permit access to biodiversity resources and associated knowledge to different parties for various purposes and levy charges by way of collection fees from required persons. 80% of the levy is given to owner if they are private and if government (full amount) deposited to Local Biodiversity Fund of BMC for the utilization of local development.

The main function of the BMC is to prepare People's Biodiversity Register in consultation with local people. The Register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use or any other traditional knowledge associated with them." The preparation of People's Biodiversity Registers (PBR) is thus an important element of the follow up of the Biological Diversity Act. The information put together through the PBR exercises would be a significant input to an integrated *Biodiversity Information System* The PBRs would, therefore, not be isolated efforts, but would be part of a coordinated on-going activity with regulated access to information, feeding, in part, into a country-wide, networked database, that is expected to keep growing over time.

CHAPTER IX

CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

The link between culture and environment is clear among indigenous peoples. All indigenous people share a spiritual, cultural, social and economic relationship with their traditional lands. Traditional laws, customs and practices reflect both an attachment to land and a responsibility for preserving traditional land for use by future generations.

Over centuries, the relationship between indigenous people and their environment has been eroded . Land rights, land use and resource management remain critical issues for indigenous people around the world. Development projects, mining and forestry activities, and agricultural programmes continue to displace indigenous people. Environmental damage has been substantial: flora and fauna species have become extinct or endangered, unique ecosystems have been destroyed, and rivers and other water catchments have been heavily polluted. Commercial plant varieties have replaced the many locally adapted varieties used in traditional farming systems, leading to an increase in industrialized farming methods.

It is being recognized that no legal provisions can be effective unless local communities are involved in planning, management and monitoring conservation programmes. There are several initiatives to do this, both by government as well as non-governmental organizations. Successful conservation strategies will have to have the confidence and participation of the local communities.

Conservation of traditional knowledge

There is today a growing appreciation of the value of traditional knowledge. This knowledge is valuable not only to those who depend on it in their daily lives, but to modern industry and agriculture as well. Many widely used products, such as plant-based medicines, health products and cosmetics, are derived from traditional knowledge. Other valuable products based on traditional knowledge include agricultural and non-wood forest products as well as handicraft.

Traditional knowledge refers to the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language,

and agricultural practices, including the development of plant species and animal breeds. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general.

Traditional knowledge can make a significant contribution to sustainable development. Most indigenous and local communities are situated in areas where the vast majority of the world's genetic resources are found. Many of them have cultivated and used biological diversity in a sustainable way for thousands of years. Some of their practices have been proven to enhance and promote biodiversity at the local level and aid in maintaining healthy ecosystems. However, the contribution of indigenous and local communities to the conservation and sustainable use of biological diversity goes far beyond their role as natural resource managers. Their skills and techniques provide valuable information to the global community and a useful model for biodiversity policies. Furthermore, as on-site communities with extensive knowledge of local environments, indigenous and local communities are most directly involved with conservation and sustainable use.

Participation of NGO's

NGOs working can implement effective conservation and economic development projects. NGOs will continue to be the driving forces behind biodiversity conservation and sustainable economic development projects.

INTELLECTUAL PROPERTY RIGHTS (IPR) AND BIODIVERSITY CONSERVATION

The CBD's objectives are (1) to conserve biological diversity, (2) to promote the sustainable use of its components, and (3) to achieve fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. These objectives find expression in the provisions of the CBD, many of which are affected, directly or indirectly, by IPRs.

Intellectual property rights are private rights. As an incentive for innovation, they grant their holder the ability to exclude others from certain activities, such as using a product or process, for a defined period of time. The control afforded by IP protection thus enables right holders to limit who can use the resource, and so claim the benefits of commercialisation with little competition. While related to a number of aspects of biodiversity conservation, IPRs are proving particularly relevant to provisions of the CBD .

Access to and the Fair and Equitable Sharing of Benefits arising from the Utilisation of Genetic Resources: By encouraging its parties to provide access to and to equitably share the benefits arising from the utilisation of genetic resources, the CBD seeks to establish incentives to conserve biodiversity.

Preservation of and Respect for the Knowledge, Innovations, and Practices of Indigenous and Local Communities: the preservation of and respect for the knowledge, innovation and practices of indigenous and local communities. This "traditional knowledge" has often been conserved by indigenous and local communities through informal, collective processes extending across generations. This knowledge – regarding, for example, the long-term selective breeding of food crops, and knowledge of medicinal plants – provides an important source of information for the sustainable management of biological diversity, and for the development of new, socially beneficial products.

Transfer of Technology: IPRs may also influence the nature of technologies developed from genetic resources, and how those technologies are transferred and used. Parties are responsible for identifying processes and categories of activities that have or are likely to have significant adverse impacts on biological diversity and monitoring their effects.

PEOPLES'S BIODIVERSITY REGISTER (PBR)

A biodiversity register is a compilation of day-to-day observations of the immediate environment. It is a documentation of knowledge of diversity of life known to local people. It is a means of recording the wealth of biodiversity of a region. The register may include minute details about plants and animals, both wild and domesticated. The record may include traditional knowledge regarding use of the various species.

A biodiversity register has many uses. It helps to make the complete inventory of all organisms of an area. It makes us familiar with the biodiversity of an area. It helps to understand the inter-linkages between plants and animals and the direct and indirect benefits they offer to humans. It allows us to analyze the reasons for depletion of biodiversity and plan conservation measures.

The very first step in the PBR process would be to communicate to people provisions of and new opportunities under the Biological Diversity Act. These would include community regulation of access to local biodiversity resources

with a prospect of promoting sustainable harvests, and opportunities to generate funds through imposition of collection fees. It would also open avenues to conserve valued resources and record biodiversity related knowledge, and open up possibilities of value addition. However, it may take some time to for these promises to be translated into reality, and it would be fitting to directly address what might be gained by engaging in a PBR exercise and in developing and managing a database. It may be stressed that PBR is a document that should facilitate knowledge-based management of agriculture, livestock, fish, forests and public health so as to enhance the quality of life of the community members. The documentation should also help prevent loss of grass-roots knowledge associated with biodiversity, secure recognition for such knowledge and add value to it.

The general advantages of PBR

1) Help the local communities to become aware of the resources and their real economic values in their village.,
2) Provide better understanding of the ecological process in the local area
3) Help to record and promote an assessment of possible value of a variety of conservation oriented traditional resource use practices such as sacred groves.
4) Play a valuable role in social mobilisation such as literary movement and environmental awareness and action programmes
5) The possibilities of PBR servicing as a basis of equitable sharing of benefits from commercial application of traditional knowledge
6) Help recording of biodiversity related knowledge pertaining to management

A. Source of information

Local Self Governments

Direct observation

Interview:

i) visiting houses
ii) Discussing with head of a village
iii) Discussing with panchayath/municipality/corporation members/ nongovernmental organisations/Farmers/Teachers/traditional medical practioners/fishermens/people depending on forest for their life/people with farm animals and birds/ adivasis/ traditional knowledge bearers and forest employers

B. Collection of information

All general information about the local panchayath/municipality/ corporation/ habitat/ climate/soil

Agricultural crops and diversity

Domestic diversity: plants and animals

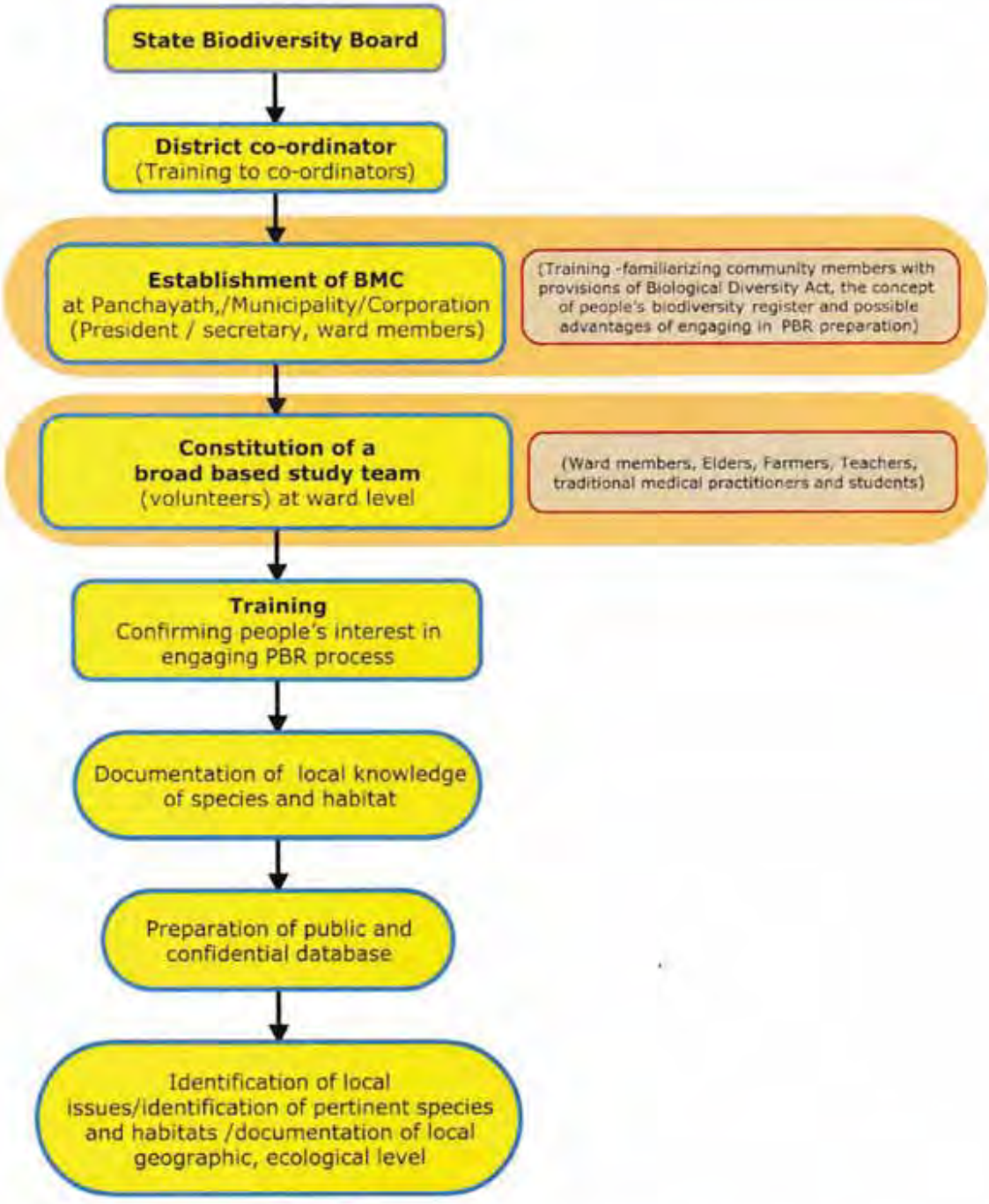
Wild diversity: plants and animals.

Wet land diversity: plants and animals

Urban biodiversity: plants and animals

Simultaneous compilation of scientific and technical knowledge available on local species/habitat

Compilation of all information so collected and preparation of PBR



Main steps involved in the preparation of PBR

Possible applications of PBR information	
Crop Fields and Orchards	• Good information on identity of pests and diseases of crop fields and orchards and on effective and environment friendly control measures could help reduce chemical input and increase both profitability and sustainability of agriculture. • Such information could also be used to promote biological control measures including local production of biological control agents. • Good information on nutrient/ micronutrient status of soils and on composting/ vermiculture could help reduce chemical input and increase both profitability and sustainability of agriculture. • Maintain and locally add value to indigenous crops and varieties. Thus, grain Amaranths are an excellent protein source, Kokum (*Garcinia indica)* has much value in food and pharmaceutical industry. Koraput in Orissa grows Kala Jeera and many other medicinal rices. Several cultivars are resistant to specific pests and diseases, e.g. Pattambi rice against leaf hopper. • Promote on-field conservation measures of crop varieties and claim rewards for farmer-conservators under the Protection of Plant Varieties and Farmers' Rights Act. • Promote positive role of non-cultivated plants and animals associated with agro-ecosystem, e.g. weeds serving as leafy vegetables; fish, crabs, even edible rats from paddy fields. • Press for protection of crops against pollution e.g. from Cement factories by generating good evidence. Thus lichens serve as bio-indicators of air pollution and could be monitored locally. • Develop a database on pests and diseases to fulfill requirements of international conventions pertaining to export of agricultural commodities.
Tree Plantations	• Forest Departments tend to develop monocultures of species of little local interest. Information may be generated to suggest alternative set of species of fodder, mulch, nectar source, bio-cosmetic, vegetable dyes or other values. • Monitor and generate good information on pollution threats such as from spraying of Endosulfon on cashew plantations. • Link appropriately with JFM programmes.
Trees associated with Agriculture	• Maintain, restore and add value to trees associated with Agriculture such as khejadi, neem and honge. • Plan Agro-forestry activities.
Animal husbandry	• Promote on-field conservation measures for land races of domesticated animals; several of them are resistant to specific diseases and have special characteristics as well as cultural values attributed to them. It is likely that in near future there will be rewards for herder-conservators like those for crop cultivars under the Protection of Plant Varieties and Farmers' Rights Act.
Forest Lands	• Promote provision of goods and services from forest lands to rural economy; encourage maintenance of watershed services, grazing resources; promote planting of trees yielding fodder, leaf manure, bamboos, other minor forest produce. • Work out methods and schedules of sustainable harvests of minor forest produce. • Promote value addition to minor forest produce. • Record and check destructive harvests by community members as well as outsiders. Many little known species such as the insectivorous plant *Drosera* are being collected and exported to Japan without any official agency being in the know. • Establish proper links to JFM.

	• Maintain proper records of people- wild life conflict to devise ways of minimizing them and obtain due compensation. • Promote traditional conservation practices like protection to sacred groves, trees and animals.
Grasslands	• Promote maintenance of grasslands. • Devise methods and schedules of sustainable use of grazing resources. • Promote planting of fodder trees, control of weeds on grassland. • Promote traditional conservation practices with respect to systems like Orans of Rajasthan and bugyals in Himalayas. • Record and appropriately regulate grazing pressure by outsiders and nomadic herders.
Hilly Lands	• Promote maintenance of natural biological communities on hill slopes. • Promote maintenance of hills supporting natural communities in urban areas for their recreational value.
Ponds, lakes, streams and rivers	• Promote maintenance of natural biological communities in wetlands. • Promote maintenance of ponds, lakes, streams and rivers supporting natural communities in urban areas for their recreational value. • Protect wetlands from encroachments, reduction of water inflow from catchments. • Promote eradication of alien invasive species like Water Hyacinth and African catfish from water-bodies. • Organize effective pollution monitoring using more accessible bio-indicators such as Chironomids. • Promote traditional conservation practices like protection to sacred ponds, fish and heronries. • Promote sustainable fishing practices such as protection to fish migrating upstream for spawning. • Promote traditional conservation practices like protection to sacred stretches of rivers, fish and dolphins. • Document and regulate destructive fishing practices such as use of dynamite and pesticides. • Forge proper links to Watershed programmes.
Seas	• Promote sustainable fishing practices • Organize effective pollution monitoring using, where possible, more accessible bio-indicators • Document and regulate over-fishing, especially by foreign vessels. • Record and check destructive harvests by community members as well as outsiders. Many little known species of marine organisms such as sponges and sea pens are being collected and exported without any official agency being in the know.
Sea coast	• Forge proper links with Coastal Regulatory Zone programmes. • Promote maintenance of coastal areas supporting natural communities for their recreational value.
Roads	• Promote planting of a variety of indigenous tree and other plant species along roads and highways. • Organize pollution monitoring using bio-indicators such as lichens.
Habitation	• Promote traditional conservation practices like protection to sacred trees and animals. • Promote biodiverse natural communities in parks and open spaces around habitations. • Promote cultivation of nutritious plants such as leafy vegetables and medicinal plants in kitchen gardens. • Promote technique of terrace gardening in urban areas.
Institutional Lands	• Promote biodiverse natural communities and plantation of medicinal/endangered species in open spaces.

Industrial Establishments	• Promote biodiverse natural communities in open spaces. • Organize effective monitoring of pollution using more accessible bio-indicators such as lichens and chironomids.
Public health	• Monitor populations of vectors of human diseases and devise newer methods of control as the older chemical methods are proving ineffective. • Monitor microbial pollution of water sources and devise ways of provision of safer drinking water.
Human resources	• Promote recording of traditional knowledge as well as grass-roots innovations associated with biodiversity such as medicinal uses, vegetable dyes, cosmetics, pest control agents. This should be accompanied by appropriate measures for regulation of access to this information, protection of intellectual property rights and equitable sharing of benefits. • Promote recording of folk arts and crafts associated with biodiversity, accompanied by appropriate measures for regulation of access, protection of intellectual property rights and equitable sharing of benefits. • Involvement of students and teachers in first hand collection of information in the PBR exercises would enhance the quality of their education • Use of modern Information and Communication Technologies in the PBR exercises would provide excellent opportunities for human resource development.

NATURE CLUB /ECO CLUB/BIODIVERSITY CLUB/GREEN CLUB

Nature clubs and Ecoclubs may play an important role in creating environmental awareness amongst the future generations. It is a voluntary group which promotes the participation of students in learning about and improving their environment. People today, especially young people, are concerned about the environment. A green club is a means by which students and youth can organize themselves to learn more about this issue, and also take action to improve their immediate environment.

For teachers it is a wonderful opportunity to create awareness, build attitudes and help students to take up activities in real world, in a way in which the constraints of the classroom and curriculum will not allow.

A green club can thus help to extend the boundaries and scope of the formal educational system, encourage creativity, and empower students for conservative action. Such club activities can thus help to meet the objectives of environmental education, which are to:

1. Create awareness and sensitivity among individuals and social groups to the total environment and its allied problems.
2. Impart knowledge to help individuals and social groups gain a variety of experience in and acquire a basic understanding of the environment and its associated problems.
3. Build attitudes to help individuals and social groups acquire a set of values and feelings of concern for the environment, and motivation for actively participating in environmental improvement and protection.

4. Teach skills to help individuals and social groups to identify and solve environmental problems
5. And lead students towards action to participate in appropriate action to help solve these problems and avoid future problems.

Formation and setup of club

Any teacher who is concerned about the environment can take the lead in forming a club. Those students expressing interest should be encouraged to become members of the club. Teacher-in-charge and co-teacher provide guidance and continuity to club activities.

All clubs should have students office bearers also.

President: He/She collect call meeting; coordinate with the teachers, school administration etc, on behalf of the club takes a leadership role in organising events and in managing projects.

Secretary: Keeps minutes of the meetings; send copies of the minutes to concerned persons including principal, parents etc, maintain the record of attendance, prepares the report of activities at the end of every term year.

Treasurer: He/She collects and manages all the money of the club; keeps accounts of the fund received/spent etc.

Materials manager: Is in-charge of the safe keeping of all the equipment, materials, books, videos, charts etc of the club.

These office bearers could be elected by the members. In order to give more children a chance to take responsibility, office bearers could hold office for a period of six months or one school term.

Students will gain a special identity of their club too. The club must have a name, could have a symbol or logo. They could also have badge/ arm band etc. the club could also have a pledge that all members have to solemnly take and adhere by, like a pledge to 'save the environment'. Club members may also compose and sing their own club song,

Activities which can taken up by club in school include:

Organize tree plantation programmes, awareness programmes such as Quiz, essay, painting competitions, rallys, nukkad natak etc. regarding various environmental issues and educate children about re-use of waste material & preparation of products out of waste

Motivate the students to keep their surroundings green and clean by undertaking plantation of trees.

SUSTAINABLE AGRICULTURE

Sustainable agriculture may be defined as environmentally-friendly methods of farming that allow the production of crops or livestock without damage to human or natural systems. More specifically, it might be said to include preventing adverse effects to soil, water, biodiversity, surrounding or down-

stream resources as well as to those working or living on the farm or in neighbouring areas. Some important elements of sustainable agriculture are permaculture, agroforestry, mixed farming, multiple cropping, and crop rotation.

Biodiversity and agriculture are strongly interdependent

Biodiversity is the basis of agriculture. It has enabled farming systems to evolve ever since agriculture was first developed some 10,000 years ago. Biodiversity is the origin of all species of crops and domesticated livestock and the variety within them. It is also the foundation of ecosystem services essential to sustain agriculture and human well-being. Today's crop and livestock biodiversity are the result of many thousands years of human intervention.

Biodiversity and agriculture are strongly interrelated because while biodiversity is critical for agriculture, agriculture can also contribute to conservation and sustainable use of biodiversity. Indeed, sustainable agriculture both promotes and is enhanced by biodiversity. Maintenance of this biodiversity is essential for the sustainable production of food and other agricultural products and the benefits these provide to humanity, including food security, nutrition and livelihoods.

Importance of agricultural biodiversity

⇒ Biodiversity is essential to:

⇒ ensure the production of food, fibre, fuel, fodder etc

⇒ maintain other ecosystem services

⇒ allow adaptation to changing conditions- including climate change

⇒ and sustain rural peoples' livelihoods

Agricultural biodiversity provides humans with food and raw materials for goods - such as cotton for clothing, wood for shelter and fuel, plants and roots for medicines, and materials for biofuels . Agricultural biodiversity also performs ecosystem services such as soil and water conservation, maintenance of soil fertility and biota, and pollination, all of which are essential to human survival. In addition, genetic diversity provides species with the ability to adapt to changing environment and evolve, by increasing their tolerance to frost, high temperature, drought and water-logging, as well as their resistance to particular diseases, pests and parasites for example. This is particularly important re-

garding climate change. The importance of agricultural biodiversity encompasses socio-cultural, economic and environmental elements. All domesticated crops and animals result from human management of biodiversity, which is constantly responding to new challenges to maintain and increase productivity under constantly varying conditions.

Special nature of agricultural biodiversity

- Agricultural biodiversity is essential to satisfy basic human needs for food and livelihood security.
- Agricultural biodiversity has been - and is still - shaped and developed through human activities and practices over generations. Farmers' communities play a key role as custodians and managers of agricultural biodiversity. This is why local and traditional knowledge and culture are considered as integral parts of agricultural biodiversity management.
- Because of the degree of human management, conservation of agricultural biodiversity in production systems is inherently linked to sustainable use.
- Nonetheless, much agricultural biodiversity is now conserved *ex situ* in gene banks or breeders' materials.
- For crops and domestic animals, diversity within species is at least as important as diversity between species and has been greatly expanded through agriculture.
- Many farming systems are based on alien crop species introduced from elsewhere; this creates a high degree of interdependence between countries for the genetic resources for food and agriculture.
- The interaction between the environment, genetic resources and management practices that occurs *in situ* within agro-ecosystems often contributes to maintaining a dynamic portfolio of agricultural biodiversity.

CONSEQUENCES OF OVEREXPLOITATION AND LOSS OF NATURAL HABITAT ON BIODIVERSITY

Over hunting

It has been a significant cause of the extinction of hundreds of species . Commercial hunting and overhunting, particularly illegal poaching is the principal threat to biodiversity.

Habitat loss and fragmentation

All species have need specific food and habitat for survival. The more specific these needs the greater vulnerability of species to loss of habitat. One of the major cause of loss of habitat in earlier times is the conversion of forest land for agricultural purposes.

The dramatic increase in the world population, (settlement) also causes a reduction in agricultural land and forest.

INVASIVE ALIEN SPECIES AND THREAT TO BIODIVERSITY

Alien Species (AS) are species which are introduced outside their natural distribution area and succeed in surviving and subsequently reproducing. Invasive Alien Species (IAS) are alien species whose introduction and/or spread threaten local biological diversity. Invasive Alien Species have affected native biodiversity in almost every type of ecosystem on Earth. As one of the greatest drivers of biodiversity loss, they pose a threat to ecosystem integrity and function and therefore, to human well-being. The damage and economic impact of IAS extend to waterways, buildings, urban areas, forestry, and agriculture.

What is an invasive alien species ?

- A species that is new to a region
- Has a negative impact on the new environment, either, ecologically, economically or socially
- A small fraction of aliens have become invasive but these few can do enormous damage
- Invasive represent all taxonomic groups and originate from all continents

What we know about the impacts of invasives?

- Invasive alien species have altered evolutionary trajectories
- Invasives can disrupt community and ecosystem processes
- Invasives are causing large economic losses and are threats to human health and welfare and
- to sustainable development

Why we face a great challenge?

- Invaders are self replicating
- Invaders alter and respond to community interactions in complex ways
- Movement of potential invasive material is increasing
- Global changes mostly favor invasive
- Information inadequate for risk assessment and control
- Inadequate public awareness of the problem

Chromolaena odorata

Lantana camara L.

Invasive alien species in Kerala

Kerala's plant biodiversity faces a severe threat from 89 alien invasive species, which were recorded in a survey commissioned by the Kerala State Biodiversity Board. Of these, 19 present a high risk; many were found displacing and destroying a large number of native species, causing environmental and economic loss. Around 40 per cent of the varieties belonging to Brazil, Trinidad, Costa Rica, Chile, and Mexico were believed to have reached the State mostly through timber and food grain imports. While some were brought for agriculture and forestry, some others inadvertently reached the State. With the years, they have established and spread, displacing the natural vegetation, including medicinal plants, and reduced the availability of fodder.

The list comprises 11 trees, 39 herbs, 24 shrubs, and 15 climbers. The high risk species include *Acacia mearnsii* (Black wattle), *Antigonon leptopus* (Mountain rose), *Arundo donax* (Giant reed), *Chromolaena odorata* (Siam weed), Ipomoea *cairica* (Kolambipoo), *Mikania micrantha* (American vally, Kaipu vally, Dhritharashtra pacha), *Mimosa diplo*tricha var. *diplotricha* (Anathottavadi), *Prosopis juliflora* (Sali) and *Sphagneticola trilobata* (Singapore daisy).

The listed plants were at various stages of invasion and colonisation, and different strategies are required for the management of each. *Sesbania bispinosa* and *Senna siamea* have started spreading, and they were noticed only in a few localities. However, *Hypoestes sanguinolenta* and *Heliconia psittacorum* have started reproducing. *Mimosa diplotricha* var. *diploticha* and *Spahgneticola trilobata* have established satellite populations. *Chromolaena odorata* and *Lantana camera* have started naturalisation.

Pollinating insects usually preferred these species as they produced more pollen grains and nectar than the native ones. The resultant fall in the pollination rate of the native plants would affect the local biodiversity and its regeneration.

Senna hirsute (Local name : Ponninthakara)

CONSERVATION OF WETLANDS

Wetlands are areas of land where the water level remains near or above the surface of the ground for most of the year. The association of man and wetlands is ancient, with the first signs of civilization originating in wetland habitats such as the flood plains of the Indus. Wetlands cover about 6% of the earth's land surface.

There are several kinds of wetlands such as marshes, swamps, lagoons, bogs, fens and mangroves. They are home to some of the richest, most diverse and fragile of all natural resources. As they support a variety of plants and animal life, biologically they are one of the most productive ecosystems. Wetland systems directly and indirectly support lakhs of people, providing goods and services to them. They help to preserve water quality and increase biological productivity for both aquatic life as well as human communities of the region. India has a wealth of wetland ecosystems spread over different geographical regions. At present, only 50 percent of India's wetlands remain. They are disappearing at the rate of 2% to 3% every year. The loss of wetlands leads to environmental and ecological imbalances, which have a direct impact on the biodiversity. Wetlands are important as a genetic reservoir for various species of plants including rice, which is a staple food for 3/4th of the world's population. India is a signatory to the Ramsar Convention.

Some Ramsar sites which are located in India are: Wular Lake Jammu & Kashmir); Sambhar Lake (Rajasthan); Keoladeo National Park (Rajasthan); Harike Lake (Punjab); Chilika Lake (Orissa) and Loktak Lake (Manipur).

MANGROVES AND BIODIVERSITY

Mangroves are the only trees that are capable of thriving in salt water. They form unique intertidal forests at the edge of land and sea. They are represented on all continents with tropical and subtropical coasts, i.e. North and South America, Africa and Middle-East, Asia and Oceania (incl. Australia).

Mangrove forests or mangals are a type of intertidal wetland ecosystems. The word mangrove is derived from the Portugese word 'mangue' which means "tree" and the English word grove which is used for trees and shrubs that are found in shallow, sandy or muddy areas. They replace Salt marshes in tropical and subtropical regions. They are salt-tolerant forested wetlands at the sea-land interface which forms the link between the terrestrial landscapes and the marine environment. Mangroves are woody trees and shrubs with a thick, partially exposed network of roots that grow down from the branches into the water and sediment. They occur where there is little wave action and where sediments accumulate. These fine grained (muddy and sandy) sediments lack oxygen. They are frequently associated with saline lagoons and are regularly found on protected sides of islands, atolls and tropical estuaries.

Experiences have proved that the presence of mangrove ecosystems on coastline save lives and property during natural hazards such as cyclones, storm surges and erosion. These ecosystems are also well known for their economic importance. They are breeding, feeding and nursery grounds for many estuarine and marine organisms. Hence, these areas are used for captive and culture fisheries. The ecosystem has a very large unexplored potential for natural products useful for medicinal purposes and also for salt production, apiculture, fuel and fodder, etc.

The distribution of mangrove ecosystem on Indian coastlines indicates that the Sundarban mangroves occupy very large area followed by Andaman-Nicobar Islands and Gulf of Kachch in Gujarat. Rest of the mangrove ecosystems is comparatively smaller. However, good number of studies has been carried out in almost all ecosystems. Over 1600 plant and 3700 animal species have been identified from these areas.

Intrinsic Values of Mangroves

Coastal Resilience

Mangrove forests provide protection and shelter against extreme weather events, such as storm winds and floods, as well as tsunamis. Mangroves absorb and disperse tidal surges associated with these events

Biodiversity

Mangrove forests are rich in biodiversity providing a habitat for wide varieties of animal and plant species. They are dynamic areas, rich in food. Live and decaying mangrove leaves and roots provide nutrients that nourish plankton, algae, fish and shellfish. Many of the fish caught commercially in tropical regions reproduce and spend time in the mangroves as juveniles or adults. Mangroves are also home to many birds and mammals – such as mangrove monkeys in South Asia.

Livelihoods

Traditional economic activities vary from fishing and gathering of crustaceans to usages of the trees for timber or tannin production.

Economic importance

Next to economic value, mangroves also bear great cultural significance for communities, such as the *Concheras* (shellfish-gatherers) in South America, as their identity is strongly related to the ecosystem they live in.

Carbon Storage

Storage of carbon in mangroves takes place through accumulation in living biomass and through burial in sediment deposits. With living biomass typically ranging between 100-400 tonnes/ha, and significant quantities of organic matter being stored in the sediments, mangroves rival the sequestration potential of rainforests.

Threats to Mangrove vegetation

The mangroves are threatened in their existence by several causes. The main source of these threats is induced by humans.

- Variations in river and surface run-off, that inhibit the tropical coastal deltas of fresh water and silt, cause losses of mangrove species diversity and organic production. This results in alternations in both the terrestrial and aquatic food web. This has an effect on the types of refugees available to consumers.
- People will always be engaged in making projects. Soil reclamation for agriculture and aquaculture reduce the regional levels of biodiversity

due to loss of mangrove habitats. The shrimp aquaculture for example has major effects on the biodiversity in the mangroves.

- People are clear cutting the mangrove trees (deforestation, habitat loss) and are building dikes. This forms ponds with anoxic water. These anoxic conditions increase the level of sulphide in the soil and increase the pH leading to major shrimp losses.
- Another negative impact of humans on the mangrove habitat is the use of pesticides and fertilizers. The products that are used in the upstream agriculture end up in the water around the mangroves. This causes an increased nutrient concentration, especially nitrogen and phosphorus. These nutrients cause oxygen depletion in the water and promote the growth of algae. As a result, the ecosystems will be no longer in equilibrium.
- Another problem is the clear cutting of the mangrove for their hard wood. This wood is an important export product for building constructions in areas with large concentrations of termites. This is because the wood is resistant against these termites. The wood can also be used as charcoal and fuelwood. The substrate will be no longer stable when the trees are cut away. The result of this unstable condition is erosion.
- A similar effect as with the added fertilizers and pesticides is the use of mangroves in waste-water treatment. Nutrients are added into the water and the equilibrium in the food web is disturbed. Mangroves no longer can survive in this environment and die off. The organic matter, normally stored in the mangroves, will be transported to open water and increases the aquatic primary production. This results in a huge amount of phytoplankton and causes water turbidity. Corals and sea grasses are influenced negatively by these processes and will be deteriorated.
- Other coastal development activities have an influence on the quality of the water. Industry, tourism and port development involve land reclamation and dredging. This causes resuspension of the sediment and makes the water turbid. Because of this, light cannot penetrate enough in the water and causes damage to mangroves.
- Spills of oil, toxic chemicals and dumping of waste into the water causes localized impacts on the mangroves. Also the introduction of alien species by ballast water on the hulls of vessels will have negative effects on the mangrove habitats. They will compete with indigenous species for space and food.
- Another threat is climate change. Storms will become more frequent and more intense and the sea level rises. The storms cause damage to the mangroves .

AFFORESTATION

Afforestation is the establishment of a forest or stand of trees in an area where there was no forest. Reforestation is the reestablishment of forest cover, either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting). Many governments and non-governmental organizations

directly engage in programs of *afforestation* to create forests, increase carbon capture and sequestration, and help to improve biodiversity.

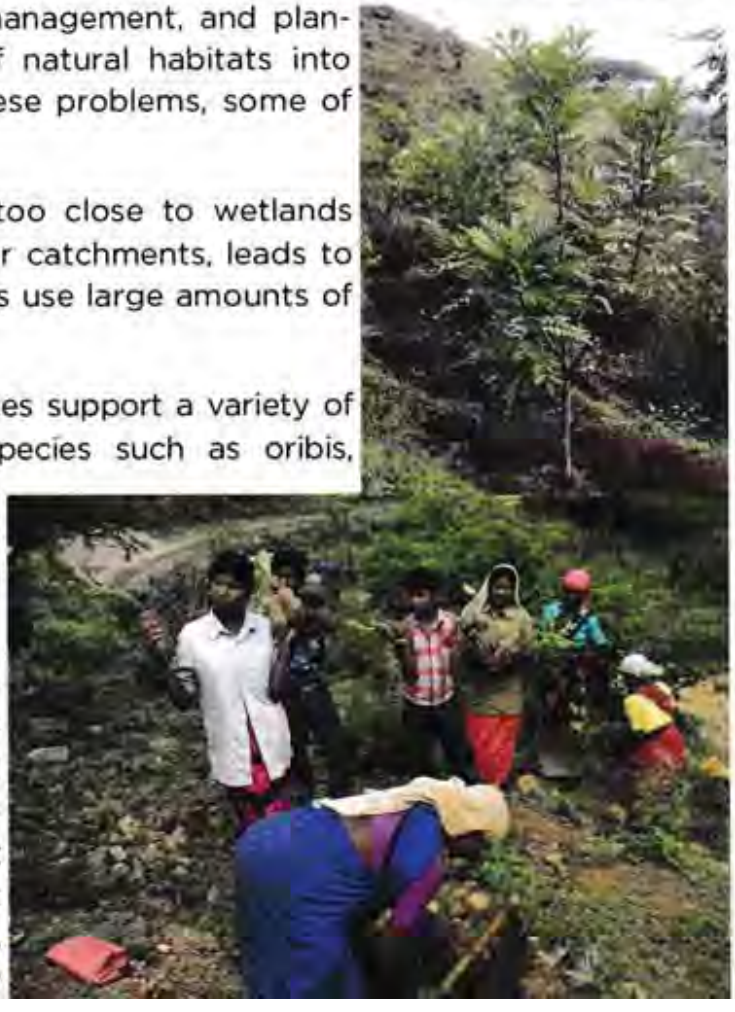
Woodlots and agroforestry:

The increasing demand for fuelwood and building material in rural areas has caused widespread deforestation of natural woodlands, riverine zones, and water catchments. To reduce this problem woodlots have been established at a number of villages throughout the country to supply fuelwood and poles. The incorporation of trees with crops, a system known as agroforestry, is one method of increasing fuelwood production that is gaining popularity in Third World countries. Trees grown amongst crops supply timber, nuts, fruit, and fodder for cattle. Appropriate species of trees enrich the soil, prevent erosion, retain water, and shield crops from damaging wind and excessive sunlight.

Afforestation and the environment:

The supply of wood and wood products from afforested areas has prevented the over-exploitation and destruction of our indigenous forests. However, unwise planning and management of afforestation can lead to negative environmental impacts.

Habitats most severely affected by afforestation include wetlands, grassland, and indigenous forests. Good management, and planning that takes conservation of natural habitats into consideration, can overcome these problems, some of which are outlined below:



Wetlands: Plantations situated too close to wetlands and perennial streams, or in their catchments, leads to their eventual drying out as trees use large amounts of water.

Grasslands: These rich communities support a variety of animals, including threatened species such as oribis, Stanley bustards and blue swallows. Afforestation converts grasslands to plantations, and so these animals lose their 'home'.

Indigenous forests: When plantations next to indigenous forests are logged, trees may fall onto the forest margin and damage it. Once damaged, the forest margin can no longer protect the indigenous forest from fire. In addition, logging can destroy

the diverse habitat where forest and grassland meet. The forest margin is an important food source for many forest animals.

River catchments: Trees use large amounts of water. Afforestation in water catchments thus reduces runoff and water availability for other uses.

Afforestation and the greenhouse effect

Trees absorb carbon dioxide (CO2) from the atmosphere during photosynthesis. It has been suggested that large scale afforestation could successfully absorb the CO_2 generated by the burning of the fossil fuels, coal and oil. The vast areas of afforestation required to achieve this would result in many negative environmental impacts. From a local perspective, in the short term such afforestation would cause as much environmental destruction as global warming could in the long term.

INDISCRIMINATE USE OF INORGANIC FERTILIZERS, PESTICIDES AND INSECTICIDES IN AGRICULTURE AND LOSS OF BIODIVERSITY

Pesticides have a major effect on biological diversity, alongside habitat loss and climate change. They can have short-term toxic effects on directly exposed organisms, and long-term effects can result from changes to habitats and the food chain. An endless number of mostly small and often inconspicuous organisms, such as bees, earthworms and soil microbes make much of our agriculture possible. Many of the organisms that live on, or move through farms help to keep soils healthy, or pollinate crops; however, insufficient management of potential pests poses risks to agricultural productivity and human health. In the event of a pest threat, and where no appropriate substitutes to the use of pesticides exist, a conventional or organic farmer may use pesticides to protect their crops.

Pesticides

Pesticides are biologically active compounds, formulated to affect target species. They are designed and used for the control of weeds, plant pathogens and animal pests. These products can have different biologically active origins. for example:

- Natural compounds, such as sulphur;
- Plant extracts, such as that derived from a daisy flower;
- Microbes, like insect viruses;
- Synthetic compounds, like those used in the azole class of fungicides.

Nearly all forms of agriculture, including both organic and conventional farming, require pest

control, and pesticides are the most widely used and recognised tool for this job. Organic farming relies on naturally occurring inorganic molecules such as copper or microorganisms like bacteria and viruses; conventional farming uses

in addition, synthetic compounds, which are formulated to be efficient and targeted in their action.. There are several classes of pesticides, the most relevant for crop protection are:

- Fungicides, for the suppression of fungal infections;
- Herbicides, used to control weeds;
- Insecticides, for the management of insect pests.

There are three key factors that determine the effectiveness of a product: the intrinsic properties of its active ingredient formulation, the characteristics of the target organism(s), and the mode of product application. Environmental variables such as local temperature and weather conditions also have influence over the effectiveness of pesticides.

Pesticides contain biologically active compounds and can therefore have direct or indirect unwanted effects on biodiversity. For example, the effective use of herbicides to remove weeds can have the secondary effect of reducing forage for pollinators if weeds that flower, are destroyed; likewise, the use of insecticide to manage aphids reduces the availability of food for ladybird beetles. Direct unintended effects of pesticides may occur for example, when a fungicide is translocated into a freshwater body, thereby exposing and potentially damaging aquatic organisms.

Pesticides are harmful to the ecosystems

Pesticides can travel great distances through the environment. When sprayed on crops or in gardens, pesticides can be blown by the wind to other areas. They can also flow with rain water into nearby streams or can seep through the soil into ground water. Some pesticides can remain in the environment for many years and pass from one organism to another.

Pesticides differ according to their effects on various organisms. Selective pesticides are toxic only to the target pests. They cause little or no harm to other organisms. However, nonselective pesticides can harm--or even kill--organisms that are not considered pests.

Effect on beneficial organisms

Pollinators

Flies, butterflies, moths, beetles, bumblebees, solitary bees, and the honey bee all make important contribution to the pollination of certain crops and wild plants. The economic contribution to agriculture made by pollinators is crop-specific. Cereals or maize are wind-pollinated and therefore do not require insect pollination (although maize, for instance, provides pollen for honey bees). Many species of fruit absolutely depend upon pollinators for their sexual reproduction; apple and cherry, for example. Pollinators also help us maintain variety in our diets, with many fruit and several vegetable species requiring insect polli-

nation. There are also crops that may produce an enhanced yield when insect pollination occurs; oilseed rape is one such example.

Soil organisms

Soil is home to one of the richest, most complex biological communities on earth. The soil organisms that inhabit the world beneath our feet are vital for maintaining balanced ecosystems, healthy soils, climate control and agricultural production. Soil organisms ensure soil fertility through humification (composting) and nitrogen fixation. Spaces created in the soil by earthworms and other organisms improve the water holding capacity of soils. Soil is the second largest CO2 sink on Earth, consequently, soil and soil organisms have considerable influence on the climate. The number of microorganisms under a footprint is tremendous. Additionally, numerous higher organisms such as arthropods and various worm taxa inhabit the soil ecosystem. The absolute number of organisms under a footprint can be in the range between 109 and 1014 individuals.

Pesticide poisonings of people, livestock, and wildlife have occurred when proper care was not taken. Pesticide applicators must be very careful to avoid these risks. Mishandling of pesticides can lead to

- Reduced control of the target
- Injury of non-target plants and animals
- Environmental damage.
- May disrupt the natural balance in ecosystems

Insecticides generally are the most toxic pesticides to the environment, followed by fungicides and herbicides.

The most hazardous pesticides include those that can be distinguished on the basis of:

1. Water solubility
2. Fat solubility

Water soluble pesticides are easily transported from the target area into ground water and streams since the pesticides get dissolved in the water. This means that the pesticides may run off to other areas and cause damage to untargeted animals and plants in other places.

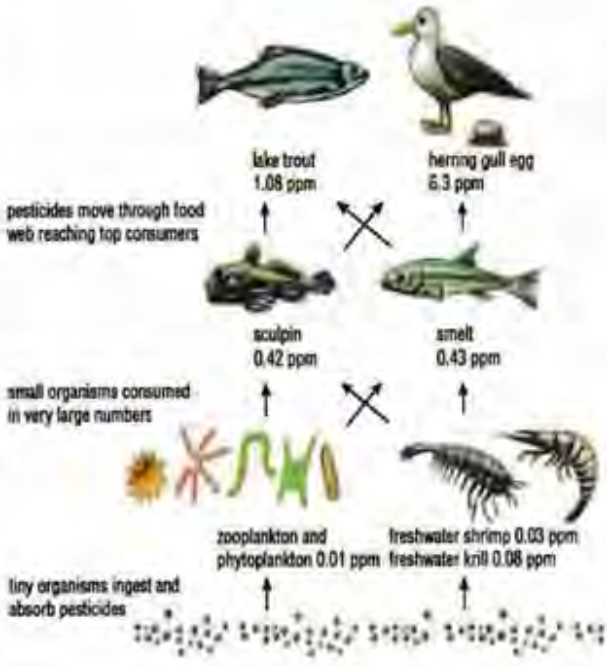
Fat soluble pesticides are readily absorbed in insects, fish, and other animals, often resulting in extended persistence in food chains.

Bioamplification

Pestcides such as DDT are fat soluble pesticides.

When there is a small amount of pesticide in the environment, it will enter the bodies of the animals that are low in the food chain - grasshoppers

1. Even though there is only a small amount of the toxin in each grasshopper, the shrews will receive a larger amount of the toxin in its body because the shrew will eat many grasshoppers.
2. When the secondary consumer is eaten (shrews), the higher-level predator, the owl will get all of its toxins, plus those of all the other prey it eats.



This means that the higher the trophic level, the greater the concentration of toxins. This process is referred to as Bioamplification. Therefore the top carnivore which has the higher trophic level which is the owl, will be the most badly affected as it will obtain the most concentrated toxins.

This will lead to a decline of the population of owls because a lot of owls will be poisoned. If there would be a decline of the owls, there would be a dramatic increase of the population of shrews as there would not be many predators, and if this happens there will be a decrease in the population of grasshoppers as they will be more predators (shrews) to eat them.

All of this comes to a final conclusion about pesticides:

1. Pesticides damage ecosystems
2. Pesticides may damage or harm un-targeted animals
3. Pesticides decrease biodiversity
4. Pesticides may cause a decline in populations or even cause extinction of species
5. Pesticides "mess up" food chains/webs
6. Pesticides disrupt the natural balance in ecosystems

Pros	Cons
• crops are saved from harmful pests • populations of harmful insects that cause or spread diseases are eliminated • harmful or inconvenient pests are eliminated • disease carrying pests will also be eliminated	• pesticides may damage the environment • pesticides may affect non-targeted organisms that may be useful or important • species may undergo a decline of population, or even go extinct • humans may be affected and may get diseases • the balance in ecosystems will be broken

PROPAGATION OF LOCAL CULTIVARS, LOCAL DOMESTIC ANIMAL AND BIRD VARIETIES

The Malabar region is a long and narrow coastline on the south-western shore of the Indian subcontinent. The region is credited for the development of a unique system for the management of the excessive water and backwaters with a chain of networks of both natural and man-made water channels (canals) and meticulously using them for transport and productive upland and aqua agriculture. The local communities have further utilized the situation with ingenuity for eco-friendly farming by developing unique cultivation systems of rice, such as 'pokkali' and 'kaipad', with the selection of salinity- and submergence-tolerant rice landraces/varieties for cultivation in saline water and below the sea level. These systems are being further enriched with the integration of rice–shrimp/prawn farming. Agricultural biodiversity in Kerala

The agriculture and agricultural practices have evolved according to the variations in climate, altitude, and the edaphic conditions. It is accounted by 142 crops belonging to 43 families and 104 genera in Kerala. Rice is the staple food and the main crop. Other crops are coconut, banana, mango, cashew, black pepper, areca nut, cardamom, vanilla, cinnamon, ginger, turmeric, nutmeg, clove and commercial crops such as rubber, tea, and coffee.

Tea, coffee, and cardamom are predominantly cultivated in the highlands. Teak and rubber are cultivated in the lower slopes of the highland region. The midlands are mainly occupied by coconut palms, with paddy, tapioca (cassava), pepper, pineapple, and pulses. Banana, ginger, and rubber are also grown in the midlands.

There are three major cropping systems, based on the primary crop and way of cultivation:

1. Coconut-based cropping systems: coconut is the major crop intercropped with crops such as pepper, areca nut, cocoa, banana, turmeric, ginger, small tubers, and fodder, and in some areas with upland rice, pulses, and oilseeds
2. Rice based crop system: Either a single or two crops of rice are grown, depending on the availability of water. In some areas, vegetables, pulses, and oilseeds are grown in fallows or as summer crops. Fish farming or prawn culture is practiced, after the rice crop, in the coastal areas of water inundation.
3. Homestead farming systems: The traditional system of home garden, as per the agro-climatic conditions, favours growing of a wide variety of crops. In this system, farmers choose their crop combinations and livestock or fish farming as per the prevailing conditions.

The important rice varieties cultivated in Kerala are Jyothi, Rohini,Annapurna, Triveni, Jaya, Aswathy, Sabari,Bharathy, Mahsuri, Ponni, and Samba. Indigenous aromatic rice varieties cultivated in Kerala: Gandhakasala, Jeerakasala, Velumba, Chomala, Kayama, Kothampala, Pookilathari, Jnavara, Chennellu, Kavungin Poothala etc.

Commercial/cash crops are the major constituents of the agriculture and agrobiodiversity, and play an important role in the economy of the region. The main cash crops are spices, coconut, rubber, tea, coffee, arecanut, cashewnut, ginger, etc.

Native cattle breeds of Kerala: Vechur cow and Kazaragod dwarf

Native goat breeds of Kerala: Malabari and Attappady Black

Native poultry breeds of Kerala: Tellichery chicken, Naked neck and Kuttanad duck

National Parks and Bioreserves in Kerala		
National park	**Area (km2)**	**Year started**
Eravikulam National Park	97	1978
Periyar National Park	350	1982
Silent Valley National Park	237. 52	1984
Anamudi Shola National Park	7.5	2003
Mathikettan Shola National Park	12.817	2003
Pambadum Shola National Park	1.318	2003
Biosphere Reserve		
Nilgiri Biosphere Reserve	1455.4	1986
Agasthyamalai Biosphere Reserve	1701	2002
Wildlife sanctuary		
Periyar Wildlife Sanctuary	777	1950
Neyyar Wildlife Sanctuary	128	1958
Peechi-Vazhani Wildlife Sanctuary	125	1958
Wayanad Wildlife Sanctuary	344.44	1973
Parambikulam Wildlife Sanctuary	285	1973
Idukki Wildlife Sanctuary	70	1976
Thattekad Bird Sanctuary	25	1983
Peppara Wildlife Sanctuary	53	1983
Chimmony Wildlife sanctuary	85	1984
Chinnar Wildlife Sanctuary	90.44	1984
Shendurney Wildlife Sanctuary	171	1984
Aralam Wildlife Sanctuary	55	1984
Mangalavanam Bird Sanctuary	0.0274	2004
Kurinjimala Sanctuary	32	2006
Chulanur Wildlife Sanctuary	3.42	2007
Malabar Wildlife Sanctuary	74.215	2010

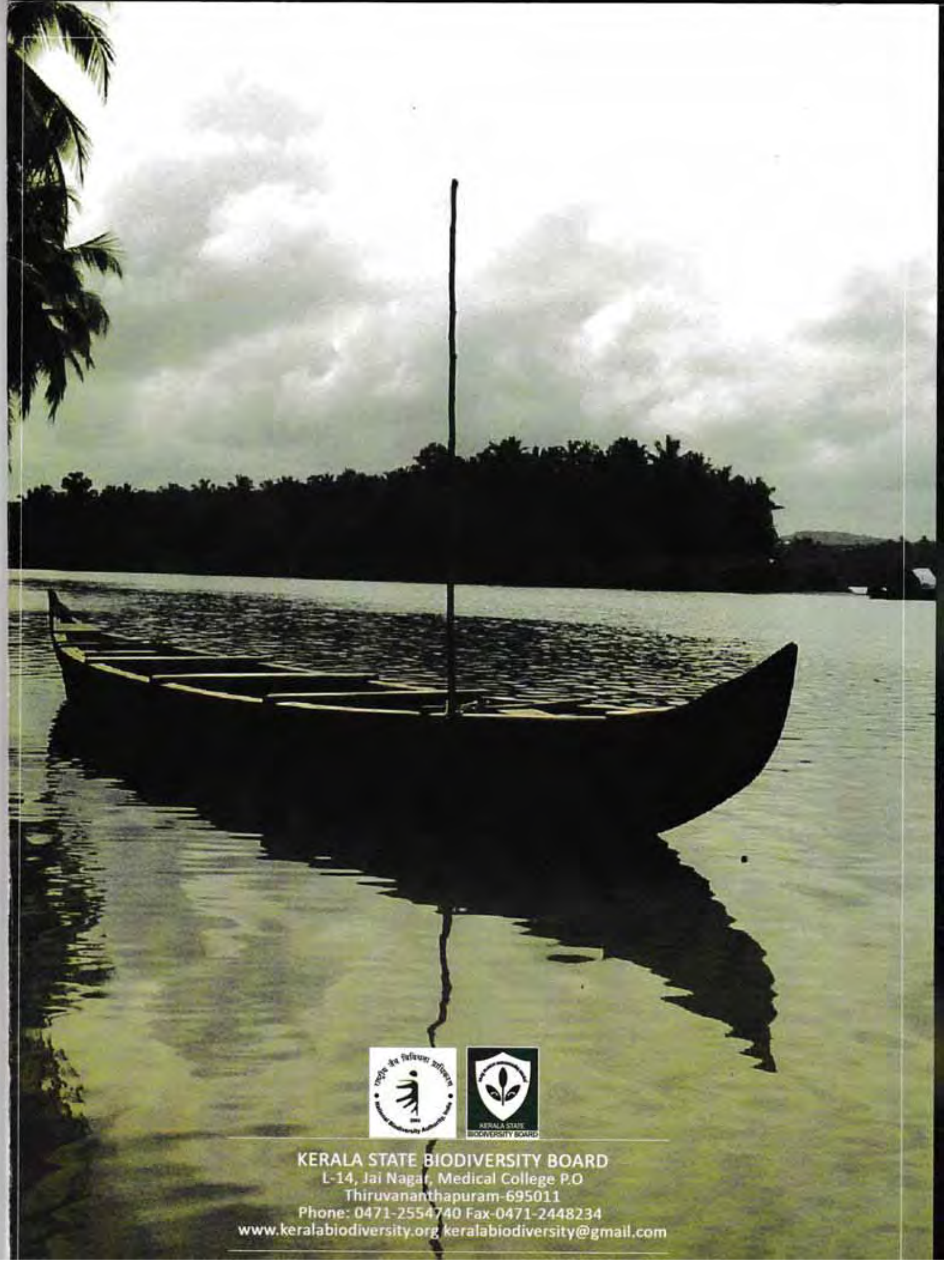
CELEBRATION OF IMPORTANT DAYS RELATED NATURE, ENVIRONMENT AND BIOLOGICAL DIVERSITY	
World Wet land day	- February 2
International Polar bear Day	- February 27
World Sparow Day	- March 20
World Planting Day	- March 21
World Water Day	- March 22
World Meteorological Day	- March 23
Earth Day	- April 22
Arbor Day (Best tree planting time)	- Last Friday in April
International Migratory Bird day	-May 3
World Migratory Bird Day	- May 10-11
World Biodiversity Day	- May 22
World Environment day	- June 5
World Ocean Day	- June 8
Global Wind Day	-June 15
World Day to Combat (Desertification and Drought)	-June 17
International Tiger Day	- July 29
World Elephant Day	- August 12
International Day for the preservation of ozone layer	- September 16
World Water monitoring Day	-September 18
World Environmental health day	- September 26
World Rivers Day	- Every last Sunday in September
World Habitat Day	- First Monday in October
International Day for natural Disaster reduction	-Second Wednesday in October
International Day for climate action	- October 24
World Soil Day	- December 5
International Mountain day	- December 11

Saving biodiversity - Saving life

Following are some conservation actions that we can take up:

- *Plant trees. Grow native species of plants (trees, shrubs and climber) where possible, this would attract local wildlife such as birds, butterflies and insects.*
- *Grow local vegetables in your school garden that are not usually available in the markets. This would allow to help conserve them for generations to come.*
- *Initiate, organize and participate in responsible citizen action against existing or proposed activities that harm or are likely to harm local biodiversity.*
- *Make a list of different kinds of trees in your campus or locality. For each one find out the names, uses, flowering season, animals and birds that depends on it. Present this information in an interesting way, and put it up by the tree. Many people will stop by to read this information and know more about the tree.*
- *Curb our greed for products made out of animal parts like skin, fur, ivory, bones, nails, etc., to discourage wildlife traders and poachers, and spare the lives of the remaining animals.*

- *Avoid using insecticides, pesticides and inorganic fertilizers and try to use natural plant-based substitutes wherever possible. Paper and cloth should replace non-biodegradable plastic and polyester which damage the ecosystem.*
- *Make children aware of their surroundings and the need for biodiversity.*
- *Promote bio-farming which is less intensive and environmental-friendly.*
- *Make use of sustainable technologies like smokeless chulhas, ground water recharging unit, wind energy, solar power, etc.*
- *Assist in recording and preserving rare and endemic species*
- *Create 'Biodiversity Registers' in communities, schools, villages*



KERALA STATE BIODIVERSITY BOARD
L-14, Jai Nagar, Medical College P.O
Thiruvananthapuram-695011
Phone: 0471-2554740 Fax-0471-2448234
www.keralabiodiversity.org keralabiodiversity@gmail.com