Introduction to biodiversity & Values of biodiversity

WHATISBIODIVERSITY?

-the sum of total of life form sat all levels of organization in biological system.

Biodiversityisdefinedas"***theintrinsically-inbuiltplustheexternally-imposedvariabilityin and among living organisms existing in terrestrial, marine and other ecosystem at a specific period of time***".

- Article 2of the CBD defines "*Biological diversity means the variability among living organismsfromallsourcesincluding,inter alia,terrestrial,marineandotheraquatic ecosystems and the ecological complexes of which they are part; this includes biological diversity within species and ecosystems*".

- "*Biodiversity includes assemblages of plant, animals and micro-organisms, their genetic variability expressed and populations, their habitats, ecosystems and natural areas, the mosaic of which constitutes the landscape which gives the richness to the natural environment*" (Denny, 1997).

- For the assessment of global biodiversity, it is defined as the total diversity and variability of living organisms and of the systems of which they are a part. Thiscovers thetotal rangeofvariation andvariabilityamong systems andorganisms atthe bioregional, landscapes, ecosystem, habitat (levels), and organismal level down to species, populations, individuals and genes (genetic diversity) [Heywood, 1995].

According to Edward Wilson "Biodiversity is the combined diversity at all the levels of biological organization."

Historyof Biodiversity

The term 'diversity' is not new, rather has a long history, but 'biological diversity' came into use in scientific literature only in the 1980s. The term was first coined by Lovejoy who, however, did not provide any formal definition to it, but considered it as only the number of species (Lovejoy, 1980). Rosen in 1985 used the term 'biodiversity' in the first planning conference of the 'National Forum on Biodiversity', Washington D. C., on Sept. 1986. Wilson (1988) edited the proceedings of the conference titled Biodiversity, and this popularized the concept.

ConventiononBiologicalDiversityinJune1992,constitutedahistoricalcommitment by all (many) nations of the world. For the first time, biodiversity was comprehensively addresses in this global treaty. At the same time the genetic diversity was considered and conservation of biodiversity was accepted as the common concern for the cause of human welfare (Gatson, 1998).

HowManySpecies arethereonEarthandHow Manyin India?

Since there are published records of all the species discovered and named, we know how manyspecies inall havebeenrecordedsofar,butitisnoteasytoanswerthequestionofhow manyspeciestherareonearth.AccordingtotheIUCN(2004),thetotalnumber ofplantand animal species described so far is slightly more than 1.5 million, butwehaveno clear ideaof how many species are yet to be discovered and described. Some extreme estimates rangefrom 20 to 50 million, but a more conservative and scientifically sound estimate made by Robert May places the global species diversity at about 7 million.

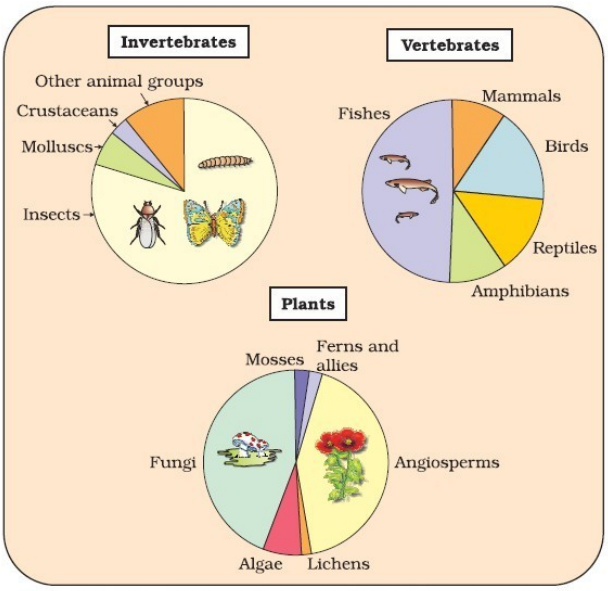


Figure 15.1 Representing global biodiversity: proportionate number of species of major taxa of plants, invertebrates and vertebrates

Although India has only 2.4 per cent of the world's land area, its share of the globalspeciesdiversityisanimpressive 8.1 per cent. That is what makes our country one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India. How many living species are actually there waiting to be discovered and named? If we accept Robert May'sglobal estimates, only 22 per cent of the total species have been recorded so far. Applying this proportion to India's diversity figures, we estimate that there are probably more than 1,00,000 plant species and more than 3,00, 000 animal speciesyettobediscoveredand described. Would we ever be able to complete the inventory of the biological wealth of our country? Consider the immense trained manpower (taxonomists) and the time required to completethejob.Thesituationappearsmorehopelesswhenwerealizethatalargefractionof these species faces the threat of becoming extinct even before we discover them. Nature's biological library is burning even before we catalogued the titles of all the books stocked there.

GlobalBiodiversityGradient

Biodiversityisnotdistributedevenlyacrosstheplanet:
Biodiversityisnotdistributedevenlyacrosstheplanet butshowsaratherunevendistribution, certain ecosystems and regions contain far more species than others. Tropical rain forests, coral reefs, the deep sea, and large tropical lakes appear to be the most species rich ecosystems on the planet (WCMC 1992; Heywood 1995; Levin 2001). For most groups of terrestrial plants and animals, species diversity is lowest near the poles and increases toward the tropics, reaching its peak in tropical rain forests. These forests, occupying only 6 percent of the earth's land surface, are believed to contain more than half the species on earth.

EvolutionofBiodiversity

Biodiversity is a product of the numerous biological and geophysical events that have occurred over the history of life on Earth.

- LifeonEarthis3.7-3.85x10^9yearsold
- Evolutionaryhistoryshapescontemporaryphysicalandbiologicalenvironment
- Currentdiversityofspeciesisaproductoftheprocessesofextinctionandspeciation

Extinction

Extinction is an important part of the process of evolution of biodiversity and does not occur at a constant pace. It is the complete disappearance of a species from Earth. Thus, extinction is the final and irreversible event of species loss. In contrast, *extirpation* is the local or regional disappearance of a species from only a part of its range.

There have been at least five periods when there was a sudden increase in the rate of extinction – to at least double – affecting many different types of plants and animals.

MajorFiveExtinctioneventsinclude:
Cretaceous-Tertiary Extinction Event (75% of all species including the dinosaurs) about 75 million years ago.
Triassic–JurassicExtinctionEvent (60%ofallspeciesincludingmostAchosaurs,Therapsids, and large Amphibians) about 205 million years ago.
Permian–TriassicExtinctionEvent(96%ofAquaticSpeciesincludingmostofthesessile species; and 70% of land species including most Synapsids) 251 million years ago.
LateDevonianExtinctionEvent(70%ofallspeciesincludingmostBrachiopodsand Trilobites) 360 million years ago.
Ordovician–SilurianExtinctionEvent(80%ofallspecies,mostlybrachiopods,bivalves, echinoderms, bryozoans, and corals) 450 million years ago.

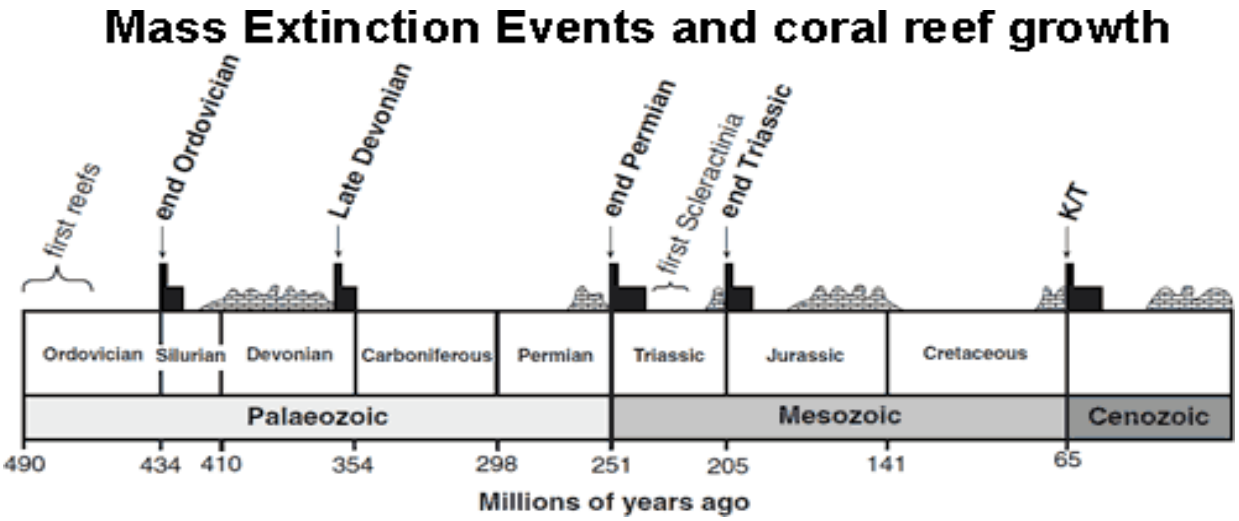


Figure 1:Timeline of mass extinction events. The five named vertical bars indicate mass extinction events. Black rectangles (drawn to scale) represent global reef gaps and brick-pattern shapes show times of prolific reef growth (Veron 2008).

6thextinctioncrisis
The world has begun, relatively recently, to lose species and habitats at an ever-increasing and alarming rate. This is often referredas **6th extinction crisis**,after the5knownextinction waves in geological history.

So what is the Sixth Extinction? When is it coming? And what is its cause?
"It'sthe nextannihilation of vastnumbers of species. Itishappening now, andwe, thehuman race, are its cause," explains Dr. Richard Leakey, the world's most famous paleoanthropologist.

- Extinction of species that is currently occurring as a result of human activities of various kinds.

From a study of the history of life on earth through fossil records, we learn that large-scale loss of species like the one we are currently witnessing have also happened earlier, even before humans appeared on the scene. During the long period (> 3 billion years) since the origin and diversification of life on earth there were five episodes of mass extinction of species. How is the 'Sixth Extinction' presently in progress different from the previous episodes? The difference is in the rates; the current species extinction rates are estimated tobe100to1,000times fasterthaninthepre-human times andouractivities areresponsible for the faster rates. Ecologists warn that if the present trends continue, nearly half of all the species on earth might be wiped out within the next 100 years.

Humans endanger the existence of species in *three* principal ways. The first is through direct *exploitation*, such as hunting. Second is the *biological havoc* that is occasionally wreaked following the introduction of alien species to new ecosystems, whether deliberately or accidentally. The third, and by far the most important, mode of human-driven extinction isthe *destruction and fragmentation of habitat*, especially the inexorable cutting of tropical rainforests. The forests, which cover just 7 percent of the world's land surface, are a cauldron of evolutionary innovation andare home to half of the world's species. The continued growth of human populations in all parts of the world daily encroaches on wild habitats, whether through the expansion of agricultural land, the building of towns and cities, or the transport infrastructure that joins them. As the habitats shrink, so too does the Earth's capacity to sustain its biological heritage.

Howa6thmassextinctionmightdifferfrompreviousmassextinctions

- causes-apparentlyhumaninduced(humanpopulation,pollution,globalclimate change, over hunting, etc.)
- rate-possibly greater
- possiblebreadthoftaxonomicgroupsaffected
- itcanbestoppedoratleast slowed!

Dimensionsof biodiversity

Biodiversity is the variety of life on Earth at all its levels, from genes to ecosystems, and the ecological and evolutionary processes that sustain it.

Geneticcomponent	Spatialcomponent	Functional component	Temporalcomponent
withinindividuals	communities	e.g.	daily
within populations	ecosystems	reproductive	seasonal
between populations	landscapes	behavior,	annual
between species	ecoregions biogeographicregions	predation, parasitism	geologicalorevolutionary

A comprehensive definition of biodiversity takes into account several dimensions, often overlapping. For example, genetic diversity exists over a hierarchy from individuals to populations to species.

Collections of different populations and species form communities and ecosystems, which can vary over spatial scales from the local level to the global level. Spatial patterns of

biodiversityareaffectedbyclimate,geologyandphysiography.Temporaldimensionsof

biodiversity range from daily to seasonal to annual, and evolutionary. Another dimension is Functional biodiversity, that is, the role that a group of organisms plays in the web of life. So,biodiversityisalargesubjectthatcanbestudiedfromavarietyof angles.

Levelsof biodiversity

Biodiversityiscommonlyconsideredatthreedifferentlevels:

1. Within species (intraspecific) diversity; usually measured in terms of genetic differences between individuals or populations.
2. Species(interspecific)diversity,measuredasacombinationofnumberandevennessof abundance of species.
3. Communityorecosystemdiversity,measuredasthenumberofdifferentspecies assemblages.

Biodiversity,therefore,isusuallyconsideredatthreehierarchicallevelsi.e.
Genetic*,*Species*and*CommunityandEcosystemlevels.

1. **Geneticdiversity**

Genetic diversity refers to any variation in the nucleotides, genes, chromosomes, or whole genomes of organisms. This is the "fundamental currency of diversity" (Williams and Humphries, 1996) and the basis for all other organismal diversity.

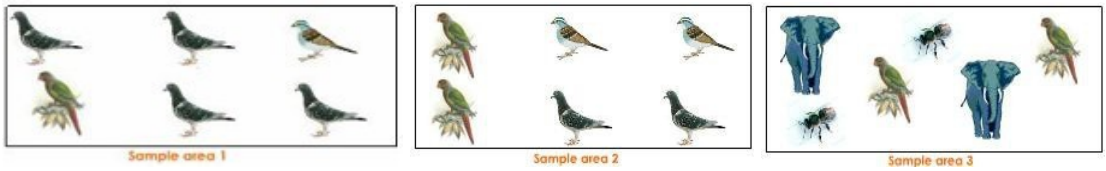
- Geneticdiversityisthesumtotalofgeneticinformation,containedinthegenesof individuals of plants, animals and microorganisms that inhabit the earth.
- Itisneededbyanyspeciesinordertomaintainreproductivevitality,resistanceto disease and the ability to adapt to changing conditions.
- Itenablesapopulationtoadapttoitsenvironmentandtorespondtonatural selection.
- Theamount ofgeneticvariation isthebasisofspeciation.
- Geneticdiversitywithinaspeciesoftenincreaseswithenvironmentalvariability.
- Such genetic variability has made it possible to produce new breed of crops plants and domestic animals, and in the world allowed species to adapt to changing conditions.

2. **Species diversity**:

- Agroupoforganismsgeneticallysosimilar,thattheycaninterbreedandproduce fertile offsprings is called a **species**.
- Thespeciesdiversityisusuallymeasuredintermsofthetotalnumberofspecies within discrete geographical boundaries.

Speciesdiversity-"speciesaregroupsofactuallyorpotentiallyinterbreedingnaturalpopulations that are reproductively isolated from other such groups" (Mayr 1963)

- Speciesaredistinct unitsofdiversityeachplayingaspecificroleintheecosystem.
- In nature, both the number and kind of species, as well as the number of individuals per species vary, leading to greater diversity.



Thedifferentsampleareasshowingspeciesrichness(samplearea1),Speciesevenness (sample area 2) and diversity due to taxonomically unrelated species (sample area 3).

3. **Community-leveldiversity**:

It is defined by the species that occupy a particular locality and the interactions betweenthem. It represents the collective response of species to different environmental conditions. Biological communities such as deserts, grasslands, wetlands, and forest support the continuity of proper ecosystem functioning by providing ecological beneficial services to people.

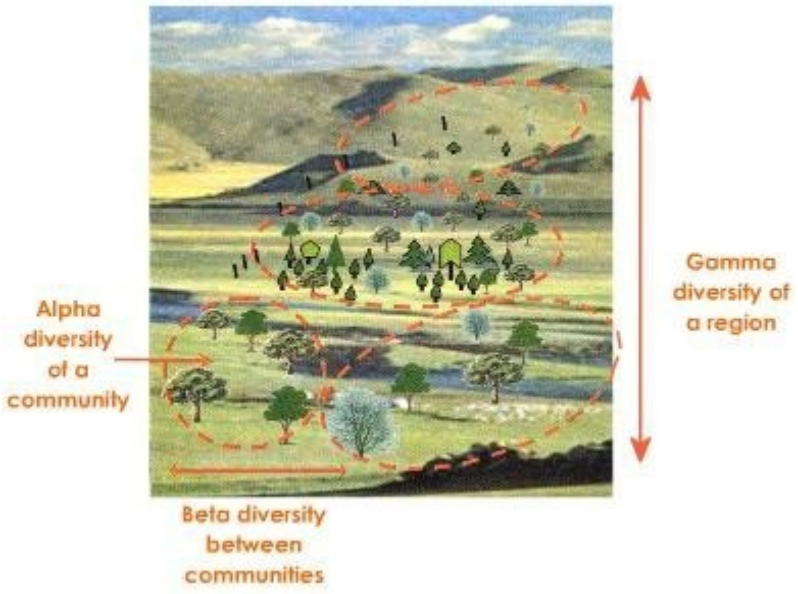
Diversityatthelevelofcommunityandecosystemexistsalong3levels.

- Itcouldbewithin-communitydiversity(alphadiversity),
- between-communitiesdiversity(betadiversity)or
- diversityofthehabitatsoverthetotallandscapeorgeographicalarea(gamma diversity).

Alpha,Beta,andGamma Diversity

Whittaker(1972)describedthreetermsformeasuringbiodiversityoverspatialscales:alpha, beta, and gamma diversity.

- *Alpha Diversity*refers to the diversity within a particular area or ecosystem, and isusually expressed by the number of species (i.e., *species richness*) in that ecosystem.
- *Betadiversity:* acomparisonofdiversity betweenecosystems,usuallymeasuredas the amount of species change between the ecosystems .
- *Gammadiversity:*ameasureoftheoveralldiversitywithinalargeregion.Geographic-scale species diversity according to Hunter (2002)



BIODIVERSTYPRINCIPLES

1. Go native - Native areas (wetlands, aquatic areas, riparian areas, forests/woodlands, and grasslands) provide the most important contribution to biodiversity on land.
2. Semi-natural is valuable -Semi-natural areas (e.g., shelterbelts, hedgerows, pastures and haylands, buffers, road margins) also contribute to the conservation of biodiversity.
3. Location - The location, pattern, and seasonal availability of habitat influences the typeand amount of biodiversity present.

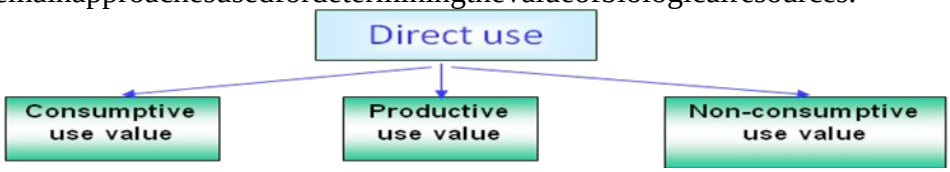
4. Connection-Connectingnativeandsemi-naturalareasoflandandwithneighbouring landscapes is important to biodiversity.
5. Achievingstructuraldiversity-Thevariationinphysicalstructureofbothnative vegetation and crops—on the land provides an important contribution to biodiversity.
6. Healthy ecosystems - The health of native and semi-natural areas, all other farmland, and soil and water influences the type and amount of biodiversity present.
7. Variety-Thenumberandmixofspeciespresent,includingcropsandlivestock, influences the type and amount of biodiversity present.
8. Aliens-Invasivealienspeciesaregenerallydetrimentaltotheconservationofbiodiversity.

THEVALUESOFBIOLOGICALDIVERSITY

- Human society depend on biological diversity for almost all thefood supply, half of its medicines, much of its clothing and in some region virtually all of its fuel and building material and as well as, of course, an important part of its mental andspiritual welfare.
- Ecologicalservices

Biologicaldiversityasaresource

Thethreemainapproachesusedfordeterminingthevalueofbiologicalresources.



- **Consumptive use value:** The biological resources are consumed directly, without passing to the market. Assessing the value of nature's products - such as fire wood, fodder, game meat, etc.
- **Productive use value:** The resource comes through market or trading. Assessing the value of products that are commercially harvested, such as timber, fish, game meat sold in a market, ivory, and medicinal plants.
- **Non-consumptive use value**: The resources meant for the future potential uses of biodiversity (tourism, scientific research) and ecological balance.

Indirectuse-Ecological services

Benefitsof biodiversity

- **Economicalbenefits–**

  a) Food value – providing food to the human population on this earth for thousands of years. In the process of development of human civilization, man has unfolded many plant and animal life forms which are directly or indirectly helpful for him in solving his food problem. Due to the scientific advancement many new taxa have been discovered which are high yielding.

  b) Commercial value –timber which is a major component of material used for providing shelter to man. Natural fibres like cotton and silk are still used for clothing by human population.

  c) Medicinal value –Medicines, drugs andpharmaceuticals. Manyplant genetic resources are used from derivation of basic drugs. These plant resources vary from actinomycetes and fungi to large trees.

  Traditional knowledge of indigenous people still keeps an edge over the scientific knowledge in this field.

  This benefit of biodiversity is still unexplored as the scientists could assess a small fraction of biodiversity for their potential for medicine and agriculture.

- **Aesthetic value** – Man has always been fascinated by the natural beauty and nature has inspired him resulting in development of his moral and ethical values.
  This intrinsic value of plants and animals are independent of their economic and commercial value. Wonderful plants and animals of this planet not only reflect their aesthetic value but they can make us think of the creator. This opens doors for spiritually which envisages to live in harmony with the nature.

- **Ecological benefits/services (Indirect use value) –** Biodiversity supplies the buffering capacity and stability to life on the planet by maintaining the interactive dynamics of the ecosystems of the world.

THREATSTOBIODIVERSITY

➢ Growinghumanpopulation

- specific types of human actions that threatened biodiversity and ecosystems and causes to extinction of many species are:

- Over-hunting/over-exploitation
- **Habitat loss/ degradation/fragmentation**
- Deforestation
- Invasionofnon-nativespecies
- Pollution
- Climatechange
- Culturalimpacts

Over-exploitation: Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed', it leads to over-exploitation of natural resources.

Habitat loss/degradation/fragmentationis an important cause of known extinctions. As deforestation proceeds in tropical forests, this promises to become the cause of mass extinctions caused by human activity. All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities. In the future, the only species that survive are likely to be those whose habitats are highly protected, or whose habitat corresponds to the degraded state associated with human activity.

The Amazon rain forest (it is so huge that it is called the 'lungs of the planet') harbouring probably millions of species is being cut and cleared for cultivating soya beans or for conversion to grasslands for raising beef cattle. Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are brokenupintosmallfragmentsduetovarioushumanactivities,mammals andbirdsrequiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

Habitat fragmentation is a further aspect of habitat loss that often goes unrecognized. The forest or other habitat that remains generally is in small, isolated bits rather than in large, intact units. Environmental fluctuations, disease, and other chance factors make such small isolates highlyvulnerable toextinction. Anyspecies thatrequires alargehome range,suchas a grizzly bear, tiger, etc will not survive if the area is too small. Moreover, small land units (fragments) are strongly affected by their surroundings, in terms of climate, dispersing species,etc.Asaconsequence,theecologyofasmallisolatemaydifferfromthatofasimilar

ecosystem on a larger scale.

Alien species invasions: When alien species are introduced unintentionally or deliberatelyfor whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species. E.g. environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia). The recent illegal introduction of the African catfish Clarias gariepinus for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.

Pollution: Chemical contaminant certainly poses a further threat to species and ecosystems. While not commonly a cause of extinction, it likely can be for species whose range is extremely small, and threatened by contamination.

Climate changes: A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes) [GCI,11/8]. Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust. The pace of climate change almost certainly will be more rapid than most plants are able to migrate. For these reasons, some species and ecosystems are likely to be eliminatedby climate change. Agricultural production likely will show regional variation in gains and losses, depending upon crop and climate.

Based on the degree of threats face by the species, species are categories into different conservation category i.e. Extinct, Endangered, Vulnerable and Risk. Therefore, it ispertinent to protect and conserve the existing biodiversity for the socio-economic development and ecological balance. Every species have its role in the environment.

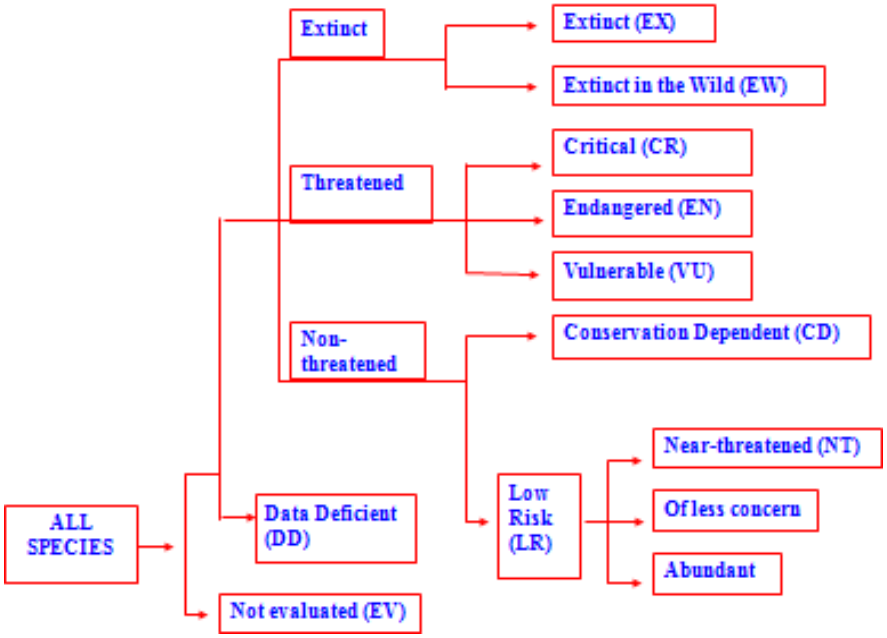
The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years. Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger. The last twenty yearsalone have witnessed the disappearance of 27 species.

ThreatenedSpeciesCategories(AccordingtoIUCN)	
Extinct (E)	AtaxonisExtinctwhenthereisnoreasonabledoubtthatthatthelast individualhasdied.
Critically Endangered(CR)	AtaxonisCriticallyEndangeredwhenitisfacinganextremelyhigh riskofextinction inthewildintheimmediatefuture.
Endangered(EN)	AtaxonisEndangeredwhenitisnotCriticallyEndangeredbutfacing averyhighriskofextinctioninthewildinthenear future.
Vulnerable(VU)	AtaxonisVulnerablewhenitisnotCriticallyEndangeredbutfacing ahighriskofextinctioninthewildinthemedium-termfuture.
LowerRisk(LR)	AtaxonisLowerRiskwhenit hasbeenevaluated,doesnotsatisfythe criteriaforanyofthecategoriesCR,E,orVU.

Endemic species: Species restricted to a particular region or ecosystem due to various environmental factors or due to the barriers of dispersal.
Rarespecies: Somespeciesarenaturallyrareduetopresenceinsmall numbers.

THREATCATEGORIES

THREAT CATEGORIES



ThreatenedspeciesofIndia	
Taxonomicgroup	Numberofthreatenedspecies
Mammals	86
Birds	73
Reptiles	25
Amphibians	3
Fish	3
Molluscs	2
Othervertebrates	21
Plants	244
Total	459
Source:IUCN2000	

BIODIVERSITYCONSERVATION

WhyShouldWeConserveBiodiversity?

There are many reasons, some obvious and others not so obvious, but all equally important. They can be grouped into three categories: **narrowly utilitarian**, **broadly utilitarian, and ethical.**

The **narrowly utilitarian** arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from nature food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and products of medicinal importance. More than 25 per cent of the drugs currently sold in the market worldwide are derived from plants and 25,000 species of plants contribute to the traditional medicines used by native peoples around the world. Nobody knows how many more medicinally useful plants there are in tropical rain forests waiting to be explored. With increasingresourcesputinto‘bioprospecting’(exploringmolecular,geneticandspecies-level

diversity for products of economic importance), nations endowed with rich biodiversity can expect to reap enormous benefits.

The **broadly utilitarian** argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast dwindling Amazon forest is estimated to produce, through photosynthesis, 20 per cent of the total oxygen in the earth's atmosphere. Can we put an economic value on this service by nature? You can get some idea by finding out how much your neighborhood hospital spends on a cylinder of oxygen. Pollination (without which plants cannot give us fruits or seeds) is another service, ecosystems provide through pollinators layer – bees, bumblebees, birds and bats. What will be the costs of accomplishing pollination without help from natural pollinators? There are other intangible benefits –thatwederivefromnature–the aestheticpleasures ofwalkingthroughthickwoods, watching spring flowers in full bloom or waking up to a bulbul's song in the morning. Canwe put a price tag on such things?

The **ethical** argument for conserving biodiversity relates to what weowe to millions of plant, animal and microbe species with whom we share this planet. Philosophically or spiritually, weneed to realise that every species has an intrinsic value, even if it may not beof current or any economic value to us. We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

Biodiversity knows no political boundaries and its conservation is therefore collective responsibilities of all nations.

PROTECTINGBIODIVERSITY:LEGALANDNON-LEGALBINDINGS

Conservationofbiodiversity

- Conservation of biodiversity is essential for the human survival, notably through health, food and industry.
- All forms of life-human, animal and plants are so closely interlinked that disturbance in one gives rise to imbalance in the others.
- If species of plants and animals become endangered they signify degradation in the environment, which may threaten man's own existence.
- The maintenance of biodiversity at all levels is fundamentally the maintenance of viable population of species or identifiable populations.
- Approaches of biodiversity conservation should be concise with due consideration of national problems.
- Priority should be given first to conserve those species which have vital resource which benefit to mankind at shorter duration and also to conserve threatened, endangered and rare species of the nation.
- *Insitu* and *exsitu* conservationofbiodiversityshouldbedoneforthosespecieswhich are threatened, rare, endangered as well as species expenditure.
- Extraction of timber from the forest areas should be based on ecological planning by taking into the consideration of stability of ecosystem.
- The scientific knowledge of biodiversity conservation should not be restricted on paper that should be spread among the people through the mass communication, training, awareness programmes at the grassroots level.
- An approach of sustainable harvest or exploitation of the species will be helpful for the conservation of biodiversity, offering all the basic necessities for the subsistence of man's life.
- Therefore, sustainable use of resources and sustainable development are highly needed in order to save the loss of biodiversity.

HowdoweconserveBiodiversity?

In situ conservation- In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India has also a history of religious and cultural traditions that emphasized protection of nature eg.Sacred groves.

*Exsitu*Conservation–Inthisapproach,threatenedanimalsandplantsaretakenoutfromtheir natural habitat and placed in special setting where they can be protected and given special care and protective maintenance. Examples; zoological parks and botanical gardens, in vitro fertilisation, tissue culture propagation and cryopreservation of gametes.

Forestsand wildlife

TheForest(Conservation)Act, 1980

ThisActwasadoptedtoprotectandconserveforests.TheActrestrictsthepowersofthestate inrespectofde-reservationofforestsanduseofforestlandfornon-forestpurposes(the term ?non-forest purpose? includes clearing any forestland for cultivation of cash crops, plantation crops, horticulture or any purpose other than re-afforestation).

TheWildlife(Protection)Act,1972,Amendment1991

The WPA (Wildlife Protection Act), 1972, provides for protection to listed species of flora and fauna and establishes a network of ecologically-important protected areas. The WPA empowers the central and state governments to declare anyarea awildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the huntingofwildanimals;protectspecifiedplants,sanctuaries,nationalparksandclosedareas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Actprohibitshuntingofanimalsexceptwithpermissionofauthorizedofficerwhenananimal has become dangerous to human life or property or so disabled or diseased as to be beyond recovery(WWF-India, 1999).Thenear-totalprohibition onhunting wasmademore effective by the Amendment Act of 1991.

NationalParks

Definition:Anareadedicatedbystatuteforalltime,toconservethesceneryandnaturaland historical objects of national significance, to conserve wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations, with such modifications a local conditions may demand". (IBWL 1952)

WildlifeSanctuary

Definition:It is an area where killing and capturing of any species of birds or animals is prohibited except under orders of competent authority and whole boundaries and characteristics should be sacrosanct (free from outrage) as far as possible". (IBWL 1952)

AimsofestablishmentofNationalParksandWildlifeSanctuary

Thesanctuariesandnationalparks(Protectedareas)areestablishedwiththeview to:-

1. Adequaterepresentationofbio-geographicdiversity.
2. PropergeographicdistributionsofPAsacrossprominentwildernessbelts.
3. Setting-upnewPAsrationalizingboundariesofexistingonessoastomeettheimperative in the above 1 & 2.

4. OvercomingmanagementdeficienciesinPAs.

5. Promoting corridor values (conducive to movement of major mammals and long terms, long ranging gene-travel of all species of flora and fauna) through forests and multiple-use areas that lie between PAs in a given wilderness belt.
6. EstablishingamonitoringmechanismtoaccesstheviabilityofnetworkofPAs.

DifferencebetweenNPandWLS

- NationalparkisdeclaredbythestategovernmentundersectionSS(1)oftheWildLife (Protection) Act, 1972; whereas sanctuary is declared under section 18(1) of the Act.

- In NP, the boundary is well-defined and accurate at the time of its declaration; while the boundary is demarcated approximately at the time of its declaration in sanctuary.
- TheclaimofrightoflandofthepeopleissettledbeforeitsdeclarationinNP;whereas in case of sanctuary the same is settled after its declaration.

- No alternation of the boundaries of the NP shall be made except on a resolution passed by Legislative Assembly of the State Government; but on contrary, in sanctuary, such alternation may be done by the order of the state Government.

- In NP grazing is not permissible while in sanctuary grazing and movement of the cattle may be permitted for the benefit of wild animals.

- In sanctuary, the Chief Wildlife warden may pass his/her order after getting concurrence of the state Government to kill or catch the certain wild animal for the welfare of wild community and he/she is also empowered to dismiss the order; but in case of NP, such order is governed by the state Government itself and then the Chief Wild Life warden issues the concerned order which cannot de dismissed by him/her.

The status and degree of permanency and protection is, therefore, much higher in NP than ina sanctuary.

BiosphereReserve

Biosphererereservesareareasofterrestrialandcoastalecosystemspromotingsolutionsto reconcile the conservation of biodiversity with its sustainable use.

They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located.

Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity.

Collectively, biosphere reserves form a World Network. Within this network, exchanges of information, experience and personnel are facilitated. There are over 480 biosphere reserves in over 100 countries.

To prevent loss of biodiversity, the Government of India is setting up 17 biosphere reservesin different parts of the country. (Ministry of Environment and Forests: "Annual Report2010-2011")

- These are multipurpose protected areas to preserve the genetic diversity in different ecosystems.

- Seven of the seventeen biosphere reserves are a part of the World Network of Biosphere reserves, based on the UNESCO Man and the Biosphere (MAB) Programme list. Namely, Nilgiri, Gulf of Mannar, Sundrbans, Nanda Devi, Nokrek, Pachmarhi, and Similipal Biosphere Reserves

FunctionsofBiosphereReserve

Each biosphere reserve is intended to fulfill 3 basic functions, which are complementary and mutually reinforcing:

- **a conservation function** - to contribute to the conservation of landscapes,ecosystems, species and genetic variation;
- **a development function** - to foster economic and human development which issocio-culturally and ecologically sustainable;
- **a logistic function** - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

Sacred groves

- Sacredgrovesarethetractofvirginforestharbouringrichbiodiversity,protectedbythelocalpeoplebased onthe ground of beliefs of culture, religion and taboos ofindigenous people.

- They are the repositories of rare and endemic species and can easily be thought of as remnants of primary forest left untouched by the local inhabitants and protected by them due to the consideration that deities resides inthese forests.

- It is one of the oldest form of conservation of nature, practiced by the indigenous communities and rural people.

- The inextricable link between present society to the past in terms of biodiversity, culture, religious and ethnic heritage has been found in sacred groves.

- It is believed that sacred virgin forest dates back to several thousands of years when human society was in the primitive state.

- Historical links of the sacred groves has been traced from pre- agricultural, hunting and gathering stage of societies and believed to be pre-Vedic in origin.

- Thegroveshaveevolved under different socio-ecological and cultural situations. Everysacredgrovecarriesitsownlegends,loreandmythswhichformthe integralpartoftheoraltraditionsoflocalpeople.

- This unique community-linked forest conservation concept is still followed in many tribal and agrarian regions of the world. For example, a number of humansocietiesinAsia, Africa, Europe, Americaand Australiahad long preservation sections of their natural environment as sacred groves.

- Theprotection and conservationofgrovesdependsentirelyonthecontrolof the community over the forest and the people.

- Theyhavebeensurvivedformanyhundredsofyearsandtodaythey serve asreservoirofmuch localbiodiversity. Groves provides many ecological, environmental and socio-cultural functions to the society.

❖ Inthecontext oftherecent concern over thehighratesofdeforestation and natural resourceuse,thesacredgrovesofferapotentialtooland modeltorevisitand explore the possibilities of conservationofbiological diversity.

Classificationofsacredgroves

Traditional Sacred Groves – It is the place where the village deity resides, who is represented by an elementary symbol.

TempleGroves–Hereagroveiscreatedaroundatempleandconserved.

Grovesaroundtheburialorcremationgrounds.

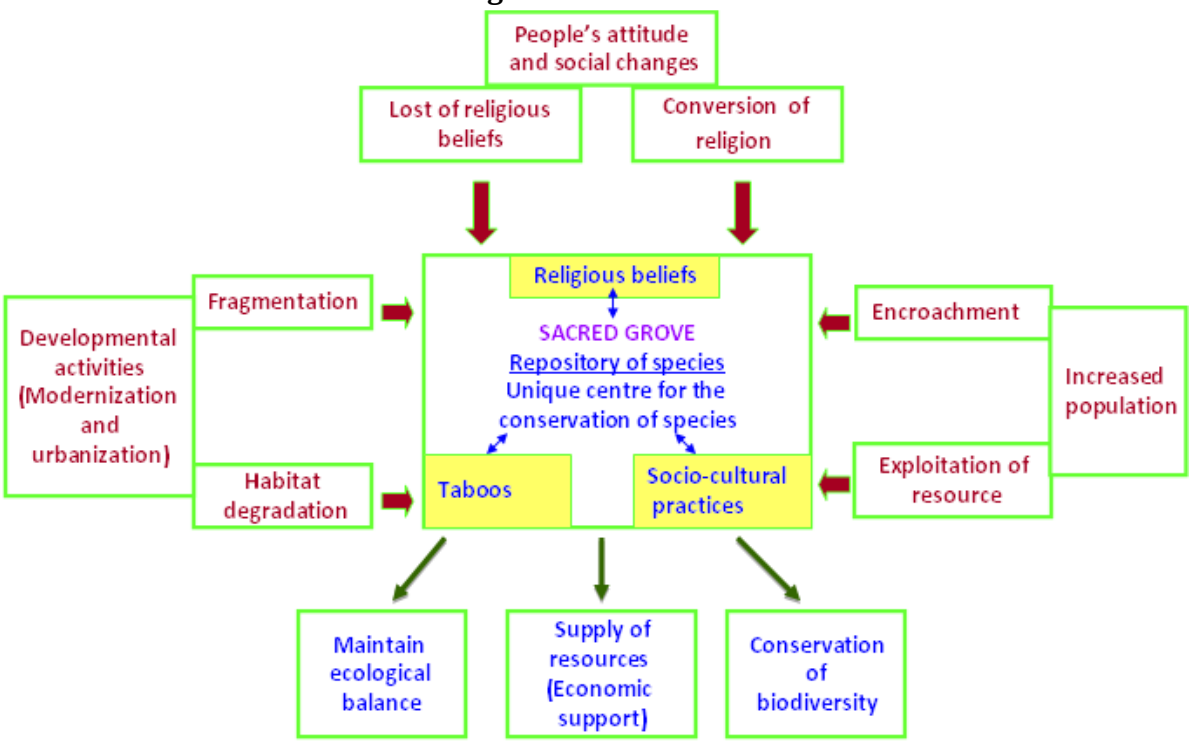


Figure . Diagrammatic representation of sacred grove: it's benevolent to human and nature, and fortune due to human impacts. (Source: Khumbongmayum, et al 2004)

BIODIVERSITYOFNORTHEASTINDIA

- Northeast India is blessed with a wide range of physiography and ecoclimatic conditions. It represents the transition zone between the Indian, Indo-Malayan and Indo-Chinesebiogeographicregionsandameetingplaceoftheastern Himalayan Mountains and Peninsular India.
- The region is one of the richest in biological values. It is in this lowland-highland transition zone that the highest diversity of biomes or ecological communities can be found, and species diversities within these communities are also extremely high.

FLORA

The vegetation of the northeastern region is fairly well known. With about 1,67,000 sq.km. area under forest, this region accounts for approximately 7500 species ofangiosperms.The State of Sikkim alone holds about 5000 species of flowering plants. Out of 315 families of

AngiospermsinIndia,morethan200arerepresentedinNortheastIndiaandthisregion

accounts for nearly 50% of the total number of plant species in India as a whole. Though the flora of this region exhibits an Indo-Malayan affinity, the floral elements of other parts of India, and of neighbouring and far off countries, have also contributed to its richness and diversity. It is of interest to note that about one third of the flora of Northeast India isendemic to this region.

- The NE region accounts for nearly 50% of the total number of plant species in India as a whole.
- The region has at least 7,500 flowering plants, 700 orchids, 58 bamboos, 64 citrus, 28 conifers, 500 mosses, 700 ferns and 728 lichen species. Some of the important gene pools of citrus, banana and rice have been reported to be originated from this region (Anonymous 1996).
- Outofthe315families ofAngiosperms inIndia,morethan200arerepresentedinNE India.
- It is of interest to note that about one third of the flora of NE India is endemic to this region.

The carnivorous/ Pitcher plant (*Nepentheskhasiana*) is endemic to Meghalaya and is listed in Appendix I of CITES and placed in Schedule VI of the wildlife (Protection) Act, 1972.

Siroy lily (*Lilium mackliniae*) a ground lily that produces beautiful flowers, is a narrow endemic found in the eastern border area of Manipur in Ukhurl district.

Agarwood (*Aquilaria malaccensis*) that occurs in the tropical forests of the NE regions is highly prized and is listed in Appendix II of CITES Schedule VI of the Wildlife (Protection) Act, 1972.

The yew tree (*Taxus baccata*) is a highly toxic plant that has occasionally been used medicinally, mainlyinthetreatment ofchestcomplaints.Modernresearchhasshownthatthe plants contain the substance 'taxol' in their shoots. Taxol has shown exciting potential as an anti-cancerdrug,particularlyinthetreatmentofovariancancers.
Taxus baccata found in West Kameng and Tawang district of Arunachal Pradesh are cut down by the local people and exploit for commercial purpose. Due to the large scale destruction, the survival of species are threatened and immediate conservation is needed. Therefore, in Bomdila a nursery of *Taxus* baccata is set up and helping from the verge of extinction.

Rhododendron

The genus Rhododendron of Ericaceae is another remarkable group of showy plants with nearly98%ofthetotalRhododendronsreportedfromIndiaareconfinedtoHimalayan region (Singh et al. 2003).
In total 72species, 20sub species and19 varieties listed from India, eastern Himalaya region harbors 71 species. Out of 12 species, 2 sub species and 5 varieties of Rhododendronendemic to India, in north eastern region, Arunachal Pradesh has maximum number of endemic species with 9 species and 1 sub species, followed by Manipur and Sikkim with 3 species and 1 sub species and Mizoram with 2 species (Mao et al 2001).

Orchid

Orchidaceae, the most fascinating and highly evolved groups of plants with 1229 species belonging to 184 genera in India (Singh & Chauhan 1999), about 700 species have been reported from north eastern region of India.

Of these, 545 species belonging to 122 genera are reported from only Arunachal Pradesh (Chowdhery 1998). Of which 12 species are under endangered category, 16 species vulnerable and 31 species threatened.

FAUNA

The region is equally rich in faunal diversity. An estimated 3,624 species of insects, 50 molluscs, 236 fishes, 64 amphibians, 137 reptiles, 541 birds and 160 mammalian specieshave been so far described (Anonymous 1998b).

Primates

- Threefamiliesofprimates'occurinIndiawith15knownspecies,nineofthese species occur in North east India (Mohnot 1980 and Roonwal and Mohnot 1977).

- The Golden Langur (*Trachypithecus geei*) is a Schedule I animal and is also listed in the Appendix I of CITES.

The Slow Loris (*Nycticebus bengalensis*) is an inhabitant of tropical forests south of the Brahmaputra River in Northeast India. This highly endangered animal is listed as Schedule I animal, and in Appendix I of the CITES.

Carnivores

- Of the six largest cats of the world recorded from India, state of Arunachal Pradesh only sustain four of them - the Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Snow Leopard (*Uncia uncia*) and the Clouded Leopard (*Neofelis nebulosa*).

- Red Panda, protected under Schedule I of the Indian Wildlife (Protection) Act, 1972 and listed in Appendix I of CITES and as 'Endangered, by IUCN is also predominantly available in the region.

Ungulates

- ThefoothillgrasslandsandbroadleafforestharborimportantpopulationofAsian elephant, onehorned rhinoceros and wild water buffalo.
- In Northeast India Great Indian Rhinoceros (*Rhinoceros unicornis*) is now restrictedto Kaziranga, Pabitora and Orang in Assam.
- TheBrow-antleredDeer(*Cervuseldieldi*),locallyknownasSangaiisendemicto Manipur and one of rarest and the most localized subspecies of deer in the world.
- The Pygmy Hog (*Sus salvanius*) is the smallest and the rarest wild suid in the world, and only a few isolated wild populations survive in Northeast India.

Birds

- FromArunachalPradeshover760birdspecieshavebeenreported(Borang2004).
- Greater Adjutant (*Leptoptilos dubius*) is a globally threatened bird with the majorityof the world's population now found in Assam.
- Spot-billed Pelican (*Pelicanus philippensis*), Blacknecked Stork (*Ephippiorhyncus asiaticus*), Lesser Adjutant (*Leptotilos javanicus*), and Pale-capped Pigeon (*Columba punicea*), are only to name a few of the globally threatened birds found in the region.
- Swamp Francolin (*Francolinus gularis*), found in Northeast India, is endemic to the Indian subcontinent.

Lower Vertebrates

- So far 137 species of reptiles have been recorded from Northeast India which has the

greatest affinity to the Oriental, Indo – Malayan and Indo – Chinese regions.

- 20 lizard species fromthe State of Assam, and 18 species fromthe tiny stateof which is profoundly influenced by the Indo-Chinese connection have been recorded so far.
- Of the three species of Monitor Lizards found in the region, *Varanus flavescens* is listed in Schedule I under Wildlife (Protection) Act, 1972 and listed in Appendix I of CITES.
- The Tokay Gecko (*Gekko gekko*) is the largest gecko alive today and is found in northeast India.
- Fifty eight species of snakes have been recorded in Assam, 34 from Manipur and 92 from Arunachal Pradesh. *Python reticulatus*, the largest snake in India, is found in northeast India and *Python molurus bivittatus* is the most commonly known in the region.
- Sofar64speciesofamphibianshavebeenrecordedfromthe Northeast India.

Invertebrates

- The Biodiversity Strategy and Action Plan for Northeast Ecoregion suggests that 3,624 species of insects and 50 molluscs are recorded from the region (Tripathi and Barik 2003).
- Butterflies and moths are by far the best-studied invertebrate organisms in Northeast India, and the region contributes the maximum number of species for the group in the country.

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Abbreviationsused:

CBD: ConventiononBiologicalDiversity
CITES: ConventiononInternationalTradeinEndangeredSpeciesofWildFaunaandFlora
IBWL: IndianBoardfor Wildlife
IUCN-InternationalUnionforConservationofNature
UNESCO-UnitedNationsEducational,ScientificandCulturalOrganization
WCMC: WorldConservationMonitoringCentre
WPA-WildlifeProtectionAct
WWF-WorldWideFundfor Nature

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