TOPIC 2: BIODIVERSITY

Biodiversity is the variety of different forms of life on earth, including the different plants, animals, micro-organisms, the genes they contain and the ecosystem they form.

It also refers to genetic variation, ecosystem variation, species variation (number of species) within an area, biome or planet.

Relative to the range of habitats, biotic communities and ecological processes in the biosphere, biodiversity is vital in a number of ways including promoting the aesthetic value of the natural environment, contribution to our material well-being through utilitarian values by providing food, fodder, fuel, timber and medicine.

Biodiversity is the life support system. Organisms depend on it for the air to breathe, the food to eat, and the water to drink.

Wetlands filter pollutants from water, trees and plants reduce global warming by absorbing carbon, and bacteria and fungi break down organic material and fertilize the soil. It has been empirically shown that native species richness is linked to the health of ecosystems, as is the quality of life for humans.

The ecosystem services of biodiversity is maintained through formation and protection of soil, conservation and purification of water, maintaining hydrological cycles, regulation of biochemical cycles, absorption and breakdown of pollutants and waste materials through decomposition, determination and regulation of the natural world climate.

Despite the benefits from biodiversity, today's threats to species and ecosystems are increasing day by day with alarming rate and virtually all of them are caused by human mismanagement of biological resources often stimulated by imprudent economic policies, pollution and faulty institutions in-addition to climate change. To ensure intra and intergenerational equity, it is important to conserve biodiversity. Some of the existing measures of biodiversity conservation include; reforestation, zoological gardens, botanical gardens, national parks, biosphere reserves, germplasm banks and adoption of breeding techniques, tissue culture techniques, social forestry to minimize stress on the exploitation of forest resources.

**** Germplasm are living genetic resources such as seeds or tissues that are maintained for the purpose of animal and plant breeding, preservation, and other research uses. These resources may take the form of seed collections stored in seed banks, trees growing in nurseries, animal breeding lines maintained in animal breeding programs*

or gene banks, etc. Germplasm collections can range from collections of wild species to elite, domesticated breeding lines that have undergone extensive human selection.

Biodiversity is a comprehensive umbrella term for the extent of nature's variety or variation within the natural system; both in number and frequency. It is often understood in terms of the wide variety of plants, animals and microorganisms, the genes they contain and the ecosystem they form. The biodiversity we see today is the result of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend. So far, about 2.1 million species have been identified, mostly small creatures such as insects. Scientists believe that there are actually about 13 million species, though as per UNEP estimates there are 9.0 to 52 million species exist on earth.

Biodiversity also includes genetic differences within each species - for example, between varieties of crops and breeds of livestock. Chromosomes, genes, and DNA-the building blocks of life-determine the uniqueness of each individual and each species. Yet another feature of biodiversity is the variety of ecosystems such as those that occur in deserts, forests, wetlands, mountains, lakes, rivers, and agricultural landscapes. In each ecosystem, living creatures including human form a community, interacting with one another and with the air, water, and soil around them.

Biodiversity is thus considered at 3 major levels:

1. Genetic diversity: This is the variety of genetic information contained in all of the individual plants, animals and microorganisms occurring within populations of species. Simply, it is the variation of genes within species and populations.
2. Species diversity: This is the variety of species or the living organisms. It is measured in terms of-

i) *Species Richness* - This refers to the total count of species in a defined area.

ii) *Species Abundance* - This refers to the relative numbers among species.

If all the species have the same equal abundance, this means that the variation is high hence high diversity, however if the one species is represented by 96 individuals, whilst the rest are represented by 1 species each, this is low diversity. In nature, not all species of a community are equally different. It is possible to classify species on the basis of their functions-

a) Functional types: Functional types are those species, which perform different ecological functions.

b) Functional analogues: Functional analogues represent distinct taxa performing the same or very similar ecological functions.

*** ***Taxon****, plural* ***Taxa****, any unit used in the science of biological classification, or taxonomy. Taxa are arranged in a hierarchy from kingdom to subspecies, a given taxon ordinarily including several taxa of lower rank. In the classification of protists, plants, and animals, certain taxonomic categories are universally recognized; in descending order, these are kingdom, phylum (in plants, division), class, order, family, genus, species, and subspecies, or race. Rules for naming the various taxa are the province of biological nomenclature*

3. **Ecosystem diversity:** This relates to the variety of habitats, biotic communities and ecological processes in the biosphere. Biodiversity is not distributed evenly on Earth. It is the richest in the tropics. Terrestrial biodiversity tends to be highest near the equator, which seems to be the result of the warm climate and high primary productivity. Marine biodiversity tends to be highest along coasts in the Western Pacific, where sea surface temperature is highest and in the mid-latitudinal band in all oceans. There are latitudinal gradient in species diversity. Biodiversity generally tends to cluster in hotspots and has been increasing through time but will be likely to slow in the future.

BENEFITS OF BIODIVERSITY

1. Utilitarian benefits

Biodiversity contribute to our material well-being. We obtained various productive materials from biodiversity e.g. agricultural materials or food, medicine, industrial raw materials etc.

i) More than 60 wild species have been used to improve the world's 13 major crops by providing genes for pest resistance, improved yield, and enhanced nutrition (IUCN, 2012).

ii) Since agriculture began about 12,000 years ago, roughly 7,000 plant species have been used for human consumption. While most people depend mainly on domesticated species for their dietary needs, some 200 million depend on wild species for at least part of their food.

Case example:

Populations in South and East Asia are dependent on complex rice-fish agro-ecosystems, where fish and other aquatic animals serve as a source of nutrition to local communities, and provide essential services for rice productivity in the flooded fields.

iii) Fisheries alone account for at least 15% of animal protein directly consumed by humans. Fisheries indirectly support additional food production by providing inputs to the aqua-culture and livestock industries.

iv) Amphibians play a vital role in ecosystems, are indicators of environmental health, and are 'hopping pharmacies' being used in the search for new medicines. Yet 41% of amphibian species are threatened with extinction.

v) In some countries, medicinal plants and animals provide most of the drugs people use, and even in technologically-advanced countries like the USA, half of the 100 most-prescribed drugs originate from wild species. According to world health Organization report nearly 80% of people live in Africa rely on traditional medicines as main source for their health care needs.

More than 70,000 different plant species are used in traditional and modern medicine. Microbes have given us nearly all of our antibiotics such as penicillin, as well as the cholesterol lowering strain. The chemical taxol, derived from the Pacific yew, has been found to kill cancer cells. ACE inhibitors, which are among the most effective medicines known for treating high blood pressure, are derived from the Pit Viper (Bothrops jararaca).

*** *ACE (**angiotensin-converting enzyme inhibitors)** are blood pressure drugs or antihypertensive medications that are widely used to treat high blood pressure (hypertension). ACE inhibitors medications help relax blood vessels by blocking the formation of a natural chemical that narrows blood vessels.*

2. Ecosystem services

Ecosystem services are defined as the processes and conditions of natural systems that support human activity.

Biodiversity plays an important role in the way ecosystems function and in the services they provide.

i) Biodiversity plays a major role in mitigating climate change by contributing to long-term sequestration of carbon in a number of biomes. It is through biodiversity that sequential balance of CO2 and O2 is maintained. Due to the accumulation of CO2 in the atmosphere and ozone layer depletion, the earth is becoming warmer and more prone to natural calamities. A square kilometre of coastal ecosystem such as mangroves forests can store up to five times more carbon than the equivalent area of mature tropical forests. But these areas are being destroyed three to four times faster than forests, releasing substantial amounts of carbon dioxide into the atmosphere and the ocean, and contributing to climate change (IUCN: facts and figures on biodiversity, 2012).

ii) Regulation of biochemical cycles e.g. Oxygen, Nitrogen, hydrological cycles etc. Biological resources are important media in biochemical cycles, without which the cycles are not complete.

iii) Absorption and breakdown of pollutants and waste materials through decomposition, e.g. in food webs and food chains where the flow of energy goes through production consumption and decomposition without which breakdown and absorption of materials will not be complete. In an ecosystem there is no waste as decomposition will take place to purify our environment by transforming the waste to other forms of biodiversity.

iv) Determination and regulation of the natural world climate whether local, regional or micro level through influencing temperature, precipitation and air turbulence.

v) Biodiversity underpins ecosystem resilience and plays a critical role as part of disaster risk reduction and peace-building strategies. Forests, wetlands and mangroves play a critical role in reducing the impacts of extreme events such as droughts, floods and tsunamis. The value of the ecosystem services provided by coral reefs ranges from more than US$ 18 million per square kilometer per year for natural hazard management, up to US$ 100 million for tourism, more than US$ 5 million for genetic material and bio-prospecting and up to US$ 331,800 for fisheries

vi) Protective services of biodiversity provide protection of human beings from harmful weather conditions by acting as wind breaks, flood barriers among others.

vii) Production of at least one third of the world's food, including 87 of the 113 leading food crops, depends directly or indirectly on pollination carried out by insects (honey bee), bats and birds. This worldwide economic value of the pollinating service provided by insects is worth over US$ 190 billion per yearfor the main crops that feed the world (CBD, 2014). There have been worldwide declines in the diversity of pollinating insects that are essential for the reproduction of many plants.

viii) Wild species are important in pest regulation. Bats, toads, birds, snakes, and so on consume vast numbers of the major animal pests found on crops or in forests.

a. A single colony of Mexican Free-tailed Bat eats more than 9,000 kg of insects per night, targeting especially Corn Earthworms and Fall Armyworms, both major crop predators. Yet 18% of bat species are threatened with extinction.

b. A single brood of woodpeckers can eat 8,000-12,000 harmful insect pupae per day, helping to maintain the health of forests, whilst in fruit plantations, insectivorous birds can make the difference between a bumper crop or a costly failure.

3. Ethical and moral benefits

Every form of life on earth is unique and warrants respect regardless of its worth to human beings; this is the ecosystems right of an organism. Every organism has an inherent right to exist regardless of whether it is valuable to human beings or not. Humankind is part of nature and the natural world has a value for human heritage.

The well being of all future generations is a social responsibility of the present generations, hence the existence of an organism warrants conservation of the organism.

4. Aesthetic value

Human beings derive great enjoyment from natural environment. The shapes, structure and colour stimulate our senses and enrich our culture. This illustrate majorly in the popularity of biodiversity conservation measures and the myriad of the many organizations which fight for the protection of different organisms. A lot of money is paid to conserve wildlife for their value in nature through so many organizations. Wild species enhance our appreciation and enjoyment of the environment through:

i) Leisure activities e.g. bird watching and nature trailing;

ii) Sporting activities e.g. sport hunting, sport fishing, diving and mushroom picking;

iii) Hearing, touching or just seeing wildlife;

iv) Enjoyment as seen in art and culture e.g. dolls and teddy bears.

***Classify the above benefits of biodiversity into direct use, indirect use and non-use values

LOSS OF BIODIVERSITY

The loss of biodiversity and the related changes in the environment are now faster than ever before in human history and there is no sign of this process slowing down. Virtually all of Earth's ecosystems have been dramatically distorted and altered by human activities and are continuously being converted for agricultural and other uses. Many animal and plant populations have declined in numbers and geographical spread.

However, species extinction is a natural part of Earth's history but human activity has increased the extinction rate by at least 100 times compared to the natural rate. Loss of biodiversity is caused by a range of drivers. A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem.

- A direct driver unequivocally (clearly) influences ecosystem processes.
- An indirect driver operates more diffusely by altering one or more direct drivers. Important direct drivers affecting biodiversity are habitat alteration, climate change, invasive species, overexploitation and pollution.

Principal threats to biodiversity

A threat by definition refers to any process or event whether natural or human induced that is likely to cause adverse effects upon the status or sustainable use of any component of biological diversity. Biodiversity is declining rapidly due to factors such as habitat alteration and destruction by the land use change, over exploitation of biological resources, climate change, pollution and invasive species. Such natural or human-induced factors tend to interact and amplify each other.

1. Extinction

The most obvious loss of biodiversity is the extinction of unique taxa. Extinction occurs when no more individuals of a taxonomic group survive, either within a specified part of their range

or forever lost across their entire range. The taxonomic unit of extinction is usually measured as a species, though extinction can be assessed at subspecific (a taxonomic subdivision of a species consisting of an interbreeding, usually geographically isolated population of organisms) or population levels. A species, by definition, is evolutionarily unique; each species has distinct genetic, evolutionary, behavioural and ecological attributes that once lost cannot be replaced. The process of extinction and speciation has been continual; as new species have arisen others have dwindled and become extinct. The one constant of evolutionary change has provided varying amounts of diversity over geological time. Throughout the history of life on this planet, losses of biodiversity have been common. There is palaeontological (the science of the forms of life existing in prior geology (a science that deals with the history of the earth and its life especially as recorded in rocks) periods from their fossilized remains) evidence for five mass extinctions, during which many taxonomic groups lost a majority of species. The current extinction crisis has seen species lost at a rate perhaps 1000 to 10 000 times the average background rate identified by the fossil record.

2. Habitat fragmentation, alteration and destruction

Overall, the main factor directly driving biodiversity loss worldwide is habitat alteration and destruction. Habitat destruction renders entire habitats functionally unable to support the species present in the habitat. Biodiversity reduced in this process when existing organisms in the habitat are displaced or destroyed. Human destruction of habitats has accelerated greatly in the latter half of the twentieth century. Natural habitats are often destroyed through human activity for the purpose of harvesting natural resources for industry production and urbanization. Clearing forest areas for agriculture, changes in the riverine habitat to lacustrine (reservoir) habitat by the construction of hydroelectric projects on the rivers, mining, logging, urban sprawl, construction of highways are some examples of habitat destruction and fragmentation. A five-year estimate of global forest cover loss for years 2000–2005 was 3.1 percent. In the humid tropics where forest loss is primarily from timber extraction, 272,000 km2 was lost out of a global total of 11,564,000 km2 (or 2.4 percent). In the tropics, these losses also represent the extinction of species because of high levels of endemism. Increased greedy demand for resources has resulted into land use changes. Hence loss to genetic diversity, species reduction and increased ecosystem changes such as random population changes, disease outcrop, and habitat fragmentation among others has resulted into biodiversity losses.

3. Over-exploitation of biological resources

This results when individuals of a particular species are taken at a higher rate than can be sustained by the natural reproductive capacity of the population being harvested. This can be through hunting, fishing, trade, food gathering etc. Overexploitation remains a serious threat to many species, such as marine fish and invertebrates, trees, and animals hunted for meat. Most industrial fisheries are either fully or overexploited, while destructive fishing techniques harm estuaries and wetlands. Although the true extent of exploitation is poorly known, it is clear that rates of off take are extremely high in tropical forests. The trade in wild plants and animals and their derivatives is poorly documented but is estimated at nearly $160 billion annually. It ranges from live animals for the food and pet trade to ornamental plants and timber. Because the trade in wild animals and plants crosses national borders, the effort to regulate it requires international cooperation to safeguard certain species from overexploitation.

4. Pollution

Over the past five decades, inorganic and organic pollutants have emerged as one of the most important factor of biodiversity loss in terrestrial, aquatic- marine as well as freshwater ecosystems. Thermal pollution is another threat to biodiversity. The potential consequences of organic pollutants in a freshwater ecosystem include *eutrophication of fresh-water body, hypoxia in coastal marine ecosystems, nitrous oxide emissions contributing to global climate change, and air pollution by NO in urban areas*. Occurrence of such problems varies widely in different regions. Species in habitats are increasingly being harmed by industrial activities and pollution from excessive use of agro-chemicals such as DDT, oil spills, acid precipitation etc. For example pesticide linked decline of fish eating birds and falcons. Lead poisoning is another major cause of mortality of many species such as ducks, swans and cranes as they ingest the spent shotgun pellet that fall into lakes and marshes. The vulture was once very common in the Gangetic plains of India, and often seen nesting on the avenue trees within large cities in the region. Before the 1990s they were even seen as a nuisance, particularly to aircraft as they were often involved in bird strikes. The vulture has suffered a 99% population decrease in India and become rare due to poisoning by DDT used as pesticides and also by diclofenac which is used as veterinary non –steroidal anti- inflammatory drug, leaving traces in cattle carcasses which when fed by vultures leads to thinning of egg shells resulting into premature hatching and

kidney failure in birds. Campaigns to ban the use of diclofenac in veterinary practice have been underway in several South Asian countries

5. Species invasions

This can be intentional or accidental. Species introduced in an ecosystem will cause changes in the ecosystem. Introduced species are organisms arising in areas/ habitats in which they were previously not native. Such introduced species are usually referred to as biological pollutants. Some of the ecological impacts of the invasion include *hybridization, out competition, disruption of original ecosystem, plant pathogenic influences, disease transmission, disruption of food-webs, and to some situations extinction*. Species may be introduced intentionally for *ornamental concerns, agriculture, hunting and spotting activities, biotechnology for scientific research and for trade*.

6. Climatic changes

This is of great concern especially when global CO2 increases in the atmosphere resulting to global warming. Most species originate within a very narrow physiological limit; hence nature has a range of tolerance maintained for ecosystem stability. Changes may be gradual or abrupt such that if the limit is exceeded the upper or lower, species suffers extinction. Recent changes in climate, such as warmer temperatures in certain regions, have already had significant impacts on biodiversity and ecosystem. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Projected changes in climate by 2050 could lead to the extinction of many species living in certain limited geographical regions. By the end of the century, climate change and its impacts may become the main direct driver of overall biodiversity loss. While the growing season in Europe has lengthened over the last 30 years, in some regions of Africa the combination of regional climate changes and human pressures have led to decreased cereal crop production since 1970. Changes in fish population have also been linked to large-scale climate variations such as "El Nino" have affected fisheries off the coasts of South America and Africa, and decadal oscillations in the Pacific have affected fisheries off the west coast of North America.

****The **Pacific Decadal Oscillation** (**PDO**) is a robust, recurring pattern of ocean-atmosphere climate variability centered over the mid-latitude Pacific basin. The PDO is detected as warm or cool surface waters in the Pacific Ocean, north of 20°N. Over the past century, the amplitude of this climate pattern has varied irregularly at interannual-to-interdecadal time scales (meaning time periods of a few years to as much as time periods of multiple decades). There is evidence of reversals in the prevailing polarity (meaning changes in cool surface waters versus warm surface waters within the region) of the oscillation occurring around 1925, 1947, and 1977; the last*

two reversals corresponded with dramatic shifts in salmon production regimes in the North Pacific Ocean. This climate pattern also affects coastal sea and continental surface air temperatures from Alaska to California.

As climate change will become more severe, the harmful impacts on ecosystem services will outweigh the benefits in most regions of the world. The Intergovernmental Panel on Climate Change (IPCC) project that the average surface temperature will raise by 2 to 6.40C by 2100 compared to pre-industrial levels. This is expected to cause global negative impacts on biodiversity (Millennium Ecosystem Assessment, 2005).

7. Human Population Explosion

From 1950 to 2011, world population increased from 2.5 billion to 7 billion and is forecast to reach a plateau of more than 9 billion during the 21st century (Population Reference Bureau). As the human population is increasing, there exists insatiable demand for raw materials which is bound to cause changes in biodiversity. The human population has more impact on biodiversity than any other single factor. According to Dumont, (2012) until the middle of the 21st century, worldwide losses of pristine biodiversity will largely depend on the worldwide human birth rate. It is therefore vital to control human population which will result in biodiversity conservation.

8. Institutional / policy failure

Some institutions are created to manage biological resources. However, the institutions/policy fail to internalize the values of biodiversity within the decision making process of their Nations and individuals. Such institutions/policies in place should have a holistic approach towards biodiversity conservation rather than part conservation.

9. Genetic and Behavioural Degradation of Taxa

Biological diversity encompasses the diversity of populations within species, as well as genetic and behavioural diversity within populations. Species differences are the most easily recognizable form of diversity, although differences at the population and genetic levels are necessary components for species survival. As the line between species is sometimes vague – for example, due to hybridization or asexual reproduction – the distinction between populations within species is likewise often difficult to establish. There are two main mechanisms of genetic and behavioural degradation, the outright loss of populations and alteration of populations as a result of human activity. Extreme examples of both can be seen in captive populations, of relevance to biodiversity when most or all surviving individuals of a

species are in captivity, such as Spix's macaw (Cyanopsitta spixi). However, the main threat from such degradation is to wild populations. Many behavioural differences exist among species' populations; for example, separate chimpanzee (Pan troglodytes) populations utilize different tools, such as sticks to extract termites from their mounds or rocks to break open nuts. Behaviours are not reserved to vertebrates; invertebrates can also alter or lose behaviours as a result of human influence. For example, the monarch butterfly (Danaus plexippus), though not endangered as a species, has populations that undergo remarkable migrations along the west and east coasts of North America, involving several generations, from California and Mexico, respectively, northward and back to small overwintering areas where they are threatened with habitat loss. The loss of unique behaviours such as this will take a toll on overall diversity, and indeed can have long-term cascading effects on other populations and species. Alteration of behaviours in response to human activity also lessens natural diversity, as many species, such as house sparrows (Passer domesticus) and Northern racoons (Procyon lotor), have become acclimated to humans and have lost many of their natural behaviours.

10. Disease

A special case of the threats to biodiversity caused by species introductions is the expansion of pathogens or parasites resulting from human activity. Disease can result from genetic disorders, pathogens such as viruses or bacteria, or parasites. Coevolution of hosts and pathogens over evolutionary time results in coexistence of both host and pathogens. Imbalance resulting from human activity, such as reduction of populations to small size, opens conditions for pathogens to spread. Diseases are often transmitted across different species, with the new host species often devastated by the new pathogen. For example, American chestnut (Castanea dentata) trees are all wiped out due to the introduction of chestnut blight fungus (Cryphonectria parasitica) that had evolved in Asia with the closely related Chinese chestnut (Castanea mollissima). Organisms that are affected by environmental contaminants, such as exposure to organochlorines, may play a role in lowering immune response and resistance to disease. Compromised immune function resulting from contaminants or stress can potentially push populations or species at risk over the edge. Canine distemper virus killed most of the remaining wild black-footed ferrets (Mustela nigripes), forcing capture of the rest, which have subsequently been used in a reintroduction programme. Introduced diseases are often more deadly, as host–pathogen dynamics are usually the product of a long history of coevolution.

BIODIVERSITY CONSERVATION

Biodiversity conservation is about saving life on Earth in all its forms and keeping natural ecosystems functioning and healthy. This incorporates the preservation, maintenance, sustainable use, recovery and enhancement of the components of biological diversity. Where –

Conservation - is the sustainable use of resources and encompasses protection as well as exploitation and,

Preservation - is an aspect of conservation meaning to keep something without altering or changing it.

Sustainable development - is another intricate aspect of biodiversity conservation. This refers to development that meets the needs of the current generation without compromising the ability of future generations to meet their needs. It simply refers to intra and intergenerational equity. A balance between the environment, development and society results to sustainable development which ensures biodiversity conservation. This is only possible in the presence of proper enforcement and implementation policies/ conventions and environmental institutions.

Why Conserve Biodiversity?

Biodiversity is the life support system of our planet- we depend on it for the air we breathe, the food we eat, and the water we drink. Medicines originating from wild species, including penicillin, aspirin, taxol, and quinine, have saved millions of lives and alleviated tremendous sufferings. Wetlands filter pollutants from water, trees and plants reduce global warming by absorbing carbon. Bacteria and fungi break down organic material and fertilize the soil. It has been observed that native species richness is linked to the health of ecosystems, as is the quality of life for humans. The connections between biodiversity and our sustainable future appear closer and closer the more we look. We literally need to conserve biodiversity as our lives depend on it.

From the species lists available for the landscape, the following should become conservation priorities:

- Endemic species
- Threatened and endangered species
- “Landscape species”

- Habitat specialist species
- “Keystone Species”
- Migratory species
- “Flagship species”

It is important to note that some species may qualify for several of these categories.

1. Endemic species:

Because the distributions of endemic species are restricted to a particular country/region, or even a small area within a country/region. These species should be high priorities because they can only be conserved in that particular locality. Therefore, if endemic species are found in the landscape, their habitats must be protected from conversion and degradation.

2. Threatened and endangered species:

These can be endemic or other species that are more widely distributed. These species are listed in the national/regional Red List, available from the National Biodiversity Secretariat in any country/region. Any endemic species that are also threatened or endangered should receive the highest priority for conservation. Species that are more widely distributed but are also threatened or endangered should become conservation priorities anywhere in the range; whether in country/region or outside the country/region.

3. Landscape species:

These are species that need large areas of habitat to survive. They usually tend to be large mammals. Because habitat fragmentation and loss are severe threats to their survival, any large areas of continuous habitat should be set aside for their conservation. Usually, because these are large mammals, habitat fragmentation and loss can also escalate human-wildlife conflict, resulting in socio-economic and governance problems. In Uganda, elephants and giraffes are good examples of landscape species. Usually these landscape species also make good ‘Umbrella species’ because if enough habitat is conserved and protected for these species, they will also provide conservation cover for other biodiversity.

4. Habitat specialist species:

These are species with a very narrow niche, and require a specific type of habitat to survive. Any change in habitat composition or structure can result in local extinction of these species.

In Sri Lanka, a good example of a habitat specialist is the fishing cat, which requires wetland or riparian habitat.

5. Keystone species:

These are species that usually help to maintain ecosystem integrity. Loss of these species can cause the ecosystems to change from the current state into a different ecosystem. Therefore, conservation of these species should be a priority. Keystone species need not be large mammals. Even smaller animals can help to maintain ecosystem integrity. Fruit bats and fruit-eating birds (hornbills, barbets, and pigeons) are examples of keystone species because they disperse seeds across the landscape. If seed dispersal stops, the forest ecosystem can change. Top predators (e.g., lions and leopards) are also keystone species because they help to keep the populations of herbivores under control. If the top predators are lost and the herbivore populations increase rapidly, they can degrade the forest or grassland ecosystems

6. Migratory species:

There are several migratory species that arrive in the tropics from the rest of the world to spend summer (warm/hot) months away from their winter months in their respective countries. The best known are the birds; however, several insects such as butterflies and dragonflies also undertake long distance migrations. If the summer (warm/hot) habitats of these migratory species are destroyed, these species will not survive. Therefore, summer (warm/hot) habitats of migratory species should be conservation priorities.

7. Flagship species:

These are usually socially and culturally important species that attract a lot of attention. These species can draw attention to conservation issues and attract people's attention to wildlife. Species such as the elephant, rhinoceros and the crested crane are good examples of Flagship species.

****Give local examples not including the ones already mentioned of species that fall under the different categories explained above.*