



# ENVIRONMENT

**Updated Value Addition Material 2020**

**Part-1**



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# **Unit-1**



## **Ecological concepts**

# CHAPTER - 1 - UNDERSTANDING ECOLOGY

## 1. Understanding Ecology

### 1.1. Concept of Ecology and Environment

Ecology can be defined as a scientific study of the interactions of organism with their physical environment and with each other.

The term ecology is derived from the Greek word ‘**oikos**’ meaning ‘house’, combined with the word ‘**logy**’ meaning the ‘science of’ or ‘the study of’. Literally, **ecology is the study of the earth as a ‘household’**, of plants, human beings, animals and micro-organisms. They all live together as interdependent components. The term ecology was first used by German zoologist **Ernst Haeckel** in 1869.

An **ecosystem** is defined as a community of life forms in concurrence with non-living components, interacting with each other. The term ecosystem was coined by Arthur Tansley in 1935.

**Environment** is the sum total of all conditions and influences that affect the development and life of all organisms on earth. Thus it can be said as one’s surrounding.

**Autecology:** The study of relationship of individual species with the environment.

**Synecology:** The study of plant communities in relation to their habitats of a given ecosystem.

**Gaia hypothesis:** This refers to a scientific hypothesis which states that the earth is a complex living entity, with the sustenance of life dependent on the self-regulating interactions among organisms and their inorganic surroundings.

- For instance, climatic conditions depend on the interactions among living organisms like human beings and their non-living atmosphere, all of which regulate each other constantly.
- The Gaia hypothesis is named after the mythical Greek goddess Gaia who personifies the earth.
- It was first proposed by British scientist James Lovelock in his 1972 paper “Gaia as seen through the atmosphere.”

### 1.2. Levels of Organisation of Ecology

The seven major ecological levels of organisations are:

- **Organisms-** They makes the **basic unit of study in ecology**. At each level, the biological unit has a specific structure and function. At this level, the form, physiology, behaviour, distribution and adaptations in relation to the environmental conditions are studied.
- **Population-** In ecology, a population is a **group of individuals of the same species, inhabiting the same area**, and functioning as a unit of biotic community.
- **Biological Community-** Biological/ Biotic community organisation results from **interdependence and interactions amongst population of different species in a habitat**. This is an assemblage of populations of plants, animals, bacteria and fungi that live in an area and interact with each other.  
*(You will read about different types of interactions in detail further in this Chapter in topic 1.9 Biotic interactions)*
- **Ecosystem-** The ecosystems are parts of nature where living organisms interact amongst themselves and with their physical environment. An ecosystem is composed of a biotic community, integrated with its physical environment through the exchange of energy and recycling of the nutrients.

Ecosystems can be recognised as self-regulating and self-sustaining units of landscape, e.g., a pond or a forest.

Student Notes:

- **Landscape**- A landscape is a unit of land with a natural boundary having a mosaic of patches, which generally represent different ecosystems.

- **Biome**- This is a large regional unit characterized by a major vegetation type and associated fauna found in a specific climate zone. The biome includes all associated developing and modified communities occurring within the same climatic region, e.g., forest biomes, grassland and savanna biomes, desert biome, etc.

On a global scale, all the earth's terrestrial biomes and aquatic systems constitute the biosphere.

(You will read in detail about biomes in Chapter-2, Types of Ecosystem)

#### Biotic Potential

- The **maximum rate at which a population can increase** when resources are unlimited and environmental conditions are ideal is termed the population's biotic potential.
- Each species will have a different biotic potential due to variations in:
  - the **species' reproductive span** (how long an individual is capable of reproducing)
  - the **frequency of reproduction** (how often an individual can reproduce)
  - "litter size" (how many offspring are born each time)
  - **survival rate** (how many offspring survive to reproductive age)

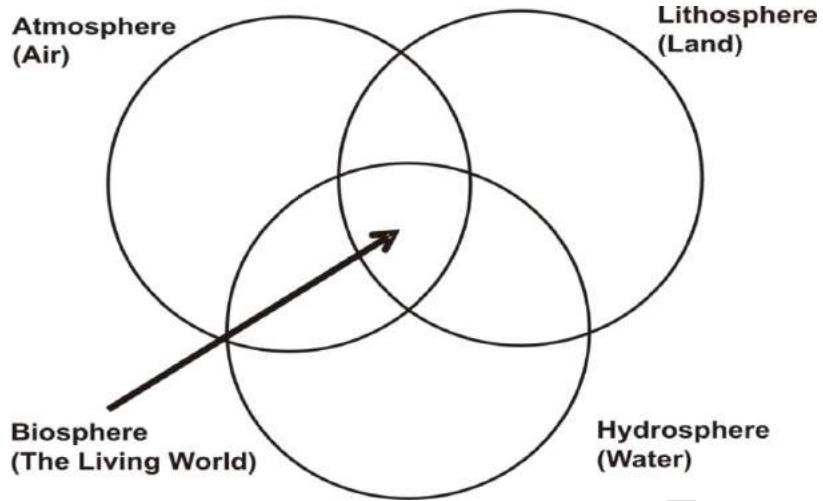
#### Carrying Capacity

- For a given region, carrying capacity is the **maximum number of individuals of a given species** that an area's resources can sustain indefinitely **without significantly depleting or degrading those resources**.

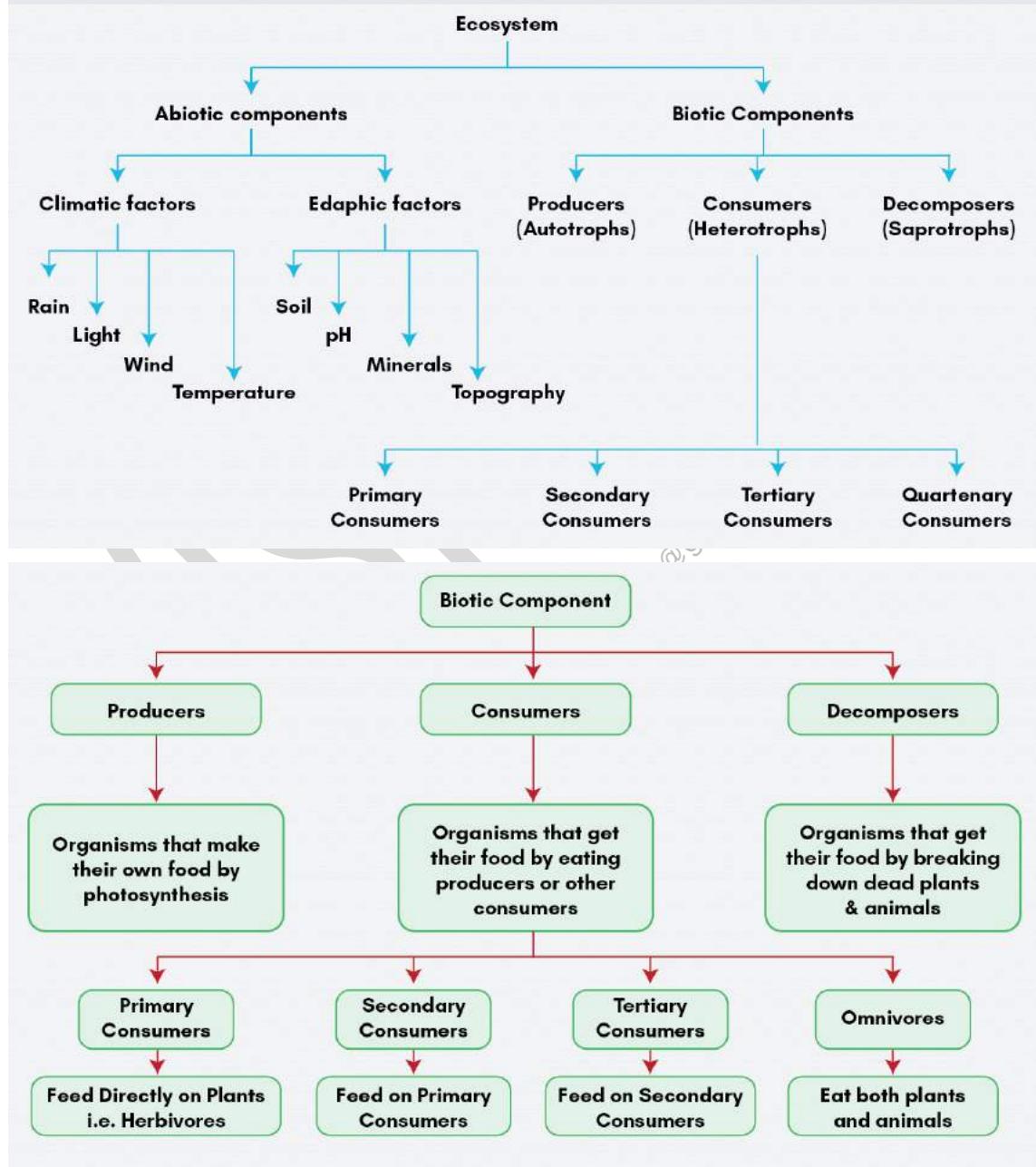
- **Biosphere**- Biosphere is a part of earth where life can exist. It represents a highly integrated and interacting zone comprising of atmosphere (air), hydrosphere (water) and lithosphere (land).

Biome and ecosystem are two different ecological concepts. Although they are closely related to each other, they are different from each other.

| Biome   | Ecosystem  |
|---|--|
| It is a large area of land with distinct climate and plant and animal species.                | It is the interaction of abiotic and biotic components between each other in a given area.                     |
| It is a large geographical area.  | It is a small geographical area.   |
| It is greatly influenced by climatic factors such as snow, ice, rainfall, temperature etc.    | It is not much influenced by the climatic factors like ice, snowfall, temperature etc.                         |
| It is a larger category of ecological units. It contains multiple ecosystems within it.       | It is a part of biome made of biotic and abiotic factors.  |
| As a biome is a collection of species it has a great diversity of plant and animal species.   | An ecosystem has a less diversity of plants and animals species than that of a biome as it is smaller in size. |
| Some common examples of biomes include desert, tundra, grasslands, and tropical rain forests. | Some common examples include coral reefs, ponds, Gulf of Mexico etc.   |
| Latitude has a great influence on a biome.  | An ecosystem is not affected by latitude.  |
| All the animals of a biome may not interact with each other.                                  | All the animals and organisms of an ecosystem interact with each other.  |



## Components of Ecosystem



**IMPORTANT TERMS**

**Ecotone:** An ecotone is a zone of junction or a transition area between two biomes (diverse ecosystems).

- Ecotone is the zone where two communities meet and integrate.
- For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem.
- Other examples are **grassland** (between forest and desert), estuary (between fresh water and salt water) and **riverbank or marshland** (between dry and wet).

**Ecocline:** Ecocline is a zone of gradual but continuous change from one ecosystem to another when there is no sharp boundary between the two in terms of species composition.

- Ecocline occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).

**Edge Effect – Edge Species**

- Edge effect refers to the changes in population or community structures that occur at the boundary of two habitats (ecotone).
- Sometimes the number of species and the population density of some of the species in the ecotone is much greater than either community. This is called **edge effect**.
- The organisms which occur primarily or most abundantly in this zone are known as **edge species**.
- In the terrestrial ecosystems edge effect is especially applicable to birds.
- For example, the **density of birds is greater in the ecotone** between the forest and the desert.

**Ecological Niche**

- Niche refers to the **unique functional role and position of a species in its habitat or ecosystem**.
- The functional characteristic of a species in its habitat is referred to as “niche” in that common habitat.
- In nature, many species occupy the same habitat, but they perform different functions:
- **Habitat niche** – where it lives, food niche – what is eats or decomposes & what species it competes with,
- **Reproductive niche** – how and when it reproduces,
- **Physical & chemical niche** – temperature, land shape, land slope, humidity & another requirement.
- Niche plays an important role in the **conservation of organisms**. If we have to conserve species in its native habitat, we should have knowledge about the **niche requirements of the species**.

### 1.3. Functions of an Ecosystem

Ecosystems are complex dynamic system, they perform following functions:

1. Energy flow through food chain
2. Nutrient cycling (**biogeochemical cycles**)
3. Ecological succession or ecosystem development
4. Homeostasis (**or cybernetic**) or feedback control mechanisms

Ponds, lakes, meadows, marshlands, grasslands, deserts and forests are examples of natural ecosystem. Many of you have seen an aquarium; a garden or a lawn etc. in your neighborhood. These are man-made ecosystem

### 1.4. Energy Flow in an Ecosystem

The cycle of energy is based on the flow of energy through different trophic levels in an ecosystem. Ecosystem is maintained by the cycling energy and nutrients obtained from different external sources.

Sun is the primary source of energy for all ecosystems on Earth. Of the incident solar radiation less than 50 percent of it is **photosynthetically active radiation** (PAR). PAR, designates the spectral range (wave band) of solar radiation from 400 to 700 nanometers that photosynthetic organisms are able to use in the process of photosynthesis.

Plants **capture only 2-10 per cent of the PAR** and this small amount of energy sustains the entire living world. The energy of sunlight fixed in food production by green plants is passed through the ecosystem by food chains and webs from one trophic level to the next. In this way, energy flows through the ecosystem.

Student Notes:

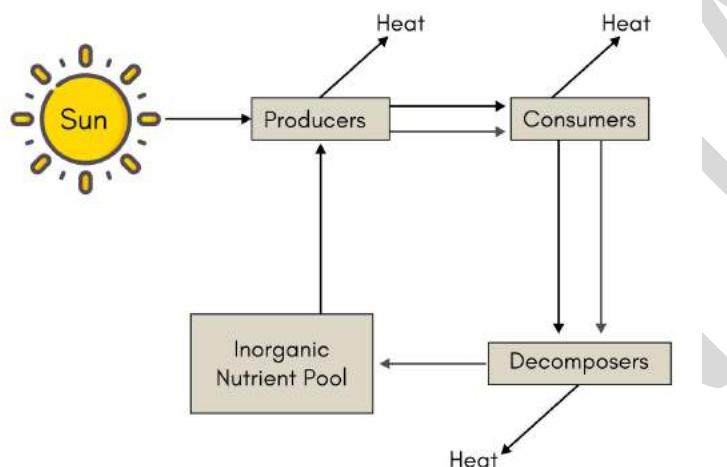
#### TROPHIC LEVEL

The trophic level of an organism is the position it occupies in a food chain. The trophic level is the number of steps an organism is from start of the chain.

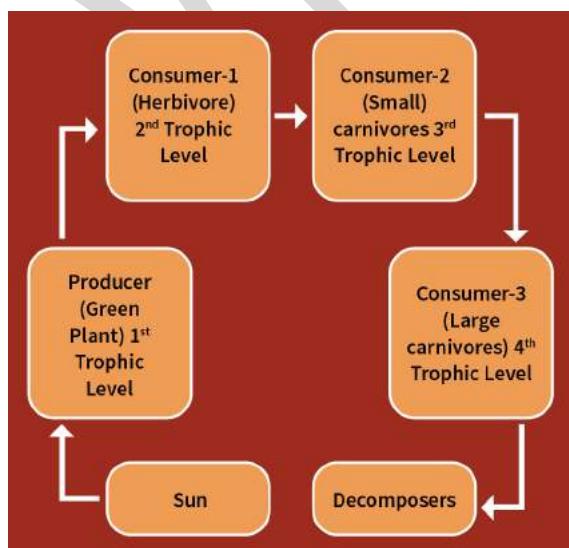
A given organism may occupy more than one trophic level simultaneously. One must remember that the trophic level represents a functional level, not a species as such.

A given species may occupy more than one trophic level in the same ecosystem at the same time; for example, a sparrow is a primary consumer when it eats seeds, fruits, peas, and a secondary consumer when it eats insects and worms.

- At the **first trophic level**, **primary producers** use solar energy to produce organic material through photosynthesis.



- The **herbivores at the second trophic level** use the plants as food which gives them energy. A large part of this energy is used up for the metabolic functions of these animals such as breathing, digesting food, supporting growth of tissues, maintaining blood circulation and body temperature.
- The **carnivores at the next trophic level** feed on the herbivores and derive energy for their sustenance and growth. If large predators are present, they represent still higher trophic level and they feed on carnivores to get energy.



## 1.5. Food Chain

### 1.5.1. Definition

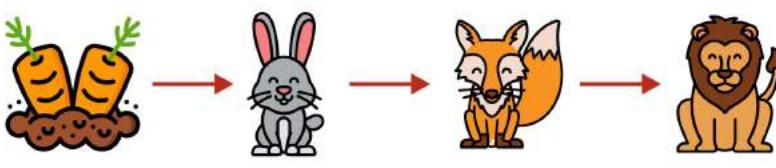
The order of living organisms in a community in which one organism consumes other and is itself consumed by another organism to transfer energy is called a food chain.

Food chain is also defined as “**a chain of organisms**, existing in any natural community, through which **energy is transferred**”.

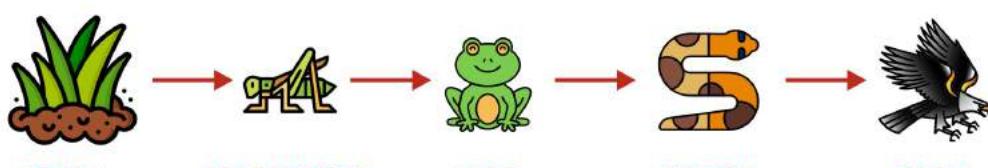
Every living being irrespective of their size and habitat, from the tiniest algae to giant blue whales, need food to survive.



A three linked food chain



A Four linked food chain



A Five linked food chain

Food chain is structured differently for different species in different ecosystems. Each food chain is the vital pathway for energy and nutrients to follow through the ecosystem.

### 1.5.2. Types of Food Chain

There are two types of food chains:

- **Grazing food chain**, beginning with autotrophs. In this, energy and nutrients move from plants to the herbivores consuming them, and to the carnivores or omnivores preying upon the herbivores.
- **Detrital food chain**, beginning with dead organic matter. In a detrital food chain, dead organic matter of plants and animals is broken down by decomposers, e.g., bacteria and fungi, and moves to detritivores and then carnivores.

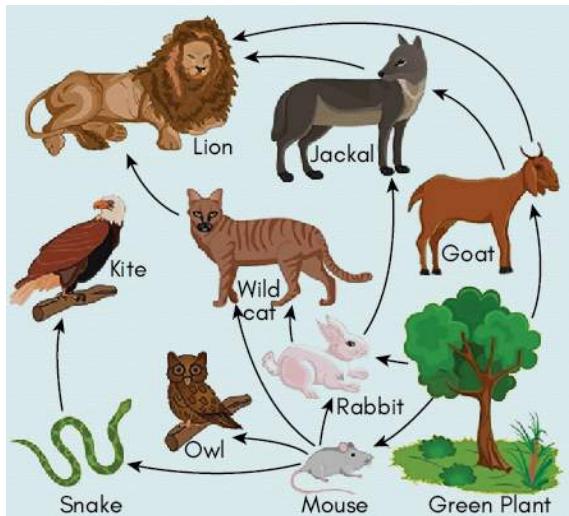
## 1.6. Food Web

The word ‘web’ means network. **Food web** can be defined as ‘a network of interconnected food chains so as to form a number of feeding relationships amongst different organism of a biotic community.

**A food chain cannot stand isolated in an ecosystem.** The same food resource may be a part of more than one chain. This is possible when the resource is at the lower trophic level.

A food web comprises all the food chains in a single ecosystem. It is essential to know that each living thing in an ecosystem is a part of multiple food chains.(As illustrated in the diagram)

A single food chain is the single possible path that energy and nutrients may make while passing through the ecosystem. All the interconnected and overlapping food chains in an ecosystem make up a food web.



Student Notes:

Food webs are significant tools in understanding that plants are the foundation of all ecosystem and food chains, sustaining life by providing nourishment and oxygen needed for survival and reproduction.

The food web **provides stability to the ecosystem.**

#### 10% rule

The important point to note is that the amount of energy decreases at successive trophic levels. The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows 10 per cent law – only 10 per cent of the energy is transferred to each trophic level from the lower trophic level.

## 1.7. Ecological Pyramid

### 1.7.1. Definition

An ecological pyramid is a graphical representation of the relationship between different organisms in an ecosystem.

Each of the bars that make up the pyramid represents a different trophic level, and their order, which is based on who eats whom, represents the flow of energy.

### 1.7.2. Types of Ecological Pyramids

- **Pyramid of Biomass** As the name suggests, the Biomass Pyramids show the amount of biomass (living or organic matter present in an organism) present per unit area at each trophic level. It is drawn with the producers at the base and the top carnivores at the top.

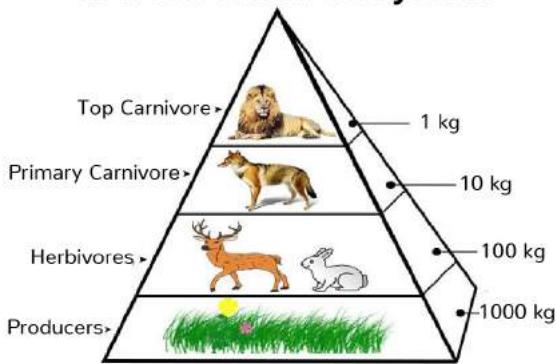
Pyramid of biomass is generally ascertained by gathering all organisms occupying each trophic level separately and measuring their dry weight.

Each trophic level has a certain mass of living material at a particular time called **standing crop**, which is measured as the mass of living organisms (biomass) or the number in a unit area.

#### *Upright Pyramid of Biomass*

Ecosystems found on land mostly have pyramids of biomass with large base of primary producers with smaller trophic level perched on top, hence the upright pyramid of biomass.

## Upright Pyramid of biomass in a Terrestrial Ecosystem

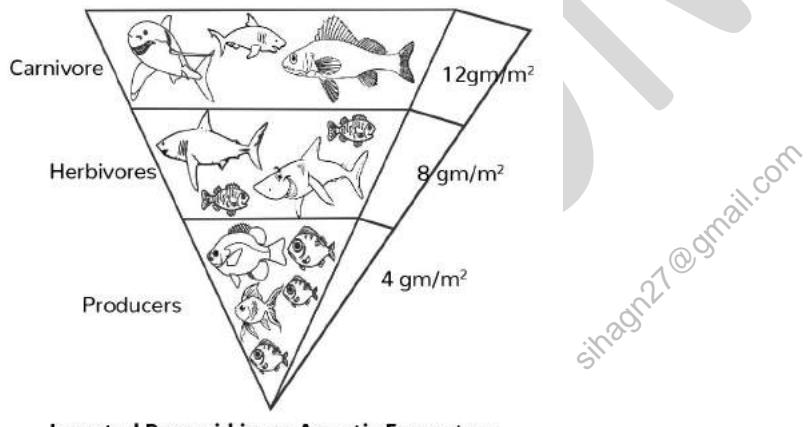


The biomass of autotrophs or producers is at the maximum. The biomass of next trophic level, i.e. primary consumers is less than the producers. Similarly, the other consumers such as secondary and tertiary consumers are comparatively less than its lower level respectively. The top of the pyramid has very less amount of biomass.

### Inverted Pyramid of Biomass

On the other hand, a reverse pyramidal structure is found in most aquatic ecosystems. Here, the pyramid of biomass may assume an inverted pattern.

This is because in a water body, the producers are tiny phytoplankton that grow and reproduce rapidly. In this condition, the pyramid of biomass has a small base, with the producer biomass at the base providing support to consumer biomass of large weight. Hence, it assumes an inverted shape.



Inverted Pyramid in an Aquatic Ecosystem

- **Pyramid of Numbers**

It is the graphic representation of number of individuals per unit area of various trophic levels. Large number of producers tends to form the base whereas lower number of top predators or carnivores occupies the top. The shape of the pyramid of numbers varies from ecosystem to ecosystem.

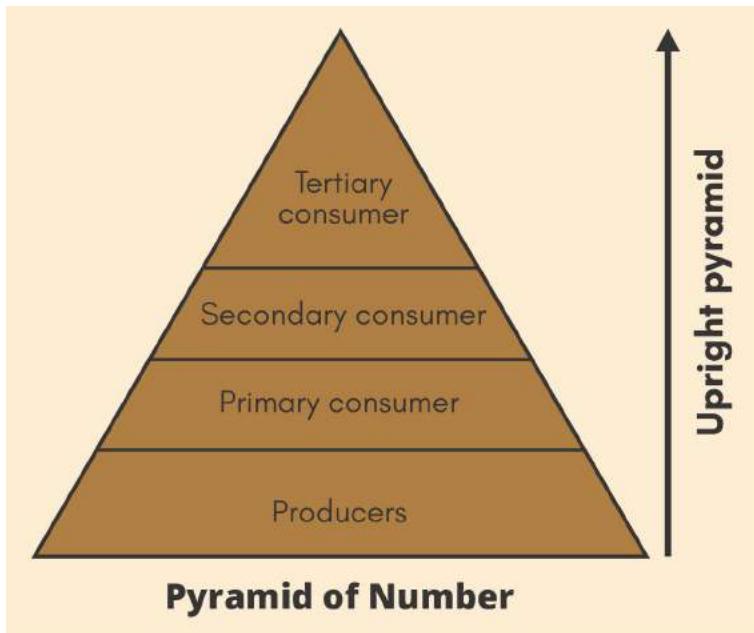
For example, in an aquatic ecosystem or grassland areas, autotrophs or producers are present in large number per unit area. The producers support a lesser number of herbivores, which in turn supports fewer carnivores.

### Upright Pyramid of Numbers

In upright pyramid of numbers, the number of individuals decreases from the lower level to the higher level. This type of pyramid is usually found in the grassland ecosystem and the

pond ecosystem. The grass in a grassland ecosystem occupies the lowest trophic level because of its abundance.

Student Notes:



#### Inverted Pyramid of Numbers

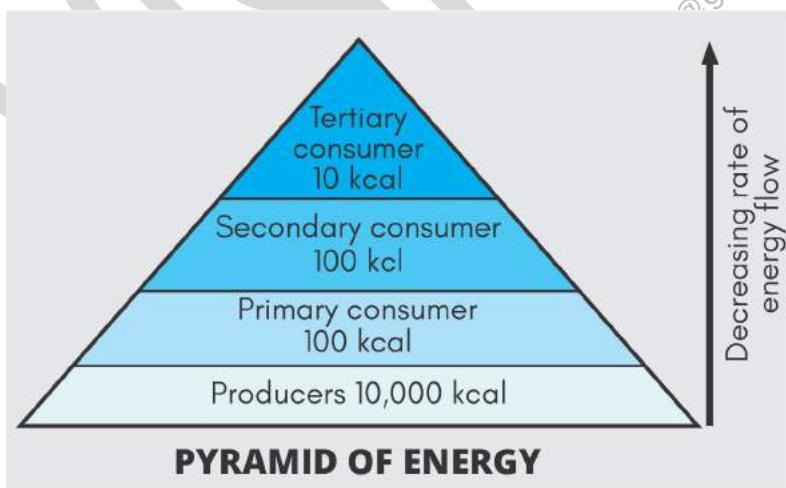
Here, the number of individuals increases from the lower level to the higher trophic level. For example, the tree ecosystem.

- **Pyramid of Energy**

It is a graphical structure representing the flow of energy through each trophic level of a food chain over a fixed part of the natural environment.

**An energy pyramid represents the amount of energy at each trophic level** and loss of energy at each is transferred to another trophic level.

**Energy pyramid, sometimes called trophic pyramid or ecological pyramid,** is used in quantifying the energy transfer from one organism to another along the food chain.



Energy decreases as one move through the trophic levels from the bottom to the top of the pyramid. **Thus, the energy pyramid is always upward.**

## 1.8. Ecological Productivity

Student Notes:

### 1.8.1. Definition

Ecological productivity refers to the primary fixation of solar energy by plants and the subsequent use of that fixed energy by plant-eating herbivores, animal-eating carnivores, and the detritivores that feed upon dead biomass.

**Ecologists refer to the productivity of green plants as *primary productivity*.**

Gross primary productivity is the total amount of energy that is fixed by plants, while net primary productivity is smaller because it is adjusted for energy losses required to support plant respiration. If the net primary productivity of green plants in an ecosystem is positive, then the biomass of vegetation is increasing over time.

$$\text{Gross Primary productivity} = \text{Net Primary Productivity} + \text{Energy loss due to respiration}$$

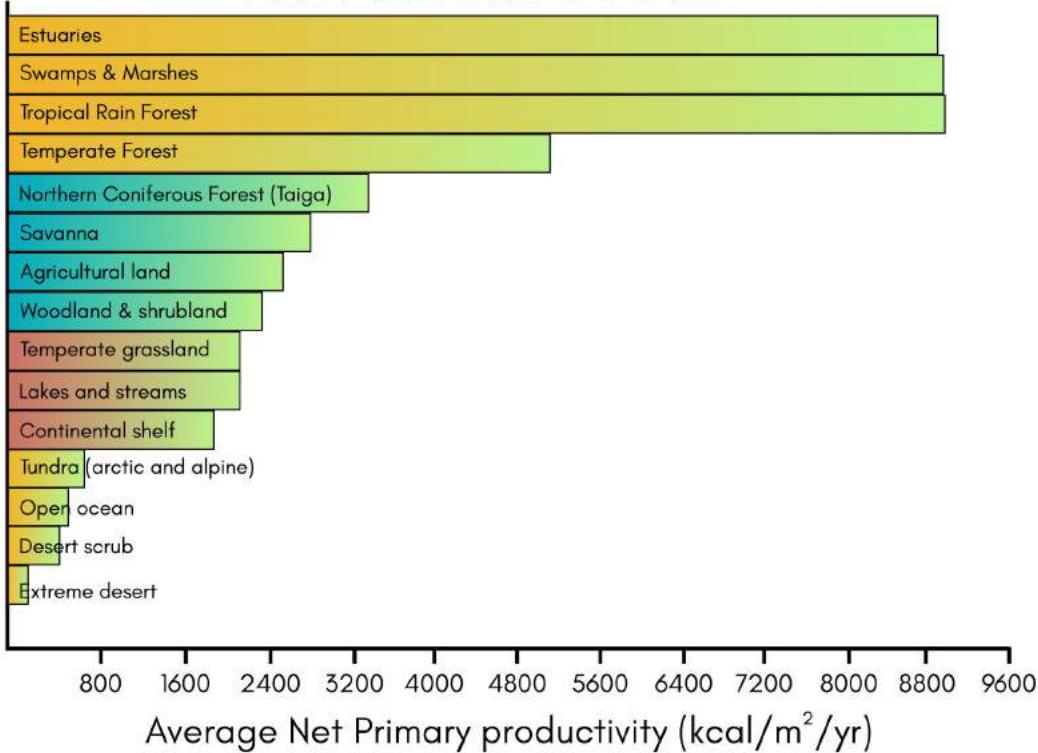
*Gross and net secondary productivities refer to herbivorous animals, while tertiary productivities refer to carnivores.*

### Different productivity of various ecosystems

Because of differences in the availabilities of solar radiation, water, and nutrients, the world's ecosystems differ greatly in their Ecological Productivity.

#### ORDER OF PRODUCTIVITY

### TYPE OF ECOSYSTEM



## 1.9. Biological Interaction

These are the manner in which species interact with each other. These interactions can be inter-specific (interactions with different species) or intra-specific (interactions between same species).

### 1.9.1. Types of Biotic Interactions in a Food Web

Student Notes:

'0' is no effect; '-' is detrimental; '+' is beneficial.

| Type of interaction          | Species |   | Effect   | Comments  |
|------------------------------|---------|---|--|---|
|                              | 1       | 2 |  |   |
| <b>Negative Interactions</b> |         |   |  |   |
| Amensalism                   | -       | 0 | One species is inhibited while the other species is unaffected.  | <ul style="list-style-type: none"> <li>The bread mould fungi Penicillium produce penicillin an antibiotic substance which inhibits the growth of a variety of bacteria.</li> <li>A large tree shades a small plant, retarding the growth of the small plant. The small plant has no effect on the large tree.</li> </ul>  |
| Predation                    | +       | - | One species (predator) benefits while the second species (prey) is harmed and inhibited.                 | <ul style="list-style-type: none"> <li>Predators like leopards, tigers and cheetahs use speed, teeth and claws to hunt and kill their prey.</li> <li>Predators help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.</li> </ul>  |
| Parasitism                   | +       | - | Beneficial to one species (parasite) and harmful to the other species (host).                            | <ul style="list-style-type: none"> <li>Parasitism involves parasite living in or on another living species called the host.</li> <li>The parasite gets its nourishment and often shelter from its host.</li> <li>Tap worm, roundworm, malarial parasite, many bacteria, fungi, and viruses are common parasites of humans.</li> <li>The <b>female mosquito is not considered a parasite</b>, although it needs our blood for reproduction. Why? Because it doesn't live on the host.</li> </ul> |
| Competition                  | -       | - | Adversely affects both species.  | <ul style="list-style-type: none"> <li>Competition occurs when two populations or species, both need a vital resource that is in short supply.</li> <li>Woodpeckers and squirrels often compete for nesting rights in the same holes and spaces in trees, while the lions and cheetahs of the African savanna compete for the same antelope and gazelle prey.</li> </ul>  |
| <b>Positive Associations</b> |         |   |  |   |
| Commensalism                 | +       | 0 | One species (the commensal) benefits, while the other species (the host) is neither harmed nor inhibited | <ul style="list-style-type: none"> <li>Suckerfish often attaches to a shark. This helps the suckerfish get protection, a free ride as well as a meal from the leftover of the shark's meal. The shark does not, however, get any benefit nor is it adversely affected by this association.</li> <li>Another example of commensalisms is the <b>relationship between trees and epiphytic plants</b>.</li> </ul>  |
| Mutualism                    | +       | + | Interaction is favourable to both species  | <ul style="list-style-type: none"> <li><b>Sea anemone gets attached to the shell of hermit crabs</b> for the benefit of transport</li> </ul>  |

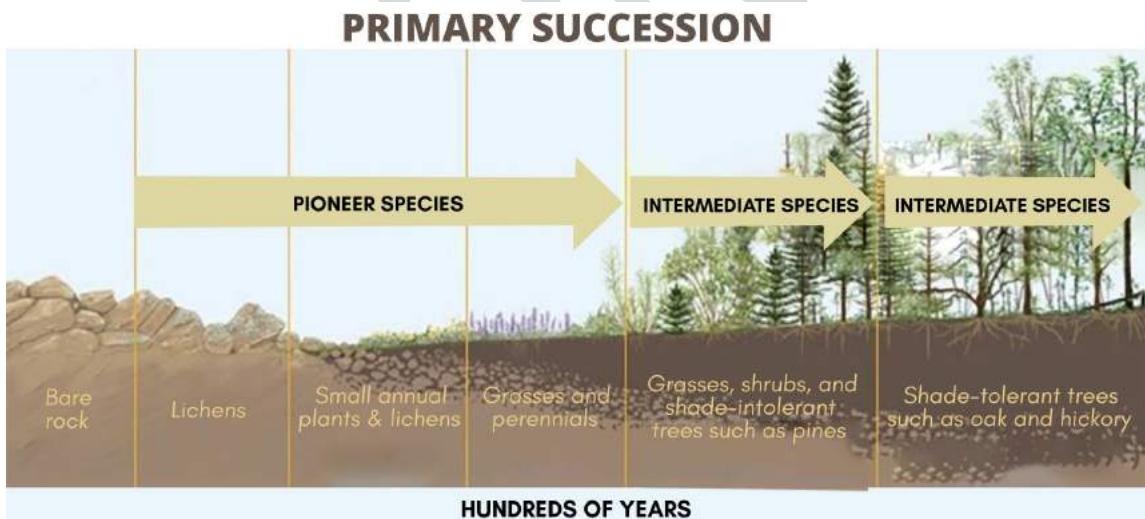
|                             |   |   |   |  |
|-----------------------------|---|---|---|--|
|                             |   |   | <p>and obtaining new food while the anemone provides camouflage and protection utilizing its stinging cells to the hermit crab.</p> <ul style="list-style-type: none"> <li>• Some mutualisms are so intimate that the interacting species can no longer live without each other as they depend totally on each other to survive.</li> <li>• Such close associations are called <b>symbiosis</b> (symbiosis is intense mutualism – E.g. coral and zooxanthellae).</li> </ul> | Student Notes:   |
| <b>Neutral Interactions</b> |   |   |   |  |
| Neutralism                  | 0 | 0 | Neither species affects the other   | <ul style="list-style-type: none"> <li>• True neutralism is extremely unlikely.</li> </ul> |

## 1.10. Ecological Succession

Ecological succession is the process by which the structure of biological community evolves over time.

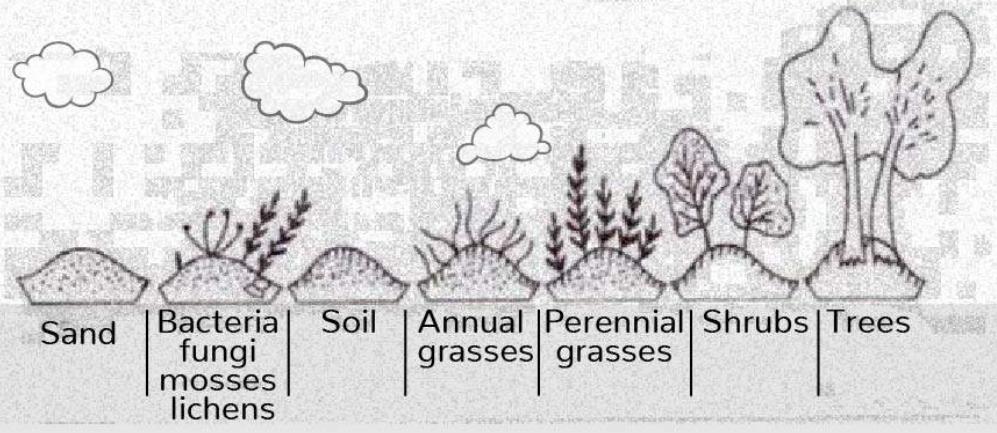
### 1.10.1. Types of Succession

- **Primary succession** –It occurs in essentially lifeless areas—regions in which the soil is incapable of sustaining life as a result of such factors as lava flows, newly formed sand dunes, or rocks left from a retreating glacier.
- **Secondary succession** –It occurs in areas where a community that previously existed has been removed; it is typified by smaller-scale disturbances that do not eliminate all life and nutrients from the environment.



In ecological terminology, the developmental stages of a community are known **seral stages** and the final stage as the **climax community**.

The entire series of communities that is characteristic of a given site is called a **sere**.



#### Other prominent types of Ecological Succession:

- **Autotrophic Succession**

Autotrophic Succession is characterised by early and continued dominance of autotrophic organisms like green plants. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely.

- **Allogenic Succession**

In Allogenic Succession, the replacement of the existing community is caused largely by any other external condition and not by the existing organisms.

- **Autogenic Succession**

Autogenic Succession refers to that type when the community itself, as a result of its reactions with the environment, modifies its own environment and thus causing its own replacement by new communities.

- **Hydrarch Succession**

Plant succession starting on relatively shallow water, such as ponds and lakes, and culminating in a mature forest.

- **Xerarch Succession:**

Plant succession starting on bare ground or rock and culminating in a mature climax forest. The pioneer species, such as lichens and mosses, result in the gradual accumulation of soil

## 1.11. Biogeochemical Cycles

All elements in the earth are recycled time and again. The major elements such as oxygen, carbon, nitrogen, phosphorous, and sulphur are essential ingredients that make up organisms.

Biogeochemical cycles refer to the flow of such chemical elements and compounds between organisms and the physical environment. Chemicals taken in by organisms are passed through the food chain and come back to the soil, air, and water through mechanisms such as respiration, excretion, and decomposition.

Biogeochemical cycles can be either **gaseous** (which the reservoir pool is the atmosphere) or **sedimentary** (reservoir pool is the Earth's crust)

- **Gaseous Biogeochemical Cycles**

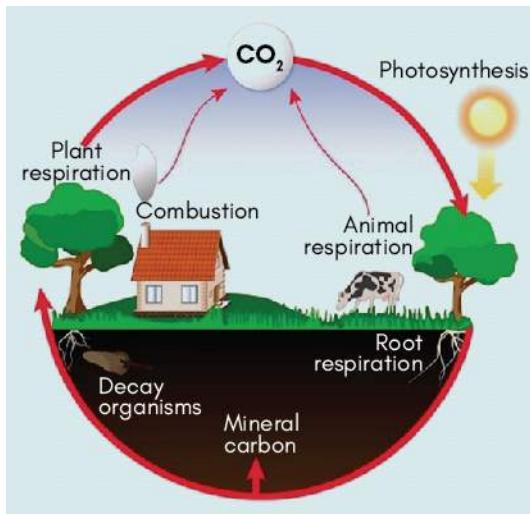
- Carbon Cycle
- Nitrogen Cycle
- Water Cycle
- Oxygen Cycle

- **Sedimentary Biogeochemical Cycle**

- Phosphorus Cycle
- Sulphur Cycle

## 1.11.1. Carbon Cycle

- Carbon enters into the living world in the form of carbon dioxide through the process of photosynthesis as carbohydrates.
- These organic compounds (food) are then passed from the producers to the consumers (herbivores & carnivores).
- This carbon is finally returned to the surrounding medium by the process of respiration or decomposition of plants and animals by the decomposers.
- Carbon is also recycled during the burning of fossil fuels.



Student Notes:

## 1.11.2. Nitrogen Cycle

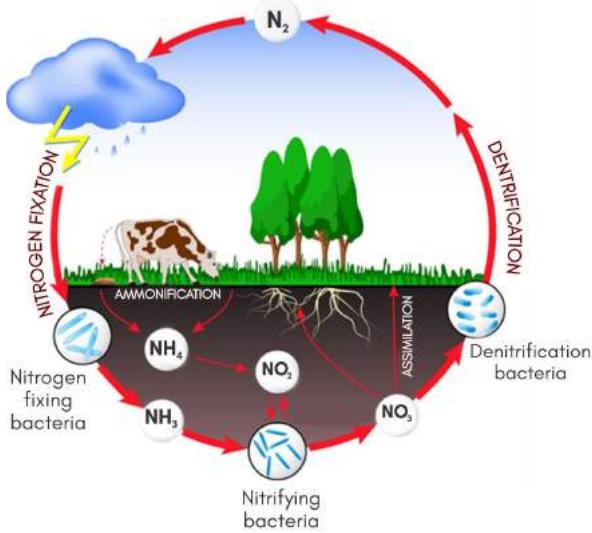
- Nitrogen is present in the atmosphere in an elemental form and as such it cannot be utilized by living organisms.
- This elemental form of nitrogen is converted into combined state with elements such as H, C, O by certain bacteria, so that it can be readily used by the plants.

**Nitrogen fixing Bacteria-** Some bacteria can turn Nitrogen in to ammonia by the process known as NITROGEN FIXATION. Examples-Azotobacter, Achaea etc.

**Denitrifying Bacteria-** These bacteria metabolize nitrogenous compounds using various enzymes turning nitrogen oxides back to nitrogen gas or nitrous oxide.

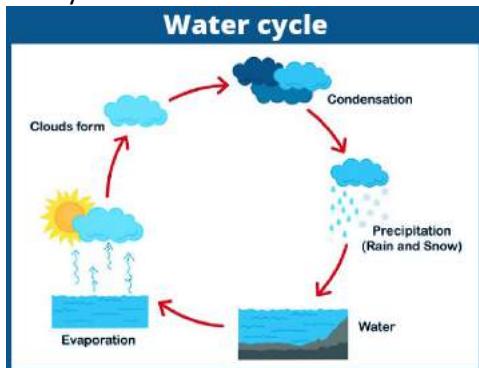
| Biological Nitrogen Fixation   |   |  |
|--|---|--|
| Agricultural Systems   |   | Natural Systems  |
| Crop   | Pastures and Fodder   |  |
| <b>Crop</b> <ul style="list-style-type: none"> <li>Plant associated           <ul style="list-style-type: none"> <li>legume-rhizobia (symbiotic)</li> <li>Azolla-cyanobacteria (symbiotic)</li> <li>cereal-associative bacteria</li> <li>cereal-endophytic bacteria</li> </ul> </li> <li>Free-living           <ul style="list-style-type: none"> <li>cyanobacteria</li> <li>heterotrophic bacteria</li> <li>autotrophic bacteria</li> </ul> </li> </ul> | <b>Pastures and Fodder</b> <ul style="list-style-type: none"> <li>Plant associated           <ul style="list-style-type: none"> <li>legume-rhizobia (symbiotic)</li> <li>cereal-associative bacteria</li> <li>cereal-endophytic bacteria</li> </ul> </li> <li>Free-living           <ul style="list-style-type: none"> <li>cyanobacteria</li> <li>heterotrophic bacteria</li> <li>autotrophic bacteria</li> </ul> </li> </ul> | <b>Plant associated</b> <ul style="list-style-type: none"> <li>legume-rhizobia (symbiotic)</li> <li>Azolla-cyanobacteria (symbiotic)</li> <li>cycad-cyanobacteria (symbiotic)</li> <li>nonlegume-Frankia (symbiotic)</li> <li>cereal-associative bacteria</li> <li>cereal-endophytic bacteria</li> </ul><br><b>Free-living</b> <ul style="list-style-type: none"> <li>cyanobacteria</li> <li>heterotrophic bacteria</li> <li>autotrophic bacteria</li> </ul> |

- Nitrogen is being continuously expelled into the air by the action of microorganisms such as denitrifying bacteria and finally returned to the cycle through the action of lightning and electrification.



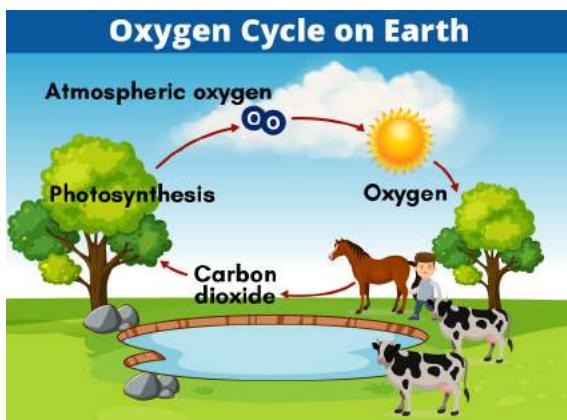
### • Water Cycle

- The evaporation of water from ocean, rivers, lakes, and transpiring plants takes water in the form of vapors to the atmosphere.
- This vaporized water subsequently cools and condenses to form cloud and water. This cooled water vapor ultimately returns to the earth as rain and snow, completing the cycle.



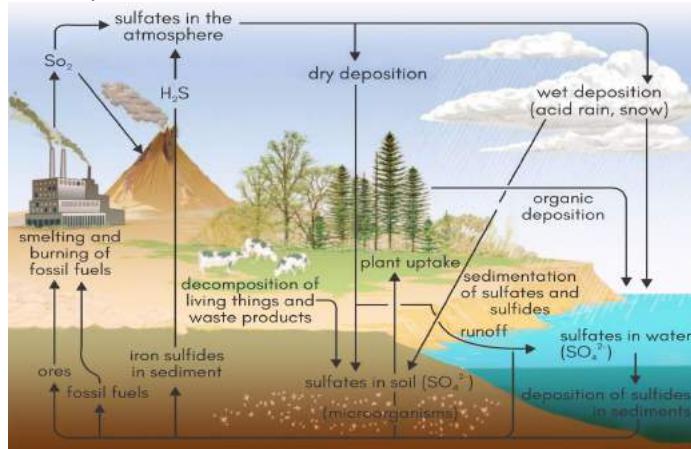
### • OXYGEN CYCLE

- The oxygen cycle is the cycle that helps move oxygen through the three main regions of the Earth, the Atmosphere, the Biosphere, and the Lithosphere. The Atmosphere is of course the region of gases that lies above the Earth's surface and it is one of the largest reservoirs of free oxygen on earth.
- The Biosphere is the sum of all the Earth's ecosystems. This also has some free oxygen produced from photosynthesis and other life processes.
- The largest reservoir of oxygen is the lithosphere. Most of this oxygen is not on its own or free moving but part of chemical compounds such as silicates and oxides



## SULPHUR CYCLE

- Sulphur occurs in all living matter as a component of certain amino acids. It is abundant in the soil in proteins and, through a series of microbial transformations, ends up as sulphates usable by plants.
- Sulphur-containing proteins are degraded into their constituent amino acids by the action of a variety of soil organisms. The sulphur of the amino acids is converted to hydrogen sulphide ( $H_2S$ ) by another series of soil microbes. In the presence of oxygen,  $H_2S$  is converted to sulphur and then to sulphate by sulphur bacteria. Eventually the sulphate becomes  $H_2S$ .

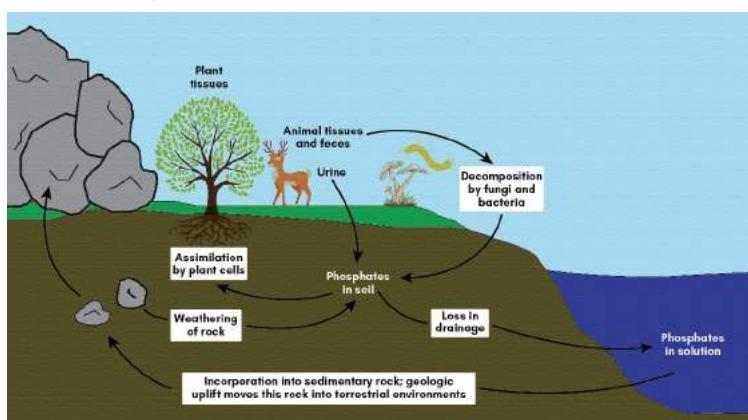


## PHOSPORUS CYCLE

- It is in these rocks where the phosphorus cycle begins. When it rains, phosphates are removed from the rocks (via weathering) and are distributed throughout both soils and water.
- Plants take up the phosphate ions from the soil. The phosphates then move from plants to animals when herbivores eat plants and carnivores eat plants or herbivores.
- The phosphates absorbed by animal tissue through consumption eventually return to the soil through the excretion of urine and faeces, as well as from the final decomposition of plants and animals after death.

### IN AQUATIC ECOSYSTEM-

- ✓ The same process occurs within the aquatic ecosystem. Phosphorus is not highly soluble in water, thus binds tightly to molecules in soil; therefore it mostly reaches waters by traveling with runoff soil particles.
- ✓ Phosphates also enter waterways through fertilizer runoff, sewage seepage, natural mineral deposits, and wastes from other industrial processes.
- ✓ These phosphates tend to settle on ocean floors and lake bottoms. As sediments are stirred up, phosphates may re-enter the phosphorus cycle. Water plants take up the waterborne phosphate which then travels up through successive stages of the aquatic food chain.



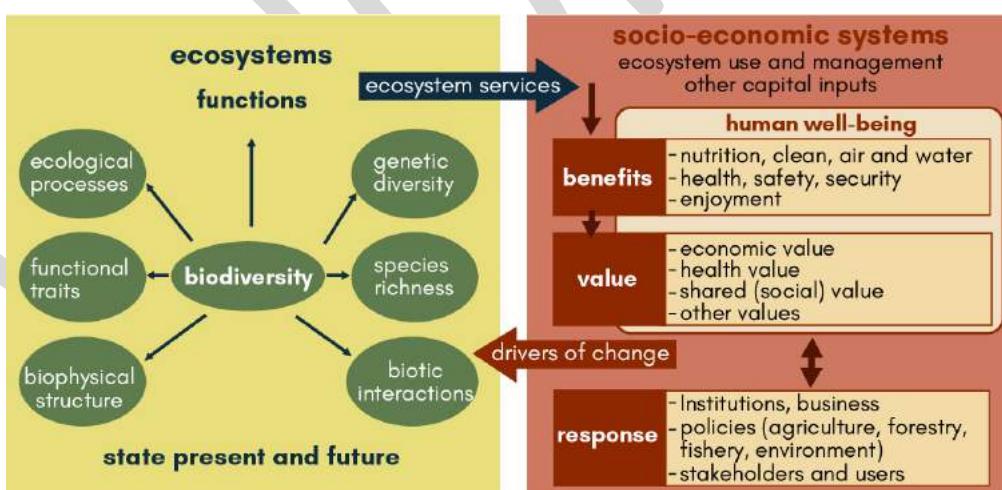
## 1.12. Ecosystem Services

Student Notes:

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services.

The **Millennium Ecosystem Assessment** (MA) was initiated in 2001 by United Nations. The objective of the MA was to assess the consequences of ecosystem change for human well-being, the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being.

| Ecosystem Services  |  |   |
|---|--|---|
| PROVISIONING SERVICES   | REGULATING SERVICES  | CULTURAL SERVICES   |
| The “products” obtained from ecosystems   | Benefits obtained from the regulation of ecosystem processes   | Nonmaterial benefits obtained from ecosystems   |
| Foods<br>Fibers<br>Ornamentals<br>Medicines<br>Biofuels<br>Fresh water<br>Genetic resources | Climate regulation<br>Flood prevention<br>Erosion control<br>Pest control<br>Pollination<br>Seed dispersal<br>Disease regulation | Educational<br>Recreational<br>Sense of place<br>Spiritual<br>Cognitive development<br>Stress relief<br>Gardening |
| SUPPORTING SERVICES   |  |   |
| Services necessary for the production of all other ecosystem services                       |  |   |
| Biodiversity<br>Nutrient recycling<br>Primary productivity                                  |  |   |



### Examples of some plant resources

**Medicinal herbs:** Chamomile, Echinacea, Feverfew, Garlic, Ginseng, Goldenseal, Valerian etc.

**Fiber Yielding Plants:** Himalayan Nettle, Sisal Hemp, Jute, Cotton etc.

### Natural Capital

- It includes those elements of the nature that provide valuable goods and services to humans, such as the stock of forests, food, clean air, water, land, minerals, etc.
- It incorporates a broad perspective on the set of services provided by ecosystems assets.
- It is essential for economic growth, employment, and, ultimately, prosperity.

### Natural Capital Accounting, or environmental-economic accounting

- It is a tool that can help to gain an understanding of the interaction between the economy and the environment.
- It can be used to measure the state of ecosystems, flows of ecosystem services as well as changes in stocks and flows of natural resources in relation to economic changes.

Student Notes:

### System of Environmental-Economic Accounting (SEEA)

- It is a **statistical system** that brings together economic and environmental information into a common framework to measure the condition of the environment, the contribution of the environment to the economy and the impact of the economy on the environment.

### Natural Capital Accounting and Valuation of Ecosystem Services

- The United Nations Statistics Division, UNEP, the Secretariat of the Convention on Biological Diversity, and the European Union have launched this project.
- The project is funded by the European Union, aims to assist the five participating partner countries, namely **Brazil, China, India, Mexico and South Africa**, to advance the knowledge agenda on environmental and ecosystem accounting.
- The project review policy demands, data availability and measurement practices in order to advance and mainstream natural capital accounting and initiate pilot ecosystem accounts in each of the five strategic partner countries.

### The Economics of Environment and Biodiversity (TEEB)

- In 2007, G8+5 countries proposed to initiate the process of analyzing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation.
- In response to this, a global study was conducted by Germany and the European Commission **under Pavan Sukhdev** which led to the establishment of **TEEB**.
- Based in Geneva, Switzerland, at the International Environment House, the TEEB office is **hosted by the UNEP**.
- TEEB is a global initiative focused on "**making nature's values visible**". Its principal objective is to mainstream the values of biodiversity and ecosystem services into decision-making at all levels.
- In October 2010 it released its report " Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB " and launched the **Bank of Natural Capital** to communicate its findings to the general public.
- It is guided by **three core principles**:
  - **Recognizing value in ecosystems** can sometimes ensure conservation and sustainable use. e.g. the existence of sacred groves in some cultures has helped to protect natural areas and the biodiversity they contain.
  - **Demonstrating value in economic terms** is often useful for policy makers and others such as business in reaching decisions that consider the full costs and benefits of an ecosystem. E.g. By including the costs and benefits of conserving the ecosystem services provided by wetlands in controlling floods compared to building flood defences.
  - **Capturing value** involves the introduction of mechanisms that incorporate the values of ecosystems into decisionmaking through incentives and price signals. This can include payments for ecosystem services, reforming environmentally harmful subsidies or introducing tax breaks for conservation.

### IPBES Global Assessment Report

- The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body established in 2012 with now over 130 member states around the world.
- The report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the **most comprehensive scientific evaluation ever made** of the state of our nature, and gives a detailed account of health of the species that inhabit this earth, and the condition of habitats that they live in and depend upon. It is the **first intergovernmental Report of its kind** and builds on the landmark Millennium Ecosystem Assessment of 2005, introducing innovative ways of evaluating evidence.
- The Report concluded that the **second-fastest mass extinction event in planetary history is underway**; the current rate of extinction is 100 to 1000 times greater than historical background rates. Over one million species are at risk of extinction within the next few decades.

- The Report highlighted the importance of indigenous community in conservation. It notes, "Nature managed by Indigenous Peoples and Local Communities is under increasing pressure but is generally declining less rapidly than in other lands." This is significant since "at least" a quarter of the world's land area is "traditionally owned, managed, used or occupied by indigenous peoples".

Student Notes:

## 1.13. UPSC Previous Years Question

### Mains

- What are the consequences of spreading of 'Dead Zones' on marine ecosystem? (2018) (10 marks)
- Define the concept of carrying capacity of an ecosystem as relevant to an environment. Explain how understanding this concept is vital while planning for sustainable development of a region. (2019)(15 marks)

### Prelims

- With reference to food chains in ecosystems, consider the following statements : (2013)
  - A food chain illustrates the order in which a chain of organisms feed upon each other.
  - Food chains are found within the populations of a species.
  - A food chain illustrates the numbers of each organism which are eaten by others.

Which of the statements given above is / are correct?

- |                |                  |
|----------------|------------------|
| (a) 1 only     | (b) 1 and 2 only |
| (c) 1, 2 and 3 | (d) None         |

**Answer: (a)**

- Which one of the following terms describes not only the physical space occupied by an organism, but also its functional role in the community of organisms? (2013)
 

|             |                      |
|-------------|----------------------|
| (a) Ecotone | (b) Ecological niche |
| (c) Habitat | (d) Home range       |

**Answer: (b)**

- With reference to the food chains in ecosystems, which of the following kinds of organism is / are known as decomposer organism/organisms? (2013)
  - Virus
  - Fungi
  - Bacteria

Select the correct answer using the codes given below.

- |                  |                  |
|------------------|------------------|
| (a) 1 only       | (b) 2 and 3 only |
| (c) 1 and 3 only | (d) 1, 2 and 3   |

**Answer: (b)**

- Which of the following adds/add carbon dioxide to the carbon cycle on the planet Earth? (2014)**

- Volcanic action
- Respiration
- Photosynthesis
- Decay of organic matter

Select the correct answer using the code given below.

- |                     |                   |
|---------------------|-------------------|
| (a) 1 and 3 only    | (b) 2 only        |
| (c) 1, 2 and 4 only | (d) 1, 2, 3 and 4 |

**Answer: (c)**

5. Which one of the following is the correct sequence of a food chain? (2014)  
 (a) Diatoms-Crustaceans-Herrings      (b) Crustaceans-Diatoms-Herrings  
 (c) Diatoms-Herrings-Crustaceans      (d) Crustaceans-Herrings-Diatoms

**Answer:** (a)

6. Consider the following statements (2019)  
 1. Agricultural soils release nitrogen oxides into environment.  
 2. Cattle release ammonia into environment.  
 3. Poultry industry releases reactive nitrogen compounds into the environment.  
 Which of the statements given above is/are correct?  
 (a) 1 and 3 only      (b) 2 and 3 only  
 (c) 2 only      (d) 1, 2 and 3

**Answer:** d

## 1.14. Vision IAS Previous Years Questions

1. *Ecosystem services are the direct and indirect contributions of ecosystems to human well-being. In this context, distinguish between supporting, provisioning, regulating and cultural services provided by ecosystems.*

**Approach:**

- Briefly discuss the importance of ecosystem services for human well-being.
- Differentiate between supporting, provisioning, regulating and cultural services provided by ecosystems.
- Conclude accordingly.

**Answer:**

Ecosystem services are critical for human well-being as they provide indispensable services at the local, regional and global scales, such as food production, water purification, flood protection and climate-change mitigation. According to **The Economics of Ecosystems and Biodiversity** (TEEB), ecosystem services can be categorized in following **four** main types:

- **Supporting services** are the ecosystem services that are necessary for the production of all other ecosystem services. These includes-
  - **Habitats for species:** Habitats provide everything that an individual plant or animal needs to survive like food, water, and shelter.
  - **Maintenance of genetic diversity:** It distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.
- **Provisioning services** are the ecosystem services that describe the material or energy outputs from ecosystems. Water, food, wood and other goods are some of the material benefits people obtain from ecosystems called 'provisioning services'. Many provisioning services are traded in markets. However, in many regions, rural households also directly depend on provisioning services for their livelihoods. They include:
  - **Food:** Ecosystem provides conditions for growing foods.
  - **Raw materials:** It provides materials for construction and fuel including wood, biofuels and plant oils.
  - **Fresh water:** Ecosystem regulates the flow and purification of water.
  - **Medicinal resources:** It provides many plants for traditional medicines and provides raw materials for the pharmaceutical industry.
- **Regulating services** are defined as the benefits obtained from the regulation of ecosystem processes. Maintaining the quality of air and soil, providing flood and

Student Notes:

disease control, or pollinating crops are some of the 'regulating services' provided by ecosystems. These services include:

- **Climate regulation:** Trees provide shade whilst forests influence rainfall and water availability both locally and regionally.
- **Carbon sequestration:** As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.
- **Natural hazard regulation:** Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage.
- **Water purification and waste management:** Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment.
- Other important services include pollination and pest control.
- **Cultural services** include non-material benefits that people obtain from ecosystems. Cultural services are deeply interconnected with each other and often connected to provisioning and regulating services: Small scale fishing is not only about food and income, but also about fishers' way of life. These are:
  - **Spiritual enrichment:** In many parts of the world, natural features such as specific forests, caves, mountains etc. are considered sacred or have a religious meaning.
  - **Intellectual development:** Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.
  - **Various kinds of tourism services:** These provide considerable economic benefits and are a vital source of income for many countries.

In spite of the ecological, cultural and economic importance of these services, ecosystems are still being degraded at an unprecedented scale. It is primarily because the value of ecosystems to human welfare is still being underestimated and not fully recognized. In this context, **Natural Capital Accounting** is a key concept that recognizes the economic cost of natural capital.

**2. Explain the concept of biogeochemical cycles and their significance in the functioning of ecosystems. What are the challenges that they face because of anthropogenic factors?**

**Approach:**

- Introduce the answer by explaining the concept of biogeochemical cycles.
- Explain its significance in the functioning of the ecosystem.
- Conclude the answer by enlisting challenges faced by these cycles due to human interventions.

**Answer:**

A biogeochemical cycle is one of several natural cycles, in which conserved matter moves through the biotic and abiotic components of an ecosystem. The main chemical elements that are cycled are: carbon (C), hydrogen (H), nitrogen (N), oxygen (O), phosphorous (P) and sulfur (S).

Important biogeochemical cycles are :

- **Water Cycle:** All of the water that falls on the land does not immediately flow back into the sea. Some of it seeps into the soil and becomes part of the underground reservoir of fresh-water. Some of this underground water finds its way to the surface

through springs. The groundwater is taken in by the roots of plants and is used for photosynthesis. The water is then released into the atmospheric through **evapotranspiration** or is consumed when the plants are eaten.

- **Nitrogen Cycle:** “Nitrogen fixers” are organisms that can turn nitrogen gas from the atmosphere into nitrogen compounds that other organisms can use to produce nucleic acids, amino acids etc. These nitrogen fixers are such a vital part of the ecosystem that agriculture cannot occur without them.
- **Oxygen Cycle:** The Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis.
- **Carbon Cycle:** Carbon is present in all living organisms and non-living things such as minerals, the atmosphere, the oceans and the interior of the earth. There are two fundamental processes in Carbon Cycles.
  - **Rapid Carbon Biogeochemical Cycle:** Here inorganic carbon, which is present in the atmosphere as CO<sub>2</sub>, is captured by autotrophs. These are usually photosynthesizing organisms such as plants, bacteria and algae.
  - **Long Term Carbon Biogeochemical Cycle:** When an organism dies, the carbon stored within their body is broken down into CO<sub>2</sub> and other organic substances by decomposers. While some of this carbon is released into the atmosphere, a large portion of it remains sequestered within the soil. Through this process, soils become major reservoirs for carbon storage.

Anthropogenic activities have disturbed natural cycling of these elements. For example:

- Fossils fuels, which have stored carbon for years are burnt at the rate much faster than the ability of the atmosphere to sink it. It results in greenhouse effect and subsequent global warming.
- Deforestation is releasing carbon stored within plant matter and is reducing the number of plants available to capture it.
- Artificial nitrate fertilizer, when washed away in water sources lead to blooms of “red tides,” “brown tides,” and *Pfiesteria* bacteria – all of which produce toxins that can sicken or kill humans and other animals.

# CHAPTER - 2 - TYPES OF ECOSYSTEM

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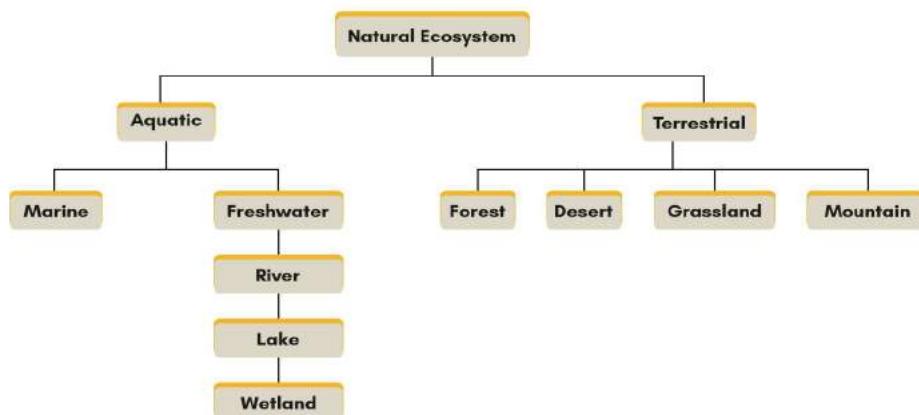
## 2. Types of Ecosystem

### 2.1. Introduction

The ecosystems are classified into many types and are classified based on a number of factors. We will discuss major types of ecosystems and will try and understand on what basis these classifications are done. It is also essential to know the different factors which differentiate the ecosystems from one another and from biome.

### 2.2. Types of Ecosystem

Ecosystems can generally be classified into two classes such as **natural and artificial**. **Artificial ecosystems are natural regions affected by man's interferences**. They are artificial lakes, reservoirs, townships, and cities.



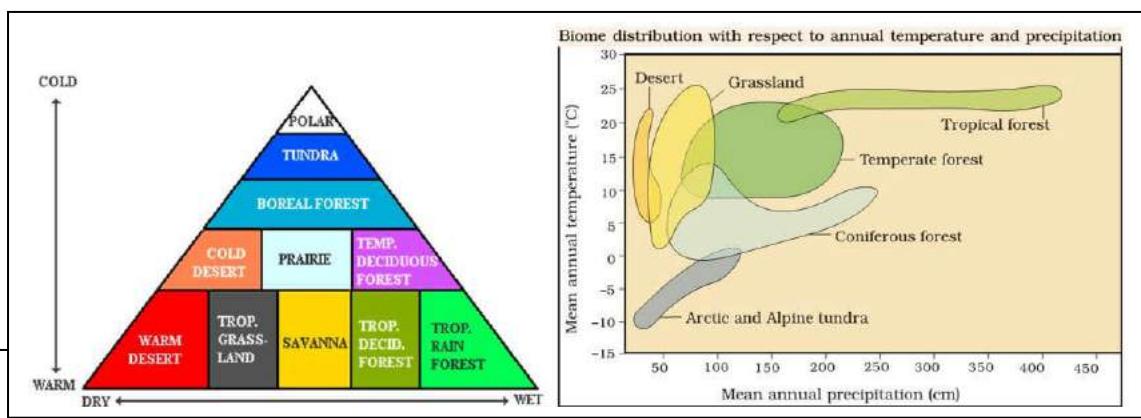
### 2.3. Terrestrial Ecosystems

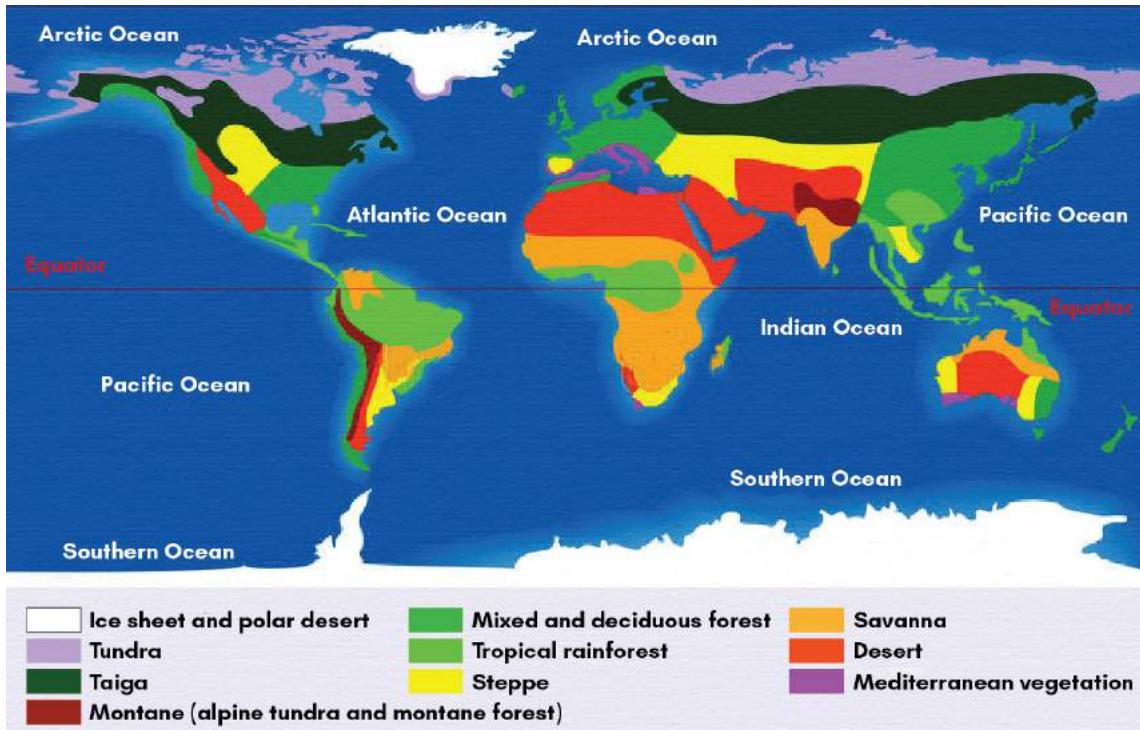
Terrestrial ecosystems are distinguished from aquatic ecosystems by the lower availability of water and the consequent importance of **water as a limiting factor**. These are characterized by greater temperature fluctuations on both diurnal and seasonal basis, than in aquatic ecosystems in similar climates.

**Availability of light is greater** in terrestrial ecosystems than in aquatic ecosystems because the atmosphere is more transparent on land than in water. Differences in temperature and light in terrestrial ecosystems reflect a completely different flora and fauna. Also,

- The terrestrial part of the biosphere is divisible into enormous regions called **biomes**.
- No two biomes are alike. They are characterized, by distinct climate (precipitation and temperature mainly), vegetation, animal life and general soil type.
- The climate determines the boundaries of a biome and abundance of plants and animals found in each one of them.

**Following is the illustration of different biomes based on Latitude and Precipitation.**





### Tundra Biome

- There are two types of tundra – arctic and alpine.
- Alpine tundra occurs at high mountains above the tree line. E.g. High ranges of the Himalayas, Andes, Alps etc.
- There are **no trees** in the tundra (due to **permafrost**).
- The lowest form of vegetation like **mosses, lichens** are sparsely found on bare rocks.
- Coastal lowlands **reindeer moss** which provides the only pasturage for reindeers.
- In the summer, birds migrate north to prey on the numerous insects which emerge when the snow thaws.
- Insects have short life cycles which are completed during the favourable period of the year.
- Animals like the reindeer, arctic fox, wolves, musk-ox, polar bear, lemming, arctic hare, arctic willow live in tundra region.
- Reptiles and amphibians are almost absent.**
- Most of the animals have **long life**, e.g. arctic willow has a life span of 150 to 300 years.
- They are protected from chillness by the presence of **thick cuticle and epidermal hair or fur**.
- Mammals **have a large body size and small tail and ear** to avoid the loss of heat from the surface.

### Taiga or Boreal Biome

- It is considered as **world's largest land biome**.
- It **extends across North America and Eurasia** on the southern margins of the tundra zone.
- The predominant vegetation is an evergreen coniferous forest with species such as spruce, fir and pine.
- The litter derived from conifer needle (leaf) is decomposed very slowly** and is not rich in nutrients (humus content is low).
- Hence, boreal forest soils are characterized by thin **podzols** and are nutrient poor.

#### Podzols

- Podzols are the typical soils of a **coniferous or boreal biome**.
- The top layer of the soil is very thin and is overlain over sandy or loamy subsurface which has no organic matter (**lost due to leaching of nutrients to the bottom layers**).
- Hence, most Podzols are **poor soils for agriculture**. They are mostly used for grazing.

- **The productivity of boreal forest is lower than those of any other forest ecosystem.**
- Animals found in this region include Siberian tiger, wolverine, lynx, wolf, bear, red fox, squirrel, and amphibians like Hyla, Rana, etc.

Student Notes:

### **Temperate Deciduous Biome (North western Europe-British Type Climate)**

- Soils of these temperate forests are **podzolic** and fairly deep.
- The natural vegetation of this climatic type is **deciduous** and trees shed their leaves in cold season.
- This is *an adaptation for protecting themselves against the winter snow and frost (unlike tropical deciduous forest trees which shed their leaves for moisture conservation)*
- Thus shedding in this biome begins in autumn, the ‘fall’ season and growth begins in spring.
- Some of the common species include **Oak, Elm, Ash, Birch, Beech, and Poplar.**

### **Temperate Rainforest Biome**

- This is a small biome in terms of area covered. The main stretch of this habitat is along the north western coast of North America from northern California through southern Alaska.
- There are also small areas in southern Chile, New Zealand, Australia and a few other places around the world.
- **Big coniferous trees** dominate this habitat, including **Douglas fir, Western red cedar, Mountain hemlock, Western hemlock, Sitka spruce and Lodgepole pine.**
- In addition to the trees, mosses and lichens are very common, often growing as **epiphytes**.
- Grizzly bears are the common mammals found in Alaska.

### **Temperate Deciduous Biome (Mediterranean Climate)**

- Trees with small broad leaves are widely spaced and never very tall.
- Regions with adequate rainfall are inhabited by low, broad-leaved evergreen trees (mostly evergreen oaks).
- **Fire** is an important hazardous factor in this ecosystem, and the adaptation of the plants enables them to regenerate quickly after being burnt.
- Plants are in a continuous struggle against heat, dry air, excessive evaporation and prolonged droughts. Thus species here are drought tolerant.

An **epiphyte** is a plant growing on other plants. **Epiphytes** are known as “air plants” because they are not anchored in the soil. **Epiphytes** derive nutrients from rainwater, air and from other sources.

### **Sub-Tropical Deciduous Biome**

- This biome supports luxuriant vegetation, found in **Eastern China, South Eastern USA**
- The lowlands carry both evergreen broad-leaved forests and deciduous trees (hardwood).
- On the highlands, various species of conifers such as pines and cypresses are important.
- Perennial plant growth is not checked by either a dry season or a cold season.

### **Steppe or Temperate Grassland Biome**

- They are practically **treeless**, and the grasses are much shorter.
- Grasses are fresh and nutritious.
- Pole ward, an increase in precipitation gives rise to a transitional zone of wooded steppes where some conifers gradually appear.
- Do not have much animal diversity.

### **Tropical Deciduous Biome (Monsoon Climate)**

- Tropical Monsoon Forests are also known as a **drought-deciduous forest; dry forest; dry-deciduous forest; tropical deciduous forest.**
- **Teak, neem, bamboos, sal, shisham, sandalwood, khair, mulberry** are some of the important species.

## Savannah or Tropical Wet and Dry Biome

- The savannah landscape is typified by **tall grass and short trees**.
- The trees are deciduous, **shedding their leaves in the cool, dry season** to prevent excessive loss of water through transpiration, e.g. acacias.
- Trees usually have **broad trunks**, with water-storing devices to survive through the prolonged drought.
- Many trees are umbrella shaped, exposing only a narrow edge to the strong winds.
- Savannah biome is **rich in mammal, bird and reptile diversity**.

## Tropical Rain Forest Biome

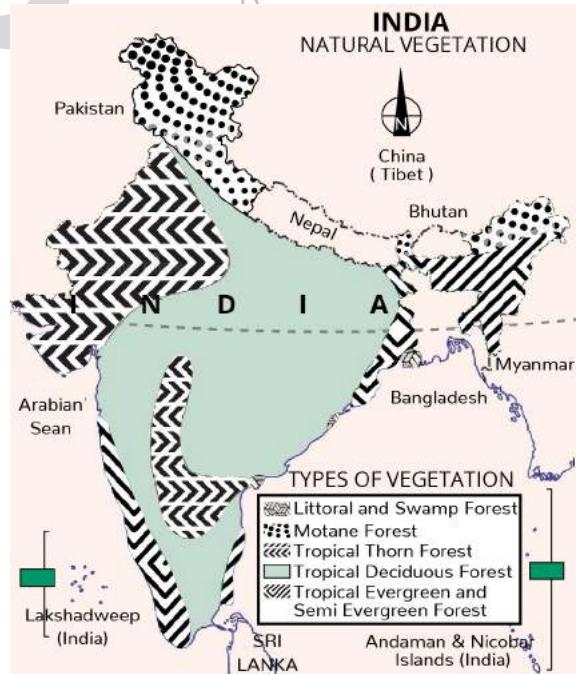
- High temperature and abundant rainfall support a luxuriant tropical rain forest.
- The equatorial vegetation comprises a multitude of evergreen trees, e.g. **mahogany, ebony, dyewoods etc.**
- In the coastal areas and brackish swamps, mangrove forests thrive.
- All plants struggle upwards (most epiphytes) for sunlight resulting in a peculiar layer arrangement (canopy).
- Beneath the tree canopy, which may itself consist of two layers, there is usually a well-developed layering of understorey vegetation which is so dense that hardly any light reaches ground level.

## Desert Biome

- The predominant vegetation of both hot and mid-latitude deserts is xerophytic or drought-resistant.
- This includes the cacti, thorny bushes, long-rooted wiry grasses and scattered dwarf acacias.
- Most desert shrubs have long roots and are well spaced out to gather moisture, and search for ground water.
- Plants have few or no leaves, and the foliage is either waxy, leathery, hairy or needle-shaped to reduce the loss of water through transpiration.
- The seeds of many species of grasses and herbs have thick, tough skins to protect them while they lie dormant.

## DIFFERENCE BETWEEN EVERGREEN & DECIDUOUS FORESTS

| Evergreen Forests  | Deciduous Forests   |
|--|---|
| 1. The evergreen forests are found in the areas of heavy rainfall and abundant sunshine.             | 1. Deciduous forests are found in the moderate cool climate with moderate rainfall.   |
| 2. Trees in these forests do not shed their leaves simultaneously during any part of the year.       | 2. Trees in these forests shed their leaves in a particular season in order to conserve loss of moisture through transpiration.     |
| 3. These forests are found on the eastern margins of continents like South China, South Brazil, etc. | 3. These forests are found in subtropical regions of Asia, Central America, Brazil, etc., with a distinct dry season like monsoons. |
| 4. These forests consist of hardwood species like bamboos, rubber, sandalwood, rosewood, etc.        | 4. In these forests trees are generally deciduous and have broad leaves like oak, ash, cedar, fir, etc.'                            |



## 2.4. Forest Vegetation in India

### 2.4.1. Tropical Evergreen Forests

- The tropical evergreen forests usually occur in areas receiving **more than 200 cm of rainfall** and having a temperature of **15 to 30 degrees Celsius**.
- They occupy about seven per cent of the earth's land surface and harbours more than half of the world's plants and animals.

- They are found mostly near the equator. Region is warm and wet throughout the year.
- Trees reach great heights up to **60 metres or even above**.
- **It has a luxuriant vegetation of all kinds** – trees, shrubs, and creepers giving it a multi layered structure.
- In India, evergreen forests are found in the western slopes of the Western Ghats in States such as Kerala and Karnataka. They are also found in hills of Jaintia and Khasi. Some of the trees found in Indian Tropical Forests are rosewood, mahogany and ebony. Bamboos and reeds are also common.
- **Common animals** found in these forests are elephants, monkey, lemur and deer. The one horned rhinoceros are found in the jungles of Assam and West Bengal.

#### **2.4.2. Tropical Deciduous Forests**

- They are the **most widespread** forests of India.
- Also called the **monsoon forests** and spread over the region receiving **rainfall between 200 cm and 70 cm**.
- Trees of this forest type **shed their leaves for about six to eight weeks** in dry summer.
- On the basis of the availability of water, these forests are further divided into moist and dry deciduous.

#### **2.4.3. Moist Deciduous Forests**

- It found in areas receiving rainfall between 200 and 100 cm.
- Exist mostly in the eastern part of the country – north-eastern states, along the foothills of the Himalayas, Jharkhand, West Orissa and Chhattisgarh, and on the eastern slopes of the Western Ghats.
- Teak is the most dominant species of this forest.
- Bamboos, sal, shisham, sandalwood, khair , kusum, arjun, mulberry are other commercially important species.

#### **2.4.4. Dry Deciduous Forests**

- The dry deciduous forests are found in areas having rainfall between 100 cm and 70cm.
- These forests are found in the rainier parts of the peninsular plateau and the plains of Bihar and Uttar Pradesh.
- There are open stretches in which Teak, Sal, Peepal, and Neem grow.
- A large part of this region has been cleared for cultivation and some parts are used for grazing.
- Common animals found are lion, tiger, pig, deer and elephant. Variety of birds, lizards, snakes, and tortoises are also found here.

#### **2.4.5. The Thorn Forests and Scrubs**

- In regions with less than 70 cm of rainfall, the natural vegetation consists of thorny trees and bushes.
- Found in the north western part of the country including semiarid areas of Gujarat, Rajasthan, Madhya Pradesh, Chhattisgarh, Uttar Pradesh and Haryana.
- Acacias, palms, euphorbias and cacti are the main plant species.
- Trees are scattered and have long roots penetrating deep into the soil in order to get moisture.
- The stems are succulent to conserve water.
- Leaves are mostly thick and small to minimize evaporation.

#### **2.4.6. Montane Forests**

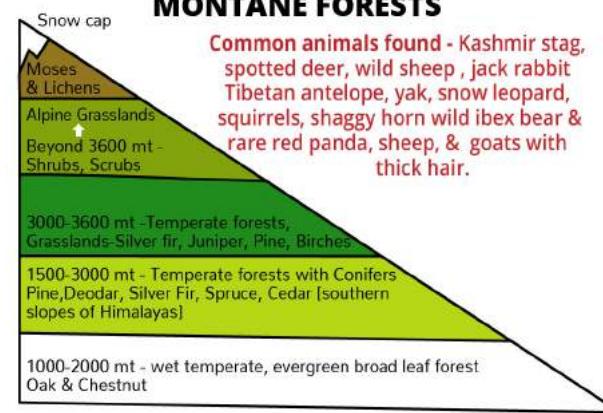
- In mountainous areas, the **decrease in temperature with increasing altitude leads to the corresponding change in natural vegetation**.

- As such, there is a succession of natural vegetation belts in the **same order as we see from the tropical to the tundra region**.
- The wet temperate type of forests are found between a height of 1000 and 2000 metres.
- Evergreen broadleaf trees such as **oaks and chestnuts** predominate.
- Between 1500 and 3000 metres, temperate forests containing coniferous trees like pine, deodar, silver fir, spruce and cedar, are found. and they cover mostly the southern slopes of the Himalayas, places having high altitude in southern and northeast India.

Student Notes:

### MONTANE FORESTS

**Common animals found -** Kashmir stag, spotted deer, wild sheep, jack rabbit, Tibetan antelope, yak, snow leopard, squirrels, shaggy horn wild ibex bear & rare red panda, sheep, & goats with thick hair.



- At higher elevations, temperate grasslands are common.
- At high altitudes, generally more than 3,600 metres above sea level, temperate forests and grasslands give way to the Alpine vegetation.
- Silver fir, junipers, pines and birches are the common trees of these forests.
- They get progressively stunted as they approach the snowline and are used extensively for grazing by nomadic tribes like the Gujjars and the Bakarwals.
- At higher altitudes, mosses and lichens form part of tundra vegetation.
- Common animals found in these forests are Kashmir stag, spotted dear, wild sheep, jack rabbit, Tibetan antelope, yak, snow leopard, squirrels, Shaggy horn wild ibex, bear and rare red panda, sheep and goats with thick hair.

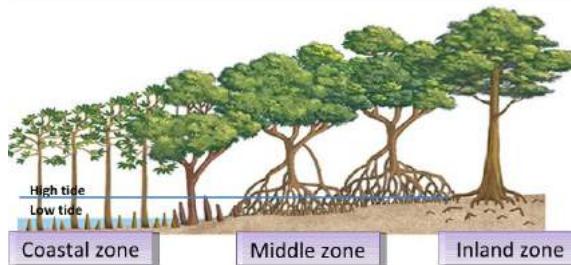


### 2.4.7. Mangrove Forests

- Found in the areas of coasts influenced by tides.
- Mud and silt get accumulated on such coasts.
- Dense mangroves are the common varieties with roots of the plants submerged under water.
- The deltas of the Ganga, the Mahanadi, the Krishna, the Godavari and the Kaveri are covered by such vegetation.
- In the Ganga Brahmaputra delta, sundari trees are found, which provide durable hard timber.
- Palm, coconut, keora, agar, also grow in some parts of the delta.
- Royal Bengal Tiger is the famous animal in these forests.
- Turtles, crocodiles, gharials and snakes are also found in these forests.

#### Structure of Mangrove Forests

- 3 horizontal zones with trees about 15m tall
- Trees vary in height from 2m – 40m as muddy soil in environment cannot provide firm support



(We will read about Mangrove in detail in further chapters)

## 2.5. State of Forest Report

Student Notes:

The India State of Forest Report (ISFR) is a biennial report published by the Forest Survey of India (FSI).

- FSI has been mandated to assess the forest and tree resources of the country including wall-to-wall forest cover mapping in a biennial cycle.
- Starting 1987, 16 assessments have been completed so far. ISFR 2019 is the 16th report in the series.

### Highlights of the report

- In the present assessment, the **total forest and tree cover** of the country is 80.73 million hectare which is **24.56 percent of the geographical area of the country**.
- The **Total Forest cover** is 7,12,249 sq km which is **21.67%** of the geographical area of the country. The target is to achieve 33% of area under forest cover.

#### Forest Survey of India

- It is a premier national organization under the union **Ministry of Environment and Forests**, responsible for assessment and monitoring of the forest resources of the country regularly.
- Established on June 1, 1981, the Forest Survey of India succeeded the "**Preinvestment Survey of Forest Resources**" (**PISFR**), a project initiated in 1965 by Government of India with the sponsorship of FAO and UNDP.
- **Objectives:**
  - To prepare State of Forest Report biennially.
  - To conduct inventory in forest and non-forest areas and develop database on forest tree resources.
  - To prepare thematic maps using aerial photographs.
  - To function as a nodal agency for collection, compilation, storage and dissemination of spatial database on forest resources.
  - To conduct training of forestry personnel in application of technologies related to resources survey, remote sensing, GIS, etc.
  - To strengthen research & development infrastructure in FSI and to conduct research on applied forest survey techniques.
  - To support State/UT Forest Departments (SFD) in forest resources survey, mapping and inventory.
  - To undertake forestry related special studies/ consultancies and custom made training courses for SFD's and other organisations on project basis.

- The Tree cover is 2.89% of the geographical area of the country.
- As compared to the assessment of 2017, there is an increase of 5,188 sq. km in the total forest and tree cover of the country.
- Out of this, the increase in the forest cover has been observed as 3,976 sq km and that in tree cover is 1,212 sq. km.
- Range increase in forest cover has been observed in open forest followed by very dense forest and moderately dense forest.
- The top three states showing increase in forest cover are Karnataka (1,025 sq. km) followed by Andhra Pradesh (990 sq km) and Kerala (823 sq km).

### Some Major Findings

- Area-wise Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra.
- In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (85.41%), Arunachal Pradesh (79.63%), Meghalaya (76.33%), Manipur (75.46%) and Nagaland (75.31%).
  - **Mangroves**
    - ✓ Mangrove cover has been separately reported in the ISFR 2019 and the total mangrove cover in the country is 4,975 sq km.
    - ✓ An increase of 54 sq Km in mangrove cover has been observed as compared to the previous assessment of 2017.
    - ✓ Top three states showing mangrove cover increase are Gujarat (37 sq km) followed by Maharashtra (16 sq km) and Odisha (8 sq km).

- **Bamboo**
  - ✓ The extent of bamboo bearing area of the country has been estimated 16.00 million hectare.
  - ✓ There is an increase of 0.32 million hectare in bamboo bearing area as compared to the last assessment of ISFR 2017.
- **Wetlands**
  - ✓ Wetlands within forest areas form important ecosystems and add richness to the biodiversity in forest areas, both of faunal and floral species
  - ✓ Due to importance of wetlands, FSI has carried out an exercise at the national level to identify wetlands of more than 1 ha within RFA.
  - ✓ There are 62,466 wetlands covering 3.8% of the area within the RFA/GW of the country.
- **Carbon Stock**
  - ✓ Under the current assessment the total carbon stock in country's forest is estimated 7,124.6 million tonnes.
  - ✓ There is an increase of 42.6 million tonnes in the carbon stock of country as compared to the last assessment of 2017.
  - ✓ The annual increase in the carbon stock is 21.3 million tonnes, which is 78.2 million tonnes CO<sub>2</sub> eq.

**Difference between forest area and forest cover**

- The term 'Forest Area' (or recorded forest area) generally refers to **all the geographic areas recorded as forest in government records**. Recorded forest areas largely comprise Reserved Forests (RF) and Protected Forests (PF), which have been constituted under the provisions of Indian Forest Act, 1927. Besides RFs and PFs, the recorded forest area may include all such areas, which have been recorded as forests in the revenue records or have been constituted so under any State Act or local laws.
- On the other hand, the term 'Forest Cover' as used in the 'SFR' refers to **all lands more than one hectare in area, having a tree canopy density of more than 10%**.
- Thus the term 'forest area' denotes the legal status of the land as per the government records, whereas the term 'forest cover' indicates presence of trees over any land.

## 2.6. Conservation and Management of Forest

### 2.6.1. National Forest Policy, 1988

- **Aim:** Ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for sustenance of all life forms, human, animal and plant. The derivation of direct economic benefit must be subordinate to this principal aim.
- **Objectives:**
  - Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests of the country.

**Major achievements of National Forest Policy, 1988**

- **Increase in the forest and tree cover:** Since, inception of the Forest Policy 1988 the forest and tree cover in the country has increased from 19.7 % of geographical area (State Forest Report, 1987) to 24.6 % of the geographical area (State Forest Report, 2019)
- Involvement of local communities in the protection, conservation and management of forests through Joint Forest Management Programme.
- Meeting the requirement of fuel wood, fodder minor forest produce and small timber of the rural and tribal populations.
- Conservation of Biological Diversity and Genetic Resources of the country through ex-situ and in-situ conservation measures.
- Significant contribution in maintenance of environment and ecological stability in the country.

- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
- Checking soil erosion and denudation in the catchments areas of rivers, lakes, reservoirs in the “interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
- Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- Meeting the requirements of fuel-wood, fodder, minor forest produce and small timber of the rural and tribal populations.
- Increasing the productivity of forests to meet essential national needs.
- Encouraging efficient utilisation of forest produce and maximising substitution of wood.
- Creating a massive people’s movement with the involvement of women, for achieving these objectives and to minimise pressure on existing forests.

Student Notes:

#### **Joint Forest Management**

The Forest Policy of 1988 (NFP) represented a major paradigm shift from the earlier policies and this shift began to take some shape through the introduction of Joint Forest Management in India in 1990.

Unlike, the use oriented policy of 1952, the Forest Policy of 1988 (NFP) gives major emphasis on the ecological roles of forests, and envisages that the rights and concessions from forests are to be primarily for bona-fide use of communities living within and around the forest areas, especially tribals. Such communities are required to be motivated to protect and develop such forests from which they derive their benefits

- Started in 1971 in Arabari Village in Midnapore district ,West Bengal, JFM today is considered as model for conservation and management of forests with the help of local community.
- The Ministry of Environment and Forest issued a **circular in June 1990** to various State Departments of Forest (encouraging the involvement of village communities and voluntary agencies for regeneration of forest land and this circular officially launched JFM in India.
  - It is a decentralised forest management operation where usually a small forest block is associated with the people living on its fringe.
  - JFM should be implemented under an “arrangement” between the village community (i. e. the beneficiaries), NGO’s and the State Forest Departments.
  - Beneficiaries should essentially be village communities and not commercial or other interests.
  - A committee called Forest Protection Committee (FPC or with different names in different states) is constituted of one or two members (one male and one female) from each family of the village. This committee with the local Forest Department jointly manages the forest block.
  - A small executive committee constitutes of members of the village and some local official and a Panchayat member. The local forester generally acts as the secretary of the committee. The committee runs the routine management of the forest and discusses with the FPC when any important decision is required.
  - A micro plan is prepared jointly. The plan incorporates the measures and works that would be undertaken to manage the forest for a specific period of time after which it would come for revision.
  - In lieu of the responsibility taken over by the village people, the FPC would be entitled to some benefits of the forest products (generally all of non-timber forest products) and a significant share of the income from final felling of the forest.
  - Neither the beneficiaries nor any NGO may acquire ownership or lease rights over the land in question. No grazing or agriculture is allowed on the selected area.
  - The selected site should be free from any existing claims or rights, privileges, or concessions.

### Draft National Forest Policy, 2018

- There is a need to revise the existing National Forest Policy, 1988 through integrating:
  - Sustainable forest management.
  - Climate change mitigation strategies.
  - An evaluation mechanism to oversee participation of multiple stakeholders in forests

### Salient feature of Draft Policy

- **Objective:** To safeguard the **ecological and livelihood security** of present and future generations.
- **Eco-security:** The country should aim to have a **minimum of one-third** of the total land area under forest and tree cover and in hilly and mountainous regions, the aim will be to maintain two-third of the area under forest and tree cover.
- **Institutions:** Setting up **National Board of Forestry (NBF)** at central level (headed by the Environment Minister) and **State Boards of Forestry** at state level (headed by state ministers in charge of forests) for ensuring inter-sectoral convergence, simplification of procedures, conflict resolution, etc. They will also **periodically review** implementation of this policy.
- **Strengthening community participation in forestry:** To ensure synergy between gram sabhas and joint forest management committees for successful community participation in forestry, **National Community Forest Management Mission** will be launched under Forest Rights Act (FRA).
- **Promote agro-forestry, farm forestry and Urban Green** to increase the tree cover outside forests.
- **Stabilizing ecologically sensitive catchment areas** with suitable soil and water conservation measures.
- **Biodiversity Conservation** through surveying of forest areas and promoting modern techniques of ex-situ conservation for Relic, Endangered and Threatened (RET) species.
- **Identifying and maintaining wildlife rich areas and corridors** outside protected areas for ensuring ecological and genetic continuity.
- Develop a **national forest ecosystems management information system** for scientific planning and management.
- **Research and Education in Forest management** for increasing forest productivity, enhancing the capacity of the forest ecosystems for carbon sequestration, reclamation of degraded and mined areas for ecological security, addressing the contemporary priorities and for increasing livelihood support and economic growth.
- **Enhance Quality and Productivity of natural forests** by promoting natural regeneration through locally suitable indigenous species.
- **Increase the productivity of forest plantations** by intensive scientific management of commercially important species like teak, sal, sisham, poplar, eucalyptus, bamboo etc.
- **Public private participation models:** will be developed for undertaking afforestation and reforestation activities in degraded forest areas and forest areas available with Forest Development Corporations and outside forests.
- **Forest Based Industry will be incentivized** as it being labour intensive can help in increasing green jobs and meeting the demand of raw materials as well.
- **Management of Non-Timber Forest Produce** through Value Chain approach would be made compulsory and part of the business plans related to NTFP.
- **Management of North-Eastern Forests** which have a vital impact on climate, agriculture production, and mitigation of floods in the plain areas of North-East.
- **Forest Certification** to enhance value of forest product harvested sustainably.
- **Forest Skill Development Centres**, for skilling forest dependent population in forestry sector jobs, will be instituted for training of frontline staff who are at the cutting edge of the forest department.
- **Addressing forest fires** by mapping vulnerable areas and develop early warning systems and methods to control fire through remote-sensing technology and community participation.
- **Human-wildlife conflicts:** It proposes dedicated and well-equipped quick response teams with health and veterinary services for speedy assessment of damage and quick payment of relief to the human victims, to minimise conflicts with the wildlife.

### Concern

Although, it recognizes the role of forests in climate change mitigation unlike previous policies, there are various concerns as well:

- Environmentalists object in involving PPP model for afforestation and reforestation activities, pointing out that this would mean **privatisation of India's natural resources** and creating **private forests**.
- National Community Forest Management** mission is based on the joint forest management model (involving both the state **forest** departments & local communities) that has no legal standing after enactment of Forest Rights Act, which vests management authority with gram sabhas.
- Policy orients itself more on the conservation and preservation of forest wealth rather than regenerating them through people's participation.
- Concern over the achievement of policy, as most of the objectives mentioned in **earlier National Forest Policy 1988** have not been met so far.
- It fails to mention or address the degradation of growing stock in the natural forests
- It persists with the methodological weakness of the Indian Forest Survey Reports of the past 30 years that conflate plantations with forest cover.

Student Notes:

## 2.6.2. Social Forestry

Social forestry means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development. The National Commission on Agriculture (1976) has classified social forestry into three categories. These are urban forestry, rural forestry and Farm forestry.

- Urban forestry** pertains to the raising and management of trees on public and privately owned lands in and around urban centres such as green belts, parks, roadside avenues, industrial and commercial green belts, etc.
- Rural forestry** lays emphasis on promotion of agro-forestry and community-forestry.

**Agro-forestry** is the raising of trees and agriculture crops on the same land inclusive of the waste patches. It combines forestry with agriculture, thus, altering the simultaneous production of food, fodder, fuel, timber and fruit. **National Agroforestry Policy 2014** has following objectives in this regard:

- Promote agroforestry to increase farm income and livelihoods of rural households, especially the small and marginal farmers.
- Protect and stabilise ecosystems, and promote resilient cropping and farming systems to minimise the risk during extreme climatic events.
- Simultaneously provide raw material to wood based industries. Thus create new avenues for rural employment, and reduce pressure on the forests.
- To develop capacity and strengthen research in agroforestry and create a massive people's movement for achieving these objectives.

### Nagar Van Scheme (Ministry of Environment, Forest and Climate Change)

- It aims at developing **200 Nagar Van (Urban Forests)** across the country in next five years in **cities having Municipal Corporation or Municipalities** by involving local communities, educational institutions, local bodies, NGOs etc.
- Under this scheme,
  - A **minimum of 20 hectares of forests** will be created in the city.
  - These forests will come up **either on existing forest land or on any other vacant land** offered by urban local bodies.
  - Van Udyam once established will be **maintained by the State Government**.
- Cities authorities will be encouraged to have a **city forest comprising area up to 100 ha in forest area** within their jurisdiction for deriving maximum ecological and environmental benefits.
- Scheme will be, in part, **paid for by the CAMPA (Compensatory Afforestation Fund Act, 2016) funds**.
- Scheme is also linked to the **Schools Nursery Yojana** that aims to build lasting bond between students and nature.
- Warje Urban Forest** in Pune (Maharashtra) will be considered as a role model for the Scheme.

#### **Community forestry:**

- It involves the raising of trees on public or community land such as the village pasture and temple land, roadside, canal bank, strips along railway lines, and schools etc.
- Community forestry programme aims at providing benefits to the community as a whole.
- Community forestry provides a means under which the people of landless classes can associate themselves in tree raising and thus, get those benefits which otherwise are restricted for landowners.

**Farm forestry:** It is a term applied to the process under which farmers grow trees for commercial and non-commercial purposes on their farm lands. Forest departments of various states distribute seedlings of trees free of cost to small and medium farmers.

Student Notes:

### **2.6.3. National Afforestation Program**

The National Afforestation Programme (NAP) has been formulated by merger of four 9th Plan centrally sponsored afforestation schemes of the Ministry of Environment & Forests. The Scheme will be **operated by the National Afforestation and Eco-Development Board, Ministry of Environment and Forests as a 100% Centrally Sponsored Scheme.**

The overall objective of the National Afforestation Programme (NAP) scheme is **ecological restoration of degraded forests and to develop the forest resources with peoples' participation**, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor.

NAP aims to support and accelerate the on-going process of devolving forest conservation, protection, and management and development functions to the Joint Forest Management Committees (JFMCs) at the village level, which are registered societies.

### **2.6.4. Green India Mission (GIM)**

Green India mission is one of the missions that come under the umbrella of National Action Plan for Climate Change. It was launched in 2014. The primary aim is to protect, restore and enhance India's diminishing forest cover.

#### **Objectives:**

Growth in forest or tree cover to 5 million hectares (mha) and increase the quality of forest cover in another 5 million hectares of forest or non-forest lands. There are separate sub-targets for a variety of forests and its ecosystems namely, grassland, dense forest, wetland etc.

- Increase the quality of degrading moderately dense forests – 1.5 million hectares (ha).
- Ecologically restore open forests which are being degraded – 3 million hectares (ha)
- Grasslands revival – 0.4 million hectares
- Wetlands revival – 0.10 million hectares
- Ecological restoration of shifting cultivation areas, mangroves, scrub, ravines, cold deserts, & abandoned mining areas – 1.8 million hectares with different sub-targets.
- Increase in forest cover in urban areas and its outskirts – 0.20 million hectares.
- Increase in forest and tree cover on marginal agricultural lands/fallows and other non-forest lands which comes under agroforestry – 3 million hectares.
- Increase forest-based livelihood income for about 3 million households in and around these forest areas.
- Increase Carbon Dioxide sequestration to a range of 50 to 60 million tonnes by 2020.

#### **Implementation:**

- At the national level implementation is done by the **Ministry of Environment and Forests**.
- The **State Forest Development Agency** will guide the mission at the state level.
- At the district level, the implementation will be done by the Forest Development Agency.
- The **gram sabha** and various committees are the key institutions for planning and implementation at the village level.

- In urban areas, the ward level committees like Residents Welfare Association (RWA) linked to the municipality/municipal corporations facilitate planning and implementation under the mission.

Student Notes:

### 2.6.5. Compensatory Afforestation

It refers to the afforestation and regeneration activities carried out as a way of compensating for forest land which is diverted to non-forest purposes.

**The Forest (Conservation) Act, 1980** provides that whenever a forest land is to be diverted for nonforestry purposes, the equivalent non forest land has to be identified for compensatory afforestation and funds for raising compensatory afforestation are to be imposed.

The act further requires that:

- the non-forest land for CA are to be identified contiguous to or in the proximity of Reserved Forest or Protected Forest, as far as possible.
- In case, non-forest land for CA is not available in the same district, non-forest land for CA is to be identified anywhere else in the State/Union Territory.
- If non forest land is unavailable in the entire State/ UT, funds for raising CA in double the area in extent of the forest land diverted need to be provided by the user agency on the basis of the rates fixed by the State Forest Department.

#### E-Green Watch

- Launched by Forest Survey of India is an integrated & online Geographic Information System (GIS) that will monitor the regeneration of vegetation cover and promoting afforestation as a way of compensating for forest land which is diverted to non-forest uses under CAMPA.

The Supreme Court of India in 2002 (TN Godhavarman Vs Union of India case) had ordered for the creation of Compensatory Afforestation Fund Management and Planning Authority fund. Government enacted **Compensatory Afforestation Fund Act 2016** to provide a proper institutional mechanism for compensatory afforestation matters. It is applicable to States, Union Territories, and the Centre as well.

#### Salient features of the Act

- The Act established **National Compensatory Afforestation Fund (NCAF)** under the **Public account of India** and **State Compensatory Afforestation Funds under public accounts of states**.
- The National Fund will receive 10% of these funds, and the State Funds will receive the remaining 90%.
- The fund will be used for compensatory afforestation, additional compensatory afforestation, penal compensatory afforestation, net present value, catchment area treatment plan or any money for compliance of conditions stipulated by the Central Government while according approval under the provisions of the **Forest (Conservation) Act, 1980**.
- Act provides **statutory status for two ad-hoc institutions**, namely
  - **National Compensatory Afforestation Fund Management and Planning Authority (NCAFMPA)** for management and utilisation of NCAF.
  - **State Compensatory Afforestation Fund Management and Planning Authority** for utilisation of State Compensatory Afforestation Fund
- The act also seeks to provide for constitution of a **multidisciplinary monitoring group** to monitor activities undertaken from these funds.
- The act also provides for **annual audit** of the accounts by **the Comptroller and Auditor General**.

#### Issues with the Act

- **Forest as commodity:** The principle of CA reduces a “forest” to a “commodity which acquires certain area on the ground”. Its loss are deemed to be compensated financially. Its ecology, biodiversity and ecosystem services were completely ignored.

- Compromising community forest rights:** The land identified for compensatory afforestation would be under forest department's jurisdiction thus, having adverse consequences for the hard-won rights of tribals and forest dwellers.
- Lack of monitoring mechanism for expenditure from funds** despite findings of Comptroller and Auditor General in 2013 about massive misutilization of funds by the forest department.
- Scarcity of land** as land is a limited resource, and is required for multiple purposes, such as agriculture, industry, etc. The problem is compounded by unclear land titles.
- Inadequate Capacity of state forest departments** for planning and implementation. Still utilisation of 90% of funds depend on it.
- Low quality forest cover:** Compensatory afforestation cannot make up for the ecological value lost by cutting the existing forests. Also, computing the appropriate Net Present Value of a forest is a challenge.
- Poor survival rate of plantations** raised under compensatory afforestation also raises serious questions about their effectiveness.
- Diversion as land banks:** The creation of land banks for CA from revenue forests and degraded forests (on which communities have got traditional rights) further allows for takeover of community land.

Student Notes:

#### Guidelines for suitability and identification of land bank for compensatory afforestation.

- It mandates that states and UTs shall create land bank for CA for speedy disposal of the forest clearance proposals under FC Act 1980.
- The states shall also set up committee with principal chief conservator of forests, chief wildlife warden and representatives of revenue department for expediting creation of land banks in a systematic manner.
- The state governments shall formulate CA scheme including activities like soil and moisture conservation, regeneration cleaning, silvicultural activities and shall ensure maintenance of these plantations for a period of seven to 10 years as per requirement.
- It stipulates that for CA the number of plants to be planted over CA land shall be at least 1,000 plants per hectare of forest land diverted. However, if 1,000 plants cannot be planted on the non-forest land identified for CA, then the balance will be planted in degraded forest land.

#### Way forward

- Primacy of Gram sabha:** The CAF Act needs to be integrated with the FRA and PESA by centring the role of gram sabhas and incorporating land and forest rights guarantees.
- Management of CA:** Emphasis should not only be on plantation but also on the maintenance of CA.

#### 2.6.6. Other Acts for Forest Conservation

| Act                           | Objective   | Essential Provisions  |
|-------------------------------|---|---|
| Forest Conservation Act, 1980 | To check further deforestation and conserve forests   | <p><b>Applicability:</b> Whole of India except the State of Jammu and Kashmir. Jammu and Kashmir has its own Forest Conservation Act, 1990.</p> <ul style="list-style-type: none"> <li>Restricts use of forest for non-forest purpose</li> <li>Restricts de-reservation of reserve forests</li> <li>Regulates diversion of forest land by way of lease to private industries and individuals.</li> <li>Restricts clear felling of trees</li> <li>Constitution of Advisory Committee for grant of approval for any of the activities above.</li> </ul> |
| Indian Forest Act, 1927       | To consolidate laws relating to forests, transit of forest produce and duty leviable on timber and forest produce | <p><b>Applicability:</b> Several States have its own Forest Act such as Andhra Pradesh, Karnataka etc. Others have adopted the IFA.</p> <ul style="list-style-type: none"> <li>Establishes three classes of forests namely Reserve Forest, Protected Forest and Village Forest.</li> <li>Has elaborate procedures for constituting the above categories with a detailed process of settlement of rights</li> </ul>  |

|                                   |  |   |                |
|-----------------------------------|--|---|----------------|
|                                   |  | <p>through the FSO.</p> <ul style="list-style-type: none"> <li>Deals with control over forests not being the property of the Government.</li> <li>Deals with duty on timber and other forest produce.</li> <li>Deals with timber and forest produce in transit.</li> <li>Regulate the rights of the owners in drift and stranded timber.</li> <li>Power to reserve specific tree species in reserve forest.</li> </ul>  | Student Notes: |
| The Biological Diversity Act 2002 | Conservation of Biological Diversity, sustainable use of its components and equitable sharing of the benefits of biological resources. | <p><b>Applicability:</b> Whole of India</p> <ul style="list-style-type: none"> <li>Provides for establishment of National Biodiversity Authority.</li> <li>Makes use and regulation of biological diversity subject to the approval of National Biodiversity Authority.</li> <li>Provides for establishment of State Biodiversity Board.</li> <li>Requires the Central Government to develop National Strategies, plans, programmes for the objectives of the Act.</li> <li>Requires the Central Govt. to notify threatened species and the State Govt. to notify biodiversity heritage sites.</li> <li>Mandates every local body to constitute Biodiversity Management Committee.</li> <li>Provides for establishment of Local Biodiversity Funds</li> </ul> |                |

#### Bamboo and its promotion

- Bamboo belongs to the family **Poaceae(Gramineae)**.
- It grows in **tropical, sub-tropical and temperate regions** of the world. Large tracts of natural bamboo forest occur in tropical Asian countries including India, Myanmar, Thailand and China.
- In India, they are found growing naturally in almost all parts of the country except Kashmir. More than 50% of bamboo species occur in Eastern India.
- Bamboo is a versatile group of plants which is **capable of providing ecological, economic and livelihood security to the people**.
  - Bamboo can grow on marginal lands which are not suitable for agriculture an agroforestry/farm forestry crop. Bamboo plantation will **optimize the farm productivity and income thereby enhancing livelihood opportunities** of small and marginal farmers including landless and the women.
  - Modern technologies allow use of bamboo as a durable and high-quality wood substitute.
  - Apart from the high above ground biomass production, **bamboo also stores substantial carbon in below ground parts, i.e. rhizomes and roots and would contribute to enriching carbon pool** at lower depths, even up to one metre and beyond. Hence scientific bamboo plantations would also be important for mitigating measures against climate change.
- India has the **highest area (13.96 million ha) under bamboo and is the second richest country, after China, in terms of bamboo diversity** with 136 species (125 indigenous and 11 exotic).
- Applications of Bamboo:** use in building materials, agricultural implements, furniture, musical instruments, food items, handicrafts, large bamboo-based industries (paper pulp, rayon etc.), packaging, etc.
- Measures to promote bamboo:**
  - National Bamboo Mission (NBM) was **launched as a Centrally Sponsored Scheme in 2006-07 and was subsumed under Mission for Integrated Development of Horticulture (MIDH) during 2014-15** and continued till 2015-16.
  - National Bamboo Mission was restructured in 2018-19** for holistic development of complete value chain of sector.
  - In 2017, Indian Forest Act 1927** was amended to **remove bamboo from the category of trees**. This allows cultivation and felling of bamboo and its products without any felling and transit permissions outside forests.
  - Import policy has also been modified** to ensure progress of the bamboo industry in the country.

## 2.7. Aquatic Ecosystems

Student Notes:

- Aquatic ecosystems refer to plant and animal communities occurring in water bodies.
- **Freshwater ecosystems:** water on land which is continuously cycling and has low salt content (**always less than 5 ppt**) is known as fresh water.
- There are two types of freshwater ecosystem- lentic and lotic ecosystems.

Static/Lentic Ecosystem

- Pond,Lakes
- Bogs,Swamps

Running water/Lotic Ecosystem

- Springs,Streams
- Rivers

- **Marine ecosystems:** the water bodies containing salt concentration equal to or above that of seawater (i.e., **35 ppt or above**). E.g. shallow seas and open ocean.
- **Brackish water ecosystems:** these water bodies have salt content in between **5 to 35 ppt**. e.g. estuaries, salt marshes, mangrove swamps and forests.

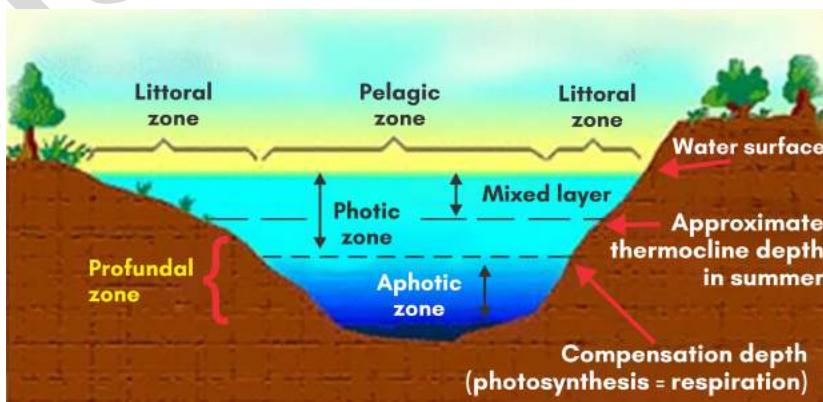
### Aquatic Organisms

- The aquatic organisms are classified on the basis of their zone of occurrence.
- **Neuston:** These organisms live at the air-water interface, e.g. floating plants.
- **Periphyton:** These are organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud such as sessile algae.
- **Plankton:** Microscopic floating organisms such as algae, diatoms, protozoans and larval forms are called plankton. This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton).
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.
- **Nekton:** This group contains powerful swimmers that can overcome the water currents.
- **Benthos:** The benthic organisms are those found living at the bottom of the water mass.

### 2.7.1. Factors Limiting the Productivity of Aquatic Habitats

#### Sunlight

- Sunlight penetration rapidly diminishes as it passes down the column of water.
- The depth to which light penetrates a lake determines the extent of plant distribution.
- Suspended particulate matters such as clay, silt, phytoplankton, etc. make the water turbid.
- Turbidity limits the extent of light penetration and photosynthetic activity in a significant way.
- Based on light penetration and plant distribution they are classified as **photic and aphotic zones**.



### Photic zone

- Photic (or “euphotic”) zone is the portion that extends from the lake surface down to where the light level is 1% of that at the surface. The depth of this zone depends on the transparency of water.
- Photosynthetic activity is confined to the photic zone.
- Both photosynthesis and respiration activity takes place.

### Aphotic zone

- The lower layers of the aquatic ecosystems, where light penetration and plant growth are restricted forms the aphotic zone (**profundal zone**). Only respiration activity takes place in this zone.
- The aphotic zone extends from the end of the photic zones to bottom of the lake.

### Dissolved oxygen

- In freshwater the average concentration of dissolved oxygen is 10 parts per million by weight.
- This is 150 times lower than the concentration of oxygen in an equivalent volume of air.
- Oxygen enters the aquatic ecosystem through the air-water interface and by the photosynthetic activities of aquatic plants.
- Dissolved oxygen escapes the water body through the air-water interface and respiration of organisms (fish, decomposers, zooplankton, etc.).
- The amount of dissolved oxygen retained in water is also influenced by temperature.
- **Oxygen is less soluble in warm water.** Warm water also **enhances decomposer activity.** Therefore, increasing the temperature of a water body increases the rate at which oxygen is depleted from the water.
- When the dissolved oxygen level falls below 3-5 ppm, many aquatic organisms are likely to die.

#### Winterkill

- An ice layer on the top of a water body can effectively cut off light. Photosynthesis stops but respiration continues in such water body.
- If the water body is shallow, the oxygen gets depleted, and the fish die. This condition is known as winterkill.

### Temperature

- Since water temperatures are less subject to change, the aquatic organisms have **narrow temperature tolerance limit.**
- As a result, even small changes in water temperature are a great threat to the survival of aquatic organisms when compared to the changes in air temperatures in the terrestrial organisms.

## 2.8. Estuarine Ecosystem

- An estuary is a place where a river or a stream opens into the sea (mouth of the river).
- It is a partially enclosed coastal area of **brackish water** (salinity varies between 0-35 ppt) with one or more rivers or streams flowing into it, and with a free connection to the open sea.
- At the estuaries, freshwater carrying fertile silt and runoff from the land mixes with the salty sea water.
- Estuaries form a **transition zone** (Eco tone) between river environments and maritime environments.
- Examples of estuaries are river mouths, coastal bays, tidal marshes, lagoons and deltas.
- Estuaries are formed due to rise in sea level, movement of sand and sandbars, glacial processes and tectonic processes.

- All the plants and animals in the estuaries are subjected to variations in salinity to which they are adapted (**osmoregulation**).
- Estuaries are greatly influenced by tidal action. They are periodically washed by sea water once or twice a day based on the number of tides.
- In some narrow estuaries, tidal bores are significant. Tidal bores cause great damage to the estuarine ecology.

Student Notes:

### 2.8.1. Importance of Estuaries

- They are the most productive (**more productive than wetlands**) water bodies in the world because of the mixing of freshwater and saline water zone where marine organisms of both the ecosystems meet.
- **Ecotone regions (transitional zones)** like mangroves, wetlands, estuaries, grasslands etc. have far greater productivity compared to natural ecosystems like a forest ecosystem, ocean ecosystem, pond ecosystem, riverine ecosystem, desert ecosystem etc. This is because of the wide-ranging species from the adjacent ecosystems being present in the Eco tone.
- Also, an estuary has **very little wave action**, so it provides a calm refuge from the open sea and hence becomes ideal for the survival of numerous aquatic species.
- Estuaries are most **heavily populated** areas throughout the world, with about 60% of the world's population living along estuaries and the coast.
- The vast mangrove forests on the seaward side of an estuary act as a barrier for the coastal habitat to check the wind speed during cyclones and high velocity landward winds.
- Mangroves act as a filter trapping suspended mud and sand carried by rivers which leads to delta formations around estuaries.
- **Precipitation of clay and alluvium particles in the estuarine region is high** because of the exposure to saline water (saline water precipitates fine alluvium).
- Estuaries store and recycle nutrients, traps sediment and form a buffer between coastal catchments and the marine environment.
- They also absorb, trap and detoxify pollutants, acting as a natural water filter.
- Estuaries with their wetlands, creeks, lagoons, mangroves and sea-grass beds are rich in natural resources including fisheries.
- They are deep and well protected from marine transgressions, and hence they are ideal locations for the construction of ports and harbours.
- The banks of estuarine channels form a favoured location for human settlements, which use the estuaries for fishing and commerce but nowadays also for dumping civic and industrial waste.

#### Differences between Lagoon and Estuary

- A lagoon is a stretch of salt water separated from the sea by a **low sandbank or coral reef**.
- Backwaters in Kerala are **mostly lagoons** where seawater flows inwards through a small inlet that is open towards the sea.
- In estuaries, the water flows fast and strong, while in lagoons the water is shallower and flows sluggishly.
- Estuaries are usually deeper than lagoons. Also, **lagoons mostly don't have any fresh water source** while the estuaries have at least one. Lagoons are more saline than estuaries.
- **Lagoons are formed due to falling in sea levels** (coastline of emergence. E.g. Kerala Coast) whereas **estuaries are mostly formed due to rise in sea levels** (coastline of submergence. E.g. Konkan coast)

### 2.8.2. Estuarine Vegetation

- Only certain types of plants and animals adapted to the “brackish” estuarine waters flourish in the estuaries.
- Factors influencing the distribution of organism in an estuary are its salinity and the amount of flooding.

- Estuaries support diverse habitats, such as mangroves, salt marshes, sea-grass, mudflats etc.
- Estuaries are very dynamic and productive ecosystems since the river flow, tidal range and sediment distribution is continuously changing in them.
- In general, the **phytoplanktons of estuaries are diatoms, dinoflagellates, green algae, blue-green algae**.
- Towards the sea coast of the estuaries, there are large algae and seagrasses. Near the mouth of the rivers and deltas, there are mangrove forests.
- Estuaries are homes to all kind of terrestrial or land-based plants and animals, such as wood storks, pelicans, coniferous and deciduous trees and butterflies.
- Estuaries are also home to unique aquatic plants and animals, such as sea turtles, sea lions, sea catfish, saltworts, eelgrass, salt grasses, cordgrasses, seagrass, sedge, bulrush etc.

### 2.8.3. India Estuarine Ecosystem

- The Country has 14 major, 44 medium and 162 minor rivers drains into the sea through various estuaries.
- **Major estuaries occur in the Bay of Bengal.** Many estuaries are locations of some of the **major seaports**.
- Most of India's major estuaries occur on the **east coast**. In contrast, the estuaries on the west coast are smaller (**in environmental studies, deltas are considered as subsections of estuaries**).
- Two typical examples of estuaries on the west coast are the **Mandovi** and **Zuari estuaries**.

### 2.8.4. Issues of Indian Estuarine Ecosystem

- Modifications of the estuarine catchments result in changes in water flow in various estuaries, either far in excess or much lower than required (E.g. Hooghly, Godavari, Pulicat etc.)
- Pollution through industries and combined city sewage discharge.
- Recreational boating and fishing.
- Navigation, dredging and shipping (e.g. Hooghly).
- Expansion of urban and rural settlements, mining & industries, agriculture and dumping of solid wastes.
- Overexploitation of target fish stock due to increased demand.
- Reclaiming the fringed areas for intensive aquaculture in pens.
- Obstructing the migratory routes of fish and prawn recruitment (e.g., Chilka, Pulicat).
- Polluting the environment through feeding of stocked fish and prawn in pens (Chilka).
- Destruction of biodiversity through prawn seed collection and operation of small-meshed nets (e.g., Hooghly, Chilka, Pulicat).
- Submergence of catchment areas due to rising in water level.

## 2.9. Vision IAS Previous Year Questions

1. *Despite the damages, forest fires are a natural and necessary part of the forest ecosystem. Discuss. In this context, do you think there is need to have a relook at India's no-forest fire policy? Give arguments in support of your answer.*

#### Approach:

- Briefly discuss the harmful impact of forest fires.
- Discuss how forest fires are advantageous for the forest ecosystem.
- Highlighting the flaws in India's forest fire policy, discuss the need for a relook its policy.

#### Answer:

As per State Forest Report (SFR) 2015, out of 70 million hectares of forest cover, more than 54% of forests are vulnerable to fire due to natural and anthropogenic causes.

Forest fires destroy many acres of natural vegetation and cause significant damage to human habitations. It forces the animals to migrate or get extinct within a short span of time. It also leads to soil erosion & landslides, ash flows if accompanied by heavy rains occur in the aftermath of a forest fire.

However, natural forest fires are intrinsic to forest ecosystem and serve many purposes:

- **Support new generations:** Some species of trees and plants are actually **fire dependent**. Some trees have fire resistant bark and cones that require heat to open and release seeds for regeneration. For e.g. Chaparral and grassland plants.
- **Cleaning the forest floor:** Fire removes low-growing underbrush, **cleans forest floor of debris, reduces resource competition** by opening it up to sunlight, and nourishing soil.
- **Prevents large fires:** Clearing underbrush from forest floor with low intensity flames can help **prevent large damaging wildfires** that spread out of control and completely destroy forests.
- **Provide habitat and increase biodiversity:** Fire clears forests of heavy underbrush, leaving room for new grasses, herbs and regenerated shrubs that provide **food and habitat** for many wildlife species. When fire removes a thick stand of shrubs, **water supply** is increased, benefiting other types of plants and animals.
- **Killing Disease:** Fire **kills diseases and insects** that prey on trees and releases valuable nutrients, thus enriching the soil.
- **Soil regeneration:** After hill forest fires, **fertilising ash** from fire washes down to fields with monsoon rains which increases soil fertility.

Currently, India follows a no-fire forest policy. Forest department has historically prevented forest fires in order to protect timber stocks. However, this one size fits all approach is not suited to Indian conditions because:

- Early dry season fires burn **less hot, and are less detrimental** to vegetation than peak dry season fires which burn much hotter. It also destroys invasive plants like lantana that act as a fuel for spread of fires in the Western Ghats region.
- By classifying forest fires as penal offence, forest department gradually legitimised forests as timber and wildlife production systems and ignored the cultural and livelihood significance of the forest ecosystem.

Thus, there is a need to relook at no fire policy and reorient it in the light of ecological and local knowledge systems. Instead of viewing forest fires as being purely destructive in nature, policymakers should view fires as being both rejuvenating and revitalizing.

## **2. What are the causes of forest fires and their effects on the ecosystem? How can forest fires be prevented? Also mention the steps that have been taken by the government in this regard.**

### **Approach:**

- Introduce by mentioning the state of forest fires in India.
- Discuss the reasons for forest fires and its impact on the ecosystem.
- Mention the measures to prevent forest fires.
- Then enumerate steps taken by government in this regard.

### **Answer:**

In the last two years, India has witnessed 125% spike in the incidents of forest fires. According to India State of Forest Report (ISFR) 2015, as much as 64.29 per cent of the Recorded Forest Area (RFA) is prone to fires.

## Causes

- **Natural causes** are largely related to climatic conditions such as temperature, wind speed and direction, level of moisture in soil and atmosphere and duration of dry spells. Other natural causes are the lightning, friction of bamboos swaying due to high wind velocity and rolling stones that result in sparks setting off fires in highly inflammable leaf litter on the forest floor
- **Anthropogenic** causes result from human activity as well as methods of forest management. These can be intentional or unintentional such as fires started by locals to clean the forest floor, burn undergrowth, to destroy evidence of illicit felling or to scare wild animals etc.

## Effects on the Ecosystem

- Forest fire causes damage to vegetation cover and loss of natural regeneration, loss of wildlife habitat, change in micro-climate, loss of biodiversity and invasion of weeds, adverse effect on the local livelihood, loss of carbon sink, and addition of greenhouse gases.
- Fire frequency also determines the floristic composition of an area by selecting species at site. A species can be removed if fire occurs too often, too early, or late in its life cycle.
- Fire may also play a role in recycling nutrients from the ground-layer vegetation and litter and counters the infertile substrates and arrested decay.

## Prevention of forest fires

- **Removal of Chir Pine:** as it is highly inflammable due to its high resin content.
- **Prevent Encroachment:** As most of the fire is set up manually, state administration should ensure that there is no encroachment of forest land or violation of forest conservation rules.
- **Traditional Forest management:** Traditional operations like forest floor clearing, controlled burning and creation of water harvesting structures are effective measures.
- **Fire Lines:** are critical in fire-fighting, because without fire lines, a fire can quickly get out of control.
- **Use of technology:** The committee preferred use of drones instead of CCTVs and fire watchers.
- **Community involvement** in forest fire management.

## Measures by the government

- Fire lines have been created to avoid any dry plants from catching fire which could eventually spread deep into the forests.
- At several places, measures are being taken to periodically fill artificial troughs with fresh water.
- Forest Fire Prevention & Management Scheme (FFPMS): a centrally sponsored scheme with an aim to focus solely on the issue of forest fire prevention & management.
- The Ministry of Environment and Forests, Government of India, has prepared a **National Master Plan for Forest Fire Control**. This plan proposes to introduce a well-coordinated and integrated fire-management programme that includes the following components:
  - Prevention of human-caused fires.
  - Prevention of forest fire by people participation through Joint Forest Fire Management.
  - Prompt detection of fires through a well coordinated network of observation points, efficient ground patrolling, and communication networks.
  - Remote sensing technology is to be given due importance in fire detection.

For successful fire management and administration, a National Fire Danger Rating System (NFDRS) and Fire Forecasting System are to be developed in the country, also participation of the forest community is inevitable for the forest fire management.

Student Notes:

**3. What is Eutrophication? Also list the various problems associated with it.**

**Approach:**

- Straight forward question. Eutrophication and its problems.

**Answer:**

- One of the main problems affecting coastal waters is the high levels of nitrogen and phosphorous based pollutants entering the water. These pollutants come mainly from human activities. Overloading coastal waters with nutrients results in excessive phytoplankton growth. Eutrophication is enhanced plankton growth due to excess supply of nutrients.
- Problems associated with eutrophication are:
  1. These blooms occur throughout the water and prevent light reaching the waters below. This stops the growth of plants deeper in the water and reduces biological diversity.
  2. When the blooms are really large, this bacterial decomposition can use up so much oxygen in the deep waters that there isn't enough left for fish to breathe and they have to swim away or else they die. Animals living on the sea floor can't easily move away and they also die.
  3. Excess nutrients can sometimes encourage the growth of phytoplankton species which produce harmful toxins. These toxins may cause the death of other species including fish in fish farms.
  4. Large phytoplankton blooms can cause huge ugly foams on beaches. These blooms are not toxic but temporarily ruin the beach, reducing its recreational value.

**4. What is eutrophication? Analyze how cultural eutrophication is different from natural eutrophication. List the measures to control the phenomenon of eutrophication.**

**Approach:**

- In the introduction, write what is Eutrophication.
- Explain how eutrophication is a natural phenomenon. Then write about Cultural eutrophication, which is nothing but artificial eutrophication by human activities. Explain how it is different from natural eutrophication.
- List the various measures to control eutrophication.

**Answer:**

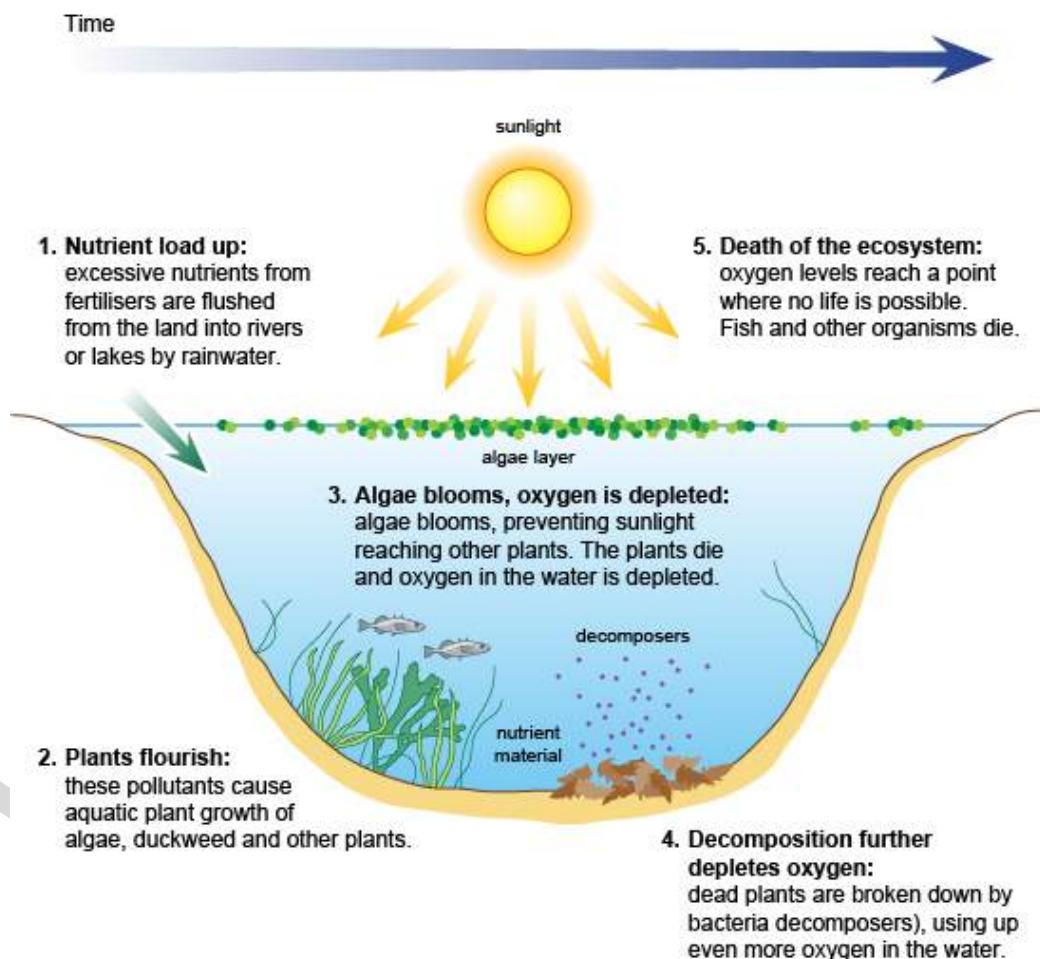
Eutrophication is the enrichment of a terrestrial or aquatic ecosystem by the addition of nutrients, especially nitrogen and phosphorus that results in a superabundant growth of plants, algae, or other primary producers. It can be a natural process (natural eutrophication) or result from human activity (cultural eutrophication).

**Difference between natural and cultural Eutrophication**

1. In natural eutrophication nutrient are introduced from the natural environment around the body of water e.g. dead aquatic and nearby terrestrial plants, dead fish, waste from all the living organisms, runoff etc.

Cultural eutrophication means any eutrophication that occurs due to human activities eg industrial waste, sewage dumping, and increased runoff in areas with poor erosion control due to human development etc.

2. Natural eutrophication is a slow process whereas process of cultural eutrophication depends on the degree to which excess nutrients are dumped into the water supply.
3. Very large natural bodies of water do not experience eutrophication on a measurable level due to their exceptionally low bio-load compared to the volume of water. These natural redistributions over time help keep the maximum amount of land mass healthy and productive as possible whereas cultural eutrophication can be catastrophic. High levels of nutrients may cause a massive algae bloom, which places a huge bio-load on the area in a relatively short amount of time. The algae block a large percentage of the sunlight that naturally filters down through the water, which may in turn kill many plants and animal life in the water body.



#### Some of the important measures to control eutrophication are:

- Controlling application amount and timing of fertilizer
- Planting vegetation along streambeds to slow erosion and absorb nutrients
- Controlling runoff from farmlands
- Uprooting and removal of macrophytes in eutrophic lakes
- Removing the sediment entirely, thus both taking away the internal source of nutrients and deepening the lake
- Ultrasonic irradiation to control algal blooming

- Use of Calcium hydroxide to neutralize low pH values in streams and lakes in areas where acidic rain has a significant impact
- Use of biological controls such as the process of denitrification uses specialized bacteria that convert nitrates to harmless molecular nitrogen
- Enforceable standards for major point-source discharges and high-risk non-point sources

Student Notes:

**5. What is eutrophication? Highlighting its ecological consequences, suggest measures to tackle it.**

**Approach:**

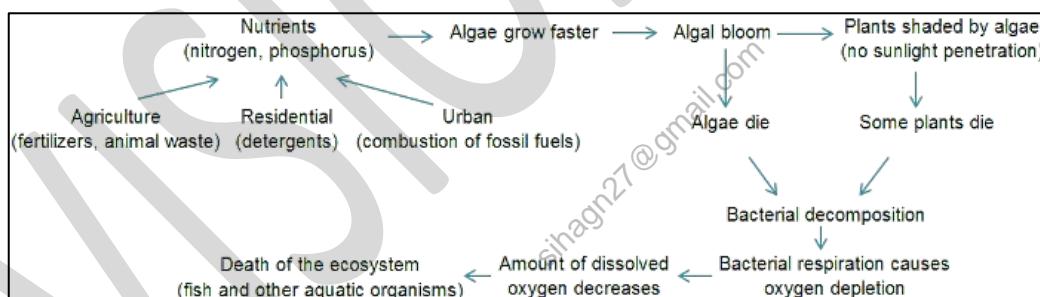
- Introduce by explaining the concept of Eutrophication.
- Mention its ecological consequences.
- Suggest some measures to tackle them.
- Conclude on the basis of the above points.

**Answer:**

**Eutrophication** is a process by which a water body gets enriched in dissolved nutrients (mainly Nitrates and Phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of oxygen.

It occurs naturally over thousands of years as the lakes grow old and get filled with sediments. This process is, however, sped up by anthropogenic factors like introduction of sewage, detergents, fertilizers and other nutrient sources into the ecosystem, and is called **cultural eutrophication**.

The two most acute phenomenon associated with eutrophication are **hypoxia** (low Oxygen level) in the deep part of the lake and **harmful algal blooms**.



**Ecological consequences of eutrophication:**

- **Decrease in biodiversity:**
  - Algal bloom restricts the penetration of sunlight resulting in the death of aquatic plants and hence restricts the replenishment of oxygen.
  - When the dissolved oxygen in the water reduces to the hypoxic level, many marine animals suffocate and die. This reduces the effective biodiversity of the water body (dead zones).
  - Eutrophication can also produce carbon dioxide, which lowers the pH of seawater (ocean acidification). This prevents shell formation of aquatic animals.
- **Increase in water toxicity:** Harmful algal blooms (like cyanobacterial blooms) in eutrophic waters release neurotoxins and hepatotoxins. These toxins can affect the entire food chain via shellfish or other marine animals and lead to the death of many animals.

- **Invasion by new species:** Eutrophication leads to changes in the availability of light and certain nutrients to an ecosystem. This causes shifts in the species composition. For instance, an increase in nitrogen might allow new competitive species such as water hyacinth to invade and out-compete original inhabitant species.
- **Deterioration of water quality:** Eutrophication leads to increased turbidity of water thereby declining the availability of clean water.

#### Measures to tackle eutrophication:

- Water quality of existing water bodies should be assessed at regular intervals.
- Industrial and domestic waste water must be treated before it is discharged into water bodies.
- Implement regulations to mitigate nutrient losses through run-off, such as standards, technology requirements, or pollution caps for various sectors.
- Incentivizing nutrient reducing actions through taxes and fees, subsidies and environmental markets. For instance, rationalization of fertilizer use in agriculture.
- Preservation and restoration of the natural ecosystems that capture and cycle nutrients.
- Establishment of strong, engaged, and coordinated institutions to implement and enforce policies to address the problem of eutrophication.
- Educational outreach programs to raise awareness of eutrophication.

Effective implementation of the above steps can help in tackling the problem of eutrophication. In this regard, the National Green Tribunal has also highlighted the need of mapping water bodies on GPS platforms and suggested unique ID for all water bodies in Delhi which can be implemented at national level.

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# CHAPTER - 3 - UNDERSTANDING ECOLOGY

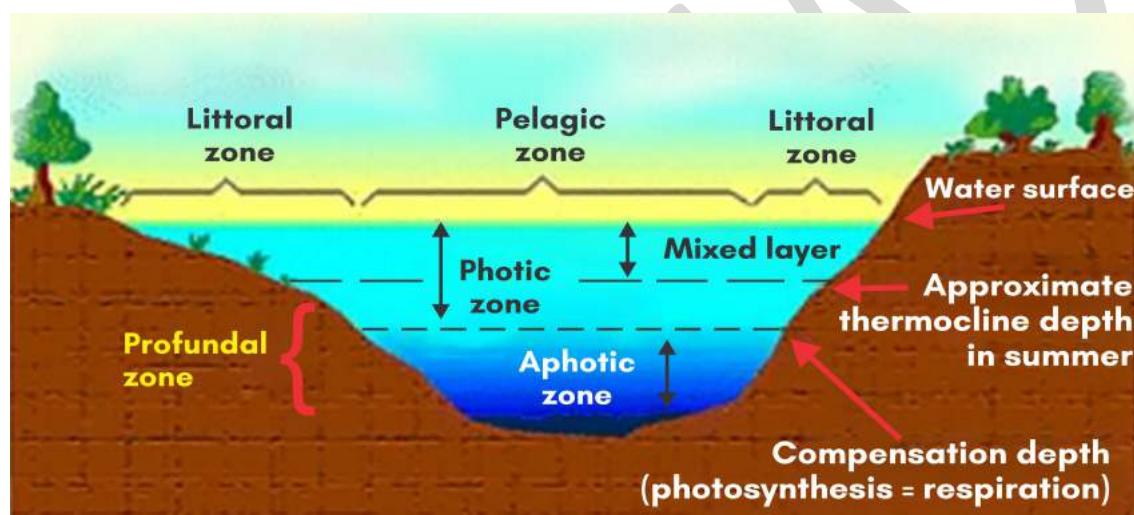
Student Notes:

## 3. Wetlands

### 3.1. Introduction

#### Wetland Ecosystem

- Wetlands are areas of marsh or peat land with water that is static or flowing, fresh, brackish or saline, including areas of marine water the depth of which at low tide does not exceed 6 m.
- Wetlands are **transition zones** (Eco zone) between terrestrial and aquatic ecosystems.
- E.g. Mangroves, lake littorals (marginal areas between highest and lowest water level of the lakes), floodplains (areas lying adjacent to the river channels beyond the natural levees and periodically flooded during high discharge in the river) and other marshy or swampy areas.
- These habitats experience periodic flooding from adjacent deep-water habitats and therefore support plants and animals specifically adapted to such shallow flooding or waterlogging.



- Waterlogged soil adapted plant life (**hydrophytes**), and **hydric soils** (not enough O<sub>2</sub>) are the chief characteristics of wetlands.
- India has over 27,000 wetlands, of which 23,000+ are inland wetlands, and around 4000 are coastal wetlands.
- Wetlands occupy 18.4% of the country's area of which 70% are under **paddy cultivation**.
- Natural wetlands in India range from high altitude wetlands in the Himalayas; flood plains of the major river systems; saline and temporary wetlands of the arid and semi-arid regions; coastal wetlands such as lagoons, backwaters, estuaries, mangroves, swamps and coral reefs, and so on.

### 3.2. Types of Wetlands

Five major wetland types are generally recognized:

- **Marine** - Coastal wetlands including coastal lagoons, rocky shores, and coral reefs.
- **Estuarine** - Including deltas, tidal marshes, and mangrove swamps.
- **Lacustrine** - Wetlands associated with lakes.
- **Riverine** - Wetlands along rivers and streams.
- **Palustrine** - Meaning "marshy" - marshes, swamps and bogs.
- **Human-made wetlands** - such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, sewage farms and canals. Also termed as urban wetland.

**Peat land**

- Peats are a **heterogeneous mixture of plant material** (vascular plants, mosses and humus) that had accumulated in a water-saturated area and are only partially decomposed due to absence of oxygen.
- The natural areas covered by peat are called peatlands. Various types of peat are – swamp forests, fens, bogs or mires.
- They form where climate, bedrock and relief create an area with permanent water saturation i.e. either in shallow water over layers of lake sediments (called terrestrialisation) or directly on mineral soil (called paludification).
- They are **mostly found in permafrost regions** towards the poles and at high altitudes, in coastal areas, beneath tropical rainforest and in boreal forests. Countries with largest peatland areas are – Russia, Canada, Indonesia, USA, Finland etc.
- Recently, Brazzaville Declaration was signed to promote better management and conservation of Cuvette Centrale Region in Congo Basin.
- The declaration has been signed by Democratic Republic of Congo, the Republic of Congo and Indonesia in the backdrop of the **3<sup>rd</sup> Conference of Partners of the Global Peatlands Initiatives (GPI)**, taking place in Brazzaville, Republic of Congo.
- GPI is an initiative by leading experts and institutions to save peatlands as world's largest terrestrial organic carbon stock and to prevent it being emitted.
- Several multilateral conventions take peatland into consideration such as UNFCCC, Ramsar Convention on Wetlands, Convention on Biodiversity and United Nation Convention to Combat Desertification.
- Several multilateral conventions take peatland into consideration such as UNFCCC, Ramsar Convention on Wetlands, Convention on Biodiversity and United Nation Convention to Combat Desertification.

Student Notes:

The theme for World Wetlands Day, 2018 was '**Wetlands for a sustainable urban future**'.

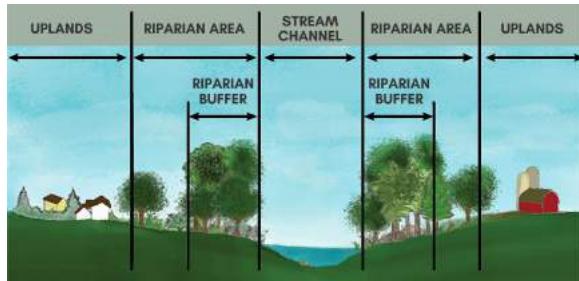
- Urban wetlands are found in and around cities or their suburbs. They include rivers and their floodplains, lakes and swamps as well as coastal variants such as salt marshes, mangroves and coral reefs.
- These wetlands control flooding, filter waste from water, improve air quality and a source of drinking water and provide livelihoods.
- As demand for land increases, the tendency is to encroach on wetlands. About half of world population lives in urban areas today. By 2020 this proportion will reach 66%.

### 3.3. Distinction Between Lake and Wetland

| Characteristic          | Lake  | Wetland (shallow lake)   |
|-------------------------|---|--|
| Origin                  | <ul style="list-style-type: none"> <li>Largest is due to tectonic forces: Fluvial, Geomorphic, increase in the water table, etc.</li> </ul> | <ul style="list-style-type: none"> <li>Mostly Fluvial, Residual lakes</li> </ul> |
| Water turnover          | <ul style="list-style-type: none"> <li>Permanent</li> </ul>   | <ul style="list-style-type: none"> <li>Permanent or Temporary</li> </ul>         |
| Water level changes     | <ul style="list-style-type: none"> <li>Relatively small</li> </ul>  | <ul style="list-style-type: none"> <li>Relatively Large</li> </ul>               |
| Thermal stratification  | <ul style="list-style-type: none"> <li>Yes</li> </ul>   | <ul style="list-style-type: none"> <li>No</li> </ul>                             |
| Vertical mixing         | <ul style="list-style-type: none"> <li>Thermally regulated</li> </ul>   | <ul style="list-style-type: none"> <li>Wind regulated</li> </ul>                 |
| Dominant Producer       | <ul style="list-style-type: none"> <li><b>Phytoplankton</b></li> </ul>  | <ul style="list-style-type: none"> <li><b>Macrophytes</b></li> </ul>             |
| Food chain              | <ul style="list-style-type: none"> <li><b>Grazing Pathway</b></li> </ul>  | <ul style="list-style-type: none"> <li><b>Detritus Pathway</b></li> </ul>        |
| Productivity            | <ul style="list-style-type: none"> <li>Low</li> </ul>   | <ul style="list-style-type: none"> <li>High</li> </ul>                           |
| Trophic status          | <ul style="list-style-type: none"> <li>Oligotrophic</li> </ul>  | <ul style="list-style-type: none"> <li>Mostly Eutrophic</li> </ul>               |
| Functions-Flood control | <ul style="list-style-type: none"> <li>Less Significant</li> </ul>  | <ul style="list-style-type: none"> <li>Significant</li> </ul>                    |
| Waste treatment         | <ul style="list-style-type: none"> <li>No</li> </ul>  | <ul style="list-style-type: none"> <li>Yes</li> </ul>                            |

### 3.4. Importance of Wetlands

- Wetlands are indispensable for the countless benefits or “ecosystem services” that they provide humanity, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation.
- Wetlands are an important resource for **sustainable tourism**.
- Play an important role in flood mitigation by controlling the rate of runoff.
- Buffer (act as a riparian buffer) shorelines against erosion and pollutants.
- They act as a genetic reservoir for various species of plants (especially rice).



## WETLAND BIODIVERSITY MATTERS



### For climate and Biodiversity



- 30% of land-based carbon is stored in peatlands
- Role in flood mitigation by controlling the rate of runoff
- Act as a riparian buffer against erosion and pollutants
- Habitat to aquatic flora and fauna, numerous species of native and **migratory birds**.

### For clean water



- Swamps and reeds remove pollutants
- Water purification, filtration of sediments and nutrients from surface water
- Nutrients recycling, groundwater recharging and stabilisation of local climate.

### For jobs



- One billion people depend on wetlands for their livelihoods

### For economies



- Wetlands provide USD 47 trillion in essential services annually
- Important resource for sustainable tourism.
- Genetic reservoir for various species of plants (especially rice).

### 3.5. Reasons for depletion

- Excessive pollutants** (Industrial effluents, domestic waste, agricultural runoff etc.) are dumped into wetlands beyond the recycling capacity.
- Habitat destruction and deforestation** create ecological imbalance by altering the population of wetland species.
- Conversion of wetlands for agriculture** and encroachments.
- Overfishing and fish farming** (Aquaculture).
- Overgrazing** in marshy soils.
- Removal of sand** from beds near seas makes the wetland vulnerable to wave action and tidal bore.

### 3.6. Mitigation

- Demarcation of wetlands using the latest technology, proper enforcement of laws and stringent punishments for violators.
- Preventing unsustainable aquaculture and cultivation of shellfish.
- Treating industrial effluents and water from farmlands before discharging into wetlands.
- Utilizing wetlands on a sustainable basis by giving enough time for natural regeneration.
- Artificial regeneration for a quick recovery.
- Afforestation, weed control, preventing invasive species is the key to wetland conservation.
- Preventive measures to stop the introduction of exotic invasive species like water hyacinth.
- Soil conservation measures & afforestation.
- Preventing grazing in peripherals of wetlands.
- Wildlife conservation, sustainable tourism, eco-tourism and sensitizing local populace.
- Eutrophication abatement by processing nutrient rich discharge into the water body.
- Involving the local population in the conservation of wetlands.

Student Notes:

### 3.7. Measure to Protect Wetland

#### 3.7.1. Global Conservation Efforts

##### Ramsar Convention

- The Convention came into force in 1975 and is one of the oldest inter-governmental accord for preserving the ecological character of wetlands.
- The Convention's mission is "**the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world**".
- At the centre of the Convention on Wetlands philosophy is the "**wise use**" of wetlands. When they accede to the Convention, Contracting Parties commit to work towards the wise use of all the wetlands and water resources in their territory, through national plans, policies and legislation, management actions and public education.
  - **The Convention defines wise use of wetlands as** "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development"

##### LIST OF RAMSAR SITES IN INDIA

- There are 41 Ramsar sites in India with a surface area of 1,071,861 hectares (as of November 2020).
- Wetlands in India account for 4.7% of the total geographical area.
- **Chilika Lake** is the **largest Ramsar Site** of India with a surface area of 1,16,500 hectares.
- Chilika Lake (Orissa) and Keoladeo National Park (Rajasthan) were recognized as the first Ramsar Sites of India.
- Uttar Pradesh has the largest number of Ramsar Sites in India with 8 Indian Wetlands.
- **Renuka Wetland in Himachal Pradesh** is the **smallest wetland** of India a surface area of 20 hectares.

| Ramsar Sites of India     | Location                   |
|---------------------------|----------------------------|
| Asan Conservation Reserve | Uttarakhand (October 2020) |
| Ashtamudi Wetland         | Kerala                     |
| Beas Conservation Reserve | Punjab                     |
| Bhitarkanika Mangroves    | Odisha                     |
| Bhoj Wetlands             | Madhya Pradesh             |
| Chandra Taal              | Himachal Pradesh           |
| Chilika Lake              | Odisha                     |
| Deepor Beel               | Assam                      |
| East Kolkata Wetlands     | West Bengal                |

|  |                               |
|--|-------------------------------|
| Harike Wetlands                            | Punjab                        |
| Hokera Wetland                             | Jammu and Kashmir             |
| Kabartal Wetland                           | Bihar (October 2020)          |
| Kanjli Wetland                             | Punjab                        |
| Keoladeo Ghana National Park               | Rajasthan                     |
| Keshopur-Miani Community Reserve           | Punjab                        |
| Kolleru Lake                               | Andhra Pradesh                |
| Loktak Lake                                | Manipur                       |
| Lonar Lake                                 | Maharashtra(November 2020)    |
| Nalsarovar Bird Sanctuary                  | Gujarat                       |
| Nandur Madhameshwar                        | Maharashtra                   |
| Nangal Wildlife Sanctuary                  | Punjab                        |
| Nawabganj Bird Sanctuary                   | Uttar Pradesh                 |
| Parvati Agra Bird Sanctuary                | Uttar Pradesh                 |
| Point Calimere Wildlife and Bird Sanctuary | Tamil Nadu                    |
| Pong Dam Lake                              | Himachal Pradesh              |
| Renuka Lake                                | Himachal Pradesh              |
| Ropar Wetland                              | Punjab                        |
| Rudrasagar Lake                            | Tripura                       |
| Saman Bird Sanctuary                       | Uttar Pradesh                 |
| Samaspur Bird Sanctuary                    | Uttar Pradesh                 |
| Sambhar Lake                               | Rajasthan                     |
| Sandi Bird Sanctuary                       | Uttar Pradesh                 |
| Sarsai Nawar Jheel                         | Uttar Pradesh                 |
| Sasthamkotta Lake                          | Kerala                        |
| Sunderbans Wetland                         | West Bengal                   |
| Surinsar- Mansar Lakes                     | Jammu and Kashmir             |
| Sur Sarovar                                | Uttar Pradesh (November 2020) |
| Tsomoriri                                  | Jammu and Kashmir             |
| Upper Ganga River                          | Uttar Pradesh                 |
| Vembanad Kol Wetland                       | Kerala                        |
| Wular Lake                                 | Jammu and Kashmir             |

Student Notes:

- **Montreux Record**

- Montreux Record is a register of wetland sites on the List of Wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.
- **Wetlands of India that are in Montreux Record:** Keoladeo National Park (Rajasthan) and Loktak Lake (Manipur).
- Chilka lake (Odisha) was placed in the record but was later removed from it.

### 3.7.2. Conservation Efforts by India

- **National Plan for Conservation of Aquatic Ecosystems (NPCA):**

- NPCA is a single conservation programme for both wetlands and lakes.
- It is a centrally sponsored scheme, currently being implemented by the Union Ministry of Environment and Forests and Climate Change.
- It was formulated in 2015 by merging of the National Lake Conservation Plan and the National Wetlands Conservation Programme.
- NPCA seeks to promote better synergy and avoid overlap of administrative functions.
- **Nodal authority:** As per the Wetlands Rules, the Wetlands Authority within a state is the nodal authority for all wetland-specific authorities in a state/UT for the enforcement of the rules.
- Prohibited activities:
  - ✓ Setting up any industry and expansion of existing industries,

- ✓ Dumping solid waste or discharge of untreated wastes and effluents from industries and any human settlements, and
- ✓ Encroachment or conversion for non-wetlands uses.
- **Integrated Management Plan:** The guidelines recommend that the state/UT administration prepare a plan for the management of each notified wetland by the respective governments.
- **Penalties:** Undertaking any prohibited or regulated activities beyond the thresholds (defined by the state/UT administration) in the wetlands or its zone of influence, will be deemed violations under the Wetlands Rules. Violation of the Rules will attract penalties as per the Environment (Protection) Act, 1986.

Student Notes:

### **Wetlands (Conservation and Management) Rules, 2017**

#### **Provisions under the rules:**

- **Definition of Wetland:** They are defined as “an area of marsh, fen peatland or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes”.
- **Decentralisation of Power:** Under the new rules, the central government has empowered the states and union territories to identify and manage their wetlands.
- **Constitute State Wetlands Authority** in each State and union territories that will be headed by the State’s environment minister and include a range of government officials. They will determine, the ‘wide use principle,’ that shall govern the management of wetlands.
- **Setting Up National Wetlands Committee:** it will replace Central Wetlands Regulatory Authority (CWRA), to monitor implementation of these rules and advise the Central Government on appropriate policies and action programmes for conservation and wise use of wetlands
- **The rules prohibit** solid waste dumping, discharge of untreated waste and effluents from industries, cities, towns, villages, and other human settlements into wetlands.
- **Banned activities:** Certain activities are banned in notified wetland like setting up of industries, dumping of solid, electronic, hazardous and construction wastes, poaching of animals, conversion of wetland area into non-wetland purposes, encroachment and even construction of any permanent structure will also be banned at the notified wetlands.

#### **ISSUES WITH THE RULE**

- **Diluted definition:** The 2010 rules and even the 2016 draft rules covered all wetlands, including man-made wetlands other than river channels and paddy fields. The new rules, however, exclude human-made water bodies and tanks specifically built for drinking water purposes and structures constructed for aquaculture, salt production, recreation and irrigation. Thus, the rules fail to cover 9.7 million hectares or 65% of the total area identified as wetlands.
- **Abuse of rule:** Provisions like “central government may consider proposals from the state government or union territory administration for omitting any of the (prohibited) activities on the recommendation of the authority” in the new rules can be misused.
- **Process of appeal against the decisions of wetland authorities:** According to the 2010 rules, anyone aggrieved with the CWRA’s decisions could have filed an appeal with the National Green Tribunal, but the new 2017 rules are silent on the appeal process.
- Subjective definition of “wise use” (Wise use is defined as the principle of sustainable uses that is compatible with conservation) which is to be determined by the state wetland authority.
- **Poor record of States:** The onus of identification and notification of wetlands has been passed on to states, which have virtually never acted on wetlands protection in the past and have been lax in implementing the old rules.

- Applicability of rules:** These rules shall apply to the following wetlands or wetlands complexes, namely: Wetlands categorised as 'wetlands of international importance' under the Ramsar Convention
- Wetlands as notified by the Central Government, State Government and Union Territory Administration.

Student Notes:

### 3.8. UPSC Previous Years Questions

#### Mains

- Discuss the wetlands and their role in ecological conservation in India. (10 MARKS)(2009)
- List any eight 'Ramsar' wetland sites located in India. What is the 'Montreux Record' and what Indian sites are included in this Record? (2011)(12 marks)
- What is wetland? Explain the Ramsar concept of 'wise use' in the context of wetland conservation. Cite two examples of Ramsar sites from India.(2018)(10 marks)

#### Prelims

- If a wetland of international importance is brought under the 'Montreux Record', what does it imply? (2014)
  - Changes in ecological character have occurred, are occurring or are likely to occur in the wetland as a result of human interference.
  - The country in which the wetland is located should enact a law to prohibit any human activity within five kilo metres from the edge of the wetland
  - The survival of the wetland depends on the cultural practices and traditions of certain communities living in its vicinity and therefore the cultural diversity therein should not be destroyed
  - It is given the status of 'World Heritage Site'

#### Solutions: (A)

- In which one among the following categories of protected areas in India are local people not allowed to collect and use the biomass?(2012)
 

|   |                          |
|---|--------------------------|
| (a) Biosphere Reserves                        | (b) National Parks       |
| (c) Wetlands declared under Ramsar Convention | (d) Wildlife Sanctuaries |

#### Solution: (B)

- With reference to the wetlands of India, consider the following statements :(2012)
  - The country's total geographical area under the category of wetlands is recorded more in Gujarat as compared to other States.
  - In India, the total geographical area of coastal wetlands larger than that of wetlands.

Which of the statements given above is/are correct?

|            |            |                  |                     |
|------------|------------|------------------|---------------------|
| (a) 1 only | (b) 2 only | (c) Both 1 and 2 | (d) Neither 1 nor 2 |
|------------|------------|------------------|---------------------|

#### Solution: (A)

- Wetland locations

##### Wetlands

- Harike wetland
- Keolado Ganga National Park
- Kolleru Lake

##### Confluence of rivers

- |                   |
|-------------------|
| Beas and Satluj   |
| Banas and Chambal |
| Musi and Krishna  |

Which of the above pairs is/are correctly matched? (2014)

- |            |                  |                  |                |
|------------|------------------|------------------|----------------|
| (a) 1 only | (b) 2 and 3 only | (c) 1 and 3 only | (d) 1, 2 and 3 |
|------------|------------------|------------------|----------------|

#### Solution: (A)

- With reference to a conservation organization called 'Wetlands International', which of the following statements is/are correct?(2015)
  - It is an intergovernmental organization formed by the countries which are signatories to Ramsar Convention.
  - It works at the field level to develop and mobilize knowledge, and use the practical experience to advocate for better policies.

Select the correct answer using the code given below.

- |            |            |                  |                     |
|------------|------------|------------------|---------------------|
| (a) 1 only | (b) 2 only | (c) Both 1 and 2 | (d) Neither 1 nor 2 |
|------------|------------|------------------|---------------------|

#### Solution (B)

### 3.9. Vision IAS Previous Year Test Series Questions

Student Notes:

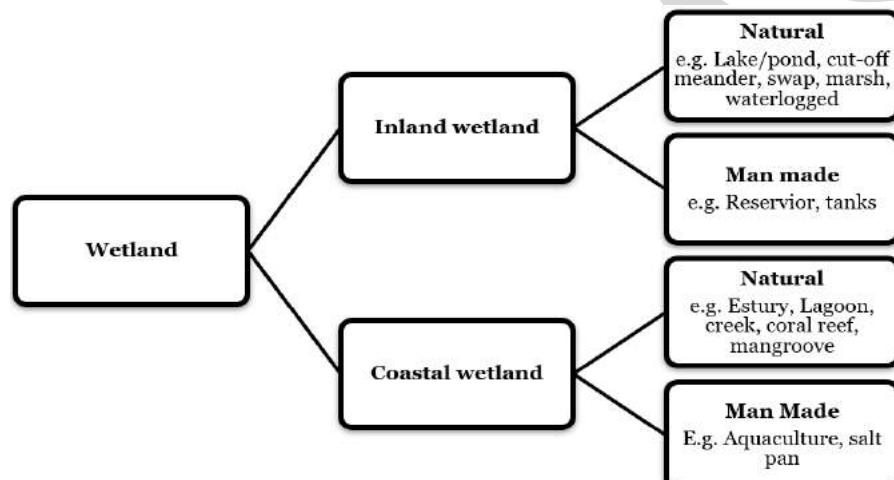
1. **What are Wetland Ecosystems? What are the functions performed by them in maintaining the ecosystem of an area? What are the reasons responsible for decrease in their size?**

#### Approach:

Define wetlands and then mention about types of wetlands in brief. Thereafter, write role played by them in protecting environment and then reasons for their destruction. Also mention some measures to protect them in conclusion.

#### Answer:

**Wetland:** A land area whose soil get saturated with the moisture either permanently or temporarily is called wet land. They can also be defined as **eco-tone** that transit between water bodies and dry land. Wet lands are the land with hydric soil. They include lake littorals, floodplains, bogs and mangroves.



#### Functions:

- filtration of nutrients and sediments from surface water
- nutrient recycling
- water purification
- flood mitigation
- maintenance of stream flow
- support unique biodiversity
- Ground water recharging
- Control rate of runoff of soil
- Buffer shorelines
- Recreation
- Stabilize local climate
- Genetic reservoir of species(rice)

#### Reasons for destruction:

- Conversion of land into other uses agriculture, industries
- Overgrazing
- Removal of sands from beds
- Aqua-culture
- Pollution, agriculture runoff, industrial effluents
- Habitat destruction and deforestation
- Climate change

2. ***Wetlands provide ecosystem services essential to people and the environment, valued at billions of dollars. Explain briefly. Enumerate the causes for wetland losses across India. Further, elaborate on some international and national measures taken to protect them.***

Student Notes:

**Approach:**

Students should follow linear approach while answering this question. Answer should be divided into three parts. In first, give example of Wetland's role in ecosystem services. In 2<sup>nd</sup> part enlist the causes for loss of wetland in India. In 3<sup>rd</sup> part explain initiatives like Ramsar Convention at international level and national legislations along with conservation initiatives. Conclude with futuristic note about success of conservation efforts.

**Answer:**

The Millennium Ecosystem Assessment (2005) study estimated that wetlands cover 7% of the earth's surface and deliver 45% of its natural productivity and ecosystem services. Globally, 1.5-3 billion people depend on wetlands as a source of drinking water as well as food and livelihood security. Wetlands perform numerous functions beneficial for man and environment as follows.

Functions to Environment and Man –:

- **Disaster mitigation**-The most significant social and economic benefit that wetlands provide is flood control. Peatlands and wet grasslands alongside river basins can act like sponges, absorbing rainfall and controlling its flow into streams and rivers. Coastal wetlands – such as reefs, mangroves and saltmarshes – act as frontline defences against potential devastation during disasters.
- Wetlands act as the **Earth's filters**, cleaning up water in a number of ways. For example Wetlands remove pollutants such as phosphorous, heavy metals and toxins which are trapped in the sediments of the wetlands.
- **Cultural value** Throughout history humans have gathered around wetlands and these areas have played an important part in human development and are of significant religious, historical or archaeological value to many cultures around the world.
- **Vital habitat**- It has been estimated that freshwater wetlands hold more than 40% of all the world's species and 12% of all animal species. Individual wetlands can be extremely important in supporting high numbers of endemic species.

Causes for loss of Wetlands in India

- Natural Causes- Sedimentation, floods, storms, sea level rise and biotic effects e.g. excessive sediment inflow into Chilka has become greatest concern for the lake. It has potential to destroy the peculiar ecosystem
- Human causes- Agricultural Activities and related discharge. Hydrological alteration by construction of dams, channelization for navigation and ground water abstraction. Pollution -waste disposal, mining for minerals, dumping and pesticides. Settlement and infrastructure development e.g. Pulicat Lake, India's second largest lagoon bordering Andhra Pradesh and Tamil Nadu, is threatened by the Dugarajapatnam port project. Kolleru Lake, the largest freshwater lake in India is under serious anthropogenic pressure. Drains from surrounding area are threatening its existence.

Measures for protection-

- International – The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty. Wetlands international global non-profit organization for sustaining and restoring wetlands. World wetlands Day, Montreux Record etc.

- National – National Wetlands Conservation Program (NWCP). Government of India in closed collaboration with concerned State Government. Under the programme 115 wetlands have been identified till now by the Ministry, which requires urgent conservation and management initiatives. National lake conservation plan was carved out to focus on lakes particularly in urban areas
- Formulation of Management Action Plan by states to define objectives taking into consideration factors responsible for degradation of the wetland
- National Environment Policy (2006), which identifies 6 fold action to conserve wetlands.

The role of the wetlands is critical in socio-economic and aesthetic well being of man. They are critical factor in environment resilience to sudden distress. We must preserve these ecosystems to secure future of the biosphere.

**3. What are wetlands and how are they different from lakes? Why are wetlands considered ecologically important? Critically examine the Draft Wetland Rules 2016.**

**Approach:**

- Define wetlands and bring out their difference with lakes.
- Then bring out ecological importance of the wetlands.
- Examine the pros and cons of the draft Wetland Rules 2016.

**Answer:**

A **wetland** is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. A lake is a body of relatively still liquid of considerable size, localized in a basin, that is surrounded by land apart from a river or other outlet that serves to feed or drain the lake. Lake has more depth of water than wetland.

**Ecological Importance of wetlands:**

**1. Water Purification**

Wetlands protect water quality by trapping sediments and retaining excess nutrients and other pollutants such as heavy metals.

**2. Flood Protection**

Wetlands hold excess runoff after a storm, and then release it slowly. Wetland soil acts as a sponge, holding much more water than other soil types.

**3. Shoreline Stabilization**

Wetlands that occur along the shoreline of lakes or along banks of rivers and streams help protect shoreline soils from erosive forces of waves and currents.

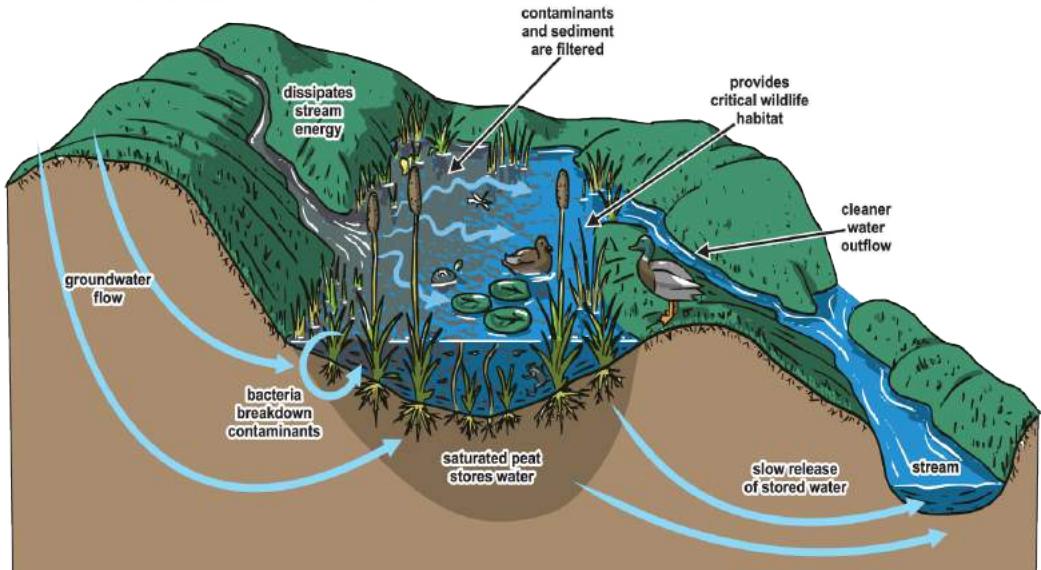
**4. Groundwater Recharge and Streamflow Maintenance**

Aquifers and groundwater are recharged or replenished with water by precipitation that seeps into ground and by surface waters. Those wetlands connected to groundwater systems or aquifers are important areas for groundwater exchange.

**5. Fish and Wildlife Habitat**

Many species of birds, fish, mammals, reptiles, and amphibians rely on wetland habitat for breeding, foraging, and cover. Wetland conditions provide unique habitat for species..

## How wetlands work



Student Notes:

The Draft Wetland (Conservation and Management) Rules, 2016, seek to replace the Rules of 2010.

### Critical examination of Draft Wetland Rules 2016

#### Why new Rules: Because of ineffective implementation of 2010 rules.

##### Positives:

- Seeks to decentralize wetlands management to states, with Centre intervening only in “exceptional cases”.
- It restricts activities like reclamation of wetlands, and conversion for non-wetland uses, any diversion or impediment to natural water inflows and outflows of the wetland and any activity having or likely to have an adverse impact on ecological character of the wetland.

##### Negatives:

- Entirely Dismantles Central Wetland Authority. There is no role for Centre to play in wetland conservation or protection except in special cases. All states shall set up state wetlands authority (SWA) entrusted with affairs related to wetland conservation, regulation and management.
- No role for local communities or non-governmental members in the State Wetland Authorities
- Criteria for wetland identification left to states. No mention of wetlands on the basis of their uses, size, ecological importance, and heritage sites, etc.
- No criteria about minimum and maximum areas of Wetlands that state has to notify.
- No mention of Wetlands of National Importance
- Does away with EIA.
- No mention of how Ramsar Wetlands would be governed.
- No mention of Interstate and Transboundary wetlands and how these would be governed and by whom.
- No guidelines about activities that should be Prohibited or even Regulated in the Wetlands by States.
- SWA does not have Powers to prohibit any activity in the Wetlands, only regulate them.
- SWA does not have any authority to take Penal Action against parties who violate Rules.

- It is not clear which department will be coordinating these activities. Earlier it was Forest Department.
- The provision of Appeal against Decision of Authority in NGTAs in 2010 rules is missing.
- Chief Minister, is also head of SWA, which can cause conflict of interest.
- 2010 Rules had timelines from notification to other stages; no timeline now.

Student Notes:

Thus, the new draft rules significantly weaken the wetlands conservation and protection. It needs a relook and the precious ecosystem should not be sacrificed at altar of development at any cost.

**4. *Highlight the significance of wetland ecosystems, particularly in the urban areas. Also mention the steps that are being taken by the government for integrated management of wetland ecosystems.***

**Approach:**

- Briefly provide an introduction about wetlands.
- Discuss their significance for urban areas.
- Steps taken by government for their management holistically.

**Answer:**

Wetlands are unique, productive ecosystems where terrestrial and aquatic habitats meet. Wetlands play a critical role in maintaining many natural cycles and supporting a wide range of biodiversity.

**Significance of wetlands ecosystem**

- **Water services** - Wetlands are particularly important providers of **all water-related ecosystem services**. They regulate water quantity, groundwater recharge, regulating floods and the impacts of storms which has become immensely important due to increasing concretization in urban areas.
- **Ecological services** – With respect to climate change adaptation and mitigation, wetlands can play an important role.
- **Carbon Sequestration**: Wetlands act as carbon sinks for CO<sub>2</sub> and other greenhouse gases especially if their vegetation is protected and their natural processes are maintained.
- **Reducing pressure on land** - Wetlands also help in erosion control and sediment transport, thereby contributing to land formation and increasing resilience to storms.
- **Reservoir of Biodiversity** - Wetlands are productive areas for plant life, animals and wetland agriculture. Compared to many other ecosystems, wetlands are one of the most productive habitats in the world. They provide spawning grounds for fish and ideal conditions for species group such as amphibians.
- **Food security** - Wetlands are an important source of food such as rice paddy systems, fish etc. The entire production of inland capture fisheries and most coastal fisheries is derived from wetlands.
- **Recreational and cultural** - Wetlands have high recreational, historical, scientific, and cultural values. Wetlands play an important part in human development. They are also useful for recreational activities such as hiking, fishing, bird watching, photography and hunting.

Apart from the above factors, wetlands provide multiple **benefits to cities and urban areas** in the following way:

- Wetlands act as filters and help reduce the urban waste water and help prevent eutrophication in lakes and streams.

- The capacity of a functional urban wetland in flood control is also very important.

Student Notes:

Government has taken following steps for integrated management of wetland ecosystems:

- **Scheme of National Wetlands Conservation Programme (NWCP)** –It aims at holistic conservation of lakes and wetlands. It is operational on cost sharing basis between the Central and State Governments.
- **Financial assistance** has been provided to the State Governments/Union Territories for undertaking wetland conservation activities like survey & demarcation, catchment area treatment, desilting & dredging, bio-fencing, fisheries development, weed control, biodiversity conservation, pollution abatement, education & awareness and community participation etc.
- **Advising state governments** for giving high priority for constitution of State wetland/ lake authorities, identification and notification of priority wetlands including delineation of their boundaries, development of integrated management plans, securing resources for implementation of management plans, monitoring and evaluation, strengthening research-management interface, etc.
- India is a signatory of Ramsar convention on wetlands of international importance for the conservation and sustainable use of wetlands. There are 26 ramsar sites in India and government takes special care for these sites.

5. ***Wetlands are being lost rapidly due to encroachment and rapid urbanization. In this context, critically analyse the provisions of the new Wetland (Conservation and Management) Rules 2017 notified by the Government in dealing with the situation.***

**Approach:**

- Start with the basic definition of Wetlands.
- Then giving a brief picture of wetlands in India, bring out some reasons for their loss.
- Finally, analyse the provisions of the New Wetland Rules, 2017 in dealing with the situation.

**Answer:**

Wetlands can be defined as lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water. They support rich biodiversity and provide wide range of ecosystem service such as water purification, flood mitigation etc.

Of late, wetlands are threatened due to encroachment, rapid urbanization and activities like pollution, hydrological alteration, over-exploitation etc. In this context, the Government has come out with new Wetland (Conservation and Management) Rules, 2017.

**Features of the new rules**

- Setting up of National Wetlands Committee (NWC), headed by MoEFCC secretary, to monitor implementation of these rules and oversee works carried out by states and to advise Central Government.
- Setting up of State Wetland Authorities in each state/ UTs headed by State's Environment Minister which will develop comprehensive list of activities to be regulated and permitted within notified wetland and their zone of influence. It will also define strategies for 'wise-use' of wetlands and its conservation
- Prohibition of activities like conversion of wetland for non-wetland uses including encroachment of any kind, setting up and expansion of industries, waste dumping

and discharge of untreated wastes and effluents from industries, cities, towns, village etc.

Student Notes:

Mandatory preparation of a list of all wetlands and list of wetlands to be notified within six months by state authorities. Based on it, a comprehensive digital inventory of all wetlands will be created and updated every ten years. However, there are some shortcomings sighted by environmentalist and therefore, they are apprehensive about the effectiveness of the new rules-

- They are silent on the process of appeal against the decision of wetlands authorities.
- The term “wise use” to be determined by the state wetland authority is open to wider interpretation and may be misused.
- 2010 and 2016 rules covered all wetlands including man-made wetlands other than river channels and paddy fields. The new rules exclude human-made water bodies and structures constructed for aquaculture, salt production etc.
- Passing of identification and notification of wetlands to the states have been criticised on the grounds that they have a poor record of their conservation in the past.

Nevertheless, the new rules have tried to decentralize the responsibilities by setting up of state wetland authority. It will also increase expertise in this area as this authority will involve one expert each in the field of wetland ecology, hydrology, fisheries etc. It may also enhance the conservation work at local level.

#### **6. *What are wetlands? Accounting for the reasons behind the disappearance of wetlands, suggest some measures which can be taken for their effective conservation.***

**Approach:**

- Introduce by giving the definition of wetlands.
- Enumerate the causes behind the disappearance of wetlands.
- Suggest measures that can be taken for their conservation.
- Conclude on the basis of the above points.

**Answer:**

The Ramsar International Wetland Conservation treaty defines wetlands as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.”

Wetlands are highly productive and support large biological diversity. They also provide services such as water purification, flood mitigation, erosion control, ground water recharge, microclimate regulation etc. However, they are one of the most threatened habitats of the country and are disappearing at the rate of 2-3 percent per year.

**Following are the reasons behind the disappearance of wetlands:**

- **Encroachment of wetlands:** Due to unplanned urbanization, expansion of industries, road construction, construction of reservoirs and canal, sand mining etc., wetlands have been drained and transformed. This results in substantial economic and ecological losses in the long term.
- **Deforestation:** Removal of trees in the catchment leads to soil erosion and siltation, thereby altering the wetland ecosystem.
- **Pollution:** Unrestricted dumping of pollutants such as sewage and toxic chemicals from industries has polluted many freshwater wetlands.

- **Salinization:** Over withdrawal of groundwater leads to salinization, which further leads to degradation of wetlands and endangers wetland species.
- **Aquaculture:** Demand for shrimps and fishes have provided economic incentives for converting wetlands and mangrove forests into aquaculture ponds.
- **Introduction of new species:** Wetlands are threatened by the introduction of exotic plant species such as water hyacinth and salvinia, which clog waterways and compete with native vegetation.
- **Climate change:** Increased temperature, shifts in precipitation, increased frequency of floods, sea level rise etc. also affect wetlands.

Student Notes:

**Following measures can be taken for effective conservation of wetlands:**

- **Identification of wetlands:** There is a need for scientific criteria for identifying wetlands. Establishment of an independent authority can help in this regard.
- **Creation of data bank on wetlands:** Various methods apart from identified Ramsar sites can be used to create a data bank on wetlands. For example, the Maharashtra Environment Department created a mobile application to create a database on all the wetlands in the state. This can be expanded on an all-India basis. Similarly, National Wetlands Atlas prepared by ISRO identified a total of 201,503 wetlands covering 14.7 million hectares across the country.
- **Collaboration with institutions:** The government can collaborate with organizations like the Wetlands International, which works to sustain and restore wetlands and their resources.
- **Use of technology:** Application of technologies such as satellite-based remote sensors, GIS tools etc. can aid in effective management and monitoring of wetlands.
- **Multi-stakeholder participation:** This can be done by the involvement of local community members, trained academicians, ecologists, hydrologists etc. for the overall management of wetlands. Also, management of wetlands has to be an integrated approach in terms of planning, execution and monitoring.
- **Spreading awareness:** It can be done by initiating educational programmes about the importance of wetlands in schools and colleges, among the general public in the vicinity of the water bodies etc.

The jurisdiction over wetlands is diffused and falls under various departments like agriculture, revenue, tourism etc. The need of the hour is to formulate a comprehensive and integrated wetland policy with a defined jurisdiction to safeguard the wetlands from further deterioration. Further, initiatives like the National Wetlands Conservation Programme, Wetlands (Conservation and Management) Rules, 2010 etc. that help in protection, planning, managing and monitoring of wetlands should be implemented in a stringent manner.

# CHAPTER - 4 - MANGROVES

Student Notes:

## 4. Mangroves

### 4.1. Introduction

- Mangroves are shrubs or small trees that grow in coastal saline or brackish water.
- Mangroves represent a characteristic littoral (near the seashore) forest ecosystem.
- These are mostly evergreen forests that grow in sheltered low lying coasts, estuaries, mudflats, tidal creeks backwaters (coastal waters held back on land), marshes and lagoons of tropical and subtropical regions.
- Mangroves grow **below the high water level of spring tides**.
- The best locations are where abundant silt is brought down by rivers or on the backshore of accreting sandy beaches.
- Mangroves are **highly productive ecosystems**, and the trees may vary in height from 8 to 20 m. They protect the shoreline from the effect of cyclones and tsunamis.
- They are breeding and spawning ground for many commercially important fishes.
- Since mangroves are located between the land and sea, they represent the best example of **Ecotone**.

### 4.2. Characteristics of Mangrove Vegetation

- Mangroves are salt tolerant trees, also called **halophytes**, and are adapted to harsh coastal conditions.
- Mangrove vegetation **facilitates more water loss**. Leaves are thick and contain salt-secreting glands. Some block absorption of salt at their roots itself.
- They contain a complex salt filtration system and complex root system to cope with salt water immersion and wave action.
- They are adapted to the **low oxygen (anoxic)** conditions of waterlogged mud.
- They produce **pneumatophores (blind roots)** to overcome the respiration problem in the **anaerobic soil** conditions.
- They require **high solar radiation** to filter saline water through their roots. This explains why mangroves are confined to only tropical and sub-tropical coastal waters.
- Mangroves occur in a variety of configurations. Some species (e.g. **Rhizophora**) send arching prop roots down into the water.
- While other (e.g. **Avicenna**) stands vertical "Pneumatophores" or air roots up from the mud.
- In size, mangroves range from bushy stands of dwarf mangroves found in Gulf of Kutch, to taller stands found in the Sunderbans.
- On the Andaman & Nicobar Islands, the small tidal estuaries and the lagoons support a dense and diverse undisturbed mangrove flora.
- Adventitious roots which emerged from the main trunk of a tree above ground level are called **stilt roots**.



*Prop roots and pneumatophores*

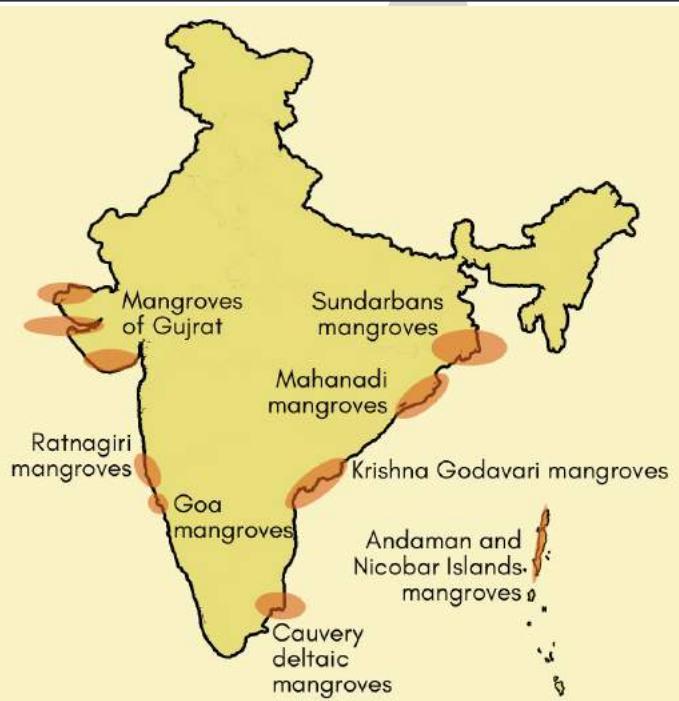
- Mangroves exhibit **Viviparity mode of reproduction**, i.e. seeds germinate in the tree itself (before falling to the ground).
- This is an **adaptive mechanism** to overcome the problem of germination in saline water.



Stilt roots

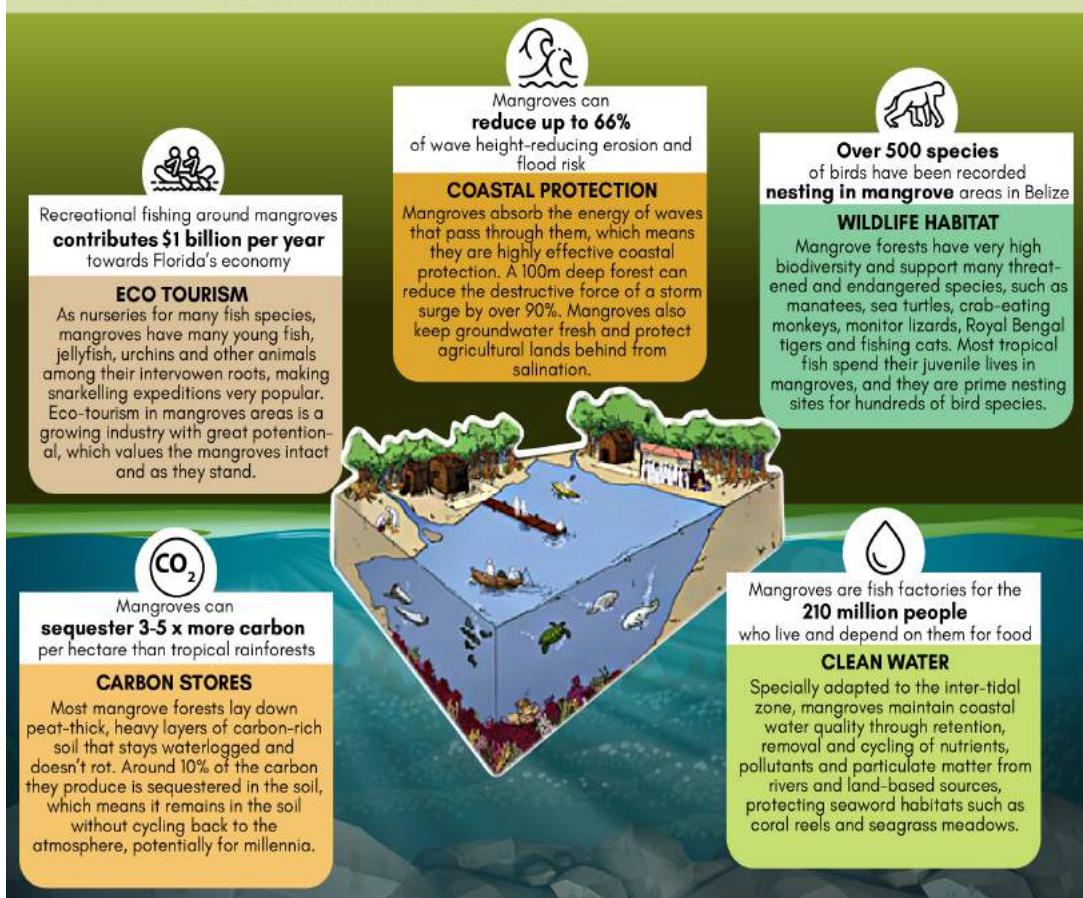
### 4.3. Mangroves in India

- Mangroves occur worldwide in the **tropics and subtropics**, mainly between latitudes 25° N and 25° S.
- The mangroves of **Sundarbans** are the largest single block of tidal halophytic mangroves of the world.
  - This mangrove forest is famous for the Royal Bengal Tiger and crocodiles.
- The mangroves of **Bhitarkanika (Orissa)**, which is the second largest in the Indian sub-continent, harbors high concentration of typical mangrove species and high genetic diversity.
- Mangrove swamps also occur in profusion in the intertidal mudflats on both side of the creeks in the Godavari-Krishna deltaic regions of Andhra Pradesh.
- Mangroves of **Pichavaram and Vedaranyam** (Tamil Nadu) are degraded mainly due to the construction of aquaculture ponds and salt pans.
- On the west coast of India, mangroves, mostly scrubby and degraded occur along the intertidal region of estuaries and creeks in Maharashtra, Goa and Karnataka.
- The mangrove vegetation in the coastal zone of Kerala is very sparse and thin.
- In **Gujarat (north-west coast)** mangroves Avicennia marine, Avicennia officinalis and Rhizophora mucronata are found mainly in **Gulf of Kutch and the Kori creek**.
- The condition of the mangroves is improving especially in the Kori creek region, which is a paleodelta of the Indus river (once upon a time it was part of Indus delta).



# Mangrove Services

Ecosystem services are the benefits people obtain from ecosystems. Ecosystem services can be grouped in four broad categories: provisioning, such as the production of food and water; regulating, such as disaster risk reduction (DRR) and control of disease; supporting, such as nutrient cycling and water purification; and cultural, such as spiritual and recreational benefits. To help inform decision makers many ecosystem services are being assigned economic values.



## 4.5. Threats to Mangroves

Climate change may reduce global mangrove area by 10-15%, but it is a long term, less significant threat to the current 1-2% annual loss from human activities.

- Natural threats:**
  - Cyclones, typhoons and strong wave actions.
  - Trampling and over grazing by wildlife and livestock close to mangrove regions.
  - Damage by crabs, oysters and pests to the young seedlings of mangroves.
- Anthropological threats:**
  - Agriculture:** Many thousands of acres of mangrove forest have been destroyed to make way for rice paddies, rubber trees, palm oil plantations, and other forms of agriculture.
  - Coastal Development:** Coastal development takes many forms but as streams and wetlands are filled by roads and concrete, they can no longer process natural chemicals. Worse still, pollutants that accompany development can damage individual trees or whole tracts of mangroves.
  - Shrimp Farming:** By far the greatest threat to the world's mangrove forests is the rapidly expanding shrimp aquaculture industry. Hundreds of thousands of acres of lush wetlands have been cleared to make room for artificial ponds that are densely stocked with shrimp.

- **Charcoal and Lumber Industries:** Chopping down mangroves for charcoal and timber is an important cottage industry for many coastal communities. Mangrove wood is used for building material, fencing, and fuel. It also yields valuable, high-quality charcoal. In places where fishing has declined below subsistence levels, many people have turned to charcoal production for their livelihood, which furthers the cycle of habitat loss and fishery decline.

Student Notes:

## 4.6. Conservation of Mangroves

- **Coastal Regulation Zone Rules** also stresses about regulating construction and haphazard infrastructure development in and around coastal areas, thus protecting mangroves.
- **SMART(Special Monitoring and reporting Tool)** monitoring in the Sundarbans empowers local administration contributing to a more effective management of natural resources.
- The state of **Gujarat** uses direct seed sowing, raised bed plantations, and fishbone channel plantations to restore degraded mangroves.
- State of Andhra Pradesh has established Eco-Development Committees and Van **Samrakshan Samithi** to implement conservation projects in mangrove areas.
- The state of **Maharashtra** has been implementing restoration, protection, regeneration, and maintenance techniques to conserve mangroves.
- **Mangrove for Future Initiative:** Mangroves for the Future (MFF) is a unique partner-led initiative to promote investment in coastal ecosystem conservation for sustainable development.
  - The goal is to promote an integrated ocean-wide approach to coastal management and to building the resilience of ecosystem-dependent coastal communities.
  - Mangroves are the flagship of the initiative, but MFF is inclusive of all types of coastal ecosystem, such as coral reefs, estuaries, lagoons, sandy beaches, seagrass and wetlands.

## 4.7. UPSC Previous Years Questions

### Mains

1. Discuss the causes of depletion of mangroves and explain their importance in maintaining coastal ecology. (2019)
2. What are mangroves and in what way are they useful to us? (2001)

# CHAPTER - 5 - CORALS

Student Notes:

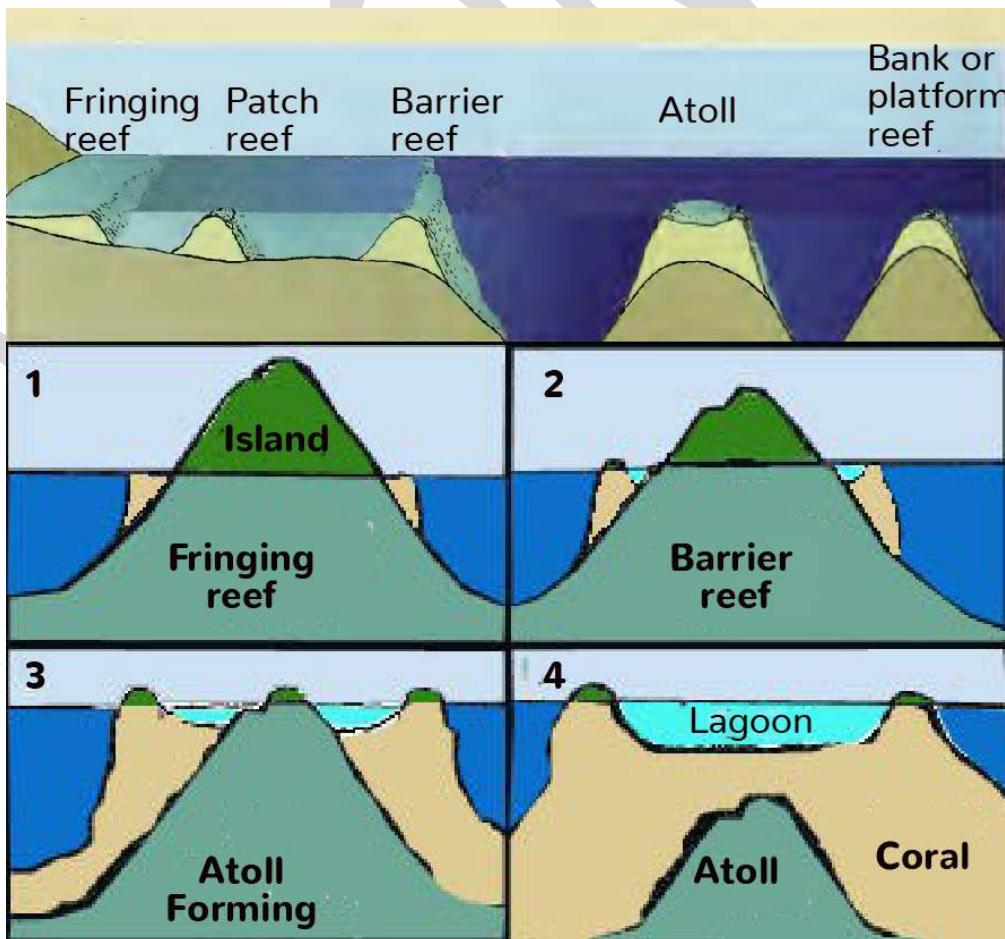
## 5. Corals

### 5.1. Coral Reef

- Coral reefs are built by and made up of thousands of tiny animals—**coral “polyps”**—that are related to **anemones and jellyfish**.
- Polyps are **shallow water organisms** which have a soft body covered by a **calcareous skeleton**. The polyps extract calcium salts from sea water to form these hard skeletons.
- The polyps live in colonies fastened to the rocky sea floor.
- The tubular skeletons grow upwards and outwards as a cemented calcareous rocky mass, collectively called **corals**.
- When the coral polyps die, they shed their skeleton [coral] on which new polyps grow.
- The cycle is repeated for over millions of years leading to accumulation of layers of corals [**shallow rock created by these depositions is called reef**].
- These layers at different stages give rise to various marine landforms. One such important landform is called **coral reef**.
- Coral reefs over a period of time transform or evolve into **coral islands** (e.g. Lakshadweep).
- The corals occur in different forms and colours, depending upon the **nature of salts** or constituents they are made of.
- Small marine plants (**algae**) also deposit calcium carbonate contributing to coral growth.

### 5.2. Coral Reef Relief Features

- Fringing reef, barrier reef and atoll (coral islands are formed on atolls)** are the most important relief features.



### 5.2.1. Fringing Reefs (Shore Reefs)

- Fringing reefs are reefs that **grow directly from a shore**. They are located very **close** to land, and often form a **shallow lagoon** between the beach and the main body of the reef.
- A fringing reef runs as a narrow belt [1-2 km wide]. This type of reef grows from the deep sea bottom with the seaward side sloping steeply into the deep sea. Coral polyps do not extend outwards because of **sudden and large increase in depth**.
- The fringing reef is by far the **most common** of the three major types of coral reefs, with numerous examples in all major regions of coral reef development.
- Fringing reefs can be seen at the New Hebrides Society islands off Australia and off the southern coast of Florida.

#### Lagoon

A lagoon – as used in the context of coral reef typology – refers to a comparatively wide band of water that lies between the shore and the main area of reef development and contains at least some deep portions.

### 5.2.2. Barrier Reefs

- Barrier reefs are **extensive linear reef** complexes that **parallel a shore** and are separated from it by **lagoon**.
- This is the **largest (in size, not distribution)** of the three reefs, runs for hundreds of kilometers and is several kilometers wide. It extends as a broken, irregular ring around the coast or an island, running almost parallel to it.
- Barrier reefs are **far less common** than fringing reefs or atolls, although examples can be found in the tropical Atlantic as well as the Pacific.
- The **1200-mile long Great Barrier Reef** off the NE coast of Australia is the world's largest example of this reef type.
- The GBR is not actually a single reef as the name implies, but rather a very large complex consisting of **many reefs**.

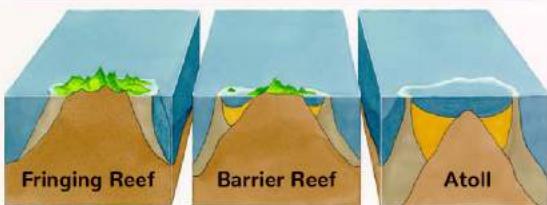
### 5.2.3. Atolls

- An atoll is a roughly circular (annular) oceanic reef system surrounding a large (and **often deep**) **central lagoon**.
- The lagoon has a depth 80-150 meters and may be joined with sea water through a number of channels cutting across the reef.
- Atolls are located at **great distances** from deep sea platforms, where the submarine features may help in formation of atolls, such as a **submerged island or a volcanic cone** which may reach a level suitable for coral growth.
- An atoll may have any one of the following three forms-
  - ✓ **true atoll—a circular reef enclosing a lagoon with no island;**
  - ✓ **an atoll surrounding a lagoon with an island;**
  - ✓ **A coral island or an atoll island which is, in fact, an atoll reef, built by the process of erosion and deposition of waves with island crowns formed on them.**
- Atolls are **far more common in the Pacific** than any other ocean. The **Fiji atoll** and the Funafuti atoll in the Ellice/Island are well known examples of atolls. A large 'number of atolls also occur in the **Lakshadweep Islands**.
- In the South Pacific, most atolls occur in mid-ocean. Examples of this reef type are common in **French Polynesia, the Caroline and Marshall Islands, Micronesia**, and the **Cook Islands**.
- The Indian Ocean also contains numerous atoll formations. Examples are found in the **Maldives** and **Chagos island groups**, the **Seychelles**, and in the **Cocos Island group**.

### 5.3. Development of Major Coral Reef Types

- The basic coral reef classification scheme was first proposed by Charles Darwin, and is still widely used today.
- Darwin theorized that **fringing reefs** began to grow **near the shorelines** of new islands as ecological conditions became ideal for hard coral growth.
- Then, as the island began to gradually **subside** into the sea, the coral was able to keep pace in terms of growth and remained in place at the sea surface, but farther from shore; it was **now a barrier reef**.
- Eventually, the island disappeared below the sea surface, leaving only the ring of coral encircling the central lagoon; **an atoll is formed**.

**The three stages of coral reef formation-fringing, barrier, and atoll**



### 5.4. Importance of Corals

**Coral Reef Ecosystem Services**

Coral reefs provide nearly **\$400 billion a year to millions of people** in economic goods and ecosystem services.

**Tourism & Recreation**  
Coral reefs attract millions of tourists every year, bringing important income to coral reef communities. Some countries derive **more than half of their gross national product** from coral reef industries.

**Medicine**  
Coral reef species are **providing new medical compounds and technology** to treat serious diseases. More than half of all new cancer drug research is focusing on marine organisms.

**Food & Fishing**  
Coral reefs sustain the fish and shellfish populations that **provide protein for 1 billion people**. Reefs are nurseries for many commercially valuable species.

**Coastal Protection**  
Coral reefs act as natural wave barriers that **protect coastal communities and beaches** from storm damage.

**Coral Reefs** are created by many tiny animals called **coral polyps**. The coral polyps' **limestone skeletons** build up over time, forming the base of the complex reef habitat that supports the world's **highest level of marine biodiversity**.

**Coral reefs are found in over 100 countries**

### 5.5. Coral Bleaching

- Coral bleaching happens when corals lose their vibrant colors and turn white. This occurs when coral polyps expel algae that live inside their tissues.
- Bleaching occurs when:**
  - The densities of zooxanthellae decline and/or
  - The concentration of photosynthetic pigments within the zooxanthellae falls. [it is no more useful for the coral and the coral will bleach it]
- When corals bleach they commonly **lose 60-90% of their zooxanthellae** and each zooxanthellae may **lose 50-80% of its photosynthetic pigments**.
- If the **stress-causing** bleaching is not too severe and if it decreases in time, the affected corals usually regain their symbiotic algae within several weeks or a few months.

- If zooxanthellae loss is prolonged, i.e. if the stress continues and depleted zooxanthellae populations do not recover, the coral host eventually dies.
- Disturbances affecting coral reefs include **anthropogenic and natural events**.
- Recent accelerated coral reef decline is related mostly to anthropogenic impacts (**overexploitation, overfishing, increased sedimentation and nutrient overloading**).
- Natural disturbances which cause damage to coral reefs include **violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, sub aerial exposures, predatory outbreaks and epizootics**.
- Coral reef bleaching is a common **stress response** of corals to many of the various disturbances mentioned above.

Student Notes:

### 5.5.1. Natural Causes of Coral Bleaching

- **Temperature**
  - Coral species live within a relatively narrow temperature margin (20-29°C), and **anomalously low and high sea temperatures [corals are absent on the west coast of tropical temperate continents because of the cold currents]** can induce coral bleaching.
  - Bleaching events occur during sudden temperature drops accompanying intense upwelling episodes [El-Nino], seasonal cold-air outbreaks.
  - Most reefs recovered, with low levels of coral deaths, but damage has been severe at places.
  - This is an instance of coral reefs' susceptibility to increased water temperatures combined with **ocean acidification**.
  - While the rising temperatures have increased the frequency and intensity of bleaching, acidification has **reduced corals calcifying ability**.
  - Small temperature increase over many weeks or large increase (3-4 °C) over a few days will result in **coral dysfunction**.
  - Coral bleaching has occurred mostly during the summer seasons or near the end of a protracted warming period.
  - They are reported to have taken place during times of **low wind velocity, clear skies, calm seas and low turbidity**. The conditions favour localised heating and high ultraviolet (UV) radiation.
  - UV radiation readily penetrates clear sea waters. The corals actually contain UV-absorbing compounds which can block potentially damaging UV radiation. But rising temperatures mean reduction in the concentration of these UV absorbing compounds in corals.
- **Sub aerial Exposure**
  - Sudden exposure of reef flat corals to the atmosphere during events such as extreme low tides, ENSO-related sea level drops or tectonic uplift can potentially induce bleaching.
  - The consequent exposure to high or low temperatures, increased solar radiation, desiccation, and sea water dilution by heavy rains could all play a role in zooxanthellae loss, but could also very well lead to coral death.
- **Fresh Water Dilution**
  - Rapid dilution of reef waters from storm-generated precipitation and runoff has been demonstrated to cause coral reef bleaching.
  - Generally, such bleaching events are rare and confined to relatively small, near shore areas.
- **Inorganic Nutrients**
  - Rather than causing coral reef bleaching, an increase in ambient elemental nutrient concentrations (e.g. **ammonia and nitrate**) actually increases zooxanthellae densities 2-3 times.

- Although **eutrophication** is not directly involved in zooxanthellae loss, it could cause secondary adverse effects such as **lowering of coral resistance and greater susceptibility to diseases.**
- Xenobiotic**
  - When corals are exposed to high concentrations of chemical contaminants like copper, herbicides and oil, coral bleaching happens.
- Epizootics**
  - Pathogen induced** bleaching is different from other sorts of bleaching.
  - Most coral diseases cause patchy or whole colony death and sloughing of soft tissues, resulting in a white skeleton (not to be confused with bleached corals).

#### Current Situation of Corals

- Nearly all of the world's major coral reef regions (Caribbean/ western Atlantic, eastern Pacific, central and western Pacific, Indian Ocean, Arabian Gulf, Red Sea) experienced some degree of coral bleaching and mortality during the 1980s.
- Prior to the 1980s, most mass coral mortalities were related to **non-thermal disturbances such as storms, aerial exposures during extreme low tides, and Acanthaster outbreaks.** Coral bleaching accompanied some of the mortality events prior to the 1980s during periods of elevated sea water temperature, but these disturbances were geographically isolated and restricted to particular reefs zones. In contrast, many of the coral bleaching events observed in the 1980s occurred over large geographic regions and at all depths.

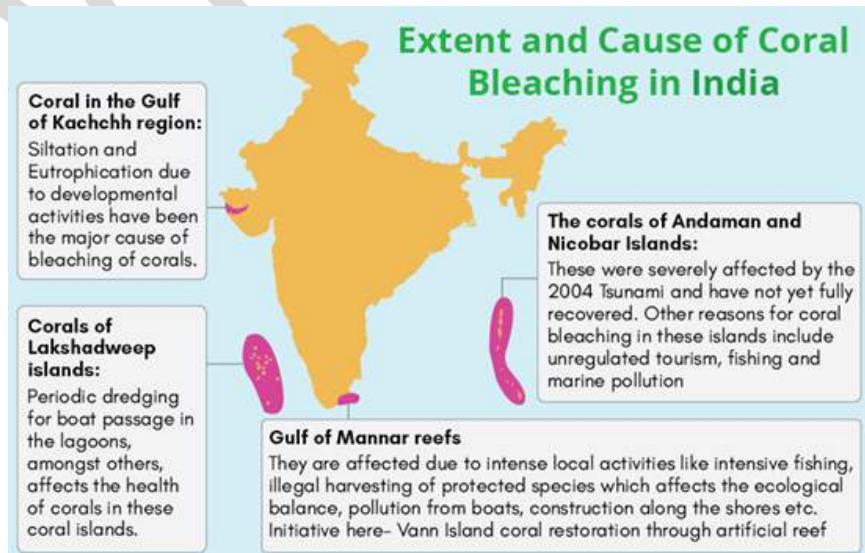
Student Notes:

#### The third global coral bleaching

- The third global coral bleaching is in progress (2015-16) — after events in 1998 and 2010.
- The present one is the longest and most severe so far.
- The longest and most severe **El Niño** ever is the main cause.
- Recent research has revealed that corals that are consistently exposed to low levels of stress may develop some kind of resistance to bleaching.

### 5.5.2 Anthropogenic Cause of Coral Bleaching

- Chemical Pollution:** Increased nutrient concentrations affect corals by promoting phytoplankton growth, which in turn supports increased numbers of organisms that compete with coral for space.
- Increased Sedimentation:** Land clearing and coastal construction result in high rates of erosion and a higher density of suspended silt particles which can
  - smother corals when particles settle out (sedimentation),
  - reducing light availability (turbidity) and
  - Potentially reducing coral photosynthesis and growth.
- Other reasons:** Over-fishing, pollution from agricultural and industrial runoff, coral mining, development of industrial areas near coral ecosystems also adversely impact corals.



## 5.6. Impact of Coral Bleaching

- **Ecological Impacts of bleaching:**
  - Decline in marine species diversity
  - Land masses will be directly exposed to waves leading to a risk of erosion.
  - Changes in coral communities affect the species that depend on them
- **Socioeconomic impacts of bleaching**
  - Degraded coral reefs are not able to provide the ecosystem services on which local human communities depend.
  - Reefs damaged by coral bleaching can quickly lose many of the features that are important for the aesthetic appeal that is fundamental to reef tourism. Thus there is loss of revenue from tourism.
  - It can drive large shifts in fish communities. This results into reduced catches for fishers targeting reef fish species, which in turn impacts food supply and associated economic activities.
  - Coral reefs are a valuable source of pharmaceutical compounds. Degraded and dead reefs are less likely to serve as a source for important medicinal resources.

## 5.7. Global Initiatives

**United Nations Environment Programme (UNEP)** has included coral reef conservation and restoration as an ecosystem based adaptation measure (EBA) for coastal protection.

### 5.7.1. International Coral Reefs Initiative (ICRI)

- The International Coral Reef Initiative (ICRI) is an informal partnership between Nations and organizations which aims to preserve coral reefs and related ecosystems around the world.
- The Initiative was founded in 1994 by eight countries: Australia, France, Japan, Jamaica, the Philippines, Sweden, the United Kingdom, and the United States of America. **India is a member of ICRI.**
- **Main objectives are:**
  - Encourage the adoption of best practice in sustainable management of coral reefs and associated ecosystems
  - Capacity Building
  - Raise awareness at all levels on the plight of coral reefs around the world.
- The ICRI declared 2018 as the third International Year of the Reef (IYOR).

### 5.7.2. Global Coral Reef monitoring network

- It is a network under ICRI which works to provide scientific information and communication on the status of coral reef ecosystems to increase conservation and management for coral reefs

### 5.7.3. International Coral Reef Action Network (ICRAN)

- ICRAN is a strategic **alliance of private and public organizations** that acts worldwide to address the management of coral reef ecosystems and the needs of the communities that depend upon them.
- It operates by sharing and promoting traditional knowledge, current research, and best practices in order to strengthen reef management.

### 5.7.4. Coral Triangle Initiative

- The six governments of the Coral Triangle – Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor Leste have established partnership to conserve coral reefs and the multitude of species and fisheries they support.

## 5.8. Conservation of Coral Reefs in India

Student Notes:

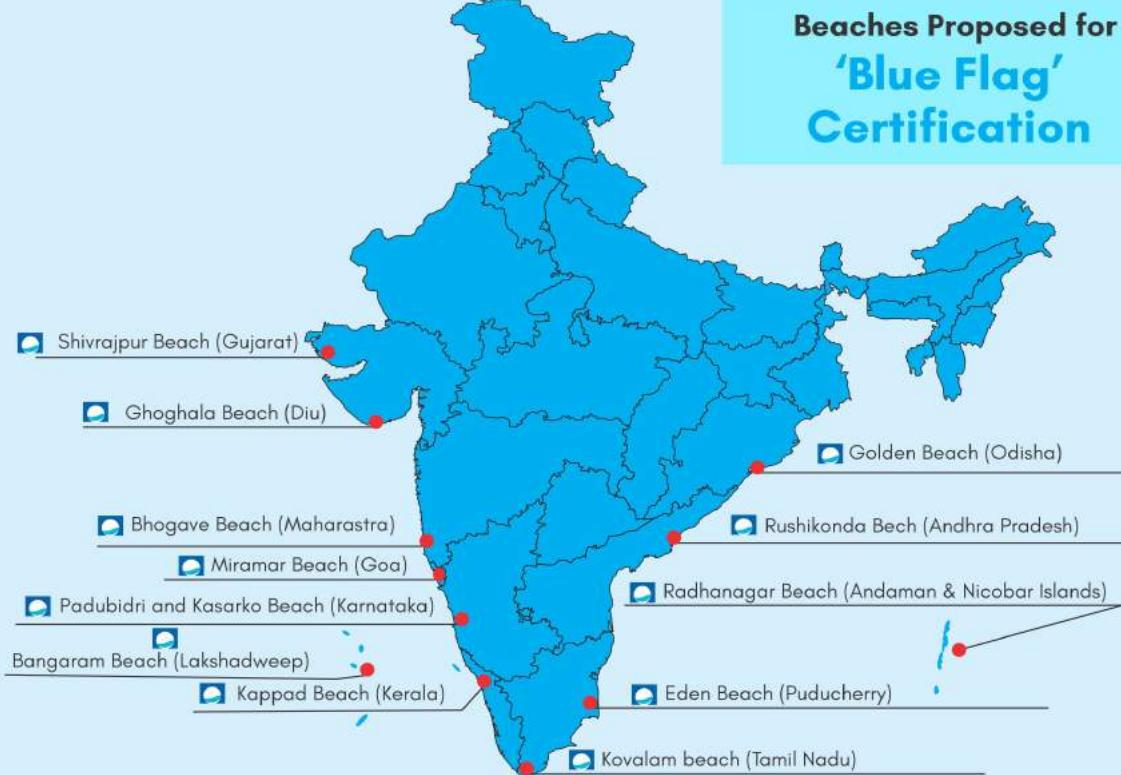
- The protection of coral reef has been stressed under Wildlife Protection Act, 1972 and Environmental Protection Act, 1986 and Coastal Regulation Zone (CRZ). Corals are included in Schedule I of the Wild Life Protection Act, 1972.
- **Coastal Zone Regulation**
  - In India, the CRZ Rules govern human and industrial activity close to the coastline, in order to protect the fragile ecosystems near the sea.
  - They restrict certain kinds of activities — like large constructions, setting up of new industries, storage or disposal of hazardous material, mining, reclamation and bunding — within a certain distance from the coastline.
  - **After the passing of the Environment Protection Act in 1986, CRZ Rules were first framed in 1991.**
  - After these were found to be restrictive, the Centre notified **new Rules in 2011**, which also included exemptions for the construction of the **Navi Mumbai airport** and for projects of the **Department of Atomic Energy**.
  - In **2018, fresh Rules were issued**, which aimed to remove certain restrictions on building, streamlined the clearance process, and aimed to encourage tourism in coastal areas.
  - While the **CRZ Rules are made by the Union environment ministry, implementation is to be ensured by state governments through their Coastal Zone Management Authorities.**
- **Application of Rules.**
  - In all Rules, the regulation zone has been defined as the area up to **500 m** from the **high-tide line**.
  - The restrictions depend on criteria such as the **population of the area, the ecological sensitivity, the distance from the shore, and whether the area had been designated as a natural park or wildlife zone**.
  - The latest Rules have a no-development zone of 20 m for all islands close to the mainland coast, and for all backwater islands in the mainland.
- **Integrated Coastal and Marine Area Management (ICMAM)** also takes up the issue of coral reef habitat destruction
- On the recommendations of the **National Committee on Mangroves and Coral Reefs** following coral reef areas in the country have been identified for intensive conservation and management since 1987:
  - Andaman & Nicobar Islands
  - Lakshadweep Islands
  - Gulf of Kutch (Gujarat)
  - Gulf of Mannar (Tamil Nadu)
- The **Coral Bleaching Alert System (CBAS)** has been initiated **by INCOIS since 2011**. This model uses the satellite derived Sea Surface Temperature (SST) in order to assess the thermal stress accumulated in the coral environs. This information yields in drawing the early signs of the intensity and spatial extents of coral bleaching
- Based on the recommendations of **National Committees on Wetlands, Mangroves and Coral Reefs**, 24 wetland, 33 mangrove and four coral reef areas in the country have been identified by the Ministry for conservation and management
- **National Coral Reef Research Centre** has been established at Port Blair. Database Network and Website on Coral Reefs has also been established.
- **Blue flag Certification of beaches-** Union Ministry of Environment, Forest and Climate Change (MoEFCC) has announced the first time eight beaches of India are recommended for the coveted International eco-label, the Blue flag certification.

### Blue Flag Certification:

- This Certification is accorded by an international agency “Foundation for Environment Education, Denmark” based on 33 stringent criteria in four major heads i.e
  - Environmental Education and Information,
  - Bathing Water Quality,
  - Environment Management and Conservation and
  - Safety and Services on the beaches.
- It started in France in 1985 and has been implemented in Europe since 1987, and in areas outside Europe since 2001 when South Africa joined.
- Japan and South Korea are the only countries in South and southeastern Asia to have Blue Flag beaches.
  - Spain tops the list with 566 such beaches; Greece and France follow with 515 and 395, respectively.

Student Notes:

### Beaches Proposed for 'Blue Flag' Certification



### 5.9. Steps to be taken

- It is important to undertake immediate actions to address climate change under the Paris Agreement's goal of **limiting global average temperature increase to 1.5°C** above pre-industrial temperatures.
- Measures to combat **local stressors causing coral bleaching**:
  - Regulate tourism
  - Check water pollution by treating industrial effluents before discharging them into the sea, reduction is use of chemical fertilizers in farms
  - Ban fishing and harvesting of protected species.
  - Regularly service and maintain fishing vessels so that they cause minimum pollution
  - Regulate construction along the coast
  - Banning of the quarrying of massive corals.
- Coral restoration programs can play an important role in conserving coral reefs. For example, the innovative **Force Blue project** is training retired Special Forces soldiers to transplant endangered coral species

- A recent paper published in Nature argues that there should be focus on strengthening the reefs, to make them immune to pollution (for example through genetic engineering and of restoring reefs by targeting more resilient corals)
- Improved scientific knowledge is required to inform an effective response to threats to coral reefs
- Community awareness and education programmes are required to educate and inform the public, policymakers and other stakeholders of the ecological and socio-economic values of coral reef ecosystems.
- Recommendations of **Task Force on Islands, Coral Reefs, Mangroves and Wetlands (11<sup>th</sup> Five Year Plan 2007-2012)** on empowerment of coastal community and sustainable solutions to be implemented.
- **Bio Rock Technology-** This technology works by passing a small amount of electrical current through electrodes in the water.
  - Bio rock is the name given to the substance formed by **electro accumulation** of minerals dissolved in seawater on steel structures that are lowered onto the sea bed and are connected to a power source, (solar panels that float on the surface of water)
  - When a positively charged anode and negatively charged cathode are placed on the sea floor, with an electric current flowing between them, calcium ions combine with carbonate ions and adhere to the structure (cathode).
  - This results in calcium carbonate formation. Coral larvae adhere to the CaCO<sub>3</sub> and grow quickly.
  - In 2015, a group of ZSI scientists had successfully restored branching coral species (staghorn corals) belonging to the family Acroporidae (Acropora formosa, Acropora humilis, Montipora digitata) that had gone extinct about 10,000 years ago to the **Gulf of Kachchh**.

Student Notes:

## 5.10. UPSC Previous Years Questions

### Mains

1. Assess the impact of global warming on the coral life system with examples.(2019)

### Prelims

1. Which of the following have coral reefs? (2015)

- Andaman and Nicobar Islands
- Gulf of Kutch
- Gulf of Mannar
- Sunderbans

Select the correct answer using the code given below.

- |                     |                   |
|---------------------|-------------------|
| (a) 1, 2 and 3 only | (b) 2 and 4 only  |
| (c) 1 and 3 only    | (d) 1, 2, 3 and 4 |

**Solution: (A)**

2. The scientific view is that the increase in global temperature should not exceed 2 °C above pre-industrial level. If the global temperature increases beyond 3°C above the pre-industrial level, what can be its possible impact/impacts on the world? (2015)

- Terrestrial biosphere tends toward a net carbon source
- Widespread coral mortality will occur.
- All the global wetlands will permanently disappear.
- Cultivation of cereals will not be possible anywhere in the world.

Select the correct answer using the code given below.

- |                     |                   |
|---------------------|-------------------|
| (a) 1 only          | (b) 1 and 2 only  |
| (c) 2, 3 and 4 only | (d) 1, 2, 3 and 4 |

**Solution: (B)**

## 5.11. Vision IAS Previous Years Test Series Questions

Student Notes:

1. Define corals and reefs. Describe the ideal conditions for coral reef formation? Also give an account of distribution of coral reefs in India.

**Approach:**

Questions are very basic and specific in nature. So, specific answers should be provided for each part.

**Answer:**

A **reef** is a strip or ridge of rocks, sand, or coral that rises to or near the surface of a body of water. The best-known reefs are the coral reefs developed through biotic processes dominated by **corals** and calcareous algae.

Corals are **animals**, even though they may exhibit some of the characteristics of plants and are often mistaken for rocks. Corals can exist as individual polyps (a small sea animal that has a body shaped like a tube), or in colonies and communities that contain hundreds to thousands of polyps. Corals are found throughout the oceans, from deep, cold waters to shallow, tropical waters.

Conditions needed for growth of Coral Reefs:

- Shallow coral reefs grow best in **warm water**.
- Reef-building corals prefer **clear and shallow water** with **lots of sunlight**.
- Corals also need **salt water** to survive.
- Other factors influencing coral distribution are *availability of hard-bottom substrate* and the *availability of food* such as plankton.

Coral Reefs in India

The coral reef ecosystems are found in four regions of India which are:

| Region                      | Type of Reef   |
|-----------------------------|----------------|
| Andaman & Nicobar Islands   | Fringing Reefs |
| Gulf of Mannar (Tamil Nadu) | Fringing Reefs |
| Gulf of Kutchh (Gujarat)    | Fringing Reefs |
| Lakshadweep Islands         | Atolls         |

2. *Lakshadweep has been facing a drastic decline in coral cover in recent years. Discuss various environmental and anthropogenic factors behind this phenomenon. How can El Nino be disastrous for the world's coral reefs? Illustrate.*

**Approach:**

Answer can be framed simply in three parts. First, brief introduction of the phenomenon. Second, explanation of underlying factors of coral bleaching. Third, description of effects of El Nino on corals, with examples.

**Answer:**

Lakshadweep is the major area of coral formation in India. Unfortunately it is facing decline in coral reefs as reported that till 2010, the live coral reef cover in the island was recorded at 27 per cent, which dropped to 11 per cent in the subsequent year because of the May 2010 bleaching. This decline is presenting the serious threat to marine ecosystem and livelihood prospects of local community.

The various environmental and anthropogenic factors that are contributing to coral degradation are:

**(i) Environmental**

- Climate change: the rise in sea surface temperature due to El-Nino phenomenon during 1998 caused extensive coral reef bleaching impacting over 40 to 90% of live coral cover.
- Coastal erosion: It is a serious problem faced by the islands every year resulting in loss of land.
- Increasing sedimentation and pollution of water is disturbing the delicate balance of coral and their survival need.

**(ii) Anthropogenic**

- Population pressure: Changing demographic pattern and lifestyle, coupled with resource harvest from the reefs have brought many reefs in the Lakshadweep to various degrees of stress.
- Developmental activities: Overexploitation and mindless mining of coral reef colonies led to degrading of coral reef.
- Coral tourism: Lakshadweep increasingly being promoted as major tourist destination for sea sports like scuba diving. This results in environmental pollution particularly of sea water.

El Nino as an anomaly is not well understood phenomenon but it is cited as major threat to coral by scientists. It raises the sea temperature and sea level disturbing the delicate ecosystem of corals. Further, it is well established that the last big El Niño in 1997/98 caused the worst coral bleaching in recorded history. In total, 16% of the world's coral was lost and some countries like the Maldives lost up to 90% of their reef coverage

**3. Explain the importance of coral reefs as an ecosystem. Why are corals rare along the western coast of the continents?**

**Approach:**

- Briefly introduce what are Coral Reefs.
- Then explain the importance of Coral reefs as an ecosystem. The key word is "ecosystem". Concentrate on the role of Coral reefs as an ecosystem. No need to write everything about Coral reefs.
- Then come to the reason behind absence of Coral reefs on the western coast of the continents.

**Answer:**

Coral reefs are diverse underwater ecosystems formed due to the accumulation and solidification of lime secreting organisms known as Coral Polyps. They are also known as the "tropical rainforests of the sea" for their astounding richness of life.

**Importance of Coral reefs as an ecosystem:**

- Coral reefs support more species per unit area than any other marine environment, including about 4,000 species of fish, 800 species of hard corals and hundreds of other species.
- Coral reefs are the source of nitrogen and other essential nutrients for marine food chains. They also assist in carbon and nitrogen fixing. They help with nutrient recycling.
- As a healthy and diverse ecosystem, Coral reefs helps in recycling and purification of water and air, the creation of soil, and the break-down of pollutants.

- Coral are very important in controlling the amount of carbon dioxide in the ocean water. Coral polyp turns carbon dioxide in the water into a limestone shell. Without coral, the amount of carbon dioxide in the water would rise.
- Coral reefs protect coastlines from the damaging effects of wave action and tropical storms.
- Coral reefs with diverse range of species provide a larger gene pool, giving natural communities survival options when environmental conditions and climates change. The greater the number of species and hence genetic diversity in an ecosystem, the lesser will be the impact of removing individual species.

Corals are rare along the western coast of the continents primarily due to upwelling and strong cold coastal currents that reduce water temperatures in these areas. Coral reefs are very sensitive organisms and grow only in particular conditions. They are usually found in the Tropical seas upto a depth of 200-300 ft where Sun rays reach. The ideal temperature for their growth is 20-25 °C. Both high Salinity and fresh water are harmful for their growth. These ideal conditions required for the growth of Corals are usually absent along the western coast of the continents due to upwelling of cold Currents.

- 4.** *Coral reefs are the most biologically diverse and economically valuable ecosystems on earth. Elaborate. Discuss the factors responsible for the decline of coral reefs across the world. Also, list some measures that have been taken for their preservation.*

**Approach:**

- Introduce the answer by bringing out facts to show that coral reefs are the most biologically diverse and economically valuable.
- Enumerate and analyse the factors responsible for the decline of coral reefs, such as rising temperature, sedimentation etc.
- Enumerate the measures taken to save coral reefs, you should bring measures taken both in India and worldwide. The questions demands measures taken, avoid giving suggestions.

**Answer:**

Coral reefs are some of the most diverse and valuable ecosystems on Earth. Coral reefs support more species per unit area than any other marine environment, including about 4,000 species of fish, 800 species of hard corals and hundreds of other species. They have high productivity and are referred to as 'the Tropical Rainforests of the oceans'.

- Reef building corals lay down the foundation of calcium carbonate which act as home to a wide array of plants and animals.
- Coral ecosystems are a source of food for millions.
- Coral reefs buffer adjacent shorelines from wave action and prevent erosion, property damage and loss of life.
- Healthy reefs contribute to local economies through tourism.
- They provide habitat, spawning and nursery grounds for economically important fish species.
- The coral biodiversity is considered key to finding new medicines for the 21st century.

**Factors responsible for decline:**

- Coral species live within a relatively narrow temperature margin hence low and high sea temperatures can induce coral bleaching.
- When corals are exposed to high concentrations of chemical contaminants or pathogens, coral bleaching happens.

- Increasing demand of fish for food and tourism has resulted in over fishing of not only deep-water commercial fish, but key reef species as well.
- The growth of coastal cities and towns generates a range of threats to nearby coral reefs.
- With increased pollution, Carbon Dioxide is absorbed by Ocean leading to rise in Carbonic acid in water. As Coral has Calcium carbonate as main component, it reacts with Carbonic acid and slowly dissolves down.

Student Notes:

#### **Measures taken for preservation of coral reefs:**

- Chapter 17 of “Agenda 21” specifically addresses the protection and sustainable development of the marine and coastal environment within the context of the United Nations Convention on the Law of the Sea (UNCLOS).
- In 2003, UN-Oceans was created as an inter-agency coordination mechanism on ocean and coastal issues, including coral reefs.
- India has taken steps to protect its coral reefs under Coastal Ocean Monitoring and Prediction system (COMAPS), Land Ocean Interactions in Coastal zones (LOICZ) and Integrated Coastal and Marine Area Management (ICMAM).
- It has notified Coastal Regulation Zones (CRZ) and has setup National Coastal Zone Management Authority and State Coastal Zone Management Authority to protect coral reefs.

5. ***State the conditions that are conducive for the formation of coral reefs. Mention the anthropogenic factors that have resulted in their decline. Also highlight its consequences.***

#### **Approach:**

- Mention the conditions that are conducive for formation of coral reefs.
- State the anthropogenic factors that have resulted in the decline of coral reefs.
- Additionally, list the consequences of decline of coral reefs.

#### **Answer:**

Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures secreted by corals. They are built by colonies of coral polyps found in marine water and are generally classified into Warm and Cold water coral reefs.

#### **Conditions conducive to Warm water/Tropical coral reefs:**

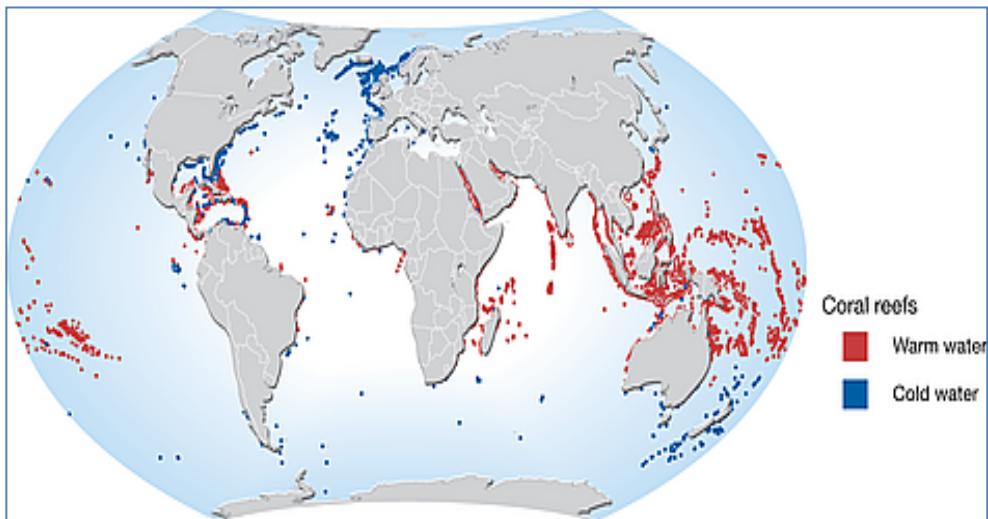
- Water temperature in the range of 22-29 degrees Celsius. Thus, areal distribution of corals is limited to tropical and sub-tropical zones. They will not flourish in areas of cold currents but thrive in warm current regions. Therefore, they are generally absent on western coasts of continents. E.g. Due to the Gulf Stream, corals are found far to the north of West Indies in Atlantic Ocean.
- Depth of water should not exceed 180 feet as the sunlight is too faint for photosynthesis which is essential for survival of microscopic algae on which coral polyps depend. However, there should be plenty of water as polyps cannot survive for too long out of water.
- Water should be salty and free of sediments. Corals are best developed on seaward side of reef, where constantly moving waves, tides and currents maintain an abundant supply of clear, oxygenated water.

#### **Conditions conducive to Cold Water Corals:**

- They are commonly found where current flow is fast.

- They are found on continental shelf, and also in deep-sea areas with topographic highs, such as seamounts, mounds, ridges, and pinnacles.
- They don't have symbiotic algae living in their polyps so don't need sunlight to survive, hence can occur at greater depth.
- Their polyps are bigger hence they can capture food particles from lesser nutrient holding water.

Student Notes:



#### **Anthropogenic factors that have resulted in decline of corals:**

- **Increase in temperature due to climate change and pollution:** Since corals survive in very narrow range of temperature, slight change in temperature can lead to massive decline.
- **Run off from agricultural land and chemical pollution:** Results in eutrophication and subsequent oxygen depletion.
- **Overfishing:** Leads to an average decrease in size of the fish and a reduction in predatory target fish, thus, resulting in large-scale ecosystem change. This affects coral ecosystem.
- **Destructive fishing and boating practices:** Leads to habitat destruction and disintegration of reef ecosystem.
- **Marine Pollution:** Incidents such as increase in sea transport, oil spill etc. destroy coral reefs
- **Uncontrolled tourism activities:** Lead to breakage of coral colonies and leads to tissue damage.
- **Coastal construction and shoreline development:** Results in heavy sedimentation, which can lead to coral reef destruction.
- **Introduction of invasive species** in ocean by humans too lead to change in the coral ecosystem.
- **Coral mining:** Live coral is removed from reefs for use as bricks etc.

About 60% of the world's reefs may be at risk due to destructive, human-related activities and climate change. Further, by 2030s, 90% of reefs are expected to be at risk; and by 2050, it is predicted that all coral reefs will be in danger.

#### **Its consequences include:**

- It will impact marine ecosystem, as coral reefs are some of the most bio diverse and productive ecosystems.
- Reefs act as natural barriers to shorelines, protecting them from the effects of moving water. As coral reefs die, coastlines become more susceptible to damage and flooding from storms, hurricanes, and cyclones.

- Without coral reefs, ocean will not be able to absorb as much CO<sub>2</sub>, leaving more CO<sub>2</sub> in atmosphere.
- Loss of the coral reefs will have a devastating impact on tropical countries' economies, food supplies, and safety of their coastal communities.

Student Notes:

Hence, it is important that efforts be taken to conserve them else thousands of years of natural change, will not survive.

**6. *Highlight the significance of corals in marine ecosystem. Also, throw a light on the phenomena of coral bleaching.***

**Approach:**

- Briefly explain the corals and coral reefs.
- Discuss the significance of coral reefs in marine ecosystem.
- Explain coral bleaching and factors responsible for it.

**Answer:**

Coral reefs are large underwater structures composed of the skeletons of colonial marine invertebrates called coral. The coral species extract calcium carbonate from seawater to create a hard, durable exoskeleton that protects their soft, sac-like bodies.

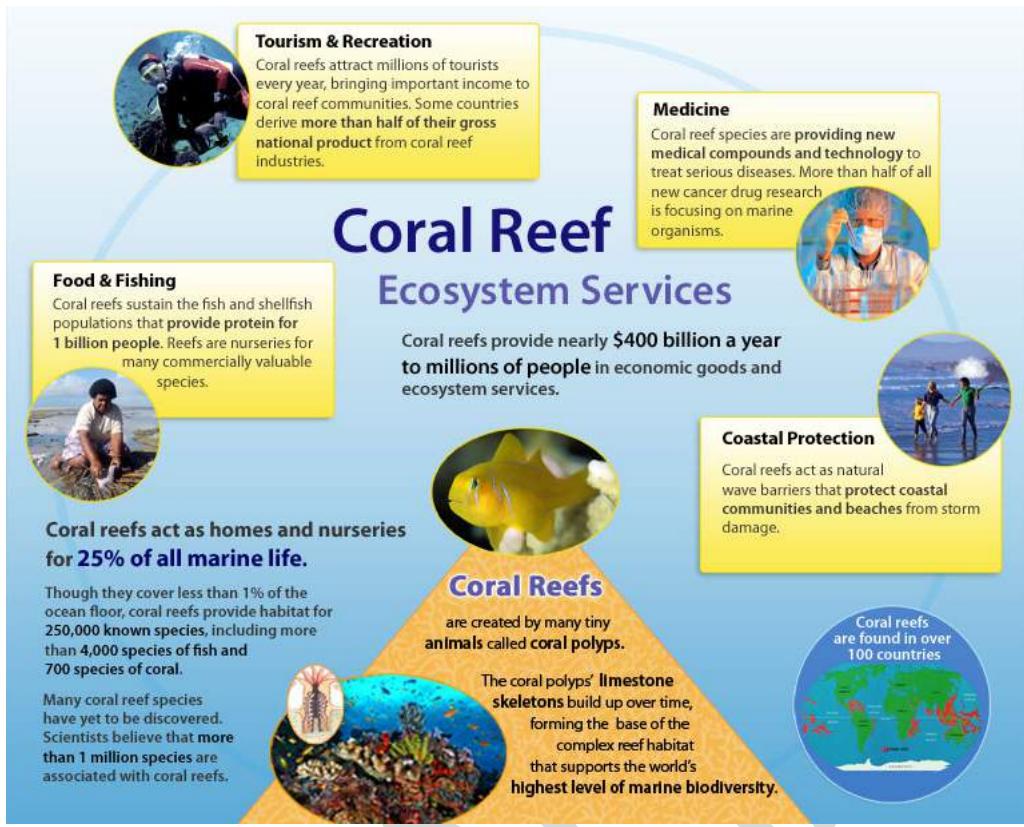
They are known as the tropical rainforests of the seas. A quarter of all marine life depends on coral reefs and over 500 million people worldwide rely on coral reefs for food security, economic well-being, and cultural identity. In India, majority of coral reefs are situated in Andaman & Nicobar, Lakshadweep, Gulf of Kutch, Gulf of Mannar and Malvan.

**Significance of coral reefs in marine ecosystem:**

- Coastal protection:** Coral reefs break the power of the waves during storms, hurricanes, typhoons, and even tsunamis. By preventing coastal erosion, flooding, and loss of property on the shore, the reefs help save economic and human cost related to destruction and displacement.
- Habitats:** Reefs provide habitats and shelter for many marine organisms. They are vital to the world's fisheries and form the nurseries for about a quarter of the ocean's fish.
- Nutrient recycling:** Reefs assist in carbon and nitrogen fixing and help with nutrient recycling. Corals are also the source of nitrogen and other essential nutrients for marine food chains.
- Water Filtration:** They act as filter feeders, which means that they consume particulate matter suspended in the water column. This contributes to enhanced quality and clarity of oceanic water.
- Climate records:** The study of coral reefs provide a clear, scientifically-testable record of climatic events over the past million years or so.

However, corals are now facing threat of Coral bleaching due to various different anthropogenic factors. **Coral bleaching** occurs when abnormal environmental conditions, such as warmer sea temperatures, cause corals to expel tiny photosynthetic algae, draining them of their color. It is a stress response to other biotic and abiotic factors such as:

- Exposure to increased solar irradiance:** Photosynthetically active radiation and ultraviolet band light combined with thermal stress causes bleaching in shallow-water corals.
- Runoff and pollution:** Storm generated precipitation can rapidly dilute ocean water and run-off can carry pollutants, which can bleach near shore corals.



- **Extreme low tides:** They can also cause bleaching in shallow corals due to exposure to the air during these tides.

Recognizing these threats, there are many global initiatives focused on protecting Coral reefs around the globe such as - **Global Coral Reef Monitoring Network (GCRMN)**, **Global Coral Reef Alliance (GCRA)**, and **International Coral Reef Initiative (ICRI)**. They play an important role in monitoring the reef zones and raising awareness in the public. Additionally, prohibiting establishment of industries causing harm to corals reefs and preventing plastic pollution would protect coral ecosystems.

# **Unit-2**



## **Biodiversity and its conservation**

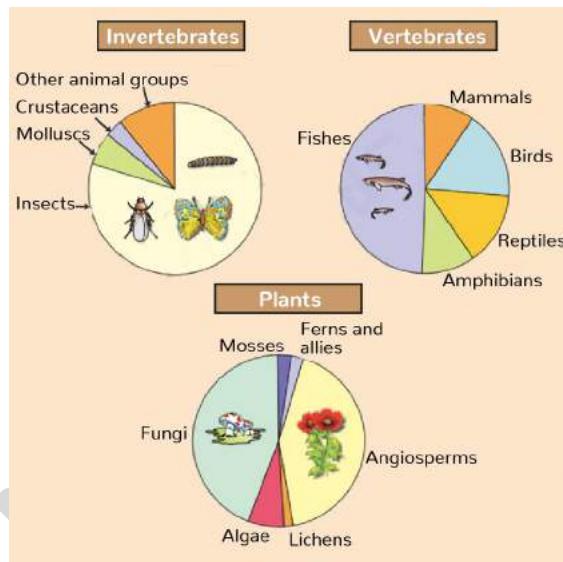
# CHAPTER - 6 - BIODIVERSITY

## 6. Biodiversity

### 6.1. Introduction

Biodiversity is the **diversity of and in living nature**. Diversity, at its heart, implies the number of different kind of objects, such as species. However, defining biodiversity or measures of biodiversity is not so simple. The living beings range from very small size microbes to large size mammals. In the most widely used system of classification these have been divided into 5 main kingdoms: **Monera, Protista, Fungi, Plantae and Animalia** based on certain common features and are further subdivided into many categories.

The **1992 Earth Summit** in Rio de Janeiro defined **biodiversity** as: “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.”

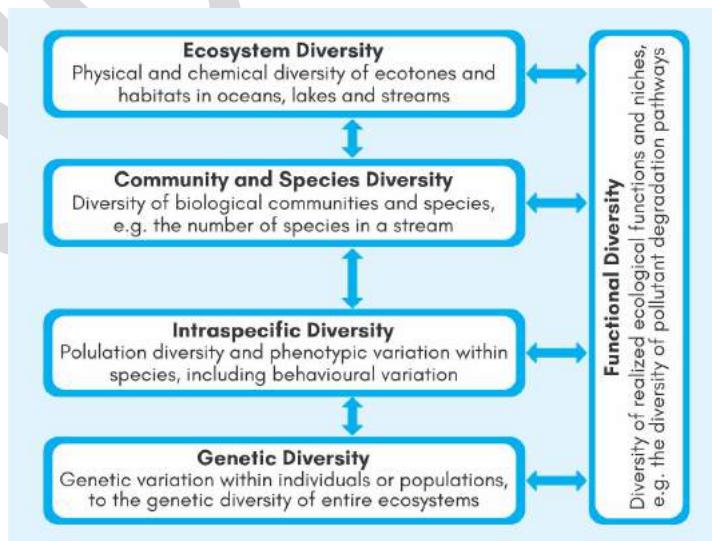


Representing global biodiversity: proportionate number of species of major taxa of plants, invertebrates and vertebrates

### 6.2. Levels of biodiversity

Biodiversity is considered to exist on the following three levels:

- a) **Species diversity**-Species diversity is determined not only by the number of species within a biological community—i.e., **species richness**—but also by the relative abundance of individuals in that community. **Species abundance** is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among species in a community. Two communities may be equally rich in species but differ in relative abundance
- b) **Ecosystem diversity**- describes the aggregation of and interaction of species with one another and deals with the variations in ecosystems within a geographical location and its overall impact on human existence and the environment especially during stress conditions.
- c) **Genetic diversity**- is the total number of genetic characteristics in the genetic makeup of a species and is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary. The magnitude of variation increases along with size and environmental parameters.



### Other Key Terms

- **Intraspecific diversity** is the variation within a population from the same species while interspecific diversity occurs in a community made up of different species.
- **Population diversity** may be measured in terms of the variation in genetic and morphological features that define the different populations.
- **Phenotype** refers to all the observable characteristics of an organism that result from the interaction of its genotype (total genetic inheritance) with the environment.
- **Functional Diversity** is a function of functionally disparate species within a population. For example, different feeding mechanism, different motility, predator vs prey etc.

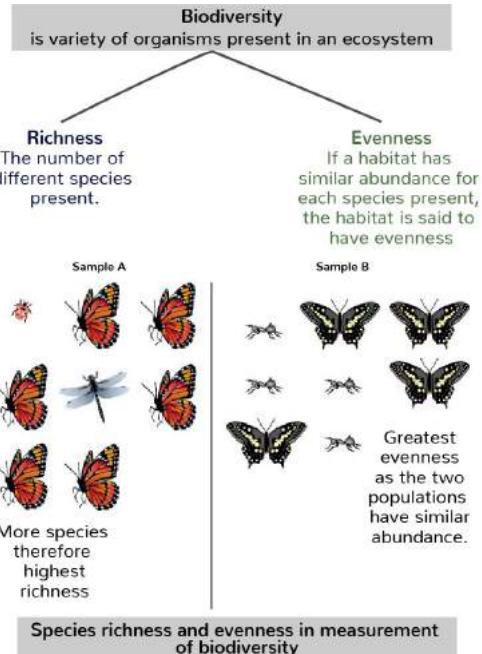
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## 6.3. Measurement of Biodiversity

The two main factors taken into account when measuring diversity are **richness and evenness**.

### 1. Species Richness

- a)  **$\alpha$ -Diversity**- Alpha diversity refers to diversity within a particular area, community or ecosystem, and is measured by counting the number of taxa (usually species) within the ecosystem.
- b)  **$\beta$ -Diversity**- Beta diversity is species diversity between ecosystems; this involves comparing the number of taxa that are unique to each of the ecosystems.
- c)  **$\gamma$ -Diversity**- Gamma diversity is a measurement of the overall diversity for different ecosystems within a region.



### 2. Species Evenness

It refers to how close in numbers each species in an environment is. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically.

**Species diversity and Ecosystem Stability:** A stable community should not show too much variation in productivity from year to year; it must be either resistant or resilient to occasional disturbances (natural or man-made), and it must also be resistant to invasions by alien species.

- **David Tilman's Long-term Ecosystem experiments** using outdoor plots found that plots with more species diversity showed less year-to-year variation in total biomass. He also showed that **increased biodiversity contributed to higher productivity**.

**Rivet Popper Hypothesis:** It was given by ecologist **Paul Elrich** to explain the importance of species richness in maintaining the health of an ecosystem.

- In an airplane (ecosystem) all parts are joined together using thousands of rivets (species). If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed, the plane becomes dangerously weak over a period of time.
- Loss of rivets on the wings (key species that drive major ecosystem functions) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane.

**Simpson's Index:** The Simpson's reciprocal index can be used to measure the relative biodiversity of a given community. It takes into account both the number of species present (richness) and the number of individuals per species (evenness). A higher index value is indicative of a greater degree of biodiversity within the community

**Shanon-Wiener Index:** is used to describe the disorder and uncertainty of individual species. The higher the uncertainty, the higher the diversity.

- There are two factors in Shanon-Weiner diversity index:
  - number of species, i.e. richness;
  - the average or evenness of individual distribution in the species.

- A large number of species can increase diversity.
- Similarly, increasing the uniformity of individual distribution among species will also increase diversity.
- If each individual belongs to a different species, the diversity index is the largest.
- If each individual belongs to the same species, its diversity index is the smallest.

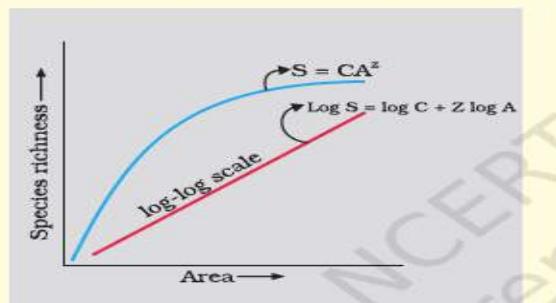
### 6.3.1. Patterns of Biodiversity

- **Latitudinal gradient:** The diversity of plants and animals is not uniform throughout the world but shows a rather uneven distribution. For many groups of animals or plants, there are interesting patterns in diversity, the most well-known being the latitudinal gradient in diversity.
  - In general, species diversity decreases as we move away from the equator towards the poles. With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbour more species than temperate or polar areas.
  - The largely tropical Amazonian rain forest in South America has the greatest biodiversity on earth- it is home to more than 40,000 species of plants and more than 1,25,000 invertebrates. Scientists estimate that in these rain forests there might be at least two million insect species waiting to be discovered and named.
  - Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species. India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds.
- **Impact of Altitude on Biodiversity Patterns:** Elevational diversity gradient (EDG) is an ecological pattern where biodiversity changes with elevation. The EDG states that species richness tends to increase as elevation increases, up to a certain point, creating a "diversity bulge" at middle elevations. There have been multiple hypotheses proposed for explaining the EDG, none of which accurately describe the phenomenon in full.
  - **Area Hypothesis:** It states that larger areas are able to support more species. As elevation increases, total area decreases; thus, there are more species present at middle elevations than high elevations.
  - **Rainfall Hypothesis:** This hypothesis states that diversity increases with increasing rainfall, however the correlation between rainfall and plant diversity varies from region to region. Rainfall and soil richness affect productivity trends which are also believed to affect diversity. A mid elevation peak is usually seen in mean annual rainfall.
  - **Resource Diversity Hypothesis:** The resource diversity hypothesis states an increase in diversity can be seen when an increase in the diversity of available resources such as soil and food is present. In this hypothesis diversity increases in an area of higher resource diversity even when resource abundance is constant.
  - **Productivity Hypothesis:** It is generally thought that productivity decreases with an increase in elevation, however there is some research that shows a peak in productivity at mid elevation which may be related to a peak in rainfall within the same area.
  - **Temperature Hypothesis:** The temperature hypothesis correlates increasing temperature with an increase in species diversity, mainly because of temperature's effect on productivity.

Ecologists and evolutionary biologists have proposed various hypotheses; for more number of species in tropical regions such as:

- Speciation is generally a **function of time**. Unlike temperate regions which were subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification,
- Tropical environments, unlike temperate ones, are **less seasonal, relatively more constant and predictable**. Such constant environments promote niche specialization and lead to a greater species diversity.
- There is **more solar energy** available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

- **Competition:** There are conflicting views on the effect of competition on species diversity. Some hold the view that an increase in interspecies competition leads to local extinctions and a decrease in diversity. Others view competition as a means of species specialization and niche partitioning, resulting in increase diversity.
- **Species Area Relationship:** During his explorations in South American jungles, German naturalist and geographer Alexander von Humboldt observed that within a region **species richness increased with increasing explored area, but only up to a limit.**
  - The relation between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a rectangular hyperbola.

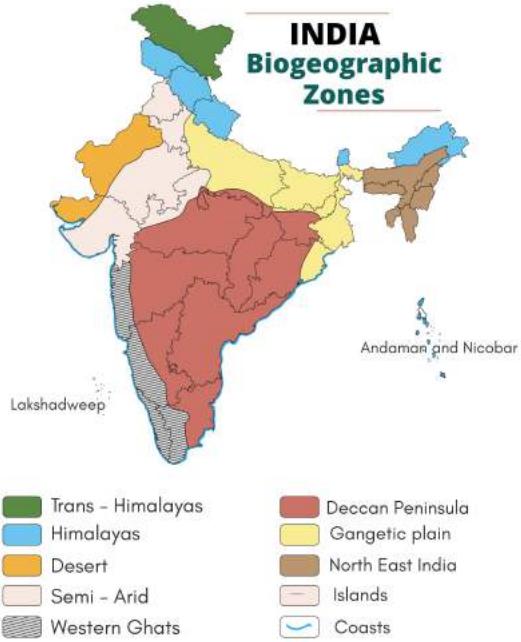


**Figure 15.2** Showing species area relationship. Note that on log scale the relationship becomes linear

## 6.4. The Biogeographic Zones of India and their Biodiversity

**Biogeographic zones** represent the major species groupings. In addition, each of these ten zones indicates a distinctive set of physical, climatic and historical conditions. The Himalayas and Gangetic Plains are examples of two adjacent but obviously extremely different zones.

India has been divided into ten biogeographic zones (refer infographic).



### 6.4.1. Trans Himalayan Zone

This zone has an area of about 1,86,200 sq. km and it covers mainly Ladakh and Lahul-Spiti, with altitude between 4,500 and 6,000 m at mean sea level. This zone represents an **extremely fragile ecosystem**, because of its harsh climatic conditions and the inhospitable terrain.

| Flora   | Fauna   |
|---|---|
| ➤ The vegetation of Ladakh and Lahul-Spiti is largely a <b>sparse alpine steppe</b> . In addition, several endemic species also occur here. | ➤ The flatter plateaux have a distinct grazing community comprising of <b>Wild Yak, Tibetan Ass, Tibetan Gazelle, Ibex and Tibetan Antelope</b> .<br>➤ The region has an equally distinctive set of carnivores including <b>Snow Leopard, Indian Wolf, Pallas's Cat, Fox</b> and smaller animals like <b>Marbled Pole Cat, Pika and Marmot</b> .<br>➤ The lakes and marshes too, have a distinctive avifauna including the spectacular <b>Black-necked Crane</b> , which is a migratory bird. |

### 6.4.2. The Himalayas

The Himalayan mountain ranges in India stretch for over 2,000 km from east to West.

The Himalayan zone is one of the richest areas of India in terms of habitat and species diversity. These are:

| Flora   | Fauna   |
|---|---|
| <ul style="list-style-type: none"> <li>➤ Mixed deciduous community merging into Chir Pine and Ban Oak in the lower sub-tropical foothills</li> <li>➤ Forests of <b>maples, walnuts, oak</b> and a <b>variety of conifers</b> like Blue Pine, Fir and Spruce in the temperate areas.</li> <li>➤ <b>Scrub vegetation</b> of Birch and Rhododendrons interspersed with grasslands in sub-alpine region.</li> <li>➤ Blue Pine and Deodars in the drier western region.</li> </ul> | <ul style="list-style-type: none"> <li>➤ <b>Ibex, Markhor and Hangul</b> found in the Central part of the Himalayas.</li> <li>➤ <b>Mishmi Takin, a Snow leopard, Indian Rhinoceros, clouded leopards</b> are found in the eastern part.</li> <li>➤ The <b>kashmir stag or Hangul</b> is found in the western part.</li> </ul> |

Student Notes:

#### 6.4.3. The Desert

This zone is located in the western part of the country and is also known as the Thar desert. It covers west Gujarat and west Rajasthan. Parts of Punjab and Haryana were once a part of this desert, but the irrigated cultivation has changed the situation there.

The wildlife of the desert zone is peculiar not because of its great diversity or density, but because of the extraordinary ecological adaptations to the desert conditions.

| Flora  | Fauna   |
|--|---|
| <ul style="list-style-type: none"> <li>➤ The natural vegetation consists of tropical thorn forests and tropical dry deciduous forests, sandy deserts with seasonal salt marshes and mangroves are found in the main estuaries.</li> <li>➤ Typical shrubs are phog growing on sand dunes. Sewan grass covers extensive areas called pali.</li> <li>➤ <b>Prosopis cineraria, Salvadoria Oleoides</b> are common trees of Indian desert.</li> </ul> | <ul style="list-style-type: none"> <li>➤ Thar desert possesses most of the major <b>insect</b> species. 43 <b>reptile</b> species and moderate bird endemism are found here. No niche of the Thar is devoid of birds.</li> <li>➤ The <b>black buck</b> was once the dominant mammal of the desert region, now confined only to certain pockets.</li> <li>➤ The <b>gazelle</b> is the only species of the Indian antelope of which the females have horns. Wild ass, a distinct subspecies, is now confined to the Rann of Kutch which is also the only breeding site in the Indian subcontinent for the flamingoes. Other species like desert fox, great Indian bustard, chinkara and desert cat are also found.</li> <li>➤ <b>Desert Fox, Desert Cat, Great Indian Bustard and some Sand Grouse species</b> are restricted only to the Thar area.</li> </ul> |

#### 6.4.4. The Semi-Arid

This zone with an area of 508,000 sq. km occupies 15% of the total area in our country. The presence of several grass species and palatable shrubs in these areas has made them a favourite of a vast number of wildlife species. This zone has strong biological links with western Asia, primarily with Pakistan, Iran, Middle-east and Northern Africa.

| Flora  | Fauna   |
|--|---|
| <ul style="list-style-type: none"> <li>➤ The natural vegetation consists of tropical thorn forests and tropical dry deciduous forests, moisture forests (extreme north) and mangroves.</li> <li>➤ The plant species found here show African affinity. The sandy plains have a few scattered trees of Acacia and Prosopis. The gravelly plains have Calotropis, Gymnosporia, etc.</li> <li>➤ The rocky habitats are covered by bushes of Euphorbia while species of Salvadoria and Tamarix occur mainly near saline depressions.</li> </ul> | <ul style="list-style-type: none"> <li>➤ The fauna consists of larger Herbivores-Blackbuck, Chowsingha, Gazelle and Nilgai (largest Asian antelope).</li> <li>➤ The lion of Gir is the endemic species in this zone.</li> </ul> |

#### 6.4.5. The Western Ghats

The Western Ghats represent one of the major tropical evergreen forest regions in India. In the west, the zone is bound by the coast and in the east, it shares boundary with the Deccan peninsular zone. The tropical evergreen forests occupy about one third of the total area of this zone.

In recent years, a large chunk of the forest cover has been lost and this zone is now of great conservation concern, more so because of its exceptional biological richness. **About two-thirds of India's endemic plants** are confined to this region. However, the potential of many of these species is yet to be tapped. Besides harbouring diverse biological communities, the forests in this zone also play an important role in maintaining the hydrological cycle. The well known species found exclusively in Western Ghats include the following:

| Flora   | Fauna   |
|---|---|
| <ul style="list-style-type: none"> <li>➤ The various major vegetation types are tropical evergreen forests, moist deciduous forests, dry deciduous forests, scrub jungles, sholas, savannas including high rainfall savannas, peat bogs and Myristica swamps. Four thousand species of flowering plants are known from the Western Ghats</li> </ul> | <ul style="list-style-type: none"> <li>➤ <b>Primates</b> – Nilgiri Langur and Lion-tailed Macaque.</li> <li>➤ <b>Rodents</b> – Platacanthomys, the Spiny Dormouse.</li> <li>➤ <b>Squirrels</b> – Several subspecies of Ratufa indica with separate forms in Maharashtra, Mysore, Malabar and Tamil Nadu Ghats. The Grizzled Squirrel is restricted to two localities in the drier Tamil Nadu forest.</li> <li>➤ <b>Carnivores</b> – Malabar Civet in southern evergreen forests, Rusty spotted Cat in northern deciduous forests.</li> <li>➤ <b>Ungulates</b> – Nilgiri Tahr in Nilgiris to Agasthyamalai montane grassland.</li> <li>➤ <b>Hornbills</b> – Malabar Grey Hornbill.</li> <li>➤ In addition to the above endemic species, the other species found are: Tiger, Leopard, Dhole ,Sloth Bear, Indian Elephant and Gaur.</li> </ul> |

#### 6.4.6. The Deccan Peninsula

This zone covers the largest area in India that amounts to about 43% of the total land mass, and about 1,421,000 sq. km area. Though a large area of this zone has been greatly altered by humans, still some forest areas exist, particularly in Madhya Pradesh, Maharashtra and Odisha.

| Flora   | Fauna   |
|---|---|
| <ul style="list-style-type: none"> <li>➤ This zone has <b>deciduous forest, thorn forests and degraded shrublands</b>. There are small areas of <b>semi-evergreen</b> forests in the Eastern Ghats and, <b>dry evergreen</b> forests or <b>thorn scrub</b> on the coastal side of the plains of Andhra Pradesh and Tamil Nadu.</li> </ul> | <p>The <b>faunal species</b> are widespread throughout the whole zone, e.g., Chital, Sambar, Nilgai, Chowsingha, Barking Deer, and Gaur. Some species such as the Blackbuck are restricted to dry open area. Small, relict populations of species also exist, e.g., Elephant (Bihar-Odisha, and Karnataka-Tamil Nadu) and Wild Buffalo (in a small area at the junction of Odisha, M.P. and Maharashtra).</p> |

#### 6.4.7. The Gangetic Plain

This zone has one of the most fertile areas in the world, and it supports a dense and growing human population. It covers an area of about 359,400 sq km. The original vegetation found in most of the area is no longer there, as a major portion of this area has been brought under cultivation.

| Flora  | Fauna   |
|--|---|
| <p>The Lower Gangetic plains moist deciduous forests extends across the alluvial plain of the lower Ganges and Brahmaputra rivers, which form the world's largest river delta. The ecoregion is currently one of the most densely populated regions on earth, and the forests have largely been replaced with intensive agriculture.</p> | <ul style="list-style-type: none"> <li>➤ Small relict populations of <b>Nilgai, Blackbuck and Chinkara</b> interspersed with dense cultivation presently exist in the western areas.</li> <li>➤ The wetlands and rivers also contain Crocodile – <b>Mugger and Gharial</b> - populations, relict populations of Gangetic Dolphin and a rich, freshwater turtle community having over 20 species.</li> </ul> |

#### 6.4.8. North-East India

North-East India represents the transition zone between the India, Indo-Malayan and Indo-Chinese regions as well as the meeting point of Himalayan mountains and Peninsular India. It is one of the most important zones in the Indian Subcontinent for its rich biological diversity and a large number of endemic species.

| Flora   | Fauna   |
|---|---|
| <ul style="list-style-type: none"> <li>➤ The Brahmaputra valley of this zone contains unique natural vegetation – swamps, grasslands and fringing woodlands and forests.</li> </ul> | <ul style="list-style-type: none"> <li>➤ The fauna consists of Rhinoceros, Buffalo, Swamp Deer, Hog Deer, Pygmy Hog and Hairy Hare. This area also contains the largest elephant populations.</li> <li>➤ This is also the flyway for waterfowl and other birds traveling between the warmth of the subcontinent and their summer grounds in Siberia and China.</li> </ul> |

Student Notes:

#### 6.4.9. The Islands

In this category we shall discuss the Andaman and Nicobar group of islands in the Bay of Bengal, and the Lakshadweep in the Arabian Sea. The Andaman and Nicobar Islands are a long group of 348 north-south oriented islands.

The zone possesses a unique kind of plant and animal life exhibiting a **high degree of endemism**. One finds these islands with impoverished mammal fauna. This may be largely due to the isolation of Andaman and Nicobar Islands and the small island size.

| Flora   | Fauna  |
|---|--|
| <p><b>Andaman</b></p> <ul style="list-style-type: none"> <li>➤ They have a tropical rainforest canopy, made of a mixed flora with elements from Indian, Myanmar, Malaysian and endemic floral strains. So far, about 2,200 varieties of plants have been recorded, out of which 200 are endemic and 1,300 do not occur in mainland India.</li> <li>➤ The South Andaman forests have a profuse growth of epiphytic vegetation, mostly ferns, and orchids.</li> <li>➤ The Middle Andamans harbours mostly moist deciduous forests.</li> <li>➤ North Andamans is characterised by the wet evergreen type, with plenty of woody climbers.</li> <li>➤ The North Nicobar Islands (including Car Nicobar and Battimalv) are marked by the complete absence of evergreen forests, while such forests form the dominant vegetation in the central and southern islands of the Nicobar group.</li> <li>➤ Grasslands occur only in the Nicobars, and while deciduous forests are common in the Andamans, they are almost absent in the Nicobars.</li> </ul> <p><b>Lakshadweep</b></p> <ul style="list-style-type: none"> <li>➤ The flora of the islands include Banana, Vazha, Colocassia, Chambu, Bread Fruit, Chakka, wild almond which are grown extensively.</li> <li>➤ Some of the <b>shrub jungles plants</b> like Kanni, Punna,, Chavok, Cheerani are unevenly grown throughout the island.</li> <li>➤ Two different varieties of sea grass are seen on the beaches.</li> </ul> | <p><b>Andaman</b></p> <ul style="list-style-type: none"> <li>➤ The state bird of Andaman (the Andaman wood pigeon), the Narcondam hornbill (found exclusively in the Narcondam islands), the Andaman scops owl, the blue-eared kingfisher, and the fulvous breasted woodpecker can be spotted extensively here.</li> <li>➤ Wild boars, elephants, various species of sea turtles, and wild saltwater crocodiles make the islands a wildlife hotspot.</li> </ul> <p><b>Lakshadweep</b></p> <ul style="list-style-type: none"> <li>➤ The marine life of the sea is quite elaborate and difficult to condense. The commonly seen vertebrates are cattle and poultry. Oceanic birds generally found in Lakshadweep are Tharathasi and Karifetu. They are generally found in one of the uninhabited islands known as PITTI. This island has been declared as a bird sanctuary.</li> <li>➤ Molluscan forms are also important from the economic point of the islands. The money cowrie are also found in abundance in the shallow lagoons and reefs of the islands.</li> <li>➤ Among crabs, the hermit crab is the most common. Colorful coral fish such as parrot fish, Butterfly fish, Surgeon fish are also found in plenty.</li> </ul> |

#### 6.4.10. The Coasts

India has a vast coastal stretch of about 5689 km (Srinivasan, 1969). On the west, the Arabian Sea washes the shores of Gujarat, Maharashtra, Goa, Karnataka and Kerala States. On the east, the Bay of Bengal washes the coasts of Sunderbans in West Bengal, Odisha, Andhra Pradesh and Tamil Nadu states. The southern promontory of Indian Peninsula is bathed by the Gulf of Manaar and Indian Ocean, along the coasts of southern portions of Tamil Nadu.

| Flora   | Fauna   |
|---|---|
| <ul style="list-style-type: none"> <li>➤ <b>Mangroves</b> – that have a variety of community types from seaward to landward facing areas of estuaries, lagoons and deltas.</li> <li>➤ <b>Sandy beaches</b>, including raised beaches and distinctive plant communities such as Casuarina – Calophyllum – Pandanus.</li> <li>➤ <b>Mud flats</b> with a range of successional stages to completely terrestrial vegetation.</li> <li>➤ Raised <b>corals</b> and rocky coast lines.</li> <li>➤ <b>Marine angiosperm pastures</b></li> </ul> | <ul style="list-style-type: none"> <li>➤ Some of the interesting <b>coastal wildlife species</b> include: Dugong; Hump-back Dolphin of estuarine turbid waters; Estuarine or salt-water Crocodile; Olive Ridley, Green, Hawksbill, Leather and Loggerhead sea Turtles; the Estuarine Turtle – Batagur baska of Sunderbans and the huge Soft-shell Estuarine Turtle; Pelochelys birbornii off the Utkal-bengal Coast fish – mud skippers or semi-terrestrial Gobies, small Crabs in association with Anemones; avifaunal communities of mangrove, mud flats and lagoons. In the higher regions of mangroves, there are Spotted Deer, Pigs, Monitor Lizards, Monkeys, and the Sunderban Tiger.</li> </ul> |

Student Notes:

## 6.5. Biodiversity Hotspots

**Conservation International** was a pioneer in defining and promoting the concept of hotspots. In 1989, just one year after scientist Norman Myers wrote the paper that introduced the hotspots concept, Conservation International adopted the idea of protecting these them as the guiding principle of their investments.

Hot spots are areas that are extremely rich in species, have high endemism and are under constant threat. Myers (1988) identified 18 regions or “Hot spots” around the world. Interestingly these areas contain nearly 50,000 endemic plant species, or 20% of the world’s plant species, in just 746,000 km<sup>2</sup>, or 0.5% of the Earth’s total land surface.

To qualify as a biodiversity hotspot, a region must meet **two strict criteria**:

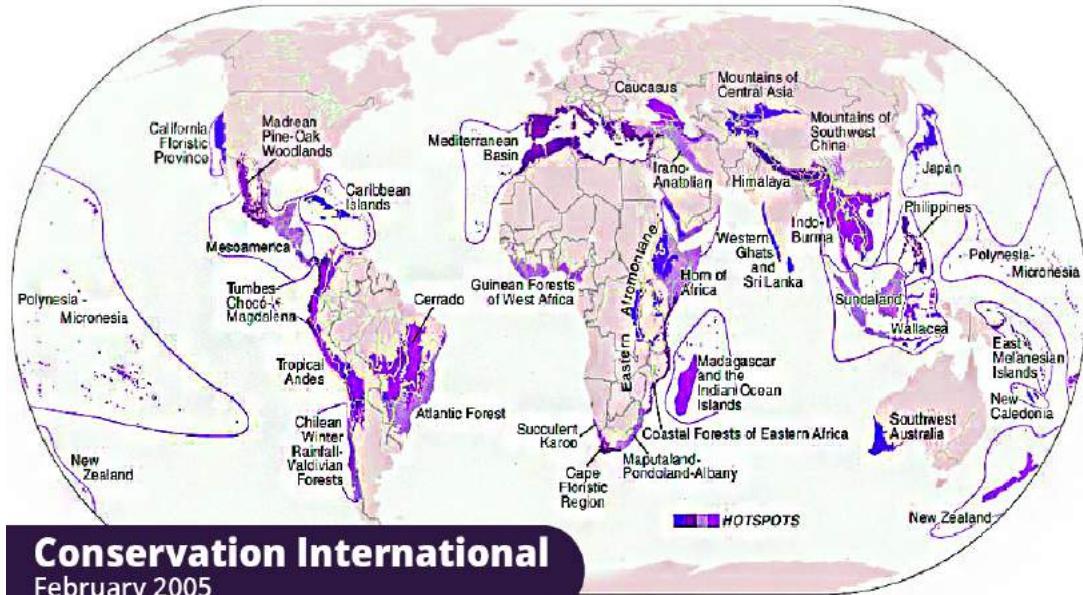
- It must have **at least 1,500 vascular plants as endemics** — which is to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is **irreplaceable**.
- It must have **30% or less** of its original natural vegetation. In other words, it must be **threatened**.

### Conservation International

- Conservation International (CI) is an American **nonprofit** environmental organization headquartered in Crystal City, Arlington, Virginia.
- Its mission is to spotlight and secure the critical benefits that nature provides to humanity, such as food, fresh water, livelihoods and a stable climate

### Vascular vs Nonvascular Plants

- The main difference between vascular and nonvascular plants is that a **vascular plant has vascular vessels to carry water and food** to all the different parts of the plant.
  - **The phloem** is the vessel that transports food and the **xylem** is the vessel that transports water.
- On the other hand, a **nonvascular plant doesn't have a vascular system**. This means nonvascular plants are much smaller than vascular plants.
- Another difference is that a **nonvascular plant doesn't have roots like a vascular plant does**. Instead, a nonvascular plant has rhizoids, small hairs that keep the plant in place.
- Nonvascular plants are most commonly found in moist environments, which ensures they get enough water without relying on roots.
- Nonvascular plants have much **more simple methods of reproduction than vascular plants**. Most nonvascular plants reproduce by producing single-celled spores or through the asexual process of vegetative propagation, where a new plant grows from a portion of the parent plant.
- **Vascular Plant Examples:** Clubmosses, horsetails, ferns, gymnosperms and angiosperms (flowering plants) are some examples of vascular plants.
- **Non Vascular Plant Examples:** Three non vascular plants examples are mosses, liverworts and hornworts, which all have flattened, green plant bodies.



The map shows **34 biodiversity hotspots** which cover **2.3%** of the Earth's land surface, yet more than **50%** of the world's plant species and **42%** of all terrestrial vertebrate species are endemic to these areas (Conservation International). These are the areas which are suffering biodiversity loss and where attention is needed.

### 6.5.1. Biodiversity Hotspots in India

As per Conservation International, India has 4 Biodiversity Hotspots. They are:

1. **Himalaya:** Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar)
  - The Himalayas house more than 10,000 plant species, 300 mammals, 970 birds, 105 amphibians, 170 reptiles and 270 freshwater fishes.
  - Large areas of remaining habitat in the hotspot are highly degraded. **Overgrazing** by domestic livestock, including cattle and domesticated yak, is widespread in the lowlands and alpine ecosystems.
  - In addition to **habitat loss and degradation** – which has led to perhaps no more than 25% of the original vegetation in this hotspot still intact – poaching is a serious problem in the Himalayan Mountains, with tigers and rhinoceros hunted for their body parts for traditional Chinese medicine, while snow leopards and red pandas are sought for their beautiful pelts.
  - Other threats to biodiversity and forest integrity include mining, the construction of roads and large dams, and pollution due to the use of agrochemicals.
2. **Indo-Burma:** Includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China).
  - This hotspot also holds remarkable endemism in **freshwater turtle species**, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss.
  - Bird life in IndoBurma is also incredibly diverse, holding almost 1,300 different bird species, including the threatened **white-eared night-heron, the grey-crowned crocias, and the orange-necked partridge**.
  - Indo-Burma is one of the most threatened biodiversity hotspots, due to the rate of resource exploitation and habitat loss. Only about 5% of natural habitats remain in relatively pristine condition, with another 10 to 25% of the land in damaged, but ecologically functional, condition.
  - Indo-Burma was one of the first places where humans developed agriculture, and has a long history of using fire to clear land for agriculture and other needs. The need for

agricultural products has only increased in recent years, with the expansion of both human populations and markets. This has contributed to widespread forest destruction; tree plantations (teak, rubber, oil palm) have replaced large areas of lowland forest, while coffee, tea, vegetable crops and sugarcane plantations threaten montane and hill forests.

- Other threats to forests include logging, mining for gems and ore, firewood collection, and charcoal production.

### 3. Sundalands:

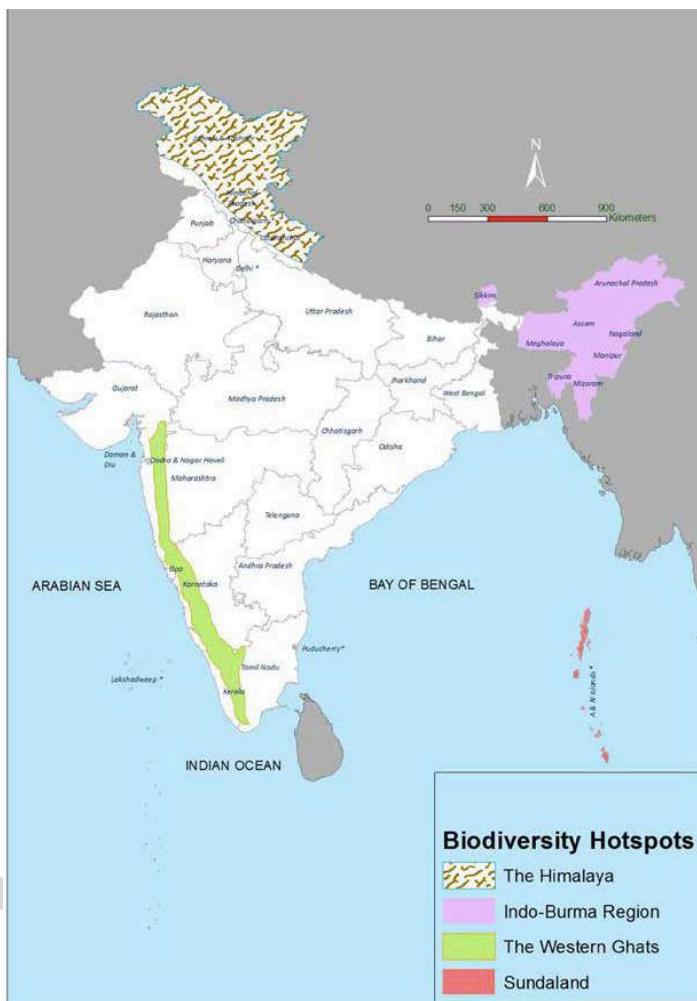
Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines)

- The spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosive growth of industrial forestry in these islands and to the international animal trade that claims tigers, monkeys, and turtle species for food and medicine in other countries.
- Populations of the orangutan, found only in this hotspot, are in dramatic decline. Some of the last refuges of two Southeast Asia rhino species are also found on the islands of Java and Sumatra.
- Like many tropical areas, the forests are being cleared for commercial uses. Rubber, oil palm, and pulp production are three of the most detrimental forces facing biodiversity in the Sundaland Hotspot.

### 4. Western Ghats and Sri Lanka:

Includes entire Western Ghats (and Sri Lanka)

- Faced with tremendous population pressure, the forests of the Western Ghats and Sri Lanka have been dramatically impacted by the demands for timber and agricultural land. Remaining forests of the Western Ghats are heavily fragmented; in Sri Lanka, only 1.5% of the original forest remains.
- Population levels are also applying increased stress on the fringes of protected areas where many farms, loggers, and poachers use the resources illegally. Due in part to the varying effect of the yearly monsoons and the high mountain regions, this hotspot is home to a rich endemic assemblage of plants, reptiles, and amphibians.
- Sri Lanka alone may be home to as many as 140 endemic species of amphibians. The region also houses important populations of Asian Elephants, Indian Tigers, and the Endangered Lion-tailed Macaque. Freshwater fish endemism is extremely high as well, with over 140 native species.



Student Notes:

### **6.5.2. India- A Mega-Biodiversity Country**

## Student Notes:

This is because of the following reasons:

- Four hot spots out of 34 global biodiversity hot spots are in India with its neighbouring countries.
  - The endemics of Indian biodiversity is high. About 33% of the recorded flora is endemic to the country. Of the 49,219 plant species, 5150 are endemic and distributed into 141 genera under 47 families corresponding to about 30% of the world's recorded flora.
  - India has 26 recognised endemism centres that are home to nearly a third of all the flowering plants identified and described to date in the country.
  - India has two major realms called the Palaearctic and the Indo-Malayan and three biomes i.e. tropical humid forests, tropical deciduous forests and the warm deserts/semi-deserts.
  - India has ten biogeographic regions.
  - India is one of the 12 centres of origin of cultivated plants

## 6.6. UPSC Previous Year Questions

## Mains

1. What do you understand by the term 'biodiversity'? Examine the causes and consequences of degeneration of biodiversity. (2007)

Prelims

- 1.** Consider the following statements: (2011)

  1. Biodiversity is normally greater in the lower latitudes as compared to the higher latitudes.
  2. Along the mountain gradients, biodiversity is normally greater in the lower altitudes as compared to the higher altitudes.

Which of the statements given above is/are correct?



**Answer: (c)**

- 2.** Biodiversity forms the basis for human existence in the following ways : (2011)

1. Soil formation
  2. Prevention of soil erosion
  3. Recycling of waste
  4. Pollination of crops

Select the correct answer using the codes given below:

- (a) 1, 2 and 3 only      (b) 2, 3 and 4 only  
(c) 1 and 4 only      (d) 1, 2, 3 and 4

**Answer: (d)**

- 3.** Three of the following criteria have contributed to the recognition of Western Ghats-Sri Lanka and Indo-Burma regions as hotspots of biodiversity: (2011)

1. Species richness
  2. Vegetation density
  3. Endemism
  4. Ethno-botanical importance
  5. Threat perception
  6. Adaptation of flora and fauna to warm and humid conditions

6. Adaptation of flora and fauna to warm and humid conditions  
Which three of the above are correct criteria in this context?



**Answer: (c)**

4. The Himalayan Range is Very rich in species diversity. Which one among the following is the most appropriate reason for this phenomenon? (2011)
- It has a high rainfall that supports luxuriant vegetative growth
  - It is a confluence of different bio-geographical zones
  - Exotic and invasive species have not been introduced in this region
  - It has less human interference

**Answer: (b)**

5. The Millennium Ecosystem Assessment describes the following major categories of ecosystem services-provisioning, supporting, regulating, preserving and cultural. Which one of the following is supporting service? (2012)
- Production of food and water
  - Control of climate and disease
  - Nutrient cycling and crop pollination
  - Maintenance of diversity

**Answer: (d)**

6. With reference to an initiative called 'The Economics of Ecosystems and Biodiversity (TEEB)', which of the following statements is/are correct? (2016)
- It is an initiative hosted by UNEP, IMF and World Economic Forum.
  - It is a global initiative that focuses on drawing attention to the economic benefits of biodiversity.
  - It presents an approach that can help decision-makers recognize, demonstrate and capture the value of ecosystems and biodiversity.

Select the correct answer using the code given below.

- |                  |                |
|------------------|----------------|
| (a) 1 and 2 only | (b) 3 only     |
| (c) 2 and 3 only | (d) 1, 2 and 3 |

**Answer: (c)**

7. Recently, our scientists have discovered a new and distinct species of banana plant which attains a height of about 11 metres and has orange-coloured fruit pulp. In which part of India has it been discovered? (2016)
- |                     |  |
|---------------------|--|
| (a) Andaman Islands | (b) Anaimalai Forests                  |
| (c) Maikala Hills   | (d) Tropical rain forests of northeast |

**Answer: (a)**

8. Recently, there was a growing awareness in our country about the importance of Himalayan nettle (*Girardinia diversifolia*) because it is found to be a sustainable source of (2019)
- |                             |                   |
|-----------------------------|-------------------|
| (a) anti-malarial drug      | (b) biodiesel     |
| (c) pulp for paper industry | (d) textile fibre |

**Answer: (d)**

Student Notes:

## 6.7. Vision IAS Previous Year Questions

Student Notes:

### 1. How has the vegetation of tropical rainforests adapted to its environment? Illustrate.

**Approach:**

- Introduce your answer by explaining climatic conditions of tropical rainforests.
- Discuss the features and characteristics of such vegetation.
- Discuss how climate of these regions influence the vegetation of these regions.

**Answer:**

High temperature and abundant rainfall in the tropical regions support a luxuriant type of vegetation referred as the tropical rain forest. They have a rich floristic composition. These forests are best developed in tropical America, particularly the Amazon basin, in the East Indies and surrounding areas, Malaysia and the Congo.

Plants there have adapted to the rainforest environment which is dark and wet all year round through various mechanisms. Some such adaptations are:

1. Buttress Roots - Buttress roots are roots above ground which support the tree and encourage growth. The taller the tree becomes the more sunlight it can get from above. Ground root system to ensure stability for the tallest trees and to increase the surface area over which the plant can draw its nutrients.
2. Drip Tips - The leaves are shaped to shed the heavy rainfall. The trees have leaves that have a drip tip so water is collected and dripped down to the roots.
3. Branchless Trees - These plants forget about roots in the soil - they perch high up on branches. The trees put their energy into climbing upwards towards the canopy rather than growing branches at intervals along their trunks.
4. Ferns grow very well on the forest floor as they have adapted to the shady conditions.

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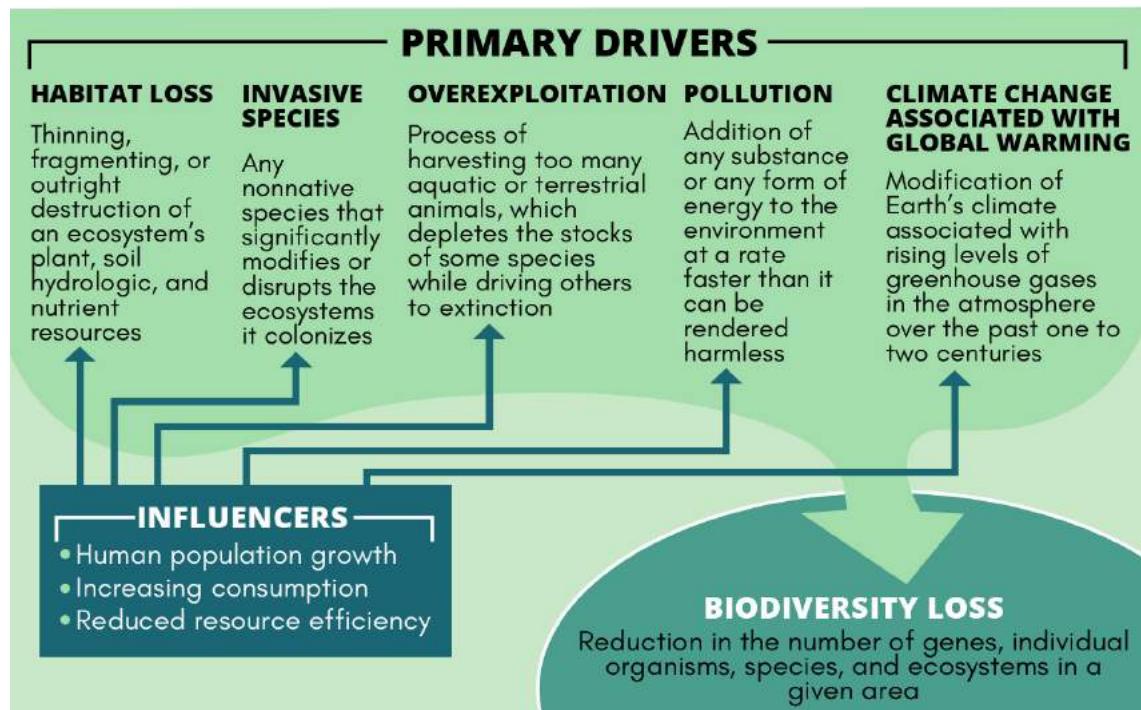
# CHAPTER - 7 - CONSERVATION OF BIODIVERSITY

Student Notes:

## 7. Conservation of Biodiversity

### 7.1. Causes of Biodiversity loss

Loss of species is a serious cause of concern for human survival. It has been observed that 79 species of mammals, 44 of birds, 15 of reptiles and 3 of amphibians are threatened. Nearly 1500 species of plants are endangered in India.



There are four major causes that have lead to this rapid extinction of biological diversity, sometimes referred as "**The Evil Quartet**". The principal mechanisms are:

- **Habitat destruction:** It results from clearing and burning forests, draining and filling of wetlands, building of roads etc. These change either kill or force out may species from the area causing disruption of interactions among the species.
  - Fragmentation of large forest tracts (eg. the corridors) affects the species occupying the deeper part of the forest and are first to disappear. 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.
  - Apart from the direct loss of species during the development activities, the new environment is unsuitable for the species to survive.

#### Why should we conserve biodiversity?

- **Narrowly utilitarian arguments:** humans derive countless direct economic benefits from nature. With increasing resources put into search for plant and animal species from which medicinal drugs and other commercially valuable compounds can be obtained (bioprospecting), nations endowed with rich biodiversity can expect to reap enormous benefits.
- **Broadly utilitarian argument:** biodiversity plays a major role in many ecosystem services and aesthetic pleasures that nature provides. It is not possible to put a monetary value on such services.
- **Ethical argument:** every species has an intrinsic value. Humans have a moral duty to care for their well-being and pass on the biological legacy in good order to future generations.

- **Over-Exploitation:** due to exponential increase in human dependence for natural resources to meet the rising demand for development has lead to over-exploitation.
  - Over exploitation reduces the size of the population of a species and may push it towards extinction. Many species extinctions in the last 500 years (Steller's sea cow, passenger pigeon) were due to overexploitation by humans.
  - **Co-Extinction:** When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate. Another example is the case of a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.
- **Alien Invasive Species:** An invasive alien species is any species that is **established outside of its natural past or present distribution**, whose introduction and/or spread **threaten biological diversity**. For example, The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.
  - It can be **any kind of living organism**—an amphibian (like the cane toad), plant, insect, fish, fungus, bacteria, or even an organism's seeds or eggs.
  - The most common characteristics of invasive species are **rapid reproduction and growth, high dispersal ability, ability to survive on various food types** and in a wide range of environmental conditions and the ability to **adapt physiologically to new conditions**, called **Phenotypic plasticity**.
  - They may be transported to a new location, either intentionally (for food or economic purposes) or unintentionally (by natural means like birds/winds/ocean currents etc.) The recent rapid growth of world trade, travel and has greatly increased the rate of unintentional introductions. The natural protection provided by oceans and mountains, that once acted as natural barriers to the movement of species, have now been breached, ending millions of years of biological isolation.
  - An analysis of the IUCN Red List shows that they are the second most common threat associated with species that have gone completely extinct, and are the most common threat associated with extinctions of amphibians, reptiles, and mammals.

Student Notes:

Apart from biodiversity loss, invasive alien species also threaten in different ways such as:

- **Change in the ecosystem:** Invasive alien species can also lead to changes in the structure and composition of ecosystems leading to significant detrimental impacts to ecosystem services, affecting economies and human wellbeing. For example, the water hyacinth is spreading across Africa, Asia, Oceania, and North America. It is a fast-growing floating aquatic plant forming dense mats on the water surface, limiting oxygen and preventing sunlight reaching the water column. Infestations have led to reduced fisheries, blocked navigation routes, increased cases of vector-borne diseases, reduced hydropower capacity and affecting access to water.
- **Lead to resource crunch:** Invasives can also threaten native species by outcompeting them for resources. Asian carp introduced into the United States outcompete native fish for both food and space, leading to large declines in native fish populations.
- **Impact on Human health:** Invasive species can also impact human health when these species may accumulate toxins in their tissues when other organisms prey on these species, the toxins are passed up the food chain and can also enter animals consumed by humans. Infectious disease agents may themselves be invasive species or may be introduced by invasive vectors (e.g. introduced mosquitoes carrying malaria). West Nile Virus is an example of this.

## List of invasive flora and fauna in India

| Name  | Native to  | Affected area   |
|---|--|---|
| <b>African apple snail</b>                    |  | It is now found across country and is threatening the habitat of several native species.  |
| <b>Papaya Mealy Bug</b>                       | Mexico and Central America,                                | Destroyed huge crops of Papaya  |
| <b>Cotton Mealy Bug</b>                       | North America  | Affected cotton crops   |
| <b>Amazon sailfin catfish</b>                 |  | Fish population in the wetlands of kolkata  |
| <b>Black Wattle</b>                           | South East Australia                                       | It is distributed in forests and grazing lands in high altitude areas   |
| <b>Water Hyacinth</b>                         | Tropical America   | Aggressive colonizer. Abundant in still or slow floating waters. A nuisance for an aquatic ecosystem.                                 |
| <b>Black Mimosa</b>                           | Tropical North America                                     | Aggressive colonizer. It invades watercourses and seasonally flooded wetlands.  |
| <b>Parthenium/ Congress grass, Parthenium</b> | Tropical North America                                     | Aggressive colonizer. A common weed of cultivated fields, forests, overgrazed pastures, wastelands, and gardens.                      |
| <b>Cannibal Snail/ Rosy wolf snail</b>        | Native to the southeastern United States.                  | Indian Ocean  |
| <b>Indian Bullfrog</b>                        | Afghanistan, Bangladesh, India<br>Myanmar, Nepal, Pakistan | Threat to marine species, especially small endemic vertebrates  |
| <b>Lantana camara</b>                         | South America  | It hinders the growth of native vegetation that herbivores such as deer and elephants feed on. Further, its fruit is toxic to animals |
| <b>Prosopis juliflora</b>                     | South and Central America                                  | introduced in India to meet the fuelwood requirement of the rural poor and to restore degraded lands.                                 |

### Managing invasive species

- In the last decade, there have been efforts to compile lists of invasive plant species in India and to study the impacts of invasive species in different parts of the country. In 2009, the Indian Council for Forestry Research and Education set up a Forest Invasive Species Cell to develop capacities for invasive species management and to create a database on invasive species.
- An **integrated forest protection scheme** was devised to include the management of invasive species. The last tiger census conducted by the National Tiger Conservation Authority included a survey of the distribution of a subset of invasive plants in tiger landscapes across the country. And the 12th five-year plan proposed a **national invasive species monitoring system**.
- India has a number of different legislations relating to invasive species. Some of these were enacted long before invasive species were a global concern – but have since been amended to include invasive species. An indicative, though incomplete, list includes;
  - a) The Plant Quarantine (Regulation of Import into India) Order 2003.
  - b) The Destructive Insects and Pests Act, 1914 (and amendments).
  - c) Livestock Importation Act 1898 and the Livestock Importation (Amendment) Ordinance, 2001.
  - d) Environment Protection Act 1986 and
  - e) The Biological Diversity Act 2002.
- So also, we have a number of different agencies charged with preventing the introduction of invasive species and for management and control of invasive species. These include the Ministry of Environment Forests and Climate Change, the National Bureau of Fish Genetic Resources, the Plant Quarantine Organisation of India and various departments of the Ministry of Agriculture.

### Other steps taken to control Invasive Alien Species (IAS)

- **Article 8(h) of CBD and Aichi Target 9** aim to control or eradicate alien species which threaten ecosystems, habitats and species.
- **Global Invasive Species Program** is supporting to implement Article 8(h) of CBD with IUCN as partner organization and also working to address the global threat to IAS.
- **IUCN's Invasive Species Specialist Group** has also been working to promote and facilitate the exchange of IAS information and knowledge across the globe and ensure linkages between policy making and flow of knowledge.
- IUCN has also developed a number of global databases which provide critical information on IAS such as **Global Invasive Species Database** and the **Global Register of Introduced and Invasive Species**.

Student Notes:

## 7.2. IUCN Red List of Endangered Species

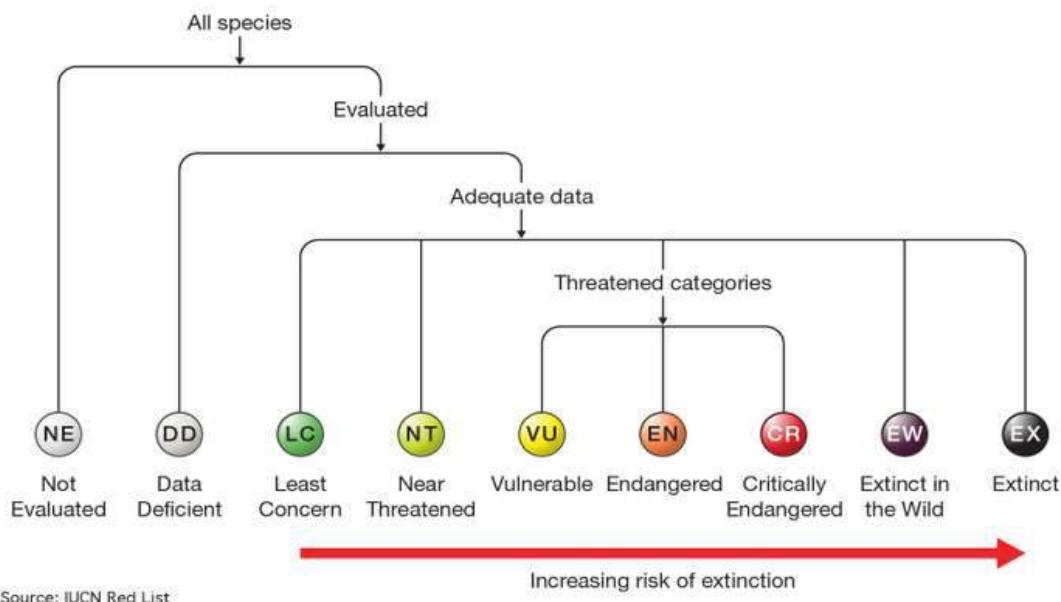
- IUCN Red List of Threatened Species, also called IUCN Red List, is one of the most well-known objective assessment systems for classifying the status of plants, animals, and other organisms threatened with extinction. The International Union for Conservation of Nature (IUCN) unveiled this assessment system in 1994. It contains explicit criteria and categories to classify the conservation status of individual species on the basis of their probability of extinction.
- The IUCN system uses a set of five quantitative criteria to assess the extinction risk of a given species. In general, these criteria consider:
  - a) The rate of population decline
  - b) The geographic range
  - c) Whether the species already possesses a small population size
  - d) Whether the species is very small or lives in a restricted area
  - e) Whether the results of a quantitative analysis indicate a high probability of extinction in the wild

### About IUCN

- IUCN is an international organization (NGO) working in the field of nature conservation and sustainable use of natural resources.
- It is involved in data gathering and analysis, research, field projects, advocacy, lobbying and education.
- The organization is best known for compiling and publishing the IUCN Red List, which assesses the conservation status of species worldwide.
- Its headquarters are in Gland, Switzerland.

- After a given species has been thoroughly evaluated, it is placed into one of several categories. (The details of each have been condensed to highlight two or three of the category's most salient points below.) In addition, three of the categories (CR, EN, and VU) are contained within the broader notion of "threatened." The IUCN Red List of Threatened Species recognizes several categories of species status:

Student Notes:



Source: IUCN Red List

- Extinct (EX)**, a designation applied to species in which the last individual has died or where systematic and time-appropriate surveys have been unable to log even a single individual.
  - Extinct in the Wild (EW)**, a category containing those species whose members survive only in captivity or as artificially supported populations far outside their historical geographic range.
  - Critically Endangered (CR)**, a category containing those species that possess an extremely high risk of extinction as a result of rapid population declines of 80 to more than 90 percent over the previous 10 years (or three generations), a current population size of fewer than 50 individuals, or other factors.
  - Endangered (EN)**, a designation applied to species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors.
  - Vulnerable (VU)**, a category containing those species that possess a very high risk of extinction as a result of rapid population declines of 30 to more than 50 percent over the previous 10 years (or three generations), a current population size of fewer than 1,000 individuals, or other factors.
  - Near Threatened (NT)**, a designation applied to species that are close to becoming threatened or may meet the criteria for threatened status in the near future.
  - Least Concern (LC)**, a category containing species that are pervasive and abundant after careful assessment.
  - Data Deficient (DD)**, a condition applied to species in which the amount of available data related to its risk of extinction is lacking in some way. Consequently, a complete assessment cannot be performed. Thus, unlike the other categories in this list, this category does not describe the conservation status of a species.
  - Not Evaluated (NE)**, a category used to include any of the nearly 1.9 million species described by science but not assessed by the IUCN.
- All else being equal, a species experiencing an 90 percent decline over 10 years (or three generations), for example, would be classified as critically endangered. Likewise, another

species undergoing a 50 percent decline over the same period would be classified as endangered, and one experiencing a 30 percent reduction over the same time frame would be considered vulnerable. It is important to understand, however, that a species cannot be classified by using one criterion alone; it is essential for the scientist doing the assessment to consider all five criteria when determining the status of the species.

### 7.3. Illegal Wildlife Trade

As per Worldwide Fund for nature, "illegal wildlife trade is estimated to reach \$20 billion per year, which makes **wildlife trafficking the world's fourth largest illicit trade**, after narcotics, human trafficking and trade in counterfeit goods. Illegal wildlife trade not only is a threat to conservation of species but also poses risks to human health and negatively impacts a country's natural resources and local communities.

**State of India's Environment 2017** highlights a 52 % spike in poaching and wildlife crimes between 2014 and 2016. In 2018, **TRAFFIC India** released a study which revealed that at least 5,772 **pangolins** were captured in India from 2009 to 2017 for illegal trade.

There are **variety of products which are demanded by the trade and poaching** includes Exotic pets and Luxuries, Bush meat, Traditional Medicines, Clothing & Jewellery made from animal fur, tusks, fins, shells, skins, horns and internal organs. In India, the **illegal wildlife trade includes diverse products** including mongoose hair; snake skins; Rhino horn; Tiger and Leopard claws, etc.

The **main reason for the unabated wildlife trafficking across India** is its porous international land borders. The **main consumer markets** are China and South East Asia, but wildlife is also smuggled to the Gulf, Europe and Northern America. Beyond India, the main transit countries are Nepal, Bangladesh, Bhutan, Sri Lanka and Myanmar.

#### Steps taken in India to counter IWT

- **Constitutional safeguard:** Under **Article 51A (g)**, it is a fundamental duty of every citizen of India to protect and improve natural environment including forests, lake, rivers and wildlife and to have compassion for living creatures.

#### Laws and Government Initiatives:

- Trade in over 1800 species of wild animals, plants and their derivative are prohibited under **the Wildlife (Protection) Act, 1972**.
- **The Prevention of Cruelty to Animals Act 1960** empower authorities to penalize and jail those who harm wildlife.

There are three main types of hunting:

- **Commercial hunting** – in which the animals are killed for profit from sale of their furs, bones or other parts;
- **Subsistence hunting** – the killing of animals to provide food for survival; and
- **Sport hunting** – the killing of animals for recreation.

#### International Organizations for control of Wildlife Trafficking:

- **TRAFFIC**, established in 1976, is a wildlife trade monitoring network and a **joint programme of WWF and IUCN**.
  - It works closely with the National and the State Governments and various agencies to help study, monitor and influence action to curb illegal wildlife trade and bring wildlife trade within sustainable levels.
- **CITES**, (the Washington Convention), signed in 1973 provides a mechanism to regulate the trade in wildlife. Under its guidance, governments all over the world have taken steps to prevent this illegal trade and bring it under control.
  - **India is a member**.
- **IFAW**: The International Fund for Animal Welfare is one of the largest animal welfare and conservation charities in the world. The organization works to rescue individual animals, safeguard populations, preserve habitat, and advocate for greater protections.
- In 2015, the United Nations General Assembly unanimously adopted a resolution for tackling illicit trafficking in wildlife. The Sustainable Development Goals has laid down specific targets to combat poaching and trafficking of protected species.

- **Indian Penal Code, 1860:** Section 428 and Section 429 reads that killing, poaching, maiming, poisoning or torturing an animal is a cognizable offence and the punishment for such act is rigorous imprisonment which may extent to five years or fine or both.
- **Wildlife Crime Control Bureau (WCCB)** is a statutory multi-disciplinary body established by the Government under the Ministry of Environment and Forests, to combat organized wildlife crime in the country, under **Wild Life (Protection) Act, 1972**.
- **Other initiatives:**
  - **Participation of local community:** Five crore, people living around national parks and sanctuaries are working as partners in environment conservation.
    - ✓ A **15-year National Wildlife Action Plan (2017-31)** with a special focus on peoples' participation has been launched.
  - **Demand-reduction campaigns:** In May 2019, the WCCB launched a campaign in collaboration with the UN Environment named '**Not all animals migrate by choice**' **campaign launched to raise awareness on illegal wildlife trade** at airports across India.
    - ✓ Tiger, Pangolin, Star Tortoise and Tokay Gecko featured in the campaign.

## 7.4. Human- Animal Conflict

In India, human-animal conflict is seen across the country in a variety of forms, including monkey menace in the urban centres, crop raiding by ungulates and wild pigs, depredation by elephants, cattle lifting and human death and injury by tigers, leopards and other wild animals.

In the Monsoon session (2019), the Union Environment Ministry informed the Lok Sabha that 2398 people in India were killed by elephants while tigers claimed 224 lives in the last five years.

Human-animal conflict occurs both inside Protected Areas as well as outside Protected Areas. The intensity of the conflict is generally more in areas outside Protected Area network than inside.

Such conflict situations generally lead to **growing antipathy among the people towards wildlife conservation** resulting in retaliatory killings or injuries to animals. Conflict-related mortality of wildlife does not bode well for conservation. Moreover, **loss to agricultural production and livestock** adds to the farmer's distress.

### Reasons for Human-Wildlife Conflicts:

- **Habitat loss and fragmentation-** thereby increasing the chances of wild animals moving out of natural habitat and encountering cultivation and people. E.g. there exist clear evidence for conflict between Asian elephants and agriculture. At the same time, **local overabundance** of elephants may also cause them to move into human production landscapes as seen in parts of southern India.
- **Increasing Population:** For e.g. the substantial recovery of once dwindling populations of ungulates such as **black buck and nilgai** has also resulted in increased conflict with agriculture in northwest and central India.
- Presence of a large number of animals and birds **outside the notified protected areas**. For e.g. around 29% of tigers are outside tiger reserves and 67% of elephants are outside protected areas.
- **Land Use Changes:** Land-use change outside forest areas, with irrigation from tube wells and canals aiding the cultivation of crops for longer time periods may also attract animals such as elephants. **Highly productive crop fields that provide more palatable and nutritious forage** also promote conflicts with herbivores
- **Adverse climatic events** such as droughts have been implicated in increased conflicts between lions and people as well as elephants and people.
- **Adaptability:** Many wildlife species have adapted to the changing landscape through behavioural changes for crop raiding. This is true of elephants and of certain commensal

- wildlife species such as black buck, nilgai, rhesus macaque of northern India, as well as the bonnet macaque of southern India.
- Even non-commensal animals such as leopard have adapted to surviving in human-inhabited areas.
  - Another reason why animals move to new geographical areas is the government's **practice of translocating** them.
  - Wildlife species are also impacted by accidental **deaths due to development of infrastructures**, such as railway lines, roads, electricity wires etc.

### Government initiatives

- **Governance framework-**
  - The management of human-animal conflict is handled by **State Government**.
  - The Union Government has issued **guidelines** in context of human-wildlife conflict to the Chief Wildlife Wardens of all the State Governments/Union Territory Administrations in 2014 and 2015.
  - The **National Tiger Conservation Authority (NTCA)** has brought out several Standard Operating Procedures (SOPs) to deal with various challenges of the human-tiger interface.
- **National Wildlife Action Plan (NWAP-3) (2017-2031)** prescribes guidelines to mitigate the Human- Wildlife Conflict (HWC).
  - These include creation of **national, regional and state level database of HWC, scientific management** of wildlife populations as well as land-use practices **and** comprehensive, species- and region-specific **conflict-mitigation plans**.
  - It further talks about encouraging **community participation** in the HWC mitigation through extensive **education and awareness programmes** by well-trained and adequately equipped workforce.
  - It provides for a **Centre of Excellence (CoE) on HWC mitigation**, under the aegis of the MoEFCC, to address, develop and implement long-term and short-term measures to reduce the adverse impacts of HWC.
  - **Draft National Forest Policy, 2018** also reasserts the objectives and guidelines of **NWAP-3**.
- **Provisions for culling of errant animals-**
  - The Wildlife (Protection) Act, 1972 empower the concerned authorities to deal with problematic animals including **declaring any protected species as vermin and to be culled**. E.g. Monkeys in Himachal Pradesh and Nilgai and Wild Boar in Bihar were declared vermin in recent times.
  - **Mass sterilisation** drive is conducted to control the faster population growth of monkeys and boars as seen in Himachal Pradesh.
- A scheme to **Augment Fodder & Water in Protected Areas/Forest Areas** for augmenting the availability of forage and water for wild herbivores in Protected Areas (PAs)/Forests where poor habitat is known as the cause of significant human-wildlife conflict has been initiated by the MoEFCC.
- Uttar Pradesh government has given its in-principle approval to bring man-animal conflict under listed disasters in State Disaster Response Fund to ensure better coordination and relief during such incidents.
- The National Green Tribunal (NGT) has asked the Ministry of Environment, Forests and Climate Change (MoEF&CC) to consider **declaring all elephant corridors in India as eco-sensitive zones**.
- **Indo-German Human-Wildlife conflict mitigation project** with an objective to frame guidelines and standard operating procedures (SOPs) so that humans and wildlife could co-exist.

- It also **provides technical support** at the national level and in selected states for effective implementation of conflict mitigation measures so that both human and animal lives could be saved by **shifting from 'conflict' to 'co-existence' mode**.

#### Landscape-Level Approach to Address Human-Elephant Conflicts

- A study involving close monitoring of elephants on daily basis for two years in Karnataka has concluded that landscape-level management is necessary for mitigating human-elephant conflicts.
- As per the Food and Agricultural Organisation (FAO), Landscape level strategy deals with large-scale processes in an integrated and multidisciplinary manner, combining natural resources management with environmental and livelihood considerations.
- It can be used as a viable solution for minimising the Human-Elephant conflicts, such as-
  - **Scientific management of Monoculture Plantations:** Since elephants prefer to stay in monoculture plantations (for example **monoculture plantations of Acacia, Eucalyptus**), forest departments should think strategically when to clear-fell these plantations. If these places are not available, elephants will start using **agriculture habitats** more frequently which may aggravate human-elephant conflict situation
  - **Regular Monitoring of land-use practices:** Proper planning needs to be done before making any change in the land –use practices in habitats such as coffee, agriculture or forest patches as it may have **negative effects on elephant conservation** or **aggravate human-elephant conflict**.
  - **Preserving Forest remnants and monoculture refuges:** These refuges are vital for elephants and helpful in containing conflicts as most of the forest is fragmented



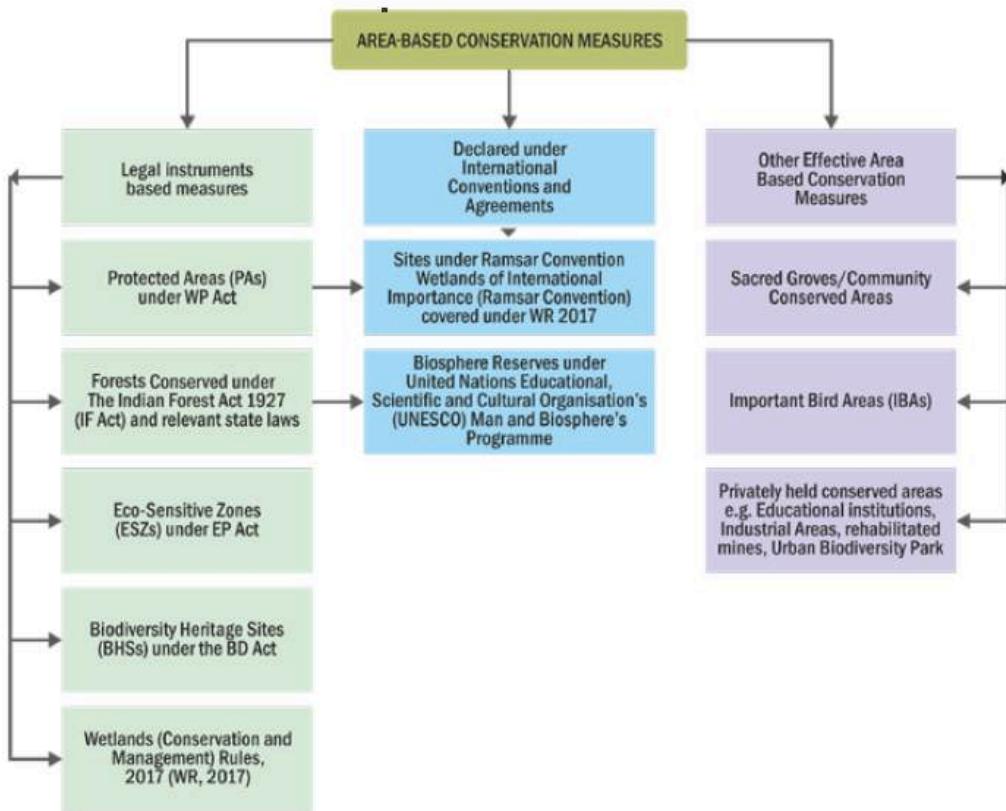
## 7.5. Conservation Strategies

Conservation needs different strategies, they can be species based or habitat based or ecosystem based. Some species are given importance at national level while some need treatment at international levels. Conservation efforts can be largely grouped into the following two categories:

- **In-situ conservation** means “on-site conservation”. It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators. The benefit to in-situ conservation is that it maintains recovering populations in the surroundings where they have developed their distinctive properties.
- **Ex-situ conservation** means, literally “off-site conservation”. It is the process of protecting population of an endangered species of plant or animal by removing it from an unsafe or threatened habitat and placing it, or part of it, under the care of humans. While ex-situ conservation is comprised of some of the oldest and best known conservation methods known to human, it also involves newer, sometimes controversial laboratory methods.

### 7.5.1. In-Situ conservation methods

- **Protection of Habitats:** This approach deals with maintaining species in their natural habitats, which is believed to be the best way to maintain the earth's biological diversity. Thus **Protected Areas** play a very important role in in-situ conservation of species, particularly threatened species, by ensuring conservation of their habitat.



- Species specific program:** Certain species have been identified as needing a concerted and specifically directed protection effort. Project Tiger, Project Elephant and Project crocodile are examples of focusing on single species through conserving their habitats.

### 7.5.2. Ex-Situ conservation Strategies

Ex-situ conservation is comprised of some of the oldest and best known conservation methods known to human, it also involves newer, sometimes controversial laboratory methods.

Ex situ conservation has **certain limitations** for conservation of animals. These include adaptation problems, loss of genetic variability due to inbreeding, and concentration in small place, surplus animals, and continuity in funds. Research on captive population can provide insight into the basic biology of the species and suggest new conservation strategies. Some of the important ex-situ conservation strategies are:

- Botanical gardens, zoos, etc.** To complement in-situ conservation efforts, ex-situ conservation is being undertaken through setting up botanic gardens, zoos, medicinal plant parks, etc by various agencies. The Indian Botanical Garden in Howrah (West Bengal) is over 200 years old. Other important botanical gardens are in Ooty, Bangalore and Lucknow. The most recent one is The Botanical Garden of Indian Republic established at NOIDA, near Delhi in April, 2002.
- Gene Banks:** Ex-situ collection and preservation of genetic resources is done through gene banks and seed banks. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi preserves seeds of wild relatives of crop plants as well as cultivated varieties; the National Bureau of Animal Genetic Resources at Karnal, Haryana maintains the genetic material for domesticated animals, and the National Bureau of Fish Genetic Resources, Lucknow for fishes.
- Cryopreservation:** (“freeze preservation”) is particularly useful for conserving vegetative propagated crops. Cryopreservation is the storage of material at ultra low temperature of liquid nitrogen (-196°C) and essentially involves suspension of all metabolic processes and activities. Cryopreservation has been successfully applied to meristems, zygotic and somatic

embryos, pollen, protoplasts cells and suspension cultures of a number of plant species.

- **Conservation at molecular level (DNA level):** In addition to above, germplasm conservation at molecular level is now feasible and attracting attention. Cloned DNA and material having DNA in its native state can all be used for genetic conservation. Furthermore, non-viable material representing valuable genotypes stored in gene banks can all be used as sources of DNA libraries from where a relevant gene or a combination of genes can be recovered.

## Student Notes:

- **Cultural model of Conservation**

- This is based on a **respect for the rights of indigenous peoples** and other bearers of “traditional knowledge” and prevents social conflicts.
  - It involves forest dwellers in forest management and governance and acknowledges traditional rights of tribal over minor forest produce and provisions for making conservation more effective and more transparent.
  - It is different from **colonial Model of Conservation** where human presence is taken as threat to nature and which **denied indigenous peoples’ rights** and provoked long-term social conflict.
  - The **Kinshasa Resolution of 1975** (under IUCN) provides international recognition to cultural model of conservation. It acknowledges the importance of traditional ways of life and land ownership and called on governments to maintain and encourage customary ways of living.

#### **Application by Cultural model of conservation in different tribes of India**

- **Bishnoi Tribe of Rajasthan:** Bishnois consider **trees** as sacred and protect the **entire ecosystem** including animals and birds that exists in their villages. Tribe has organized their own **Tiger Force** which is a brigade of youth actively pursue wildlife protection.
  - **Chenchu Tribe of Andhra Pradesh:** They are involved in tiger conservation at Nagarjunasagar Srisailam Tiger Reserve (NSTR). Tribe has been coexisting with **tigers and wild animals** for long without disturbing the ecological balance, which ensures enough water and fodder for the herbivores.
  - **Maldhari Tribe in Junagadh (Gujarat):** The success of lion conservation in Gir forest area is due to **peaceful coexistence** of tribe with lions.
  - **Bugun Tribe of Arunachal Pradesh:** The tribe using Community-led conservation initiatives **and traditional knowledge helped to protect the critically endangered bird Bugun Liocichla**. For its efforts Singchung Bugun Community Reserve won the India Biodiversity Award 2018.
  - **Nyishi tribe of Arunachal Pradesh** in conserving hornbills in the **Pakke/Pakhui** Tiger Reserve. Recently, government of Arunachal Pradesh declared the Pakke Paga Hornbill Festival (PPHF)—the **state's only conservation festival**, as a '**state festival**'.

## 7.6. UPSC Previous Year Questions

Prelims



**Answer: (b)**

- 2.** The “Red Data Books” published by the International Union for Conservation of Nature and Natural Resources (IUCN) contain lists of: (2011)

  1. Endemic plant and animal species present in the biodiversity hotspots,
  2. Threatened plant and animal species.
  3. Protected sites for conservation of nature and natural resources in various countries.

Select the correct answer using the codes given below:

|             |            |
|-------------|------------|
| (a) 1 and 3 | (b) 2 only |
| (c) 2 and 3 | (d) 3 only |

**Answer: (b)**

3. Which of the following can be threats to the biodiversity of a geographical area?(2012)

1. Global warming
2. Fragmentation of habitat
3. Invasion of alien species
4. Promotion of vegetarianism

Select the correct answer using the codes given below :

- |                     |                   |
|---------------------|-------------------|
| (a) 1, 2 and 3 only | (b) 2 and 3 only  |
| (c) 1 and 4 only    | (d) 1, 2, 3 and 4 |

**Answer: (a)**

4. Why is a plant called Prosopis juliflora often mentioned in news ? (2018)

- (a) Its extract is widely used in cosmetics.
- (b) It tends to reduce the biodiversity in the area in which it grows.
- (c) Its extract is used in the synthesis of pesticides.
- (d) None of the above

**Answer: (b)**

## 7.7. Vision IAS Previous Year Questions

1. *What are the causes for the loss of biodiversity? Why is it necessary to conserve biodiversity? Explain the in-situ and ex-situ measures of conservation.*

**Approach:**

- Explain the causes of biodiversity loss.
- Give reasons to conserve biodiversity.
- Explain the in-situ and ex-situ measures of biodiversity conservation.

**Answer:**

The biological wealth of our planet has been declining rapidly. The current species extinction rates are estimated to be 100 to 1,000 times faster than in the pre-human times. This accelerated rate is largely due to human activities.

### Causes of biodiversity loss

- **Habitat loss and fragmentation:** This is the most important cause driving species to extinction. Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. Fragmentation of habitats leads to population decline.
- **Over-exploitation:** Many species extinctions in the last 500 years were due to overexploitation by humans. Presently many marine fish populations around the world are over harvested, endangering their continued existence.
- **Alien species invasions:** When alien species are introduced, some of them turn invasive, and cause decline or extinction of indigenous species.
- **Co-extinctions:** When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct.

### Why should we conserve biodiversity?

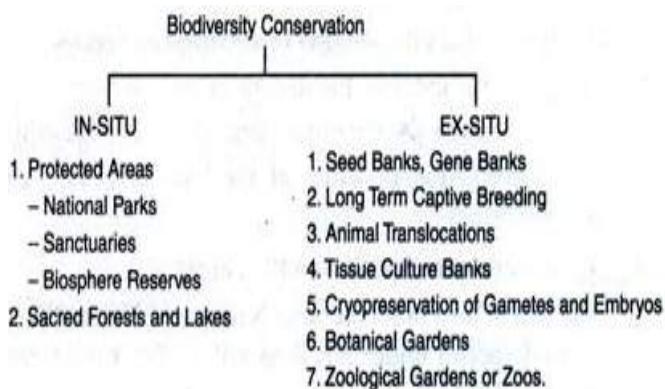
- **Narrowly utilitarian arguments:** humans derive countless direct economic benefits from nature. With increasing resources put into search for plant and animal species from which medicinal drugs and other commercially valuable compounds can be obtained (bioprospecting), nations endowed with rich biodiversity can expect to reap enormous benefits.
- **Broadly utilitarian argument:** biodiversity plays a major role in many ecosystem services and aesthetic pleasures that nature provides. It is not possible to put a monetary value on such services.

Student Notes:

- **Ethical argument:** every species has an intrinsic value. Humans have a moral duty to care for their well-being and pass on the biological legacy in good order to future generations.

Student Notes:

### Biodiversity conservation



- **In-situ measures** – In situ conservation, the endangered species are protected in their natural habitat so that the entire ecosystem is protected. Examples are biodiversity hotspots, biosphere reserves, national parks, wildlife sanctuary, sacred grooves etc.
- **Ex-situ measures** - In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. Examples are zoological parks, botanical gardens, seed banks etc.

Conservation of biodiversity is a collective responsibility of entire mankind. Therefore, appropriate measures must be taken for its conservation and sustainable utilization of its benefits.

- 2. Define the term *invasive species* and provide examples from flora and fauna in India. What are the threats associated with the expansion of invasive species? In this context also discuss measures to address these threats.**

#### Approach:

- Briefly explain the concept of invasive species.
- Cite data and example of invasive species from fauna and flora in India.
- Discuss the threats associated with the expansion of these species.
- Finally discuss the measures to address these threats.

#### Answer:

According to Convention on Biological Diversity (CBD), invasive alien species are species that are established outside of its natural past or present distribution, whose introduction or spread threatens biological diversity. These are found in all taxonomic groups such as animals, plants, fungi etc and can affect all types of ecosystems. Many invasive species are successful because they have no natural predators in the environment. The rise in spread of invasive species is attributable to the increase in international trade and globalization.

Zoological survey of India has made a list of 157 invasive alien species out of which 58 are found on land and freshwater and 99 are found in marine ecosystem. Some of the common animal species found in India are African Apple Snail, Papaya Mealy Bug affecting papaya crops in Assam and West Bengal, Cotton Mealy Bug threatening cotton crops in Deccan, Amazon Sailfin Catfish destroying fish population in wetlands etc.

Also, 173 species of invasive exotic plants such as Cassia Uniflora, Prosopis Juliflora etc. are also found in India.

Student Notes:

Threats associated with expansion of these species are:

- According to IUCN, around 5 to 20 percent alien species become invasive and is second most serious threats to the biodiversity after global warming. These species may threaten indigenous species by competing with them for the same resources. They can also change the food chain.
- Invasive species have been identified as an important factor of extinction.
- Many invasive alien species are major pests for the agriculture, forestry and fishing industries.
- Alien species can also pose a health hazard or function as disease carriers.
- At the economic front they may cause problems for recreational activities and tourism.

Measures taken to address the threats of alien invasive species are:

- Article 8(h) of CBD and Aichi target 9 aimed at controlling or eradicating alien species, by 2020.
- Global invasive species program to support Article 8(h) of CBD.
- IUCN's invasive species specialist group has been working to promote and facilitate the exchange of information and knowledge to ensure linkages between policy makings.
- Sustainable development goal (SDG) 15, which is aimed at controlling and eradicating it.
- Invasive alien species management through border control measures such as screening routes of transmission of these species.

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# CHAPTER - 8 - PROTECTED AREAS NETWORK

Student Notes:

## 8. Protected Areas Network

### 8.1. Protected Areas of India

- Protected areas are those in which human occupation or at least the exploitation of resources is limited. The definition that has been widely accepted across regional and global frameworks has been provided by the **International Union for Conservation of Nature (IUCN)** in its categorization guidelines for protected areas.
- There are several kinds of protected areas, which vary by level of protection depending on the enabling laws of each country or the regulations of the international organizations involved.
- The term "**protected area**" also includes Marine Protected Areas, the boundaries of which will include some area of ocean, and Transboundary Protected Areas that overlap multiple countries which remove the borders inside the area for conservation and economic purposes.
- A **National Board for Wildlife (NBWL)** chaired by the Prime Minister of India provides for policy framework for wildlife conservation in the country.
- India's conservation planning is based on the philosophy of identifying and protecting representative wild habitats across all the ecosystems. The Indian Constitution entails the subject of forests and wildlife in the Concurrent list. ( Figure as of December 2019)

#### IUCN - World Database of Protected Areas

- The World Database on Protected Areas (WDPA) is the largest assembly of data on the world's terrestrial and marine protected areas.
- The WDPA is a **joint venture** between the **United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)** and the **International Union for Conservation of Nature (IUCN) World Commission on Protected Areas (WCPA)**.
- The role of custodian is allocated to the Protected Areas Programme of UNEP-WCMC, based in Cambridge, UK, who have hosted the database since its creation in 1981.
- The WDPA delivers invaluable information to decision-makers around the world, particularly in terms of measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets.

| No.                                | Total Area (Km <sup>2</sup> ) | Coverage % of Country |
|------------------------------------|-------------------------------|-----------------------|
| <b>National Parks (NPs)</b>        | 101*                          | 40,564.03             |
| <b>Wildlife Sanctuaries (WLSs)</b> | 553                           | 119,756.97            |
| <b>Conservation Reserves (CRs)</b> | 86                            | 3,858.25              |
| <b>Community Reserves</b>          | 163                           | 833.34                |
| <b>Protected Areas (PAs)</b>       | <b>903</b>                    | <b>1,65,012.59</b>    |
|                                    |                               | <b>5.02</b>           |

### 8.2. Wildlife Sanctuaries

- Any area other than area comprised with any reserve forest or the territorial waters can be **notified by the State Government** to constitute as a sanctuary if such area is of adequate ecological, faunal, floral, geomorphological, natural. or zoological significance, for the purpose of protecting, propagating or developing wildlife or its environment.
- Some restricted human activities are allowed inside the Sanctuary area.
- There are 553 existing wildlife sanctuaries in India covering an area of 119776.00 km<sup>2</sup>, which is 3.64 % of the geographical area of the country (National Wildlife Database, December, 2019).

### 8.3. National Parks

Student Notes:

- An area, whether within a sanctuary or not, can be notified by the state government to be constituted as a National Park, by reason of its ecological, faunal, floral, geomorphological, or zoological association or importance, needed to for the purpose of protecting & propagating or developing wildlife therein or its environment.
- No human activity is permitted inside the national park except for the ones permitted by the Chief Wildlife Warden of the state.
- There are 101 existing national parks in India covering an area of 40,564.00 km<sup>2</sup>, which is 1.23% of the geographical area of the country (National Wildlife Database, December, 2019).



| Wildlife Sanctuaries  | National Parks   |
|---|--|
| <ol style="list-style-type: none"> <li>Wildlife Sanctuary, as the name implies, is the place that is reserved exclusively for wildlife use, which includes animals, reptiles, insects, birds, etc. wild animals, especially those in danger of extinction and the rare ones, so that they can live in peace for a lifetime and keep their population viable.</li> <li>It has relatively less restrictions and is open to people, without the requirement of official permission.</li> <li>It does not have fixed boundaries and human activities are permitted to a specified limit.</li> </ol> | <ol style="list-style-type: none"> <li>National parks provide protection to the entire ecosystem, that is, flora, fauna, landscape, etc. of that region. The national parks not only conserve wildlife but also provide a diversion of environmental and landscape heritage in a manner that does not harm it, in order to provide enjoyment to future generations.</li> <li>National parks are given a greater degree of protection, with human activity greatly restricted.</li> <li>Boundaries are fixed by the administration. Only certain areas can be visited and only activities permitted by the chief wildlife warden of the state are allowed in the park.</li> </ol> |
| <b>Similarities include:</b>  |  |
| <ol style="list-style-type: none"> <li>The WildLife (Protection) Act (WPA) of 1972 provided for the declaration of National Parks by the State Government in addition to the declaration of wildlife sanctuaries. The Central Government may also declare, Wild Life Sanctuary and National Park under certain conditions.</li> </ol>   |  |

### 8.4. Marine Protected Areas

- A marine protected area (MPA) is essentially a space in the ocean where human activities are more strictly regulated than the surrounding waters - similar to parks we have on land. These places are given special protections for natural or historic marine resources by local, state, territorial, native, regional, or national authorities.

- The MPAs in marine environment in India are primarily classified into following categories:
  - Category-I:** This covers National Parks and Sanctuaries and having entire areas in intertidal/sub-tidal or mangroves, coral reefs, creeks, seagrass beds, algal beds, estuaries, lagoons.
  - Category-II:** This includes Islands, which have major parts in marine ecosystem and some part in terrestrial ecosystem.
  - Category-III A:** This includes sandy beaches beyond intertidal line but occasionally interacting with the seawater.
  - Category-III B:** This includes ever green or semi ever green forests of Islands.
- The Marine Protected Areas (MPAs) in India comprise of a 33 national parks and wildlife sanctuaries designated under the Wildlife (Protection) Act, 1972, encompassing a few of the country's richest coastal habitats.

Student Notes:

## 8.5. Community Reserves & Conservation Reserves

- Conservation reserves and community reserves in India are terms denoting protected areas of India which typically act as buffer zones to or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India.
- Such areas are designated as conservation areas if they are uninhabited and completely owned by the Government of India but used for subsistence by communities and community areas if part of the lands are privately owned.
- These protected area categories were first introduced in the **Wildlife (Protection) Amendment Act of 2002** – the amendment to the Wildlife Protection Act of 1972.
- These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land, and land use.

## 8.6. Regulations/Laws relating to Protected Areas (PAs)

- The PAs are constituted and governed under the provisions of the Wild Life (Protection) Act, 1972, which has been amended from time to time, with the changing ground realities concerning wildlife crime control and PAs management.
- Implementation of this Act is further complemented by other Acts viz. Indian Forest Act, 1927, Forest (Conservation) Act, 1980, Environment (Protection) Act, 1986 and Biological Diversity Act, 2002 and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.
- In order to strengthen and synergise global wildlife conservation efforts, India is a party to major international conventions viz. Convention on International Trade in Endangered Species of wild fauna and flora (CITES), International Union for Conservation of Nature (IUCN), International Convention for the Regulation of Whaling, UNESCO-World Heritage Committee and Convention on Migratory Species (CMS).
- The Wildlife Crime Control Bureau of the Central Government supplements the efforts of provincial governments in wildlife crime control through enforcement of CITES and control of wildlife crimes having cross-border, interstate and international ramifications.

## 8.7. Other Areas of Importance for Conservation

### 8.7.1. Eco-Sensitive Zones

- ESZs are ecologically important areas **notified under the Environment Protection Act** to be protected from industrial pollution and unregulated development.
- According to the Environment (Protection) Act, 1986, the government can prohibit industrial operations such as mining, sand quarrying and building thermal power plants in sensitive areas.
- To categorise an area as ecologically sensitive**, the government looks at topography, climate and rainfall, land use and land cover, roads and settlements, human population, biodiversity corridors and data of plants and animal species.

- As per orders of the Supreme Court, **no project can be allowed within 10 km of the boundary** of national parks and sanctuaries without the approval of the National Board of Wildlife (NBWL), the highest body on wildlife regulatory issues, unless a site-specific Eco-Sensitive Zone (ESZ) is notified around that park or sanctuary.
- **Purpose for declaring ESZ** around National Parks and Sanctuaries is to create some kind of “shock absorber” for the protected areas.
  - They would also act as transition zone from areas of high protection to areas involving lesser protection.
  - The activities in the ESZ would be of a **regulatory nature rather than prohibitive nature**, unless and otherwise so required.
- **Extent of ESZ:** The width of the ESZ and type of regulations would **differ from one protected area (PA) to other**. However, as a general principle the width of the ESZ could go up to 10 kms around a PA (may not be uniform all around it) as provided in the Wildlife Conservation Strategy-2002.
  - In case where sensitive corridors, connectivity and ecologically important patches, crucial for landscape linkages, are even beyond 10 kms width, these should be included in the ESZ.
- **Nature of Activities in ESZ:** While some of the activities could be allowed in all the ESAs, others will need to be regulated/ prohibited. However, which activity can be regulated or prohibited and to what extent, would have to be PA specific. There are 3 categories of activities-
  - **Prohibited**- commercial mining, polluting industries, major hydroelectric projects etc.
  - **Restricted with safeguards (Regulated)** - Felling of trees, Establishment of hotels and resorts, Drastic change of agriculture system, widening of roads, introduction of exotic species etc.
  - **Permissible**- Rainwater Harvesting, Organic farming, Ongoing Agricultural Practices etc.

### 8.7.2. Coastal Regulation Zones (CRZ)

To conserve and protect the coastal environment, and to promote sustainable development based on scientific principles Ministry of Environment and Forest and Climate Change (MoEFCC), under the Environment (Protection) Act, 1986, notified the CRZ Notification in 1991, subsequently revised in 2011 and 2018.

**CRZ:** The MoEFCC declares the coastal stretches and the water area up to territorial water limit, excluding the islands of Andaman and Nicobar and Lakshadweep and the marine areas surrounding these islands, as Coastal Regulation Zone as under:

- Land area from **High Tide Line (HTL)** to 500 mts on the landward side.
- Land area between **HTL to 50 mts or width of the creek** whichever is less on the landward side along the tidal influenced water bodies connected to the sea.
- The **intertidal zone** i.e. land area between the HTL and the Low Tide Line( LTL).
- The water and the bed area **between the LTL to the territorial water limit** (12 Nautical miles (Nm)) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank of tidal influenced water bodies.

#### Classification of the CRZ

- **CRZ-I** areas are environmentally most critical and are classified as under:
  - **CRZ-I A:** The ecologically sensitive areas and the geomorphological features which play a role in the maintaining the integrity of the coast viz. **Mangroves; Corals and coral reefs; Sand Dunes; Biologically active Mudflats; Salt Marshes; Turtle nesting grounds; protected areas** etc.
  - **CRZ-I B:** The intertidal zone.
- **CRZ-II:** The developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas.
- **CRZ-III:** Land areas that are relatively undisturbed (viz **rural areas** etc) and those do not fall under CRZ-II. CRZ-III is further classified as:
  - **CRZ-III A:** Areas with population density more than 2161 per sq km as per 2011 census.

- **CRZ-III B:** areas with population density of less than 2161 per sq km, as per 2011 census.
- **CRZ- IV:** It constitutes the water area and further classified as:
  - **CRZ- IV A:** The water area and the sea bed area between the LTL up to 12Nm on the seaward side.
  - **CRZ- IV B:** the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., **salinity of five parts per thousand (ppt) during the driest season of the year.**

#### **Salient Features of Coastal Regulation Zone (CRZ) Notification, 2018:**

- Easing FSI norms: This notification de-freezes the restrictions imposed on Floor Space Index (FSI) or the Floor Area Ratio (FAR) under CRZ, 2011 in accordance to 1991 Development Control Regulation (DCR) levels.
- No development zone (NDZ) reduced for densely populated areas: For CRZ-III areas
  - **CRZ-III A areas** shall have a NDZ of **50 meters from the HTL** on the landward side as against 200 meters from the HTL stipulated in the CRZ Notification, 2011.
  - **CRZ-III B areas** shall continue to have an **NDZ of 200 meters from the HTL**.
- Tourism infrastructure for basic amenities to be promoted: The notification allows for temporary tourism facilities such as shacks, toilet blocks, change rooms, drinking water facilities etc on beaches at a minimum distance of 10 metres from HTL. Such temporary tourism facilities are also now permissible in the NDZ of the CRZ-III areas.
- CRZ Clearances streamlined:
  - CRZ clearances are needed only for projects located in CRZ-I and CRZ IV.
  - States to have the powers for clearances w.r.t CRZ-II and III with necessary guidance.
- **NDZ of 20 meters** has been stipulated for all Islands: in the wake of space limitations and unique geography and to bring uniformity in treatment of such regions.
- All Ecologically Sensitive Areas have been accorded special importance: Through Specific guidelines related to their conservation and management plans.
- Pollution abatement has been accorded special focus: By permitting construction of treatment facilities in CRZ-I B area subject to necessary safeguards.
- Defence and strategic projects have been accorded necessary dispensation.

**CRZ helps in reducing the ecological vulnerability through:**

- **Regulated activities in ecologically most sensitive areas (CRZ-I A)**
  - Regulate activities such as Eco-tourism subject to approved Coastal Zone Management Plans(CZMPs), exceptional construction of public utilities in the mangrove buffer etc.
  - Construction of roads and roads on stilts, by way of reclamation shall be **permitted only in exceptional cases** for defence, strategic purposes and public utilities, subject to a detailed marine/terrestrial environment impact assessment, to be **recommended by** the Coastal Zone Management Authority and **approved by** the MoEFCC.
  - **compensatory plantation of mangroves (Minimum three times the mangrove area affected/destroyed/cut).**
- **Areas requiring special consideration in the CRZ**
  - **Critically Vulnerable Coastal Areas (CVCA):** Sunderban region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 such as Gulf of Khambat and Gulf of Kutchchh in Gujarat, Malvan, Achra-Ratnagiri in Maharashtra, Karwar and Coondapur in Karnataka, Vembanad in Kerala, Gulf of Mannar in Tamil Nadu, Bhaitarkanika in Odisha, Coringa, East Godavari and Krishna in Andhra Pradesh shall be treated as CVCA and **managed with the involvement of coastal communities** including fisher folk who depend on coastal resources for their sustainable livelihood.
  - CRZ for **inland Backwater islands** and islands along the mainland coast.
  - CRZ falling **within municipal limits of Greater Mumbai.**

- Enhanced activities in the coastal regions thereby promoting economic growth while also respecting the conservation principles of coastal regions.
  - Boost tourism in terms of more activities, more infrastructure and more opportunities in creating employment opportunities.
  - greater opportunities for development of densely populated rural areas in the CRZs.
- CRZ, 2018 is also in sync with the thrust being given to port-led industrialisation and the Coastal Economic Zones projects.
- Additional opportunities for affordable housing which will benefit not only the housing sector but the people at large looking for shelter.
- It is expected to rejuvenate the coastal areas while reducing their vulnerabilities.

### Concerns

The new notification has done away with or diluted many stringent restrictions in place at coastal areas. The emphasis of the new CRZ norms is on promotion of tourism facilities, quicker dispensation of defence and strategic projects and liberal licensing for the installation of treatment plants.

- Eco-sensitive regions could see flurry of construction activity thereby hampering the coastal eco system and biodiversity.
- The notification violates the balance between ecosystem and development. The mandatory 50 m buffer zone for mangrove forest in private land with an expanse of more than 1,000 sq m has been done away with.
- The fishermen are worried that the entry of the tourism sector will attract the real estate lobbies, who will eventually displace the coastal community and deny them the access to the seas.
- Further, the reduction of NDZ is done without taking consideration of sea level rise. The coastline is already vulnerable due to erosion, fresh water crisis and loss of livelihoods. The new changes will only increase this vulnerability and promote commercialisation of the coast.
- The Hazard Line, mapped by the Survey of India has, however, been de-linked from the CRZ regulatory regime and will be used only as a tool for disaster management and planning of adaptive and mitigation measures.
- The treatment facilities, allowed in CRZ-I to reduce coastal pollution, means several ecologically fragile areas will have sewage treatment plants transferring pollution from land to sea.
- The notification permits activities like reclamation of land for commercial activities, interference with sand dunes, large scale recreation and drawing of ground water within the 200-500 metres from the HTL, which is detrimental to the coastal ecology and that will displace the local communities and affect the bio-diversity.

**Integrated Coastal Zone Management (ICZM):** This concept was born in 1992 during the Earth Summit of Rio de Janeiro. This was a World Bank assisted project with the objective of building national capacity for implementation of comprehensive coastal management approach in the country, and piloting the integrated coastal zone management approach in states of Gujarat, Orissa and West Bengal.

- The project's multi-sectoral and integrated approach represents a paradigm shift from the traditional sector-wise management of coastal resources where numerous institutional, legal, economic and planning frameworks worked in isolation, at times with conflicting aims and outputs.
- The project puts equal emphasis on conservation of coastal and marine resources, pollution management, and improving livelihood opportunities for coastal communities.

The sustainable management depends on the nature of the social system, comprising political, economic and industrial infrastructure and its linkages, with the knowledge about coastal systems as well as local communities. **India need to move from a purely regulatory approach towards an Integrated Coastal Zone Management (ICZM).**

### 8.7.3. Sacred Groves in India

- Sacred groves comprise of patches of forests or natural vegetation – from a few trees to forests of several acres – that are usually dedicated to local folk deities (Example – Ayyanar and Amman) or tree spirits (Vanadevatais). These spaces are protected by local communities because of their religious beliefs and traditional rituals that run through several generations.
- The degree of sanctity of the sacred forests varies from one grove to another. In some forests even the dry foliage and fallen fruits are not touched. People believe that any kind of disturbance will offend the local deity, causing diseases, natural calamities or failure of crops. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. In other groves, deadwood or dried leaves may be picked up, but the live tree or its branches are never cut. For example, the Gonds of central India prohibit the cutting of a tree but allow fallen parts to be used.

#### 8.7.3.1 Classification of Sacred Groves

- Traditional Sacred Groves – It is the place where the village deity resides, who is represented by an elementary symbol
- Temple Groves – Here a grove is created around a temple and conserved.
- Groves around the burial or cremation grounds.

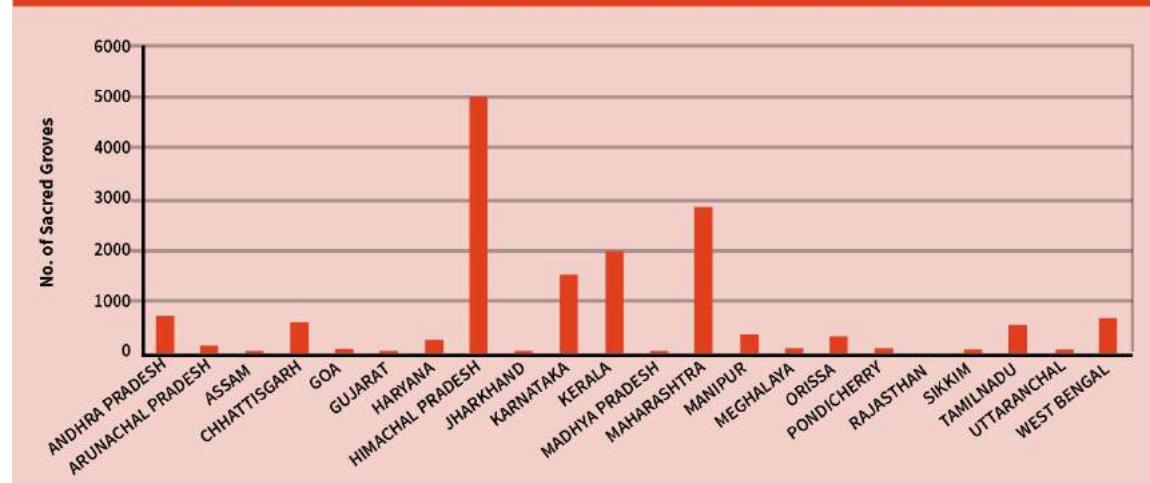
#### 8.7.3.2. Ecological Significance

- **Conservation of Biodiversity** – The sacred groves are important repositories of floral and faunal diversity that have been conserved by local communities in a sustainable manner. They are often the last refuge of endemic species in the geographical region.
- **Recharge of aquifers** – The groves are often associated with ponds, streams or springs, which help meet the water requirements of the local people. The vegetative cover also helps in the recharging the aquifers.
- **Soil conservation** - The vegetation cover of the sacred groves improves the soil stability of the area and also prevents soil erosion.

#### 8.7.3.3. Distribution of Sacred Groves in India

In India, sacred groves are found all over the country and abundantly along the western ghats in the states of Kerala and Karnataka. Although, there has been no comprehensive study on the sacred groves of the entire country, experts estimate the total number of sacred groves in India could be in the range of 100,000 – 150,000.

**Statewise Distribution of Sacred Groves in India**



## List of SACRED GROVES

| Sl.No. | STATE             | LOCAL TERM FOR SACRED GROVES                                   |
|--------|-------------------|--|
| 1      | ANDHRA PRADESH    | Pavithravana   |
| 2      | ARUNACHAL PRADESH | Gumpa Forests (Sacred Groves attached to Buddhist monasteries) |
| 3      | GOA               | Deorai, Pann   |
| 4      | JHARKHAND         | Sarana   |
| 5      | KERALA            | Kavu, Sara Kavu  |
| 6      | MAHARASHTRA       | Davrai, Devrahati, Devgudi                                     |
| 7      | MANIPUR           | Gamkhab, Mauhak (sacred bamboo reserves)                       |
| 8      | MEGHALAYA         | Ki Law Lyngdoh, Ki Law Kyntang, Ki Law Niam                    |
| 9      | PUDUCHERRY        | Kovil Kadu   |
| 10     | RAJASTHAN         | Orans, Kenkris, Jogmaya  |
| 11     | TAMIL NADU        | Swami shola, Koilkadu  |
| 12     | UTTARAKHAND       | Deo Bhumi, Bugyal (sacred alpine meadows)                      |
| 13     | WEST BENGAL       | Garamthan, Harithan, Jahera, Sabitri than, Santalburithan      |

### 8.7.3.4. Threats to the Sacred Groves

The threats vary from one region to the other and even from one grove to the other. But the common threats identified are:

- **Disappearance of the traditional belief systems**, which were fundamental to the concept of sacred groves. These systems and their rituals are now considered mere superstition.
- Sacred groves in many parts of our country have been destroyed due to **rapid urbanization and developmental interventions**.
- Many groves are suffering due to 'Sanskritisation' or **the transformation of the primitive forms of nature worship into formal temple worship**.
- **Invasion by exotic weeds** such as Eupatorium odoratum, Lantana camara and Prosopis juliflora is a serious threat to some groves.
- Pressures due to increasing livestock and fuelwood collection.

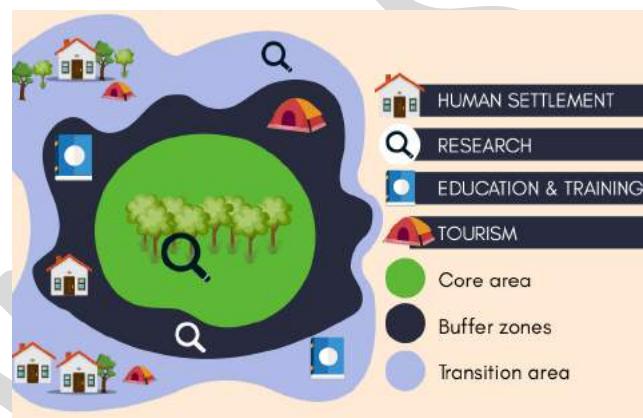
## 8.8. Biosphere Reserves

- Biosphere reserves are 'learning places for sustainable development'. They are sites for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. They are places that provide local solutions to global challenges.

- Biosphere reserves include terrestrial, marine and coastal ecosystems. Each site promotes solutions reconciling the conservation of biodiversity with its sustainable use.
- Biosphere reserves are nominated by national governments and remain under the sovereign jurisdiction of the states where they are located. Biosphere Reserves are designated under the intergovernmental MAB Programme by the Director-General of UNESCO following the decisions of the MAB International Coordinating Council (MAB ICC). Their status is internationally recognized.
  - Biosphere Reserves involve local communities and all interested stakeholders in planning and management. They integrate three main "functions":
    - a) Conservation of biodiversity and cultural diversity
    - b) Economic development that is socio-culturally and environmentally sustainable
    - c) Logistic support, underpinning development through research, monitoring, education and training
  - These three functions are pursued through the Biosphere Reserves' three main zones:

### 8.8.1. Core Areas

- It comprises a strictly protected zone that contributes to the conservation of landscapes, ecosystems, species and genetic variation



### 8.8.2. Buffer Zones

- It surrounds or adjoins the core area(s), and is used for activities compatible with sound ecological practices that can reinforce scientific research, monitoring, training and education.

### 8.8.3. Transition Area

- The transition area is where communities foster socio-culturally and ecologically sustainable economic and human activities.

The main characteristics of biosphere reserves are:

- Achieving the three interconnected functions: conservation, development and logistic support;
- Outpacing traditional confined conservation zones, through appropriate zoning schemes combining core protected areas with zones where sustainable development is fostered by local dwellers and enterprises with often highly innovative and participative governance systems;
- Focusing on a multi-stakeholder approach with particular emphasis on the involvement of local communities in management;
- Fostering dialogue for conflict resolution of natural resource use;
- Integrating cultural and biological diversity, especially the role of traditional knowledge in ecosystem management;
- Demonstrating sound sustainable development practices and policies based on research and monitoring;
- Acting as sites of excellence for education and training;

### 8.8.4. Criteria for Designation of BR in India

- A site that must contain an effectively protected and minimally disturbed core area of value of nature conservation.
- The core area should be typical of a bio-geographical unit and large enough to sustain viable populations representing all trophic levels in the ecosystem.

- The management authority to ensure the involvement/cooperation of local communities to bring variety of knowledge and experiences to link biodiversity conservation and socio-economic development while managing and containing the conflicts.
- Areas potential for preservation of traditional tribal or rural modes of living for harmonious use of environment

Student Notes:

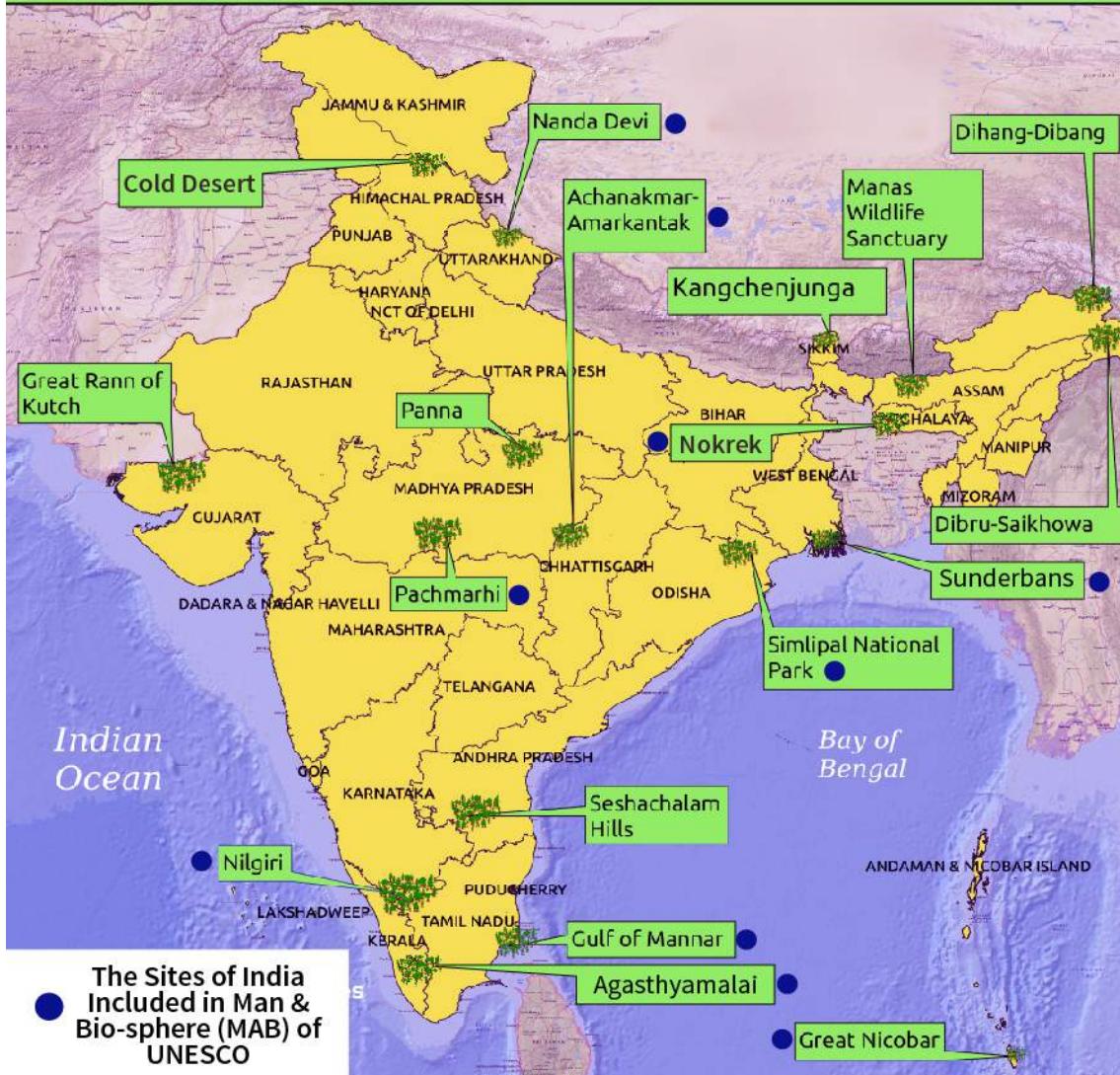
### **8.8.5. Man and Biosphere (MAB) Program**

- The MAB programme is an intergovernmental scientific programme that **aims to establish a scientific basis for enhancing the relationship between people and their environments**. It combines the natural and social sciences with a view to improving human livelihoods and safeguarding natural and managed ecosystems, thus promoting innovative approaches to economic development that are socially and culturally appropriate and environmentally sustainable.
- **UNESCO's** intergovernmental structure provides MAB with a framework to help national governments support the planning and implementation of research and training programmes with technical assistance and scientific advice.
- Participating countries establish MAB National Committees.
- The agenda of the MAB programme is defined by its main governing body, the International Coordinating Council. The MAB Council consists of 34 Member States elected by UNESCO's General Conference. The Council elects a chair and five vice-chairpersons from each of UNESCO's geopolitical regions.
- The MAB Secretariat is based at UNESCO's Division of Ecological and Earth Sciences.
- MAB is funded through the regular budget of UNESCO and mobilizes funds-in-trust granted by Member States, bilateral and multilateral sources, and extra-budgetary funds provided by countries, the private sector and private institutions. MAB-related activities are nationally financed. The Programme can grant seed funding to assist countries in developing projects and/or to secure appropriate partnership contributions.

### **8.8.6. World Network of Biosphere Reserves (WNBR)**

- The World Network of Biosphere Reserves of the MAB Programme consists of a dynamic and interactive network of sites of excellence.
- It fosters the harmonious integration of people and nature for sustainable development through participatory dialogue; knowledge sharing; poverty reduction and human well-being improvements; respect for cultural values and society's ability to cope with change - thus contributing to the 2030 Agenda and the Sustainable Development Goals (SDGs).
- Accordingly, the Network is one of the main international tools to develop and implement sustainable development approaches in a wide array of contexts.
- The World Network of Biosphere Reserves promotes North-South and South-South collaboration and represents a unique tool for international co-operation through sharing knowledge, exchanging experiences, building capacity and promoting best practices.

# BIOSPHERE RESERVES OF INDIA



## 8.9. Biodiversity Heritage Sites

- “Biodiversity Heritage Sites” (BHS) are well defined areas that are unique, ecologically fragile ecosystems - terrestrial, coastal and inland waters and, marine having rich biodiversity comprising of any one or more of the following components:
  - richness of wild as well as domesticated species or intra-specific categories,
  - high endemism,
  - presence of rare and threatened species, keystone species, species of evolutionary significance, wild ancestors of domestic/cultivated species or their varieties,
  - past pre-eminence of biological components represented by fossil beds and having significant cultural, ethical or aesthetic values and are important for the maintenance of cultural diversity, with or without a long history of human association with them.
- Under **Biological Diversity Act, 2002 (BDA)** the **State Government** in consultation with local bodies may notify in the official gazette, areas of biodiversity importance as Biodiversity Heritage Sites (BHS).
- State Government in consultation with the Central Government may frame rules for the management and conservation of BHS.
- State Governments shall frame schemes for compensating or rehabilitating any person or section of people economically affected by such notification.

### 8.9.1. The criteria for identification of BHS

Student Notes:

Accordingly, areas having any of the following characteristics may qualify for inclusion as BHS.

- Areas that contain a mosaic of natural, semi-natural, and man made habitats, which together contain a significant diversity of life forms.
- Areas that contain significant domesticated biodiversity component and/or representative agro-ecosystems with ongoing agricultural practices that sustain this diversity.
- Areas that are significant from a biodiversity point of view as also are important cultural spaces such as sacred groves/trees and sites, or other large community conserved areas.
- Areas including very small ones that offer refuge or corridors for threatened and endemic fauna and flora, such as community conserved areas or urban greens and wetlands.
- All kinds of legal land uses whether government, community or private land could be considered under the above categories.
- As far as possible those sites may be considered which are not covered under Protected Area network under the Wildlife Protection Act 1972 as amended.
- Areas that provide habitats, aquatic or terrestrial, for seasonal migrant species for feeding and breeding.
- Areas that are maintained as preservation plots by the research wing of Forest department.
- Medicinal Plant Conservation Areas.

| Biodiversity heritage sites  | Region                   | Importance   |
|--|--------------------------|--|
| <b>Nallur Tamarind Grove</b>                                       | Bengaluru                | It is popularly believed to be a relic of the Chola Dynasty.   |
| <b>Hogrekan</b>  | Chikmagalur              | The area has unique Shola vegetation and grass land and has a link with adjoining Bhadra Wildlife Sanctuary and Yemmedode Tiger Reserve and serving as "Wildlife Corridor" between Kudremukha and Bhadra Wildlife Sanctuary. |
| <b>University of Agricultural Sciences, GKVK Campus, Bengaluru</b> | Bengaluru                | The GKVK campus is considered one of the greenest areas in Bengaluru.  |
| <b>Ambaraguda</b>  | Shimoga                  | It is located between Sharavathi Wild Life Sanctuary and Someshwara Wildlife Sanctuary. It has Shola vegetation which is primitive vegetation in the Western Ghat and also has grasslands.                                   |
| <b>Glory of Allapalli</b>  | Gadchiroli (Maharashtra) | It is a reserved forest being preserved as natural forest having biological, ethnical and historical values.   |
| <b>Tonglu BHS under the Darjeeling Forest Division</b>             | Darjeeling (West Bengal) | It is a Medicinal Plant Conservation Areas   |
| <b>Dhotrey BHS under the Darjeeling Forest Division</b>            | Darjeeling (West Bengal) | It is a Medicinal Plant Conservation Areas   |
| <b>Dialong Village</b>   | Tamenglong (Manipur)     | -----  |
| <b>Ameenpur Lake</b>   | Hyderabad (Telangana)    | A man-made lake and was constructed during the reign of Ibrahim Qutab Shah, who ruled the kingdom of Golconda between 1550 and 1580.   |

## 8.10. World Heritage Sites (WHS)

Student Notes:

- A World Heritage Site is a landmark or area with legal protection by an international convention administered by the **United Nations Educational, Scientific and Cultural Organization (UNESCO)**.
- World Heritage Sites are designated by UNESCO for having cultural, historical, scientific or other form of significance. The sites are judged to contain "cultural and natural heritage around the world considered to be of outstanding value to humanity".
- The sites are intended for practical conservation for posterity, which otherwise would be subject to risk from human or animal trespassing, unmonitored, uncontrolled or unrestricted access, or threat from local administrative negligence. Sites are demarcated by UNESCO as protected zones.
- The list is maintained by the **International World Heritage Program** administered by the UNESCO World Heritage Committee, composed of 21 "states parties" that are elected by their General Assembly.
- By assigning places as World Heritage Sites, UNESCO wants to help to pass them on to future generations.
- A listed site gains international recognition and legal protection, and can obtain funds from among others the **World Heritage Fund** to facilitate its conservation under certain conditions.

### 8.10.1. Criteria for World Heritage Sites

Until the end of 2004, World Heritage sites were selected on the basis of six cultural and four natural criteria. With the adoption of the revised Operational Guidelines for the Implementation of the World Heritage Convention, only one set of ten criteria exists.

- to represent a masterpiece of human creative genius;
- to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
- to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
- to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;
- to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
- to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee

### WORLD HERITAGE SITES IN INDIA

#### Man-made Sites

|  |   |
|--|---|
| Agra Fort  | Ajanta Caves  |
| Buddhist Monuments at Sanchi                                     | Champaner- Pavagadh Archaeological Park                             |
| Chhatrapati Shivaji Terminus (formerly Victoria Terminus)        | Churches and Convents of Goa  |
| Elephanta Caves  | Ellora Caves  |
| Fatehpur Sikri   | Great Living Chola Temples  |
| Group of Monuments at Hampi                                      | Group of Monuments at Mahabalipuram                                 |
| Group of Monuments at Pattadakal                                 | Hill Forts of Rajasthan   |
| Humayun's Tomb, Delhi  | Khajuraho Group of Monuments  |
| Mahabodhi Temple, Bodh Gaya                                      | Mountain Railways of India  |
| Qutub Minar, Delhi   | Rani-ki-Vav (the Queen's step-well), Patan, Gujarat                 |
| Red Fort   | Rock Shelters of Bhimbetka  |
| Sun Temple, Konark   | Taj Mahal   |
| The Jantar Mantar, Jaipur  | Archaeological Site of Nalanda Mahavira (Nalanda University), Bihar |
| Architectural Work of Le Corbusier (Capitol Complex, Chandigarh) | Historic City of Ahmedabad  |

#### "Victorian and Art Deco Ensembles of Mumbai"

#### Natural Sites

|                               |                          |
|-------------------------------|--------------------------|
| Great Himalayan National Park | Kaziranga National Park  |
| Keoladeo National Park        | Manas Wildlife Sanctuary |

- considers that this criterion should preferably be used in conjunction with other criteria);
- to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
- to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
- to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
- to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The protection, management, authenticity and integrity of properties are also important considerations. Since 1992 significant interactions between people and the natural environment have been recognized as "cultural landscapes".

## 8.11. Important Bird Areas (IBAs)

- Birds are excellent indicators of ecosystem health. The IBA programme of Birdlife International aims to identify, monitor and protect a global network of IBAs for conservation of the world's birds and associated biodiversity.
- The IBAs serve as conservation areas for protection of birds at the global, regional or sub-regional level.
- According to Birdlife International, designation of IBAs is based on standardized criteria, namely
  - hold significant numbers of one or more globally threatened bird species,
  - be one of a set of sites that together hold a suite of restricted-range species or biome-restricted species and
  - have exceptionally large numbers of migratory or congregatory birds.
- The IBAs contain a range of habitats, such as wetlands, mudflats, microhabitats in biodiversity hotspots, grasslands and scrublands, making them excellent indicators of biodiversity richness.
- The Bombay Natural History Society and Birdlife International have identified 467 IBAs in India (Islam and Rahmani, 2004). Forty percent of these IBAs fall outside the Protected Area network and thus form an important tool for landscape-level conservation planning.

## 8.12. UPSC Previous Year Questions

### Prelims

- Two important rivers — one with its source in Jharkhand (and known by a different name in Odisha), and another, with its source in Odisha — merge at a place only a short distance from the coast of Bay of Bengal before flowing into the sea. This is an important site of wildlife and biodiversity and a protected area.  
Which one of the following could be this?(2011)
 

|                     |                      |
|---------------------|----------------------|
| (a) Bhitarkanika    | (b) Chandipur-on-sea |
| (c) Gopalpur-on-sea | (d) Simlipal         |

**Answer: A**

- Consider the following areas:(2012)
  - Bandipur
  - Bhitarkanika
  - Manas
  - Sunderbans

Which of the above are Tiger Reserves?



## Student Notes:

**Answer:** B

3. In which one among the following categories of protected areas in India are local people not allowed to collect and use the biomass? (2012)

  - (a) Biosphere Reserves
  - (b) National Park
  - (c) Wetlands declared under Ramsar Convention
  - (d) Wildlife Sanctuaries

**Answer:** B



**Answer:** A

5. The most important strategy for the conservation of biodiversity together with traditional human life is the establishment of (2014)

  - (a) biosphere reserves
  - (b) botanical gardens
  - (c) national parks
  - (d) wildlife sanctuaries

**Answer:** A



**Answer:** D



**Answer:** C



**Answer:** b

## Student Notes:

## Answer: B



**Answer:** D

11. Which one of the following are Agasthyamala biosphere reserve? (2019)

  - (a) Neyyar, peppara and shendurney wildlife sanctuaries and kalakad mundanthurai tiger reserve
  - (b) Mudumalai sathayamangalam and Wayanad wildlife sanctuaries and silent valley national park
  - (c) Kaundinya gundla bhrameshwaram and papikonda wildlife sanctuaries and mukurthi national park
  - (d) Kawal and Shree Venkateshwara wildlife sanctuaries; and Nagarjunasagar-srisailam tiger reserve

**Answer:** A

## **8.13. Vision IAS Previous Year Question**

- 1.** Discuss the relevance of sacred groves and forests in protection of biodiversity in India. Also, highlight the various challenges associated with the conservation of sacred groves.

### ***Approach:***

- Give the definition of sacred groves and forest.
  - Then bring out relevance of sacred groves and forests in biodiversity conservation
  - Finally bring out challenges faced by the conservation effort through means of sacred groves in India.

*Answer:*

Sacred groves are tracts of virgin forest with rich diversity, which have been protected by the local people for centuries for their cultural and religious beliefs. An inextricable link between present society and past in terms of biodiversity, culture, religious and ethnic heritage exists in sacred groves. Whereas a forest is defined as a land area of more than 0.5 hectares with a tree canopy cover of more than 10%, which is not primarily under agricultural or other specific, non-forest land use.

Sacred groves and forest plays significant role in in-situ protection of biodiversity in India.

## **Relevance of sacred groves**

- A diverse range of ecosystem is preserved in grove tradition along with its regional and local identities as represented in names, practices and management of groves.
  - The restriction in resource usage, undisturbed condition and suitable microclimate are the primary factors for this species richness.
  - Groves act as shelter places for forest birds and small mammals during their foraging activities.
  - Simple protection measures and monitoring can play important role in preserving these fragmentations as it portrays a fine example of community based natural conservation without any extra support.

## **Relevance of forests**

Student Notes:

- Total forest cover as percentage of geographical area is approx. about 21.34 % as per forest report 2015 which are very rich in endemic floral and faunal biodiversity.
- Forests in India now give a legal base to conservation effort, thus increasing the effectiveness of biodiversity conservation effort.
- Large expanse and contiguous forest across geographical expanse allows free movement of animals thus allowing them to migrate in case of threat to their existence in habitats.
- Forest acts as shelter against human invasion as well mitigate effects of natural disaster like flood and save the biodiversity.

However, the biodiversity conservation through sacred groves needs to overcome some challenges like:

- The high exploitation and declining microclimate outside the grove area restricted their distribution and made them vulnerable to any drastic change in environment.
- Human induced pressures on groves include fragmentation, area shrinkage and degradation, alien species invasion, grazing, resource extraction land quarrying etc.
- Changing social structure which leads to replacement of nature centric worship to temple worship etc.

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# CHAPTER - 9 - POLICY AND INSTITUTIONAL MEASURES

Student Notes:

## 9. Policy and Constitutional Measures

### 9.1. Policy Framework in India

The range of human actions and needs that impact biodiversity are varied and affect all ecosystems. Hence, nearly all sectoral policies of the government have a bearing on the conservation and sustainable use of natural resources, directly or indirectly. This section brings out the key elements of the four core policies, namely, NFP 1988, NEP 2006, National Agroforestry Policy, 2014, and National Policy on Marine Fisheries (NPMF), 2017, that directly relate to biodiversity and channelize conservation concerns into all other sectoral policies as well.

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| <b>National Forest Policy, 1988</b>        | <p>Its goals include:</p> <ul style="list-style-type: none"><li>(i) To ensure environmental <b>stability</b> and maintain ecological <b>balance</b>.</li><li>(ii) To maintain <b>atmospheric equilibrium</b> vital for sustenance of all life forms – human, animal and plant.</li><li>(iii) To allow derivation of direct economic benefits but without disturbing the goals at (i) and (ii) above <b>to bring 33% of the geographical area of the country under FTC</b>.</li></ul> <p>A new draft NFP is under consideration at present. It retains the core objectives of NFP, 1988 with, <i>inter alia</i>, greater emphasis on:</p> <ul style="list-style-type: none"><li>(i) conservation,</li><li>(ii) rehabilitation of degraded forests, and</li><li>(iii) greater involvement of local and traditional communities and women in conservation and management</li></ul>   |
| <b>National Environmental Policy, 2006</b> | <p>It ensures <b>coherence of purpose</b> of conservation and enhancement of environment in all sectoral policies. It acknowledges and commits action on international environmental agreements to which India is a Party in conformity with India's commitments. Its goals include:</p> <ul style="list-style-type: none"><li>(i) Creating a <b>consolidated and coherent guidelines</b> for all sectoral policies by outlining broad goals and parameters.</li><li>(ii) Ensuring <b>integration</b> of environmental concerns in all development planning and programmes.</li><li>(iii) Encouraging <b>partnerships</b> of different stakeholders such as public agencies, local communities, academic and scientific institutions, NGOs, and investment communities in securing environmental agenda.</li><li>(iv) Securing required <b>synergy</b> in all environment related issues and actions.</li></ul> <p>The broad goals and parameters of NEP, 2006 are integrated in sectoral policies. The specific elements pertaining to biodiversity in the NEP include:</p> <ul style="list-style-type: none"><li>(i) Creation of <b>education and awareness</b> for conservation and sustainable use of biodiversity with the involvement of people, particularly the traditional communities, the disadvantaged and the poor.</li><li>(ii) <b>Integration of biodiversity values</b> in all awareness building measures.</li><li>(iii) The adverse impact of environmental degradation on soil fertility, quantity and quality of water, air quality, forests, wildlife and fisheries is far</li></ul> |

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|  | <p>more severe on the rural poor, tribals and women as it enhances and perpetuates poverty.</p> <p>(iv) The most secure basis for conservation lies in ensuring that people dependent on particular resources obtain better livelihoods from conservation than from degradation of the resources.</p> <p>(v) Mutually beneficial <b>multi-stakeholder partnerships</b> between local communities, gender agencies, the academic and research community, investors and multilateral and bilateral development partners should become vehicles of enhancement of resources including technology and TK for conservation.</p> <p>(vi) <b>Eco Sensitive Zones</b> having environmental resources of incomparable values should be identified and conserved with adequate participation of the local communities.</p>  | Student Notes: |
| <b>National Agroforestry Policy, 2014</b>        | <p>The policy promotes <b>tree plantation in complementarity with crops and livestock</b> to:</p> <ul style="list-style-type: none"> <li>(i) improve productivity, employment, incomes and livelihoods of rural households,</li> <li>(ii) achieve efficient nutrient cycling and organic matter addition for sustainable agriculture,</li> <li>(iii) expand vegetation cover,</li> <li>(iv) increase FTC, and</li> <li>(v) contribute to conserving natural resources and forests by meeting demand for timber, food, fuel, fodder and other agroforestry products.</li> </ul>  |                |
| <b>National Policy on Marine Fisheries, 2017</b> | <p>The overarching goal of NPMF, 2017 is to ensure the <b>health and ecological integrity</b> of the marine living resources of India's EEZ for the benefit of present and future generations of the nation. Its goals include:</p> <ul style="list-style-type: none"> <li>(i) <b>Sustainable development</b> of fisheries for socio-economic uplift of fishers.</li> <li>(ii) Management of fisheries on the <b>principle of subsidiarity and partnership and gender justice</b>.</li> <li>(iii) Harvesting and management based on precautionary approach to secure <b>intergenerational equity</b>.</li> <li>(iv) Application of "<b>Public trust doctrine</b> in management while keeping fishers at the core".</li> <li>(v) <b>Mainstreaming</b> biodiversity conservation in harvesting and production processes and management plans by <b>adopting ecosystem approach</b> to management.</li> <li>(vi) Mainstreaming conservation of <b>Ecologically and Biologically Significant Areas (EBSAs)</b> and <b>Vulnerable Marine Ecosystems (VMEs)</b>, protection of iconic and endangered and threatened species.</li> <li>(vii) <b>Review and periodic evaluation</b> of the existing MPAs.</li> <li>(viii) <b>Harmonising conservation and tenurial rights</b> of the traditional fishermen.</li> <li>(ix) <b>Blending Traditional Knowledge with science</b> on the principles of sound business and effective engagement.</li> </ul> <p>The Policy recognizes that <b>women constitute 66% of workforce in post-harvest fisheries activities</b> and includes sharp focus on their needs and development.</p> |                |

## 9.2. Legislative Framework in India

Student Notes:

This section covers the enactments that directly deal with the elements and issues related to biodiversity.

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| <b>Biodiversity Act, 2002</b> | <p>The Act recognises India's richness in biological diversity and associated traditional and contemporary knowledge systems, acknowledges its commitment to implement the CBD and provides for "conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and for matters connected therewith or incidental thereto."</p> <p>The Act inter alia obligates the Central Government to:</p> <ul style="list-style-type: none"><li>(i) develop national strategies, plans and programmes for conservation and sustainable use,</li><li>(ii) institute measures to identify and monitor areas rich in biological resources,</li><li>(iii) promote in situ and ex situ conservation of biological resources</li><li>(iv) create incentives for research, training and public education to increase awareness about biodiversity, and</li><li>(v) integrate the conservation, promotion and sustainable use of biodiversity into relevant sectoral, cross sectoral plans, programmes and policies, "as far as practicable and wherever deemed appropriate."</li></ul> <p>The Act also includes specific provisions for:</p> <ul style="list-style-type: none"><li>(i) notifying species which are on the verge of extinction, or likely to become extinct in near future as threatened species; rehabilitation of such species promoting Research and Development (R&amp;D) and other necessary actions,</li><li>(ii) chronicling of knowledge related to biological resources at the local level with the object to respect, preserve and use such knowledge,</li><li>(iii) conditionalities and modalities for seeking prior approvals for undertaking certain activities such as research, biosurvey and bioutilisation, and commercial utilisation, granting access to biological resources and associated knowledge for various purposes so as to ensure fair and equitable sharing of benefits from use of biological resources and associated knowledge.</li><li>(iv) The Act creates a three tier architecture for its implementation at national, state and the local levels. This architecture coordinates the implementation of the NBAP in collaboration with line agencies and other non-government stakeholders.</li></ul> |
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| <b>India Forest Act, 1927</b> | <p>Its provisions include:</p> <ul style="list-style-type: none"><li>(i) Criteria and modalities for reserving and designating forests for conservation and legal protection,</li><li>(ii) Management of forest produce, and</li><li>(iii) Issues regarding transit of the forest produce and the fees and duties leviable on this produce.</li></ul> <p>Directorate General of Forests in the MoEFCC at the central level, state forest departments and their subordinate agencies at lower administrative levels implement the Act.</p> |
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| <b>Wildlife Protection Act, 1972 (Last amended in 2009)</b>               | <p>It empowers the State to declare areas of ecological, faunal, floral, geomorphological or zoological association or importance as protected areas, under four categories, namely,</p> <p>National Parks, Wildlife Sanctuaries, Community Reserves and Conservation Reserves.</p> <p>The wildlife division in the Directorate General of Forests in MoEFCC at Central Government level, and state wildlife departments and their subordinate offices at field level in states implement this Act.</p>  |
| <b>Forest Conservation Act, 1980</b>                                      | <p>The Act governs matters relating to diversion of forest land for any non-forest purpose. The diversion of forest is made subject to:</p> <ul style="list-style-type: none"> <li>(i) stringent scrutiny, and</li> <li>(ii) recovery of net present value (NPV) and compensatory afforestation equal to the area diverted.</li> </ul>   |
| <b>Environment Protection Act, 1986.</b>                                  | <p>It covers all matters relating to the protection and importance of environment at a broad level and empowers the State to issue notifications to protect the environment whenever necessary.</p> <p>An example of this is the Coastal Regulation Zone Notification (CRZN) issued by Ministry of Environment and Forests, 2019 declaring coastal stretches as Coastal Regulation Zone (CRZ) to regulate industrial and other activities in CRZ towards ensuring conservation and protection of coastal areas, coastal ecosystems and the livelihoods of the coastal communities.</p>   |
| <b>Wetland Rules, 2017</b>  | <p>These Rules have succeeded the Wetland (Conservation and Management) Rules, 2010. WR, 2017 aim at conservation and <b>wise use of wetlands</b> making <b>states responsible</b> for conserving and sustainably managing wetlands recognizing the fact that land and water, the two major ecological constituents of wetland ecosystems are enlisted as State subjects as per the Constitution.</p>  |
| <b>The Plant Quarantine (Regulation of Import into India) Order, 2003</b> | <p>Notified under the <b>Destructive Insects and Pests Act, 1914</b>, it aims at preventing introduction of:</p> <ul style="list-style-type: none"> <li>(i) exotic pests,</li> <li>(ii) diseases, and</li> <li>(iii) weeds likely to get introduced through import of agricultural commodities or plants/ materials into India.</li> </ul> <p>It is implemented through <b>59 Plant Quarantine Stations (PQSS)</b> located in various states.</p>  |
| <b>The Protection of Plant Varieties and Farmers' Rights Act, 2001</b>    | <p>The Act has established an effective system for:</p> <ul style="list-style-type: none"> <li>(i) protection of plant varieties,</li> <li>(ii) recognition of varieties traditionally cultivated and evolved by farmers in their fields,</li> <li>(iii) recognition of wild relatives or landraces of a variety about which the farmers possess the common knowledge,</li> <li>(iv) farmers' and plant breeders' rights including rights in respect of their contributions made at any time in conserving, improving and making plant genetic resources available for the development of new plant varieties, and</li> <li>(v) encouragement to development of new varieties of plants.</li> </ul> <p>The PPVFRA set up under the Act ensures its implementation.</p> |

Student Notes:

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| <p><b>The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (Forest Rights Act, 2006)</b></p> | <p>The Act <b>recognizes and vests the forest rights</b> and occupation in forest land in the forest dwelling Scheduled Tribes and other traditional forest dwellers, who had been residing in such forests for generations but whose rights could not be recorded in the past.</p> <p>The Act also seeks to <b>balance these rights</b> with the responsibilities for sustainable use, conservation of biodiversity and maintenance of ecological balance so that forests are conserved while ensuring the livelihood and food security of the forest dwelling Scheduled Tribes and other traditional forest dwellers.</p> <p><b>Section 3(1) of the Act</b> enumerates the types of rights that the Act recognizes. These include “Right of access to biodiversity and community right to intellectual property and TK related to biodiversity and cultural diversity”</p> <p>Several other biodiversity relevant legislations that help in securing conservation and sustainable use of biodiversity include Mineral Conservation and Development Rules (MCDR) 2017, The Energy Conservation Act, 2001, Panchayats (Extension to the Scheduled Areas) Act, 1996 (PESA Act) The Patents Act, 1970 and the Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA).</p> |
| <p><b>The National Green Tribunal Act, 2010</b></p>   | <p>The Act establishes a National Green Tribunal (NGT) inter alia for effective and expeditious disposal of cases relating to environmental protection, conservation of forests and other natural resources.</p>  |

Student Notes:

## 9.2.1. Key Legislation in Detail

### 9.2.1.1. Environment Protection Act, 1986

In the wake of the Bhopal gas Tragedy, Union government enacted the Environment Protection Act of 1986 under Article 253 of the Constitution.

#### Importance of the EPA

- The purpose and importance of the environmental protection act 1986 is to bolster and encourage the administration, security, upgrade and enlightened utilization of the earth.
- The Act talks about recognizing the following factors:
  - i. Forestalling, relieving and remediating natural effects are significant in making recommendations and taking actions.
  - ii. Delaying sensible ecological security measures should not be an outcome of dangers of genuine or irreparable damage to the natural honesty, absence of complete assurance.
  - iii. Financially or by any other means, every person is responsible for any impacts on nature because of their activities or inaction.
  - iv. Adaptive, responsive, reasonable, timely and effective, these are some of the qualities which must be present in administrative, management and administrative procedures.

#### Aims and objectives of the EPA

- Implementation of the decisions made in June 1972 at Stockholm at the United Nation Conference on the Human Environment.
- Government protection authority creation.
- Forming coordination of activities of different agencies which are operating under the existing law. They relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property.
- Enacting regular laws for environmental protection which have the probability of being unfolded in areas of severe environmental threats.
- Providing punishment to those promoting endangerment to the human environment, safety and health.

- Sustainable development of the environment.
- Achieving the purpose of the Act and protection of life under Article 21 of the Indian Constitution.

The Act is an “umbrella” legislation designed to provide a framework for central government coordination of the activities of various central and state authorities established under previous laws, such as the Water Act and the Air Act.

- It authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds.
- It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. The Act was last amended in 1991.
- The Environment (Protection) Rules lay down procedures for setting standards of emission or discharge of environmental pollutants.
- The objective of Hazardous Waste (Management and Handling) Rules, 1989 is to control the generation, collection, treatment, import, storage, and handling of hazardous waste.
- The Manufacture, Storage, and Import of Hazardous Rules define the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities.
- The Manufacture, Use, Import, Export, and Storage of hazardous Micro-organisms/ Genetically Engineered Organisms or Cells Rules, 1989 were introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and micro-organisms.

### 9.2.1.2. Wildlife Protection Act, 1986

This Act provides for the protection of the country's wild animals, birds, and plant species, in order to ensure environmental and ecological security. Among other things, the Act lays down restrictions on hunting many animal species.

#### Constitutional Provisions

- Article 48A of the Constitution of India directs the State to protect and improve the environment and safeguard wildlife and forests. This article was added to the Constitution by the 42nd Amendment in 1976.
- Article 51A imposes certain fundamental duties for the people of India. One of them is to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have compassion for living creatures.

#### Need for the Wildlife Protection Act

- Reasons for a nationwide law in the domain of environment particularly wildlife include the following:
  - i. India is a treasure-trove of varied flora and fauna. Many species were seeing a rapid decline in numbers. For instance, it was mentioned by Edward Pritchard Gee (A naturalist), that at the turn of the 20th century, India was home to close to 40000 tigers. But, a census in 1972 showed this number drastically reduced to about 1827.
  - ii. A drastic decrease in the flora and fauna can cause ecological imbalance, which affects many aspects of climate and the ecosystem.
  - iii. The most recent Act passed during the British era in this regard was the Wild Birds and Animals Protection, 1935. This needed to be upgraded as the punishments awarded to poachers and traders of wildlife products were disproportionate to the huge financial benefits that accrue to them.
  - iv. Wildlife is a part of ‘forests’ and this was a state subject until the Parliament passed this law in 1972. Now it is Concurrent List (42<sup>nd</sup> Amendment Act, 1976).
  - v. There were only five national parks in India prior to the enactment of this Act.

## Salient Features of Wildlife Protection Act

Student Notes:

This Act provides for the protection of a listed species of animals, birds, and plants, and also for the establishment of a network of ecologically-important protected areas in the country.

- The Act provides for the formation of wildlife advisory boards, wildlife wardens, specifies their powers and duties, etc.
- It helped India become a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- For the first time, a comprehensive list of the endangered wildlife of the country was prepared.
- The Act prohibited the hunting of endangered species.
- Scheduled animals are prohibited from being traded as per the Act's provisions.
- The Act provides for licenses for the sale, transfer, and possession of some wildlife species.
- It provides for the establishment of wildlife sanctuaries, national parks, etc.
- Its provisions paved the way for the formation of the Central Zoo Authority. This is the central body responsible for the oversight of zoos in India. It was established in 1992.
- The Act created **six schedules** which gave varying degrees of protection to classes of flora and fauna. (Schedule I and Schedule II (Part II) get absolute protection, and offences under these schedules attract the maximum penalties. The schedules also include species that may be hunted.)
- The **National Board for Wildlife** was constituted as a statutory organization under the provisions of this Act. This is an advisory board that offers advice to the central government on issues of wildlife conservation in India. It is also the apex body to review and approve all matters related to wildlife, projects of national parks, sanctuaries, etc. The chief function of the Board is to promote the conservation and development of wildlife and forests. It is chaired by the Prime Minister.
- The Act also provided for the establishment of the **National Tiger Conservation Authority**. It is a statutory body of the Ministry of Environment, Forest and Climate Change with an overall supervisory and coordination part, performing capacities as given in the Act. Its mandate is to strengthen tiger conservation in India. It gives statutory authority to Project Tiger which was launched in 1973 and has put the endangered tiger on a guaranteed path of revival by protecting it from extinction.

## Schedules of the Wildlife Protection Act

### Schedule I

- This Schedule covers endangered species. These species need rigorous protection and therefore, the harshest penalties for violation of the law are under this Schedule.
- Species under this Schedule are prohibited to be hunted throughout India, except under threat to human life. Absolute protection is accorded to species on this list.
- The Trade of these animals is prohibited. Examples: tiger, blackbuck, Himalayan Brown Bear, Brow-Antlered Deer, Blue whale, Common Dolphin, Cheetah, Clouded Leopard, hornbills, Indian Gazelle, etc.

### Schedule II

- Animals under this list are also accorded high protection. Their trade is prohibited. They cannot be hunted except under threat to human life.
- Examples: Kohinoor (insect), Assamese Macaque, Bengal Hanuman langur, Large Indian Civet, Indian Fox, Larger Kashmir Flying Squirrel, Kashmir Fox, etc.

### Schedule III & IV

- This list is for species that are not endangered. This includes protected species but the penalty for any violation is less compared to the first two schedules.

- Examples: hyena, Himalayan rat, porcupine, flying fox, Malabar tree toad, etc.

Student Notes:

#### Schedule V

- This schedule contains animals that can be hunted. Examples: mice, rat, common crow, fruit bats, etc.

#### Schedule VI

- This list contains plants that are forbidden from cultivation. Examples: pitcher plant, blue vanda, red vanda, kuth, etc.

### 9.2.1.3. Biodiversity Act, 2002

- The Biological Diversity, as federal legislation, was an attempt to uphold the objectives put forth by the United Nations Convention on Biological Diversity (CBD) 1992, giving immense importance to the rights of a state over its resources.
- This Act broadly sets forth to protect and conserve the biological diversity, control the utilization of resources, and maintain equality in the distribution of its resources and benefits arising from it. Section 8, sub-Section (1) and (3) of this Act, puts forth the provision of establishing a National Biodiversity Authority in Chennai.

#### Key Provisions of the Act

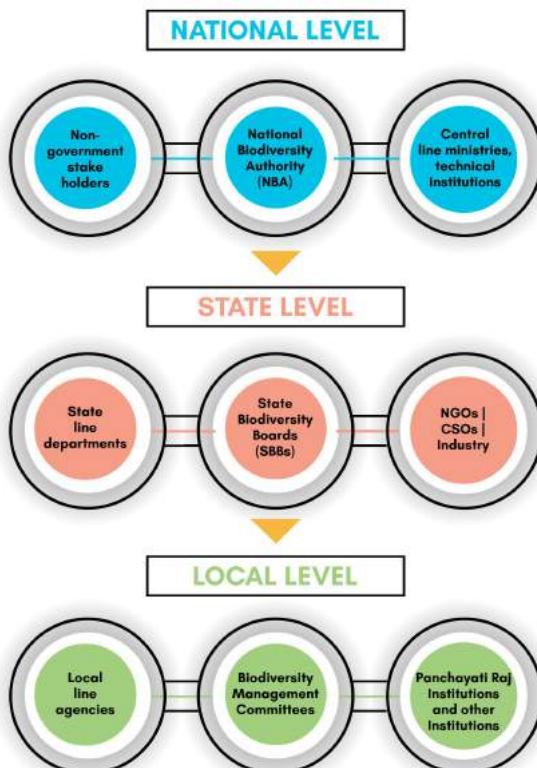
The Biological Diversity Act puts forth definitions, principles, appointed authorities, procedures, mechanisms for conservation, access benefits, etc. all related to biodiversity. It also mentions an institutional structure to be established for the same purpose.

#### Conservation Provisions

The Central government has responsibilities such as:

- It is duty-bound for formulating national strategies, plans and programmes to conserve and uphold the sustainable use of biological diversity.
- If any area rich in biological diversity or such resources seems to be facing threats, then it is the central government's responsibility of notifying the respective state government and asking them to take appropriate steps to prevent it.
- Composing sectoral and cross-sectoral plans and policies, which are practicable in the notified environment on the foundation of integration of conservation and the sustainable use of biological diversity.
- The central government has to take measures for assessing the harmful effects of upcoming projects on biodiversity and to either prevent it or come up with techniques of diminishing such effects.
- The central government must aspire to protect the traditional knowledge holders and their knowledge with methods including registration of such knowledge at the local, state or national levels, and other measures necessary for protection and so on.

### IMPLEMENTATION ARCHITECTURE FOR BIODIVERSITY ACT



- Section 8 lays down the provision of the establishment of the **National Biodiversity Authority** at the national level whereas Section 22 does the same for **state biodiversity boards** at the state level. Further Section 22(2) does not allow the State Biodiversity Board to be constituted for a Union territory.
- The National Biodiversity Authority shall exercise the powers and perform the functions of a State Biodiversity Board for the Union territory.

**Note: The detailed institutional structure under the act has been discussed under the sub-heading "Institutions".**

#### Other provisions

- Under the act:
  - All foreign national require approval from NBA for obtaining Biological Resources.
  - Indian individuals/entities to seek approval before transferring knowledge / research and material to foreigners.
  - Prior approval of NBA before applying for any kind of IPR based on research conducted on biological material and or associated knowledge obtained from India.
  - Indians required to provide prior intimation to State Biodiversity Boards for obtaining biological material for commercial purposes. SBB can regulate such access. Growers and cultivators of Biological Diversity and vaids and hakims who are practicing Indian system of medicines and local people exempted.

#### Shortcomings of the Act

- Along with several positive and worthy features, the Act also has several flaws and somewhere leaves a void. One of the major flaws is that emphasis on preventing profit-sharing from the commercial use of the biological resources rather than provisions for efficient conservation. One of the reasons for laying this act was to prevent bio-piracy by the developed nations but this did not give an opportunity for neglecting the other major aim of protecting biodiversity.
- This legislation does not act as an umbrella and overlooks its possibilities of harmonizing with prior existing legislation. Neither does it lay down guidelines for the assignment of non-monopoly rights nor for assessing contributions made by firms, local communities, or individual inventions.
- The act doesn't even give immediate rights-holders the authority of defending their rights in the way that it weaponizes the Indian state to fight against biopiracy or even with rights equivalent to that provided to patent holders or applicants. One of the main problems also stands to be no legal protection given to the information recorded in the People's Biodiversity Register. This register is open to entities wanting to exploit resources of a particular area. Such documentation has to be regulated by rigorous monitoring in order to ensure the benefits being shared.

#### 9.2.1.4. National Wildlife Action Plan 2017-31

- The Union Ministry of Environment, Forests and Climate Change (MoEFCC) has unveiled third National Wildlife Action Plan for 2017-2031 to chalk out future road map for wildlife conservation.
- The plan was unveiled at the Global Wildlife Programme (GWP) conference. It is third action plan after first released in 1983 to 2001 and second from 2002 to 2016, that had protected area-centric approach to wildlife conservation.
- The plan was initiated in February 2016 by MoEFCC. It was drafted by a 12-member committee chaired by **JC Kala**, a former secretary to the ministry. The key focus areas of this plan includes integration of climate change into wildlife planning, conservation of coastal and marine ecosystem, mitigation of human-wildlife conflict, focus on wildlife health among others.

- Climate Change impact:** It is first wildlife action plan to recognise concerns related to climate change impact on wildlife. It has stressed on integrating actions for its mitigation and adaptation into wildlife management planning processes. It recommended assisted migration of wildlife and anticipatory planting along ecological gradients, as climate change may result in die-offs of certain tree species that are unable to adapt to newer environmental conditions.
- Approach:** It adopts landscape approach in conservation of all wildlife – uncultivated flora and fauna that have an ecological value to ecosystem and to mankind irrespective of where they occur. It gives special emphasis to recovery to threatened species of wildlife while conserving their habitats which include inland aquatic, coastal and marine ecosystems.
- Human-animal conflict concerns:** It addresses rising human-animal conflict owing to shrinkage, fragmentation and deterioration of habitats generating animosity against wild animals and protected areas.
- People's support:** It underscores increasing need for people's support for conservation of wildlife. It recommends eco-development, education, innovation, training, extension, and conservation awareness and outreach programs.
- Participation of private sector:** It underlines increased role of private sector in wildlife conservation. It lays down that Government will ensure that adequate and sustained funding including Corporate Social Responsibility (CSR) funds are made available for implementation of plan.

## 9.3. Institutions

### 9.3.1. National Green Tribunal (NGT)

#### About the Organisation

- The National Green Tribunal has been established under the National Green Tribunal Act 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.
- It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues.
- The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts.
- The Tribunal is mandated to make and endeavour for **disposal of applications or appeals finally within 6 months** of filing of the same.

#### Important Judgements of NGT

- In 2012, POSCO a steelmaker company signed a MoU with the Odisha government to set up steel project. NGT suspended order and this was considered a radical step in favour of the local communities and forests.
- In 2012 Almitra H. Patel vs. Union of India case, NGT gave judgment of complete prohibition on open burning of waste on lands, including landfills – regarded as the single biggest landmark case dealing with the issue of solid waste management in India.
- In 2013 in Uttarakhand floods case, the Alaknanda Hydro Power Co. Ltd. was ordered to compensate to the petitioner – here, the NGT directly relied on the principle of 'polluter pays'.
- In 2015, the NGT ordered that all diesel vehicles over 10 years old will not be permitted to ply in Delhi-NCR.
- In 2017, the Art of Living Festival on Yamuna Food Plain was declared violating the environmental norms, the NGT panel imposed a penalty of Rs. 5 Crore.
- The NGT, in 2017, imposed an interim ban on plastic bags of less than 50-micron thickness in Delhi because "they were causing animal deaths, clogging sewers and harming the environment".

- Following the enactment of the said law, the Principal Bench of the NGT has been established in the National Capital – New Delhi, with regional benches in Pune (Western Zone Bench), Bhopal (Central Zone Bench), Chennai (Southern Bench) and Kolkata (Eastern Bench). Each Bench has a specified geographical jurisdiction covering several States in a region. There is also a mechanism for circuit benches. For example, the Southern Zone bench, which is based in Chennai, can decide to have sittings in other places like Bangalore or Hyderabad.
- The Chairperson of the NGT is a **retired Judge of the Supreme Court**.
- Other Judicial members are **retired Judges of High Courts**.
- Each bench of the NGT will comprise of **at least one Judicial Member and one Expert Member**.
- Expert members should have a professional qualification and a minimum of 15 years experience in the field of environment/forest conservation and related subjects.

### Powers

- The NGT has the power to hear all civil cases relating to environmental issues and questions that are linked to the implementation of laws listed in Schedule I of the NGT Act. These include the following:
  - The Water (Prevention and Control of Pollution) Act, 1974;
  - The Water (Prevention and Control of Pollution) Cess Act, 1977;
  - The Forest (Conservation) Act, 1980;
  - The Air (Prevention and Control of Pollution) Act, 1981;
  - The Environment (Protection) Act, 1986;
  - The Public Liability Insurance Act, 1991;
  - The Biological Diversity Act, 2002.
- This means that any violations pertaining only to these laws, or any order / decision taken by the Government under these laws can be challenged before the NGT. Importantly, the NGT has **not been vested with powers to hear any matter relating to the Wildlife (Protection) Act, 1972, the Indian Forest Act, 1927** and various laws enacted by States relating to forests, tree preservation etc.

### Principles of Justice adopted by NGT

- The NGT is **not bound by the procedure laid down under the Code of Civil Procedure, 1908**, but shall be **guided by principles of natural justice**.
- Further, NGT is also **not bound by the rules of evidence as enshrined in the Indian Evidence Act, 1872**. Thus, it will be relatively easier (as opposed to approaching a court) for conservation groups to present facts and issues before the NGT, including pointing out technical flaws in a project, or proposing alternatives that could minimize environmental damage but which have not been considered.
- While passing Orders/decisions/awards, the NGT will apply the principles of sustainable development, the precautionary principle and the polluter pays principles.
- However, it must be noted that if the NGT holds that a claim is false, it can impose costs including lost benefits due to any interim injunction.

### Review and Appeal

- Under the NGT Rules, there is a provision for seeking a Review of a decision or Order of the NGT. If this fails, an NGT Order can be challenged before the Supreme Court within ninety days.

### 9.3.2. Institutional structure under the Biodiversity Act, 2002

- The **National Biodiversity Authority (NBA)** was established in 2003 by the Central Government to implement India's Biological Diversity Act (2002). The NBA is a Statutory body

and that performs facilitative, regulatory and advisory function for Government of India on issue of Conservation, sustainable use of biological resource and fair equitable sharing of benefits of use.

- The **State Biodiversity Board (SBBs)** focus on advise the State Governments, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources.
- The Local Level **Biodiversity Management committees (BMCs)** are responsible for promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of land races, folk varieties and cultivators, domesticated stocks and breeds of animals and microorganisms besides chronicling of knowledge relating to biological diversity.

### **9.3.2.1. Powers and functions of NBA**

- It shall be the duty of the National Biodiversity Authority to regulate activities and by regulations issue guidelines for access to biological resources and for fair and equitable benefit sharing.
- The National Biodiversity Authority may grant approval for undertaking any activity.
- The National Biodiversity Authority may advise the Central Government on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of benefits arising out of the utilization of biological resources.
- The National Biodiversity Authority may advise the State Governments in the selection of areas of biodiversity importance to be notified as heritage sites and measures for the management of such heritage sites.
- The National Biodiversity Authority may perform such other functions as may be necessary to carry out the provisions of this Act.
- The National Biodiversity Authority may, on behalf of the Central Government, take any measures necessary to oppose the grant of intellectual property rights in any country outside India on any biological resource obtained from India or knowledge associated with such biological resource which is derived from India.

### **9.3.2.2. Powers and Functions of SBBs**

- The State Biodiversity Boards (SBBs) have the function of advising the State Government on matters of biodiversity and its equitable distribution.
- To the guidelines of the Central Government but more importantly to regulate granting of approvals or requests for commercial utilization of biological resources.
- The State Boards require a prior intimation for obtaining biological resources only from Indian citizens or corporate associations or organizations registered in India.

### **9.3.2.3. Powers and Functions of BMCs**

- Conservation and sustainable utilization of biological resources.
- Eco-restoration of the local biodiversity.
- Proper feedback to the SBB in the matter of IPR, Traditional Knowledge and local Biodiversity issues, wherever feasible and essential feedback to be provided to the NBA.
- Management of Heritage Sites including Heritage Trees, Animals/ Microorganisms etc., and Sacred Groves and Sacred Water bodies.
- Regulation of access to the biological resources and/ or associated Traditional Knowledge, for commercial and research purposes.
- Sharing of usufructs arising out of commercial use of bio-resources.
- Conservation of traditional varieties/breeds of economically important plants/animals.
- Biodiversity Education and Awareness building.
- Documentation, enable procedure to develop bio-cultural protocols.

- Sustainable Use and Benefit Sharing.
- Protection of Traditional Knowledge.

Student Notes:

### 9.3.3. Wildlife Crime and Control Bureau (WCCB)

- Wildlife Crime Control Bureau (WCCB) is a statutory multi-disciplinary body established by the Government under the **Ministry of Environment and Forests**, to combat organized wildlife crime in the country, **under Wild Life (Protection) Act, 1972**.

#### Powers and Functions of the WCCB

Under Wild Life (Protection) Act, 1972, it is mandated to

- Collect and collate intelligence related to organized wildlife crime activities and to disseminate the same to State and other enforcement agencies for immediate action so as to apprehend the criminals;
- Establish a centralized wildlife crime data bank; co-ordinate actions by various agencies in connection with the enforcement of the provisions of the Act;
- Assist foreign authorities and international organization concerned to facilitate co-ordination and universal action for wildlife crime control;
- Capacity building of the wildlife crime enforcement agencies for scientific and professional investigation into wildlife crimes and assist State Governments to ensure success in prosecutions related to wildlife crimes;
- Advise the Government of India on issues relating to wildlife crimes having national and international ramifications, relevant policy and laws.
- Assist and advise the Customs authorities in inspection of the consignments of flora & fauna as per the provisions of Wild Life Protection Act, CITES and EXIM Policy governing such an item.

### 9.3.4. Botanical Survey of India

- Botanical Survey of India (BSI), is the apex taxonomic research organization of the country under the **Ministry of Environment, Forest & Climate Change**.
- It was **established on 13th February 1890** under the direction of Sir George King.
- Its headquarters, are at Central National Herbarium, Central Botanical Laboratory, main Garden at Howrah, the Botanical Museum at Calcutta and nine regional circles or stations in different parts of the country.

#### Objectives of BSI

- Survey of Plant resources of the country for preparing an inventory of the plant wealth in the form of National, Regional and District Floras.
- Development of the Central National Herbarium and the various Regional Herbaria as repositories of the Types and other authentic specimens.
- Development of the Indian Botanic Garden, the Regional Experimental Gardens the National Orchidaria, for the study, introduction and conservation of flora.
- Development of the Central Botanical Laboratory and Botanical Section of the Indian Museum for experimental studies on plants and popularising their role in our lives.,
- Assessment and care of threatened plants and studies on little known or new uses of plants particularly among rural and tribal societies.

### 9.3.5. Zoological Survey of India (ZSI)

- The Zoological Survey of India (ZSI) was established on 1st July, 1916 to promote survey, exploration and research leading to the advancement in our knowledge of various aspects of exceptionally rich life of the erstwhile 'British Indian Empire'.
- The survey has its genesis in the establishment of the Zoological Section of the Indian Museum at Calcutta in 1875.

- It is under the **Ministry of Environment, Forest & Climate Change.**

Student Notes:

### **Objectives**

- The objectives of ZSI are classified as follows:

#### **Primary Objectives**

- i. Exploration, Survey, Inventorying and Monitoring of faunal diversity in various States, Ecosystems and Protected areas of India.
- ii. Taxonomic studies of all faunal components collected.
- iii. Periodic review of the Status of Threatened and Endemic species.
- iv. Preparation of Red Data Book, Fauna of India and Fauna of States.
- v. Bio-ecological studies on selected important communities/species.
- vi. Preparation of databases for the recorded species of the country.
- vii. Maintenance & Development of National Zoological Collections.
- viii. Training, Capacity Building and Human Resource Development.
- ix. Faunal Identification, Advisory services and Library Services.
- x. Publication of results including Fauna of India and Fauna of States.

#### **Secondary Objectives**

- i. Environmental Impact Studies.
- ii. Maintenance and Development of Museum at Headquarters and Regional Stations.
- iii. Development of ENVIS and CITES Centers.
- iv. Research Fellowship, Associateship and Emeritus Scientist Programmes.
- v. Collaborative research programmes on Biodiversity with other Organizations.
- vi. GIS and Remote Sensing studies for animal diversity as well as for selected threatened species.
- vii. Chromosomal Mapping and DNA finger printing.

### **9.3.6. Central Zoo Authority (CZA)**

- The CZA is the body of the government responsible for oversight of zoos constituted under the Wild Life (Protection) Act 1972.

#### **Functions of Central Zoo Authority**

- Specify the minimum standards for housing, upkeep and veterinary care of the animals kept in zoos.
- Evaluate and assess the functioning of the zoos with respect to the prescribed standards or norms.
- Recognize or derecognize zoos.
- Identify endangered species of wild animals for purposes of captive breeding.
- Provide technical and financial assistance to such zoos which have the potential to attain the desired standard in animal management.
- Regulate the exchange of animals of endangered category listed under Schedule-I and II of the Wildlife (Protection) Act among zoos.
- Exchange of animals between Indian and foreign zoos is approved by the Authority before the requisite clearances under EXIM Policy and the CITES permits are issued by the competent authority.

#### **Wildlife Trust of India (WTI)**

- WTI was formed in November 1998 in response to the rapidly deteriorating condition of wildlife in India.
- The NGO aims to conserve nature, especially endangered species and threatened habitats, in partnership with communities and governments.
- It has been credited for achieving conservation milestones such as Recovering population of critically endangered species, Translocation of Species, Reducing Human-Animal Conflict, Rescue and Rehabilitation of Animals including Elephants, Tigers, Leopards, One-horned Rhino and Bears.

#### Bombay Natural History Society (BNHS)

- The Bombay Natural History Society (BNHS), founded on 15 September 1883, is one of the largest non-governmental organisations in India engaged in conservation and biodiversity research.
- It supports many research efforts through grants and publishes the Journal of the Bombay Natural History Society.

Student Notes:

## 9.4. Global Efforts for Biodiversity Conservation

### 9.4.1. Linkage between SDGs and Biodiversity

Linkages between SDG and Biodiversity go far beyond the scope of **SDG 14 and 15** that respectively address life below water and life in land.

- Biodiversity and healthy ecosystems provide the essential resources and ecosystem services that directly support a range of societal sectors and economic activities, such as agriculture, forestry, fisheries, and tourism. Biodiversity is thus immediately relevant to the achievement of **SDG 1** on ending poverty and **SDG 8** on decent work and economic growth.
- The recognition of rights to sustainable management of natural resources for indigenous peoples, local communities, and women, and implementation of the CBD objective on fair and equitable benefit-sharing has the potential to improve socioeconomic and political inequality among countries and social groups (**SDG 10**).
- Biodiversity is key for food security and nutrition, and contributes to the achievement of **SDG 2** on zero hunger. Agricultural genetic diversity, including crop and livestock, is crucial for the resilience and adaptation of agricultural systems to pests and changing environmental conditions. All food systems depend on biodiversity and the ecosystem services that support agricultural productivity, soil fertility, and water quality and supply.
- As more and more deaths globally are attributed to environmental factors, the links between biodiversity and health (**SDG 3**) are increasingly recognized. Healthy ecosystems help to mitigate air, water, and soil pollution, and are the source of both modern and traditional medicines.
- They underpin the delivery of water supplies, water quality, and protect against water-related disasters (**SDG 6**); they are the source of energy (**SDG 7**); they can provide reliable and cost-effective natural infrastructure (**SDG 9**); and in general provide basic services to cities, and nature-based solutions to challenges related to urban well-being (**SDG 11**) and to climate change (**SDG 13**).
- All these are however undermined by current unsustainable production and consumption patterns (**SDG 12**), as well as illegal wildlife trade, fishing, and timber trade (**SDG 16**).
- The potential of biodiversity to contribute to sustainable development features in many of the decisions that CBD Parties adopted at the latest UN Biodiversity Conference, held in November 2018, in Sharm El-Sheikh, Egypt.

### 9.4.2. Convention on Biodiversity (CBD)

- It seeks to address **all threats to biodiversity and ecosystem services**, including threats from climate change.
- It aims to promote the **conservation of biodiversity**, the **sustainable use of its components**, and the **fair and equitable sharing of benefits arising from the use of genetic resources**.
- It was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit").
- It's a **legally binding** multilateral environmental agreement with a participation of 196 member countries.
- India is a member.
- The 'Aichi Target' were adopted by the Convention on Biological Diversity (CBD) at its Nagoya conference.

## Protocols adopted under the Convention:

- Cartagena Protocol on Biosafety:** It seeks to protect biological diversity from the potential risks posed by **living modified organisms** resulting from modern biotechnology.
  - It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.
  - It also establishes a **Biosafety Clearing-House** to facilitate the exchange of information on living modified organisms.
- Nagoya Protocol on Access and Benefit Sharing:** It aims at sharing the benefits arising from the **utilization of genetic resources in a fair and equitable way**, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies.

Student Notes:

| CBD strategic goal  | Aichi Target  | The 12 National Biodiversity targets of India are:  |
|---|---|---|
| Address underlying causes   | <ul style="list-style-type: none"> <li>1 Improve awareness of biodiversity</li> <li>2 Mainstream biodiversity</li> <li>3 Reform incentives</li> <li>4 Implement plans for sustainability</li> </ul>   | <p><b>1</b> By 2020, a significant proportion of the country's population, especially the youth, are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably (<b>Aichi Target 1</b>).</p> <p><b>2</b> By 2020, values of biodiversity are integrated into national and state planning processes, development programmes and poverty alleviation strategies (<b>Aichi Target 2</b>).</p> <p><b>3</b> Strategies for reducing the rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place by 2020 for environmental amelioration and human well-being (<b>Aichi Target 5 &amp;15</b>).</p>  |
| Reduce pressures and promote sustainable use  | <ul style="list-style-type: none"> <li>5 Reduce habitat loss and degradation</li> <li>6 Fish sustainably</li> <li>7 Make farming and forestry sustainable</li> <li>8 Reduce pollution</li> <li>9 Tackle invasive species</li> <li>10 Minimise climate change impacts</li> </ul> | <p><b>4</b> By 2020, invasive alien species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive alien species are managed (<b>Aichi Target 9</b>).</p> <p><b>5</b> By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries (<b>Aichi Target 6, 7, 8</b>).</p> <p><b>6</b> Ecologically representative areas under terrestrial and inland water, and also coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably, based on protected area designation and management and other area-based conservation measures and are integrated into the wider landscapes and seascapes, covering over 20% of the geographic area of the country, by 2020 (<b>Aichi Target 10,11, 12</b>).</p> |
| Safeguard ecosystems, species and genes   | <ul style="list-style-type: none"> <li>11 Protect and manage critical sites</li> <li>12 Prevent extinctions</li> <li>13 Maintain genetic diversity</li> </ul>   | <p><b>7</b> By 2020, genetic diversity of cultivated plants, farm livestock, and their wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity (<b>Aichi Target 13</b>).</p> <p><b>8</b> By 2020, ecosystem services, especially those relating to water, human health, livelihoods and well-being, are enumerated and measures to safeguard them are identified, taking into account the needs of women and local communities, particularly the poor and vulnerable sections (<b>Aichi Target 14</b>).</p>  |
| Enhance benefits from biodiversity and ecosystems                                   | <ul style="list-style-type: none"> <li>14 Safeguard ecosystem services</li> <li>15 Restore degraded forest</li> <li>16 Implement access and benefit sharing</li> </ul>  | <p><b>9</b> By 2015, Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization as per the Nagoya Protocol are operational, consistent with national legislation (<b>Aichi Target 16</b>).</p> <p><b>10</b> By 2020, an effective, participatory and updated national biodiversity action plan is made operational at different levels of governance (<b>Aichi Target 3, 4,17</b>).</p>  |
| Enhance implementation through planning, knowledge management and capacity building | <ul style="list-style-type: none"> <li>17 Implement NBSAPs</li> <li>18 Protect traditional knowledge</li> <li>19 Share biodiversity knowledge</li> <li>20 Increase conservation finance</li> </ul>  | <p><b>11</b> By 2020, national initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with the view to protecting this knowledge in accordance with national legislation and international obligations (<b>Aichi Target 18</b>).</p> <p><b>12</b> By 2020, opportunities to increase the availability of financial, human and technical resources to facilitate effective implementation of the <b>Strategic Plan for Biodiversity 2011-2020</b> and the national targets are identified and the Strategy for Resource Mobilization is adopted (<b>Aichi Target 19, 20</b>).</p>   |

#### **9.4.3. Sixth Annual Report to the CBD**

Student Notes:

Recently, India submitted Sixth National Report to the Convention on Biodiversity( CBD).

- Submission of national reports is a mandatory obligation on Parties to international treaties, including CBD.
- NR6 provides an update of progress in achievement of 12 National Biodiversity Targets (NBT) developed under the Convention, in line with the 20 global Aichi biodiversity targets

#### **Highlights of the Report**

- India is one of the few countries where forest cover is on the rise, according to the 15th India State of Forest Report (ISFR) 2017.
- While India has exceeded/overachieved two NBTs, it is on track to achieve eight NBTs and in respect of the remaining two NBTs also, India is striving to meet the targets by the stipulated time of 2020.
- More than 20% of India's total geographical area is under biodiversity conservation, India has exceeded the terrestrial component of 17% of Aichi target 11.
- India published the first internationally recognized certificate of compliance (IRCC) under the Protocol in 2015, and since then published nearly 75% of the IRCCs. Thereby, achieving target relating to access and benefit sharing (ABS) by operationalising the Nagoya Protocol on ABS.
- The population of Lion has risen to over 520 in 2015, and elephants to 30,000 in 2015.
- One-horned Indian Rhino which was on the brink of extinction during the early 20th century, now number 2400.
- Further, while globally over 0.3 % of total recorded species are critically endangered, in India only 0.08% of the species recorded are in this category.
- Measures have been adopted for sustainable management of agriculture, fisheries and forests, with a view to provide food and nutritional security to all without destroying the natural resource base while ensuring intergenerational environmental equity.
- Programmes are in place to maintain genetic diversity of cultivated plants, farms livestock and their wild relatives, towards minimising genetic erosion and safeguarding their genetic diversity.
- Mechanisms and enabling environment are being created for recognising and protecting the vast heritage of coded and oral traditional knowledge relating to biodiversity.

#### **9.5. UPSC Previous Year Questions**

##### **Mains**

1. How does biodiversity vary in India? How is the Biological Diversity Act, 2002 helpful in conservation of flora and fauna? (2018)

##### **Prelims**

1. With reference to India, consider the following Central Acts: (2011)
  1. Import and Export (Control) Act, 1947
  2. Mining and Mineral Development (Regulation) Act, 1957
  3. Customs Act, 1962
  4. Indian Forest Act, 1927

Which of the above Acts have relevance to/bearing on the biodiversity conservation in the country?

(a) 1 and 3 only  
(b) 2, 3 and 4 only  
(c) 1, 2, 3 and 4  
(d) None of the above Acts

**Answer: C**

2. In India, if a species of tortoise is declared protected under Schedule I of the Wildlife (Protection) Act, 1972, what does it imply? (2017)
- (a) It enjoys the same level of protection as the tiger.
  - (b) It no longer exists in the wild, a few individuals are under captive protection; and now it is impossible to prevent its extinction.
  - (c) It is endemic to a particular region of India.
  - (d) Both (b) and (c) stated above are correct in this context.

Student Notes:

**Answer: A**

3. According to the Wildlife (Protection) Act, 1972, which of the following animals cannot be hunted by any person except under some provisions provided by law? (2017)

- 1. Gharial
- 2. Indian wild ass
- 3. Wild buffalo

Select the correct answer using the code given below:

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

**Answer: D**

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# CHAPTER - 10 - SPECIES SPECIFIC MEASURES

Student Notes:

## 10. Species Specific Conservation Initiatives

### 10.1. Introduction

- Census of major flagship species is undertaken at the State-level by the respective State/Union Territory Governments periodically. However census of tiger and elephant is undertaken at the national level once every four and five years respectively. As per the report of the latest census carried out by the state and central government, the population of endangered species especially lions, rhinos, tigers, and elephants has increased in country.
- The Ministry has formulated the **3rd 'National Wildlife Action Plan'** for a period of 2017 to 2031 to save wild animals in the country. The Plan focuses landscape approach in conservation of all wildlife irrespective of where they occur. It also gives special emphasis to recovery of threatened species of wildlife while conserving their habitats which includes terrestrial, inland aquatic, coastal and marine ecosystems.

#### Recovery Programme for Critically Endangered Species

- It is one of the components of centrally sponsored scheme - Integrated Development of Wildlife Habitats (IDWH) which provides assistance to the State/UT governments for activities aimed at wildlife conservation.
- Species Identified under the recovery programme**
  - Snow Leopard,
  - Bustard (including Floricans),
  - Dolphin,
  - Hangul,
  - Nilgiri Tahr,
  - Marine Turtles,
  - Dugongs,
  - Edible Nest Swiftlet,
  - Asian Wild Buffalo,
  - Nicobar Megapode,
  - Manipur Brow-antlered Deer,
  - Vultures,
  - Malabar Civet,
  - Indian Rhinoceros,
  - Asiatic Lion,
  - Swamp Deer and
  - Jerdon's Courser
  - Northern River Terrapin,
  - Clouded Leopard,
  - Arabian Sea Humpback Whale,
  - Red Panda

#### Keystone species

- A species which has a large and disproportionate impact on its ecosystem relative to its abundance is called a keystone species. The term was first coined by zoologist **Robert Paine** in the 1960's. While studying marine invertebrates in the inter-tidal zone he observed that starfish had a disproportionate impact on their ecosystem. If this animal were taken out of the equation half the other species would vanish, hence making the starfish the keystone species of that ecosystem.
- The **examples of keystone species** include beaver in swamp ecosystem, elephants in African Savanna, parrotfish in the Great Barrier Reef, the starfish Pisaster ochraceus in the rocky marine intertidal communities off the northwest coast of North America, etc.

#### Flagship Species

- A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause.
- By focusing on, and achieving conservation of that species, the status of many other species which share its habitat – or are vulnerable to the same threats – may also be improved.
- Flagship species are usually relatively large, and considered to be 'charismatic' in western cultures. Flagship species may or may not be keystone species and may or may not be good indicators of biological process.

#### Priority species

- The terms "flagship" and "keystone" have generally consistent definitions across the conservation community, however "priority species" is a WWF term, and is solely for the purposes of planning and simple communication.

- For WWF, a “priority species” may be either a flagship or a keystone species and is chosen to represent an ecoregion or region.
- A “priority species” is reflective of a key threat across that ecoregion - such that conservation of the species will contribute significantly to a broader threat mitigation outcome. It is often crucial to the economic and/or spiritual wellbeing of peoples within that ecoregion.

Student Notes:

#### Indicator species

- An indicator species is a species or group of species chosen as an indicator of, or proxy for, the state of an ecosystem or of a certain process within that ecosystem.
- Examples include crayfish as indicators of freshwater quality; corals as indicators of marine processes such as siltation, seawater rise and sea temperature fluctuation; peregrine falcons as an indicator of pesticide loads; or native plants as indicators for the presence and impact of alien species.

#### Umbrella Species

- Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat. Species conservation can be subjective because it is hard to determine the status of many species.
- With millions of species of concern, the identification of selected keystone species, flagship species or umbrella species makes conservation decisions easier.
- Umbrella species can be used to help select the locations of potential reserves, find the minimum size of these conservation areas or reserves, and to determine the composition, structure and processes of ecosystems

## 10.2. Tiger

### Indian Tiger or Royal Bengal Tiger (*Panthera tigris*)

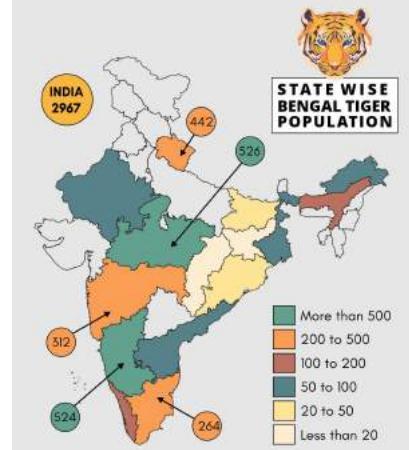
- The tiger (*Panthera Tigris*) is the largest extant cat species and a member of the genus *Panthera*.
- It is most recognizable for its dark vertical stripes on orange-brown fur with a lighter underside.
- It is an apex predator, primarily preying on ungulates such as deer and wild boar. It is territorial and generally a solitary but social predator, requiring large contiguous areas of habitat, which support its requirements for prey and rearing of its offspring.
- Bengal tiger habitats usually are tropical rainforests, marshes, and tall grasses.
- India is home to 80% of global tiger population.** The largest populations of Bengal tigers are in India, but there are some smaller groups in Bangladesh, Nepal, and Bhutan. It may also be present in areas of China and Burma
- Conservation status of Tiger:**
  - IUCN Red List: Endangered,
  - Wild life protection Act: Schedule I and
  - CITES: Appendix I.
- Threat to Tiger in India:** Habitats loss, human-wildlife conflict, Poaching and Wildlife Crime.



### 10.2.1. Conservation Efforts in India

#### 10.2.1.1. Project Tiger

- The Government of India has taken a pioneering initiative for conserving its national animal, the Tiger, by launching the **‘Project Tiger’ in 1973**.
- Project Tiger is an ongoing Centrally Sponsored Scheme under the umbrella scheme of **Integrated Development of Wildlife Habitats of the Ministry of Environment, Forest and Climate Change for providing Central assistance to the Tiger States for tiger**



conservation in designated Tiger Reserves, and also tiger bearing forests outside tiger reserves.

- From 9 Tiger Reserves since its formative years, the Project Tiger coverage has now increased to **fifty at present, spread out in 18 Tiger Range States.** This amounts to around **2.21% of the geographical area of our country.**
- The Tiger Reserves are constituted on a **Core and Buffer** strategy. The **Core** areas have the legal status of a National Park or a, Wildlife Sanctuary whereas the **buffer** or peripheral areas are mix of forest and non-forest lands and even part of protected areas (National Park or Wildlife Sanctuary) are managed as a multiple use areas.
- The Project Tiger aims to foster an exclusive tiger agenda in the core areas of Tiger Reserves, with an inclusive people oriented agenda in the buffer.
- Under the project the govt. has set up a **Tiger Protection Force** to combat poachers and funded relocation of villagers to minimize human-tiger conflicts.

Student Notes:



#### Activities funded under Project Tiger:

- anti-poaching initiatives;
- strengthening infrastructure within tiger reserves;
- habitat improvement and water development;
- addressing man-animal conflicts;
- co-existence agenda in buffer and fringe areas with landscape approach;
- deciding inviolate spaces and relocation of villages from critical tiger habitats within a time-frame by providing a better relocation package, apart from supporting States for settlement of rights of such people;
- rehabilitation of traditional hunting tribes living in and around tiger reserves;
- providing support to States for research and field equipments;
- supporting States for staff development and capacity building in tiger reserves;
- mainstreaming wildlife concerns in tiger bearing forests outside tiger reserves, and fostering corridor conservation in such areas through restorative strategy involving local people to arrest fragmentation of habitats;
- providing safeguards and retrofitting measures in and around tiger reserves and tiger bearing forests for wildlife conservation;
- strengthening the infrastructure of National Tiger Conservation Authority at the Centre;
- carrying out independent monitoring and the evaluation of tiger reserves;
- establishment and development of eight new tiger reserves;
- provision of project allowance to all categories of staff working in tiger reserves;

- (xvi) providing residential amenities to facilitate basic education to children of frontline field staff posted in tiger reserves;
- (xvii) providing assistance to States for fostering ecotourism to benefit local people.

Student Notes:

#### National Tiger Conservation Authority

- It is a statutory body established in 2006 under MoEFCC performing functions as provided in the Wildlife (Protection) Act, 1972.
- The **Minister in charge of the Ministry of Environment and Forests** is the **Chairperson of NTCA**.
- Presently It implements major tiger conservation initiatives like project tiger, Tiger conservation plan etc.
- **Objectives of NTCA:**
  - Providing statutory authority to Project Tiger so that compliance of its directives become legal.
  - Fostering accountability of Center-State in management of Tiger Reserves, by providing a basis for MoU with States within our federal structure.
  - Providing for an oversight by Parliament.
  - Addressing livelihood interests of local people in areas surrounding Tiger Reserves.
- **Powers and functions:** prescribed under Wildlife (Protection) Act, 1972, as amended in 2006 are:-
  - **to approve the tiger conservation plan** prepared by the State Government
  - **evaluate and assess various aspects of sustainable ecology** and disallow any ecologically unsustainable land use such as, mining, industry and other projects **within the tiger reserves**
  - **lay down normative standards for tourism activities** and guidelines for project tiger from time to time for tiger conservation in the buffer and core area of tiger reserves and ensure their due compliance
  - **provide for management focus and measures for addressing conflicts of men and wild animal** and to emphasize on co-existence in forest areas outside the National Parks, sanctuaries or tiger reserve, in the working plan code
  - **provide information on protection measures** including future conservation plan, estimation of population of tiger and its natural prey species, status of habitats, disease surveillance, mortality survey, patrolling, reports on untoward happenings and such other management aspects as it may deem fit including future plan conservation
  - **approve, co-ordinate research and monitoring on tiger**, co-predators, prey habitat, related ecological and socio-economic parameters and their evaluation
  - **ensure that the tiger reserves and areas linking one protected area** or tiger reserve with another protected area or tiger reserve are **not diverted for ecologically unsustainable uses**, except in public interest and with the approval of the National Board for Wild Life and on the advice of the Tiger Conservation Authority.
  - **facilitate and support the tiger reserve management in the State** for biodiversity conservation initiatives through eco-development and people's participation as per approved management plans and to support similar initiatives in adjoining areas consistent with the Central and State laws
  - ensure critical support including scientific, information technology and legal support for **better implementation of the tiger conservation plan**.
  - **facilitate ongoing capacity building programme** for skill development of officers and staff of tiger reserves.

#### All India Tiger Estimate-2018

- India conducts the **all India Tiger Estimation** (which is the world's largest wildlife estimation exercise) every four years to keep a pulse on its tiger population.

- The four-year tiger census report, 'Status of Tigers, Co-predators, Prey and their Habitat, 2018' shows the **count of tigers in India, has risen to 2967**, in 2018 from 2,226 in 2014. The 33% rise in tiger numbers is the **highest ever** recorded between cycles which stood at 21% between 2006 and 2010 and 30% between 2010 and 2014.
  - Census was led by the **National Tiger Conservation Authority and the Wildlife Institute of India**, in collaboration with State Forest Departments. World Wildlife Fund India was the implementation partner.
- India has achieved the target set by the **St. Petersburg declaration on tiger conservation (to double the number of wild tigers (T X 2) across their global range by 2022)** well ahead of the stipulated period in 2019 itself which is evident from the results of the Fourth All India Tiger Estimation, 2018-19.
- Other findings:**
  - Biggest increase in tigers:** The biggest increase has been in **Madhya Pradesh** from 308 in 2014 to 526. Now, MP has most number of tigers.
  - Continuing loss of tiger-occupied areas:** The net loss in tiger-occupied area is estimated to be 20% of the tiger habitat in four years.
  - The decline was spread over three out of India's five tiger landscapes: The Shivalik, Western Ghats and the North East, while Central India and the Sundarbans landscapes registered an increase.
  - No tiger was recorded in **Buxa (West Bengal), Dampa (Mizoram) and Palamu (Jharkhand)** tiger reserves.

Student Notes:

#### Management Effectiveness Evaluation (MEE) Framework

Using internationally applied Management Effectiveness Evaluation (MEE) Framework, the National Tiger Conservation Authority (NTCA) with technical support from Wildlife Institute of India (WII) has adapted and developed 32 headline indicators and a transparent reporting process to support tiger reserve management.

- MEE is **assessment of how well National Park and Wildlife Sanctuaries (NP&WLS) are being managed**—primarily, whether they are protecting their values and achieving the goals and objectives agreed upon.
- MEE can**
  - Enable and support an adaptive approach to management
  - Assist in effective resource allocation
  - Promote accountability and transparency
  - Help involve the community and build constituencies
  - Promote the values of NP&WLS.
- MEE is increasingly being used by governments and international bodies to understand the strengths and weaknesses of the PA management systems.

Management Effectiveness Evaluation (MEE) report of 146 national parks, wildlife sanctuaries was also recently released by MoEFCC.

- Highlights of the report**

- The overall mean MEE score is **62.01%** which is higher than the global mean of 56%.
- Rating-wise, 13% PAs are in 'very good' category, 52% PAs are in 'good' category, 29% PAs in 'fair' category and only 6% PAs have been rated in 'poor' category.
- Tirthan Wildlife Sanctuary and Great Himalayan National Park, Himachal Pradesh rated with the **highest MEE score**
- Turtle WLS, UP and khaparwas WLS, Haryana **ranked at the bottom**.

**Monitoring System for Tigers – Intensive Protection and Ecological Status (M-STripes):** It is a software-based monitoring system launched across Indian tiger reserves by the NTCA.

## 10.2.2. Global Efforts

Student Notes:

### 10.2.2.1. Global Tiger Initiative (GTI)

- It is a global alliance of governments, international organizations, civil society, the conservation and scientific communities and the private sector and includes organization like the World Bank, the Global Environment Facility (GEF), etc.
- Aim:** To work together to save wild tigers from extinction. In 2013, the scope was broadened to include Snow Leopards.
- The initiative is **led by the 13 tiger range countries**
- TX2:** In 2010, the St. Petersburg Declaration on Tiger Conservation was adopted under the GTI and TX2 was endorsed. Its goal was to double the number of wild tigers across their geographical areas. The WWF is implementing the programme in 13 tiger range countries.



### 10.2.2.2. Conservation Assured (CA|TS)

- It is a management tool which sets basic criteria for effective management of tiger conservation reserves or other conservation reserves and protected areas which have tiger populations.
- It is based on a set of seven pillars with 17 minimum standards and associated criteria for effective management.
- It addresses multiple factors which impact conservation management, including support for resident human populations (including their social, cultural, spiritual and economic needs), enhancing overall biodiversity richness, prey-base and habitat cover, and also considers the legal context of an area in terms of content, application and capacity of those on the ground to enforce those laws.
- It is **driven by the CA|TS Partnership**, which comprises of tiger range governments, intergovernmental agencies, conservation organisations and other institutions, such as Global Tiger Forum, IUCN, United Nations Development Program (UNDP), WWF etc.
- The **secretariat for CA|TS is hosted by WWF**.
- It is a key element in realizing the ambitious goal of doubling the global tiger population by 2022, a commitment made by all 13 Tiger Range Countries (TRC).
- Nepal is the first TRC to implement the process.**
- To date, three sites- **Lansdowne Forest Division in Uttarakhand, India**, Chitwan National Park in Nepal and Sikhote-Alin Nature Reserve in Russia have been awarded CA|TS Approved status.

### 10.2.2.3. The Integrated Tiger Habitat Conservation Programme (ITHCP)

- It is a strategic funding mechanism which aims to save tigers in the wild, their habitats and to support human populations in key locations throughout Asia.
- It is supported by the German Government and the German Development Bank (KfW) and was launched in late 2014.
- The programme contributes to the international goal set up during the 2010 St- Petersburg Tiger Summit to double wild tiger populations by 2022.
- IUCN as the programme implementing agency.

#### 10.2.2.4. The Global Tiger Forum (GTF)

- It is the only inter-governmental international body established with members from willing countries to embark on a global campaign to protect the Tiger.
- The GTF was formed in 1993 on recommendations from an international symposium on Tiger Conservation at New Delhi, India.
- A Chairperson, usually a Minister from one of the Tiger Range countries heads GTF for a fixed tenure of 3 Years.
- The Secretariat of GTF is located in New Delhi, India.

#### 10.2.2.5. Global Tiger Recovery Program (GTRP)

It seeks to empower Tiger Range Countries to address the entire spectrum of threats, domestic as well as those that are trans-boundary in nature, and work toward increased financial sustainability through the integration of conservation objectives into development.

### 10.3. Elephant

#### About the species

- Elephants are mammals of the family Elephantidae and the **largest existing land animals**.
- **Three species** are currently recognized: the African bush elephant, the African forest elephant, and the Asian elephant.
- Elephants are **scattered throughout sub-Saharan Africa, South Asia, and Southeast Asia** and are found in different habitats, including savannah, forests, deserts, and marshes.
- They are herbivorous, and they stay near water when it is accessible. They are considered to be keystone species, due to their impact on their environments.
- **Conservation status of Elephant:**
  - **IUCN Red List:** Asian Elephants (Endangered), African Elephants (Vulnerable)
  - **Wild life protection Act:** Schedule I and
  - **CITES:** Appendix I.
- One of the biggest threats to elephant populations is the ivory trade, as the animals are poached for their ivory tusks. Other threats to wild elephants include habitat destruction and conflicts with local people.
- It is National Heritage Animal of India.
- India has more than 60% population of Asian Elephant.
- Karnataka has the highest number of elephants followed by Assam and Kerala respectively.



#### 10.3.1. Conservation Efforts in India

##### 10.3.1.1. Project Elephant

- It was launched by the Government of India in the year 1992 as a **Centrally Sponsored Scheme** with following objectives:
  - a) To protect elephants, their habitat & corridors.
  - b) To address issues of man-animal conflict.
  - c) Welfare of captive elephants
- It also seeks:
  - To take concrete measures **to protect the elephants from poaching and other threats** by taking suitable measures like deployment of patrolling squads, intelligence gathering etc;
  - To create a viable **mechanism to ensure inter-state and regional and national level coordination** in protecting and conserving the elephant and its ranges;
  - To **create infrastructure and other facilities for conservation support activities** like veterinary care, management training, humane methods of capture, tranquilizing and translocation etc of wild elephants, as and when required;

- To improve and create infrastructure for the welfare of elephants in domestic use, including their veterinary care, training of mahouts and supervisory staff in proper treatment of elephants in captivity;
- To encourage and create facilities for research related to the management and ecology of elephant, and also with respect to its veterinary care;
- To take measures for detection and prevention of diseases in wild elephants.

Student Notes:

| List of Landscape and Elephant Reserves in India |   |                                |              |
|--|---|--------------------------------|--------------|
| Sl. No.  | Elephant Range  | Elephant Reserve               | State        |
| 1  | <b>East-Central Landscape</b><br>(South-West Bengal-Jharkhand - Orissa)                     | 1. Mayurjharna ER              | West Bengal  |
|  |   | 2. Singhbhum ER                | Jharkhand    |
|  |   | 3. Mayurbhanj ER               | Orissa       |
|  |   | 4. Mahanadi ER                 | Orissa       |
|  |   | 5. Sambalpur ER                | Orissa       |
|  |   | 6. Baitami ER                  | Orissa       |
|  |   | 7. South Orissa ER             | Orissa       |
|  |   | 8. Lemru ER                    | Chhattisgarh |
|  |   | 9. Badalkhol - Tamorpingla ER  | Chhattisgarh |
| 2  | <b>Kameng-Sonitpur Landscape</b><br>(Arunachal - Assam)                                     | 10. Kameng ER                  | Arunachal    |
| 3  | <b>Eastern-South Bank Landscape</b><br>(Assam - Arunachal)                                  | 11. Sonitpur ER                | Assam        |
| 12   | <b>Dihing-Patkai ER</b>   | 12. Dihing-Patkai ER           | Assam        |
| 13   | <b>South Arunachal ER</b>   | 13. South Arunachal ER         | Arunachal    |
| 4  | <b>Kaziranga-Karbi Anglong-Intanki Landscape</b><br>(Assam - Nagaland)                      | 14. Kaziranga-Karbi Anglong ER | Assam        |
|  |   | 15. Dhansiri-Lungding ER       | Assam        |
|  |   | 16. Intanki ER                 | Nagaland     |
| 5  | <b>North Bengal- Greater Manas Landscape</b><br>(Assam - West Bengal)                       | 17. Chirang-Ripu ER            | Assam        |
| 18   | <b>Eastern Dooars ER</b>  | 18. Eastern Dooars ER          | West Bengal  |
| 6  | <b>Meghalaya Landscape</b><br>(Meghalaya)   | 19. Garo Hills ER              | Meghalaya    |
|  |   | 20. Khasi-hills ER             | Meghalaya    |
| 7  | <b>Brahmagiri-Nilgiri-Eastern Ghats Landscape</b><br>(Karnataka - Kerala-Tamilnadu- Andhra) | 21. Mysore ER                  | Karnataka    |
|  |   | 22. Wayanad ER                 | Kerala       |
|  |   | 23. Nilgiri ER                 | Tamil Nadu   |
|  |   | 24. Rayala ER                  | Andhra       |
|  |   | 25. Nilambur ER                | Kerala       |
|  |   | 26. Coimbatore ER              | Tamil Nadu   |
| 8  | <b>Anamalai-Nelliampathy-High Range Landscape</b><br>(Tamilnadu - Kerala)                   | 27. Anamalai ER                | Tamil Nadu   |
|  |   | 28. Anamudi ER                 | Kerala       |
| 9  | <b>Periyar-Agasthyamalai Landscape</b><br>(Kerala - Tamilnadu)                              | 29. Periyar ER                 | Kerala       |
|  |   | 30. Srivilliputhur ER          | Tamil Nadu   |
| 10   | <b>North-Western Landscape</b><br>(Uttarakhand - Uttar Pradesh)                             | 31. Shivalik ER                | Uttarakhand  |
|  |   | 32. Uttar Pradesh ER           | U.P.         |

new corridors are being used by elephants. Thus at present there are approximately 100 elephant corridors in the Country.

- Steps undertaken by the Government to protect the Elephant Corridors include:
  - Financial and technical assistance is provided to 16 elephant range states under the 'Project Elephant'.
  - Improvement of elephant habitat, including Elephant Reserves and Corridors
  - Regular and extensive patrolling of forest areas and anti poaching measures by frontline field staff of the State Forest Departments.
  - Training and awareness camps are organised regularly for local people for conservation of elephants and other wildlife.
  - Local communities are organised into Joint Forest Management Committees/Eco-development Committees for protection of elephant habitat, including elephant corridors.
  - Habitat improvement and eco-restoration is taken up in critical areas of elephant reserves and corridors.

## 10.3.2 Global Efforts

### 10.3.2.1. Monitoring of Illegal Killing of Elephants (MIKE) Programme

- The MIKE Programme was established by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) by a resolution adopted at the tenth Conference of the Parties in 1997.
- It was started in South Asia in 2003.
- It is an international collaboration that tracks trends in information related to the illegal killing of elephants across Africa and Asia, to monitor effectiveness of field conservation efforts.
- Currently India has ten sites under MIKE programme.



### 10.3.2.2. Asian Elephant Alliance

- It was launched in July 2015 in London, United Kingdom.
- It is an umbrella of five NGOs-Elephant Family, International Fund for Animal Welfare (IFAW), IUCN Netherlands, World Land Trust (WLT) and Wildlife Trust of India (WTI).
- It aims to secure a safe future for the wild elephants of India, which make up approximately half of the world's wild Asian elephants.

### 10.3.2.3. Elephant Trade Information System (ETIS)

- In 1985, regulations were established for the ivory trade. All tusks being shipped from Africa are assigned a serial number. The serial number is then recorded on the exporting permit and assists in global tracking of the ivory.
- Established in 1989, the Elephant Trade Information System analyzes levels and trends in illegal trade in ivory and other elephant products.
- It is managed by TRAFFIC.

## 10.4. Snow Leopard

### About the Species

- The snow leopard is perhaps the most endangered of the large cats, with an estimated population of only 400 to 700 individuals in five Himalayan states in India.
- Habitat:** Snow leopards live in the mountainous regions of central and southern Asia. In India, their geographical range encompasses a large part of the western Himalayas including the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Sikkim and Arunachal Pradesh in the eastern Himalayas.



### Threats

- Factors that have contributed to the decline in the snow leopard populations include, reduction in prey populations, illegal poaching and increased human population infiltration into the species habitat and illegal trade of wildlife parts and products among others.

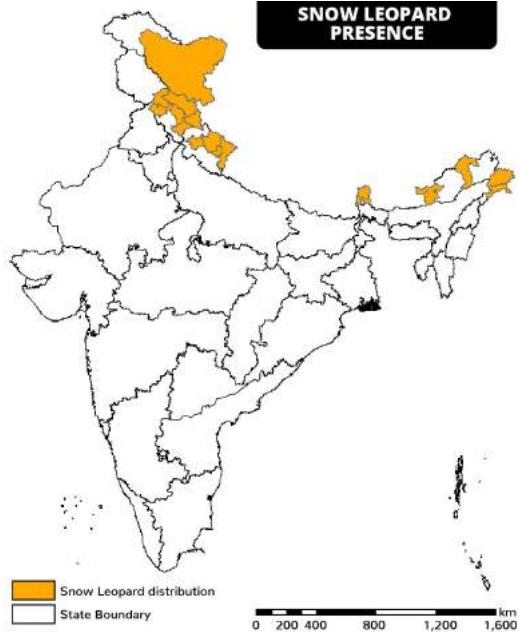
### Conservation Status

- IUCN Red List- Vulnerable
- Convention on International Trade in Endangered Species (CITES)- Appendix I
- Convention on Migratory Species (CMS)- Appendix I
- Wildlife (Protection) Act 1972- Schedule I

## 10.4.1. Conservation Efforts in India

### 10.4.1.1. Project Snow Leopard

- It was launched in 2009 to promote an inclusive and participatory approach to conserve snow leopards and their habitat.
- The strategy document stresses on knowledge based, landscape level and participatory management of wildlife in the region.
- Each of the range states will identify one landscape under the project.
- Surveys will be conducted to identify multiple 'cores' where human use will be minimized, harmonized or completely stopped in a consultative process with the community.
- The project will include representation from the village cluster-level up to a steering committee at the central-level.



Student Notes:

### 10.4.1.2. Securing livelihoods, conservation, sustainable use and restoration of high range Himalayan Ecosystems (SECURE Himalaya)

- SECURE Himalaya is a Govt. of India (MoEFCC)-UNDP-GEF project (2017- 2023) being implemented in Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Sikkim.
- SECURE Himalaya project aims to demonstrate a matrix of best practices of high range Himalayan ecosystem and snow leopard conservation for scaling up and replication in other landscapes, nationally and globally.
- The focal species for conservation is Snow Leopard which is among the 21 critically endangered species being protected in India.
- It is funded by GEF and UNDP.

#### Key Components

- Conservation of key biodiversity areas and their effective management to secure long-term ecosystem resilience, habitat connectivity and conservation of snow leopard and other endangered species and their habitats;
- Securing sustainable community livelihoods and natural resource management in high range Himalayan ecosystems;
- Enhancing enforcement, monitoring and cooperation to reduce wildlife crime and related threats

### 10.4.1.3. Snow Leopard Population Assessment in India (SLPAI)

- SLPAI has been prepared by the Wildlife Institute of India, Nature Conservation Foundation, GSLEP committee, Global Tiger Initiative Council, World Wide Fund for Nature, World Bank, Global Tiger Forum and Wildlife Conservation Trust.
- National-level estimation processes are done for Tigers, Rhinos and Elephants. With this protocol, the same can now be done for Snow Leopards.
- Only 2% of the total habitats of snow leopards have been sampled for population estimation due to difficult terrain and an elusive nature of snow leopards, according to SLPAI document.

## 10.4.2. Global Efforts

Student Notes:

### 10.4.2.1. Global Snow Leopard and Ecosystem Program (GSLEP)

- It is an inter-governmental alliance of all the 12 Snow Leopard range countries.
- The GSLEP is a range-wide effort that unites range country governments, non governmental and inter-governmental organizations, local communities, and the private sector around a shared vision to conserve snow leopards and their valuable high-mountain ecosystems.
- The Snow Leopard countries namely, India, Nepal, Bhutan, China, Mongolia, Russia, Pakistan, Afghanistan, Kyrgyzstan, Kazakhstan, Tajikistan, and Uzbekistan.

## 10.5. Asiatic Lion

### About the Species

- The lion is one of five pantherine cats inhabiting India, along with the Bengal tiger, Indian leopard, snow leopard and clouded leopard.
- Their population is limited to only five protected areas in Gujarat – Gir National Park, Gir Sanctuary, Pania Sanctuary, Mitiyala Sanctuary and Girnar Sanctuary.
- **Conservation status of Asiatic Lion:**
  - IUCN Red List: Endangered,
  - Wild life protection Act: Schedule I and
  - CITES: Appendix I.



### Asiatic vs African Lions

- **Size:** Asiatic lions tend to be smaller than their African cousins.
- **Mane:** Compared to the African lion, the male Asiatic lion has a relatively short, sparse mane. As a result, the male Asiatic lion's ears tend to remain visible at all times. In addition to being less well developed, the mane is generally darker than that of African lions.
- **Skin Fold:** The most distinguishing characteristic of the Asiatic lion is a longitudinal fold of skin that runs along the belly. This trait is found in all Asiatic lions. It is absent in African Lions.
- **Pride Size:** Asiatic prides tend to be smaller than their African counterparts.

### 10.5.1. Asiatic Lion Conservation Project

- The Ministry of Environment, Forest and Climate Change launched the “Asiatic Lion Conservation Project”.
- It will be funded from the Centrally Sponsored Scheme- Development of Wildlife Habitat (CSS-DWH) with the contributing ratio being 60:40 of Central and State share.
- **Focus:** To cause habitat improvement, scientific interventions, disease control and veterinary care supplemented with adequate eco-development works for the fringe population in order to ensure a stable and viable Lion population in the country.

## 10.6. One-horned Rhino

### About the Species

- The Indian rhinoceros (*Rhinoceros unicornis*) is a rhinoceros species native to the Indian subcontinent.
- The great one-horned rhino or Indian Rhino is the largest of the rhino species found commonly in Nepal, Bhutan, Pakistan and India, with India being home to 2,200 rhinos, or over 85% of the population.
- Rhinos in India are found in parts of **Uttar Pradesh, West Bengal and Assam**.
- According to World Wildlife fund data of 2012, **Assam has 91% of total Rhino population** of India which is mainly concentrated in Kaziranga National Park, and a few in Pobitora Wildlife Sanctuary.



## Threats

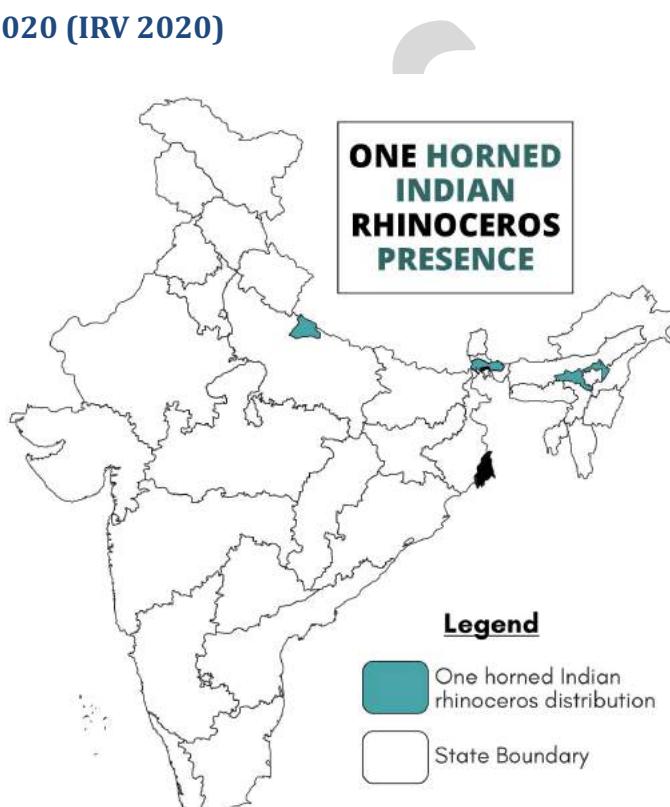
- The extent and quality of the rhino's most important habitat, the alluvial Terai-Duar savanna and grasslands and riverine forest, is considered to be in decline due to human and livestock encroachment. As of 2019, a total of 2100-2200 mature individuals were estimated to live in the wild.
- Key threats include: Poaching, Habitat destruction, flooding etc.
- **Conservation status of Indian Rhino:**
  - IUCN Red List: Vulnerable
  - Wild life protection Act: Schedule I and
  - CITES: Appendix I.

Student Notes:

## 10.6.1. Conservation Efforts in India

### 10.6.1.1. Indian Rhino Vision 2020 (IRV 2020)

- Launched in 2005, it is an ambitious effort to attain a wild population of **at least 3,000 greater one-horned rhinos** spread over seven protected areas in **Assam by the year 2020**.
- Kaziranga National Park in Assam, India, holds about 70% of the world population. IRV 2020 aims to **translocate Rhinos** from Kaziranga National Park and Pobitora Wildlife Sanctuary to five other protected areas namely Manas, Laokhowa, Buracharpori-Kochmora, Dibrusaikhowa and Orang.
- Translocations of Rhinos are being done in order to avert the risks associated with having an entire rhino population concentrated in one specific area.
- By 2012, IRV 2020 successfully translocated 18 greater one-horned rhinos from Kaziranga National Park and Pobitora Wildlife Sanctuary to Manas National Park.



### 10.6.1.2. Other measures

- **National Rhino Conservation Strategy:** It was launched in 2019 to conserve the greater one-horned rhinoceros. This is a first of its kind for the species in India which aims to work for the conservation of the species under five objectives. The objectives include strengthening protection, expanding the distribution range, research and monitoring, and adequate and sustained funding.
- Recently, the Ministry of Environment Forest and Climate Change (**MoEFCC**) has begun a project to create DNA profiles of all rhinos in the country.

## 10.7. Indian Ganges Dolphin

Student Notes:

### About the species

- It inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh.



It is among the four freshwater dolphins found in the world – the other three

- are- baiji found in the Yangtze River (China), the ‘bhulan’ of the Indus (Pakistan) and the ‘boto’ of the Amazon River (Latin America).
- It is fluviatile (riverine) in habitat, it may also be found in brackish water. It never enters the sea.
- A long thin snout, rounded belly and large flippers are its characteristics.
- It is a mammal and cannot breathe in the water and must surface every 30-120 seconds.
- Because of the sound it produces when breathing, the animal is popularly referred to as the 'Susu'.
- The presence of Dolphins in a river system signals a healthy ecosystem. Since the river dolphin is at the apex of the aquatic food chain, its presence in adequate numbers symbolizes greater biodiversity in the river system and helps keep the ecosystem in balance.
- Threats:** Ganges river dolphin is facing severe threats from water development projects, Pollution, hunting and death due to accidental catch in fishing gear.

### Other Dolphin Species

#### • Indus Dolphin (Bhulan)

- They are endangered, freshwater, and functionally blind species of dolphins which rely on echolocation to navigate, communicate and hunt prey including prawns, catfish and carp.
- Except for a tiny, isolated population of Only five to 11 individual Indus Dolphins in India's Beas River (185 km stretch between Talwara and Harike), Indus river dolphins live exclusively in the Indus river in Pakistan.
- Punjab has recently declared it as their state aquatic animal.

#### • Irrawaddy Dolphin

- They are Critically Endangered and live in both salt- and freshwater in South and Southeast Asia.
- Three exclusively freshwater populations are found in Irrawaddy/Ayeyarwady River (Myanmar), Mekong River (Lao PDR, Cambodia); and Mahakam River (Indonesia).
- In addition, very small numbers survive in the partially freshwater Songkhla Lake (Thailand) and the brackish Chilika Lake (India).

#### • Conservation status of Gangetic Dolphin:

- IUCN Red List: Endangered
  - Wild life protection Act: Schedule I and
  - CITES: Appendix I.
- It is the **national aquatic animal** and had been **granted non-human personhood status** by government in 2017.
  - Vikramshila Gangetic Dolphin Sanctuary** (VGDS) in Bihar is India's only sanctuary for the Gangetic dolphin.

## 10.7.1. Conservation Efforts in India

### 10.7.1.1. Conservation Action Plan for Dolphins

With an aim to conserve these endangered dolphins Wildlife Institute of India undertook this project titled “**Development of conservation action plan for Dolphins**” in 2016. It aims to:

- Develop a recovery plan for Ganges dolphins and their habitats in India.
- Engagement of stake holders in conservation of river ecosystems in India.

The main objective of this project are:

- To develop monitoring protocol for dolphins.
- Status of associated river fauna like Gharial, Otter, Turtles and Fishes.
- Quality assessment of river habitat in terms of water quality, anthropogenic pressure and landscape surrounding river scape.

- d) Evaluate the current status of invasive species in river scape.
- e) Involve stake holders to develop a network which will assist in dolphin conservation.

Student Notes:

### 10.7.1.2. Other Conservation Efforts

- A Conservation Action Plan for the Gangetic Dolphin 2010-2020 has been formulated by the Ministry of Environment, Forest and Climate Change. It provides following recommendations:
  - i. Potential sites for intense dolphin conservation should be demarcated and States with Gangetic Dolphin populations should have a regional Dolphin Conservation Centre.
  - ii. The use of nylon monofilament fishing gillnets should be banned and Critical water flow and minimum depths for all river dolphin habitats should be determined.
  - iii. Trans-boundary Protected Areas between India, Nepal and Bangladesh.
- **National Mission for Clean Ganga (NMCG):** In its efforts of biodiversity conservation in Ganga River basin, it has been working on the Ganges River Dolphin Conservation Action.
- **National Dolphin Research Centre (NDRC), Patna:** It's India's and Asia's first Centre for strengthening conservation efforts and research to save the endangered mammal.

## 10.8. Dugong

### About the Species

- Dugong (Dugong dugon) also called as '**Sea Cow**' is one of the four surviving species in the Order Sirenia and it is the only existing species of herbivorous mammal that lives exclusively in the sea including in India.
- They feed on seagrass.
- They can remain underwater for 3-12 minutes.
- They are found in **warm tropical waters**.
- They are distributed between East Africa and Vanuatu in South Pacific Ocean.
- In India they occur in **Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar islands**.
- Once abundant in Indian waters, Dugong population has now reduced to about 200 individuals and is believed to be continuously declining in its number and range.



### Threats:

- Despite being legally protected in many countries, the main causes of population decline remain anthropogenic and include fishing-related fatalities, habitat degradation and hunting.
- With its long lifespan of 70 years or more, and slow rate of reproduction, the dugong is especially vulnerable to extinction.
- **Conservation status of Dugong:**
  - IUCN Red List: Critically Endangered
  - Wild life protection Act: Schedule I and
  - CITES: Appendix I.
- Ministry of Environment, Forests and Climate Change has constituted a 'Task Force for Conservation of Dugongs' to look into the entire gamut of issues related to conservation of dugongs and implementation of the 'UNEP/CMS Dugong MoU'.

### 10.8.1. National Conservation Plan

The National Conservation Plan drafted for conservation Dugong, provides for following:

- **Species Level Conservation and Management:**
  - Dugong population status through advance techniques
  - Site specific monitoring plans to reduce hunting.
- **Habitat Level Conservation and Management:**
  - Reduce direct and indirect threats to seagrass habitat
  - Improve habitat quality through participatory approach.
- **Participatory management of Dugong and its habitats:**
  - Raise awareness through mobile campaigns, workshops
  - Involve local communities.

- Dugong volunteer teams to assist in long term monitoring
- Critical habitat conservation by communities.
- Network of ‘Friends of Dugong’ and ‘Dugong scholarships’
- **Capacity building of State Forest Departments and Local Communities:**
  - Underwater habitat monitoring and improvement of protection enforcement
  - Creation of “Marine Rescue and Rehabilitation Team” at state level

## 10.9. Vultures

### About the Species

- Vultures are scavenging birds of prey.
- They have been divided into **New World vultures**, which include the Californian and Andean condors, and the **Old World vultures**, which include the White-rumped and Red-headed vultures. New World vultures are found in North and South America; Old World vultures are found in Europe, Africa, and Asia.
- There are no vultures in Australia and Antarctica.
- Distinguishing characteristics of most vultures includes a **bald head, devoid of normal feathers and feathery neck**. The bare head is supposedly to maintain hygiene while feeding on carcass and also for thermo regulation.
- **Nine species of vultures** exist in India of which five belong to the genus Gyps.
- Three Gyps vultures, namely the White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* are residents, and the remaining two, the Eurasian Griffon Vulture *Gyps fulvus* and Himalayan Griffon Vulture *Gyps himalayensis* are largely wintering species.
- Vultures are nature's most efficient scavengers. The Gyps vultures are specialized to feed on the soft tissue of the large ungulate carcasses. They play a vital role in the ecosystem by cleaning up the rotten carcasses left in the open. The population of Gyps vultures in the Indian subcontinent has crashed since 1990s onwards.
- The populations of White-rumped Vulture, Long-billed Vulture and Slender-billed Vulture had declined by around 97% during the last two decades. Veterinary use of the non-steroidal anti inflammatory drug '**diclofenac**' is the main cause attributed for this drastic population decline.
- Government of India has banned the use of diclofenac in veterinary medicine, has initiated Vulture Breeding Programme for ex-situ conservation and also enhanced in situ protection of the remaining populations.

| Type   | Description   | Conservation Status (IUCN) |
|--|---|----------------------------|
| Indian Long billed Vulture - <i>Gyps Indicus</i> . | Indian vulture smaller and less heavily built vulture species breeds mainly on cliffs or human-made structures. The species feeds mostly from carcasses of dead animals and reached up to the verge of extinction because of veterinary drug diclofenac | Critically Endangered.     |
| Himalayan Vulture - <i>Gyps Himalayensis</i>       | Himalayan griffon vulture is one of the two largest old world vultures and a true raptor, found along the Himalayas in India. This huge bird of prey is the largest and heaviest bird found in the Himalayas of Indian Subcontinent.                    | Near Threatened.           |
| Bearded Vulture - <i>Gypaetus Barbatus</i>         | Bearded vulture is the only member of the genus <i>Gypaetus</i> found in mountainous regions of Himalayas and Ladakh in north India. These bearded vulture species are also distributed from Kashmir to Arunachal Pradesh of India subcontinent.        | Near Threatened            |
| Slender-Billed Vulture - <i>Gyps Tenuirostris</i>  | Slender-Billed Vulture is one of the critically endangered species of old world vulture found along the Sub-Himalayan regions of Indian Subcontinent. It has suffered an extremely rapid population decline, particularly across the India.             | Critically Endangered      |

|   |   |                        |                |
|---|---|------------------------|----------------|
| White-Rumped Vulture - <i>Gyps Bengalensis</i>  | White-Rumped Vulture is a medium-sized vulture and one of the most abundant large bird of prey in the world. This is the smallest of the <i>Gyps</i> vultures found in India and the most common vulture found in immense numbers all over the country. | Critically Endangered. | Student Notes: |
| Cinereous Vulture - <i>Aegypius Monachus</i>    | Cinereous vulture is a large raptorial bird found in India and the member of the family Accipitridae. The cinereous vulture is believed to be the largest true bird of prey in the world, found in northern India.                                      | Near Threatened.       |                |
| Egyptian Vulture - <i>Neophron Percnopterus</i> | Egyptian vulture is widely distributed species of small old world vulture found in the north-west part of India. There are three widely-recognised subspecies of Egyptian vulture found in Indian subcontinent.   | Endangered.            |                |
| Red-Headed Vulture - <i>Sarcogyps Calvus</i>    | Red-Headed Vulture is also known as Indian Black Vulture found only in the Indian Subcontinent. This medium sized vulture has no subspecies found in deciduous forests and foothills and river valleys.   | Critically Endangered. |                |

## 10.9.1. Efforts in India

### 10.9.1.1. Vulture Conservation and Breeding Centre, Pinjore

- The Vulture Conservation Breeding Centre (VCBC) is a joint project of the Haryana Forest Department and the Bombay Natural History Society (BNHS).
- It is a collaborative initiative to save the three species of vultures, the White-backed, Long-billed and Slender-billed, from looming extinction.
- The VCBC, earlier known as Vulture Care Centre (VCC), was established in September 2001 with the UK Government's 'Darwin Initiative for the Survival of Species' fund, to investigate the dramatic declines in India's *Gyps* species of vultures. The centre sprawls over 5 acres of Haryana Forest Department's land at village Jodhpur.
- It was designated as the Coordinating Zoo for Vulture Conservation in India by the Central Zoo Authority.



### 10.9.1.2. Vulture Conservation Project 2020-2025

- Uttar Pradesh, Tripura, Maharashtra, Karnataka and Tamil Nadu will get a vulture conservation and breeding centre each, according to the Action Plan for Vulture Conservation 2020-2025. The new plan has laid out strategies and actions to stem the decline in vulture population, especially of the three *Gyps* species:
  - Oriental white-backed vulture (*Gyps bengalensis*)
  - Slender-billed vulture (*Gyps tenuirostris*)
  - Long-billed vulture (*Gyps indicus*)
- This would be done through both ex-situ and in-situ conservation. The plan has also suggested that new veterinary non-steroidal anti-inflammatory drugs (NSAIDS) be tested on vultures before their commercial release. NSAIDS often poisons cattle whose carcasses the birds pray on.

## Highlights of the new plan

- A system to automatically remove a drug from veterinary use if it is found to be toxic to vultures, with the help of the Drugs Controller General of India.
- Conservation breeding of red-Headed vultures and Egyptian vultures and the establishment at least one vulture-safe zone in each state for the conservation of the remnant populations in that state.
- Coordinated nation-wide vulture counting, involving forest departments, the Bombay Natural History Society, research institutes, non-profits and members of the public.
- A database on emerging threats to vulture conservation, including collision and electrocution, unintentional poisoning, etc.

Student Notes:

## 10.9.2. Global Efforts

### 10.9.2.1. SAVE (Saving Asia's Vultures from Extinction)

- The consortium of like-minded, regional and international organizations, created to oversee and coordinate conservation, campaigning and fundraising activities to help the plight of south Asia's vultures.
- **Objective:** To save three critically important species from extinction through a single programme.
- **SAVE partners:** Bombay Natural History Society, Bird Conservation Nepal, RSPB (UK), National Trust for Nature Conservation (Nepal), International Centre for Birds of Prey (UK) and Zoological Society of London.

## 10.10. Great Indian Bustard

### About the Species

- Great Indian Bustard (hereafter GIB) is one of the rarest birds in world.
- It's among the heaviest bird with a horizontal body and long bare legs giving it an ostrich like appearance.
- **Habitat:** The species inhabits open habitats (short grasslands, open scrub and rain-fed agriculture) and breed in traditionally selected grasslands, where males display to attract females. It avoids irrigated areas.
- GIB is an indicator species for grassland habitats and its gradual disappearance from such environments shows their deterioration.
  - Once the species is lost, there will be no other species to replace it, and that will destabilise the ecosystem of the grassland and affect critical biodiversities, as well as blackbucks and wolves, who share their habitat with the GIB.
- Excessive hunting in past and current levels of habitat loss, compounded with very slow life-history traits, has caused their decline.
- It is **endemic** to Indian Sub-continent, found in central India, western India and eastern Pakistan.
- The largest population occurs in **Thar Desert, Rajasthan**. Other populations occur in Kachchh (Gujarat), Solapur and Chandrapur (Maharashtra), Kurnool (Andhra Pradesh) and Bellary (Karnataka).
- **Bustard Species Found in India:** Great Indian Bustard, the Lesser Florican and the Bengal Florican; Houbara also belong to Bustard family but it's a migratory species.
- Great Indian Bustard is Rajasthan's state bird. The state government has started "Project Godawan" for its conservation at Desert National Park (DNP) in Jaisalmer.
- It's one of the Species for The Recovery Programme under the **Integrated Development of Wildlife Habitats** of the Ministry of Environment and Forests.
- **Conservation status of Great Indian Bustard:**
  - **IUCN Red List:** Critically Endangered
  - **Wild life protection Act:** Schedule I and
  - **CITES:** Appendix I.
  - **Conservation of Migratory Species or Bonn Convention:** Appendix I



### **10.10.1. National Guidelines for Recovery of Bustards, 2013**

## Student Notes:

It advocated a multi-pronged approach involving:

- Stringent protection and research-informed management of breeding enclosures,
  - Coexistence with compatible land uses and mitigation of unfriendly land uses in priority habitats of adjoining landscapes identified through research,
  - Participation of local communities in conservation through incentives and outreach, and
  - Establishment of captive population as insurance against extinction and possible reintroduction.

Since great Indian bustard and lesser florican – both endangered bustards – share habitats, these activities will supplement and complement each other's needs. In doing so, a plethora of other endangered wildlife such as the spiny-tailed lizard, chinkara and foxes will be benefitted.



## **10.11. UPSC Previous Year Questions**

## Prelims



**Answer:** B

- 2.** Consider the following:

  1. Black-necked crane
  2. Cheetah
  3. Flying squirrel
  4. Snow leopard

Which of the above are naturally found in India? (2011)

|                     |                     |
|---------------------|---------------------|
| (a) 1, 2 and 3 only | (b) 1, 3 and 4 only |
| (c) 2 and 4 only    | (d) 1, 2, 3 and 4   |

**Answer:** B

- 3.** Which one of the following groups of animals belongs to the category of endangered species? (2011)

  - (a) Great Indian Bustard, Musk Deer, Red Panda and Asiatic Wild Ass
  - (b) Kashmir Stag, Cheetal, Blue Bull and Great Indian Bustard
  - (c) Snow Leopard, Swamp Deer, Rhesus Monkey and Saras (Crane)
  - (d) Lion-tailed Macaque, Blue Bull, Hanuman Langur and Cheetal.

(a) Answer: A

- 4.** Other than poaching, what are the possible reasons for the decline in the population of Ganges River Dolphins? (2014)

  1. Construction of dams and barrages on rivers
  2. Increase in the population of crocodiles in rivers

3. Getting trapped in fishing nets accidental  
4. Use of synthetic fertilizers and other agricultural chemicals in crop-fields in the vicinity of rivers

Student Notes:

Select the correct answer using the code given below.  
(a) 1 and 2 only      (b) 2 and 3 only      (c) 1, 3 and 4 only      (d) 1, 2, 3 and 4

**Answer: C**

5. Recently, for the first time in our country, which of the following States has declared a particular butterfly as 'State Butterfly'? (2016)  
(a) Arunachal Pradesh      (b) Himachal Pradesh  
(c) Karnataka      (d) Maharashtra

**Answer: D**

6. In which of the following regions of India are you most likely to come across the 'Great Indian Hornbill' in its natural habitat? (2016)  
(a) Sand deserts of northwest India  
(b) Higher Himalayas of Jammu and Kashmir  
(c) Salt marshes of western Gujarat  
(d) Western Ghats

**Answer: D**

7. The term M-STRIPES' is sometimes seen in the news in the context of (2017)  
(a) Captive breeding of Wild Fauna  
(b) Maintenance of Tiger Reserves  
(c) Indigenous Satellite Navigation System  
(d) Security of National Highways

**Answer: B**

8. If you want to see gharials in their natural habitat, which one of the following is the best place to visit? (2017)  
(a) Bhitarkanika Mangroves      (b) Chambal River  
(c) Pulicat Lake      (d) Deepor Beel

**Answer: B**

9. Consider the following statements: (2019)  
1. Asiatic lion naturally found in India only  
2. Double-humped camel is naturally found in India only  
3. One-horned rhinoceros is naturally found in India only  
Which one of the statement given above is/are correct?  
(a) 1 only      (b) 2 only  
(c) 1 and 3 only      (d) 1, 2 and 3

**Answer: A**

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