5TH SEM B.Sc. ZOOLOGY

CALICUT UNIVERSITY

ZOOLOGY CORE COURSE –VI
Code: ZO5B 06T
ENVIRONMENTAL BIOLOGY, WILDLIFE CONSERVATION AND TOXICOLOGY
2017 ADMISSION

PREPARED BY ,

JAMSHIYA JAITHUN C

ASSISTANT PROFESSOR

DEPARTMENT OF ZOOLOGY

CPA COLLEGE OF GLOBAL STUDIES , PUTHANATHANI

SYLLABUS

FIFTH SEMESTER B. Sc. DEGREE PROGRAMME (Theory)
ZOOLOGY CORE COURSE –VI
Code: ZO5B 06T
ENVIRONMENTAL BIOLOGY, WILDLIFE CONSERVATION AND TOXICOLOGY,
[54 hours] [3 hours per week] [3 credits]

Section A: ENVIRONMENTAL BIOLOGY (32 hrs)

1.Ecological tools and Techniques (4 hrs)

1. Sampling of animal populations

- Trapping and collecting various groups of flying insects (aquaticorganisms, soil organisms, birds and mammals).
- Marking of animals
- Determination of home range and territory
- Estimation of number of animals in population
- (vii) Indirect method of estimating wild animals by their signs and symptoms.

2. Remote sensing.

2.Ecosystem and Energetics (6hrs)

- Definition,scope and branches of ecology,Habitat,Niche,Community,Autecology and Synecology.
- Energy flow and energetics of ecosystem
- Solar energy and photosynthetic and chemosynthetic production
- Energy transformations and energy transfer
- Laws of thermodynamics

3. Biogeochemical cycles (3 hrs)

Basic types of biogeochemical cycles - Gaseous cycle - carbon and nitrogen cycles; sedimentary cycle

4. Limiting factors (2 hrs)

Basic concepts - Leibig's law of minimum - Shelford's law of tolerance, combined concept of limiting factors

5. Population Ecology (5 hrs)

Properties of population - density, natality, mortality, age distribution, biotic potential, environmental resistance and carrying capacity, population growth forms, J and S shaped curves, migration, emigration and immigration

6. Community Ecology (5 hrs)

Biotic community - definition, characteristics and classification, species diversity, fluctuations, stratification, succession, ecotone and edge effect

7. Population interactions (3 hrs)

Intraspecific and interspecific associations - Positive and negative interactions: Mutalism, Commensalism, Parasitism, Predation, Competition

8. Man and Environment (4 hrs)

- Sustainable development (in brief)
- Destruction of habitat and its consequences - wetland, paddy fields, mangrove, river encroachment, sand and clay mining, ecological impacts of tourism

MODULE : 1

ECOLOGICAL TOOLS AND TECHNIQUES

- Ecological studies require the use of several tools and techniques for a proper analysis.
- These techniques are different for plant and animal populations.
- Some of the commonly used techniques for the study of animal populations are:

1. Sampling
2. Trapping and collection of animals
3. Marking
4. Determination of home range and territory
5. Estimation of number of population
6. Indirect method of estimating wild animals by their signs and symptoms.
7. Remote sensing

SAMPLING

- Sampling is the selection of a representative subset from a whole population.
- Values obtained- *statistical values*
- Conclusions derived-*statistical inferences.*
- Types:

  a) Random sampling/chance sampling/probability sampling

  b) Non-random sampling

- ***Random sampling***- selection of sample unit is absolutely a matter of chance or probability.All the members have a equal chances for getting selected.It can be *simple,stratified,systematic,or cluster random sampling.*

- **Non-random sampling**-selection depends upon the judgement of the selector.So,all the members may not get equal chances of being selected.It can be *convenience,purposive,quota or snowball sampling.*

a) Steps,

- *Selection of samples*
- *collection of information*
- *making statistical inferences.*

TRAPPING AND COLLECTION OF ANIMALS

1. ***Trapping and collection of flying insects***

   1. Simple net
   2. Sticky trap
   3. Water trap
   4. Malaise trap
   5. Light trap

2. ***.Trapping and collection of birds***

- Food baits
- Baited box trap
- Funnel traps
- Baited net traps
- Drift traps
- Mist traps
- Nest trap
- Use of drugs

3. ***Trapping and collection of mammals***

- Food baits
- Live baits
- Curiosity baits

- Scents
- Snares
- Box trap
- Drift trap
- Use of drugs

MARKING OF ANIMALS

Marking of individual animals and releasing them for future observation is a common technique to study distribution,movements and migration of animals and also to estimate the number of animals in a population.

1.*Marking of captured mammals*

a)Mutilation

- It involves *branding,toeclipping,taildocking,earcropping,hole punching and fur clipping.*
- *Advantages:requires minimum application of equipment,marks are noticeable from distance,some are semipermanent or permanent.*

b)Tagging

- Attaching of a metallic piece to an animal
- Advantages:easy to affix and detect,and can be discovered even after the death of the animal.

c)Colouring

- Nyanzol 4R and NyanzolD are the two commonly applied dyes • Dyes may be fixed with hydrogenperoxide

d)Tattooing

- Ear tattooing is the standard markimg method
- Leaves permanent marks.

2.***Marking of captured birds***

- Banding or ringing
- Colour marking
- Mutilation(wing clipping,featherclipping,toe clipping

DETERMINATION OF HOME RANGE AND TERRITORY

HOME RANGE	TERRITORY
• Specific geographical area where it spends the whole of life. • Occupied by different species. • May overlap	• Defended area within a homerange. • Occupied by a single member,a breeding pair,or a small group of members of same species • Never overlap

Home range can be determined ,

- Movement of the animal is carefully observed and area of its movt. Is measured and outlined on a map
- Baiting technique.
- Birds very rigidly maintain territory during breeding season.

ESTIMATION OF NUMBER OF ANIMALS IN A POPULATION

- ***Census or direct counting method***:direct counting of the members of a species in a given area during a particular period of time.
  Example:elephants
- **Sampling estimation**:counting of members of a species in sample plots.
- ***Mark – recapture method***: Several members of the population are captured,marked and then returned to the field.The marked members mix with the unmarked members.Now,another set is captured from this mixed group.The ratio between the total members and the marked members of the mixed sample will probably reflect the ratio between the total.members and the marked members in the whole population.

P:M : :p:m

Where ,

P=whole population

M=number of initially marked individuals

P=mixed sample drawn

M=marked members of mixed sample

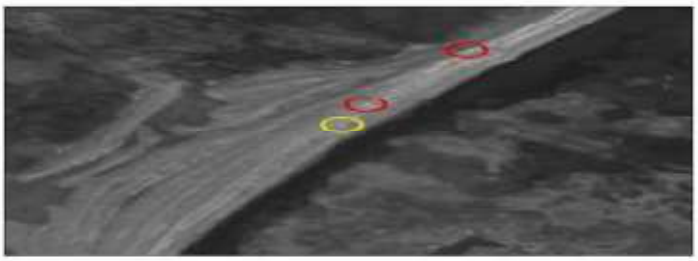
INDIRECT METHOD OF ESTIMATING POPULATION OF WILD ANIMALS

- ***Indices method/indirect count***: indicates relative size of a population and shows population trends(up,down,stable) but does not provide an actual estimate of the number of animals
- Examples: call counts are used for some birds.

REMOTE SENSING

- Science and technology of collecting information about an object,area or event through observations and measurements made from a distance.
- The information thus collected is then recorded ,stored ,processed ,analysed,and interpreted.

- Example: satellite imaging ,radar imagery ,aerial photography.



MODULE : 2

ECOSYSTEM AND ENERGETICS

HABITAT

- Habitat is a locality,place or area where an organism or a community lives.
- Major habitat : *aquatic,terrestrial and aerial*
- *Microenvironment or microhabitat :*a very small and much restricted area with only a few different populations . *Eg,* under surface of a stone.
- *Microenvironment* represents immediate surrounding of an organism.

ECOLOGICAL NICHE AND GAUSE'S LAW

- *role or functional status* of an organism as a member of a community in a habitat
- includes food relations,feedinghabits,energy transformations, response and tolerance , interactions , and resources it utilizes.
- *Ecological equivalents :*2 species of organisms having same or similar ecological niche in different geographical areas.
- *Competition exclusion principle:* two species of organisms having same or similar ecological niche in same area or community may compete with each other until one displaces the other

- According to the law,
    a. Two or more species of a community can never have the same ecological niche

    b. Two or more species with the same niche cannot coexist.

HABITAT	***NICHE***
➢ address	➢ profession
➢ Where an organism lives	➢ What an organism is doing

SUBDIVISIONS OF ECOLOGY

1. ***Autecology***

   Study of individual organisms or individual species in relation to their environment and with emphasis on their life history and behavior as adaptations to environment.

   2 types ,

Population ecology (demecology)

- deals with individual organisms or populations.

Species ecology

- deals with different species of organisms.

2. ***Synecology***

Ecological study of groups of organisms which associate to form functional units ,such as communities and ecosystems.

2 types,

Community ecology

- ***study of compositions,succession, interelations, distributions , and adaptations of different communities***

Ecocystem ecology

- ***study of organizational and functional aspects of ecosystems.***

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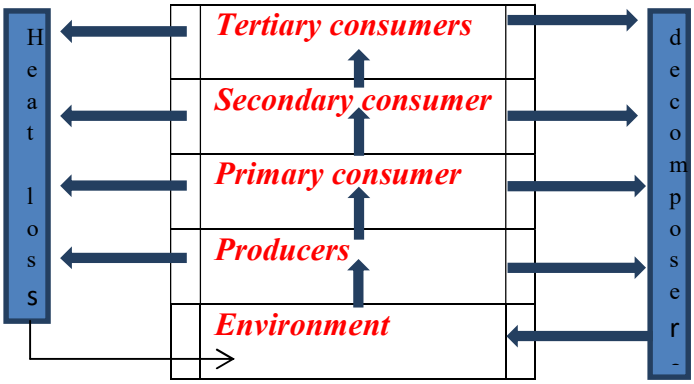
3. ***Habitat ecology***

Study of the nature of the habitat and its influence on organisms.

ENERGY FLOW AND ENERGETICS OF ECOSYSYTEM

- Photosynthetic organisms utilize only about 0.02% of solar energy.
- *Ecological energetics:sum total of the transfers and transformations of energy in an ecosysytem*
- OR *sum total of the energy transactions in an ecosystem.*
- In an ecosystem,there is continuous flow of energy from one organism to another and a regular cycling of matter from one source to another.
- *Energy flow: orderly and step by step transfer or flow of energy from producers to decomposers through the successive levels of consumers .*
  - ***a.*** The flow of energy is always *unidirectional ,linear or non-cyclic and non-reversible .*
  - ***b.*** some amount of energy would be lost at each trophic levels through metabolic consumption,excretion and decomposition.



- Energy transfer from one trophic level to the next is never 100% efficient.

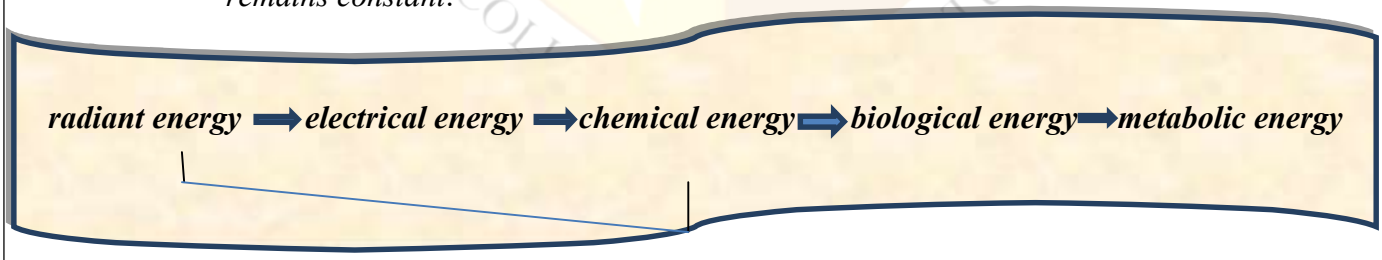
LINDEMAN'S LAW OF TEN PERCENT

- *Lindeman's efficiency law or law of ten percent : Lindeman* has estimated that only 10-20% of the capital energy is transferred from each trophic level to the next
  - ***a.*** There is considerable loss of food energy in each trophic level
  - ***b.*** Only asmall fraction of energy entering a foodchain will be passed on to the next level
  - ***c.*** There is a progressive decrease in the availability energy from lower to higher trophic levels
  - ***d.*** The longer the food chain,the lesser will be the energy available for the higher t level

ENERGY FLOW AND LAWS OF THERMODYNAMICS

a) Law of conservation of energy

Energy can neither be created nor be destroyed, but can only be transformed from one form to another and transferred from one source to another. So, the total energy in universe remains constant.



2) Law of entropy

During the transformation or transfer of energy , a portion of it dissipates as unutilizable heat energy , causing the entropy or energetic disorder. So, entropy steadily increases in the universe.

According to these laws,energy flow in the ecosystem is always,

- **Transformation of energy from one form to another**
- **Degradation of energy from a concentraredto a dispersed form**
- **Loss of some energy during every transfer**

PRODUCTIVITY

- It is the *rate of production of biomass or organic matter per unit time and area.*
- Usually,represents the annual production
- Fundamental concepts,
    - ***a. Standing crop*** – it is the *biomass or total energy content of a community of a given area at a given time*
    - ***b. Materials removed*** –materials removed from the area during a particular period include the yield taken by man, the organisms migrated from that area , and the materials withdrawn from the area as organic deposits.
    - ***c. Production rate*** –represents the rate of growth and multiplication of organisms in the area.

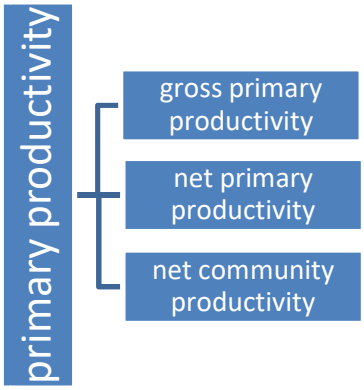
KINDS OF PRODUCTIVITY

Primary productitvity ***Secondary productitvity***

1.PRIMARY PRODUCTIVITY (PP)

- *Rate of production of biomass or oganicmatter by autotrophs, mainly phototrophs per unit area and time .*

- In phototrophs, it represents the *rate at which solar energy isfixed*,organic matter is produced and biomass is accumulated.



GROSS PRIMARY PRODUCTIVITY

- *Sum total of the organic matter produced or the sum total of the radiant energy fixed by producers through photosynthesis per unit area and unit time*
- expressed as *calories per m^2 per year*

NET PRIMARY PRODUCTIVITY

- *rate of storage of organic matter and energy in producers in excess of their metabolic consumption and other losses*
- *GPP-autotrophic consumption and losses*

NET COMMUNITY PRODUCTIVITY

- *ratee of storage of organic matter and energy in consumers in excess of their meatabolic consumption and other losses*
- NPP - *heterotrophic consumption*

PRODUCTION-RESPIRATION RATIO(P/R RATIO)

Relationship between gross production and gross community metabolism.

- **P/R=1 :** steady state community
- **P/R> 1:** organic matter accumulates
- **P/R < 1 :** organic matter depletes

2. SECONDARY PRODUCTIVITY (SP)

Rate at which food energy is assimilated and stored in the different trophic levels of the consumers. 0r it is the *rate of synthesis of new organic matter by consumers.*

MODULE : 3

BIOGEOCHEMICAL CYCLES

- *Cyclic back and forth regenerative movement of chemical elements between organisms and their physical environment.*
- Also called *mineral or nutrient cycle.*
- Minerals are concentrated in specific compartments called *pools.*
- Biogeochemical cycles are maintained and regulated by feedback mechanisms and so they constitutea *more or less self regulating system.*
- *Cyclic*
- *Bidirectional*
- Includes water cycle , carbon cycle , nitrogen cycle , phosphorus cycle ,sulphur cycle

- 2 phases,
    1) *Biotic* – exists in living organisms. Flow of energy and nutrients through foodchain
    2) *Abiotic* – exists in physical environment .dispersal and distribution of of elements in the physical environment.
- 2 componenets,
    1) *Reservoir pool* – store house and the primary source of element (physical environment).it is less active.
    2) *Exchange pool* - represented by the biotic phase and sometimes by abiotic phase also .there is active transfer of the element.
- Recycling pathways,

o Decomposition pathway
o Excretory pathway
o Respiratory pathway
o Solar energy mediated pathway
o Fossil fuel – mediated pathway
o Autolytic pathway
o Volcanic pathway

- Basic types,

1) ***Gaseous cycle*** **– prominent gaseous phase and reservoir pool is in the atmosphere or hydrosphere.*Eg.* Carbon cycle,water cycle**

2) ***Sedimentary cycle*****– reservoir pool is in the lithosphere .Eg. phosphorous cycle, sulphur cycle.**

3) ***Perfect cycle / complete cycle*** **- cycle in which nutrients are added to the reservoir pool as fast as they are removed from it so that they wil never accumulate anywhere in appreciable quantities. Eg, gaseous cycle**

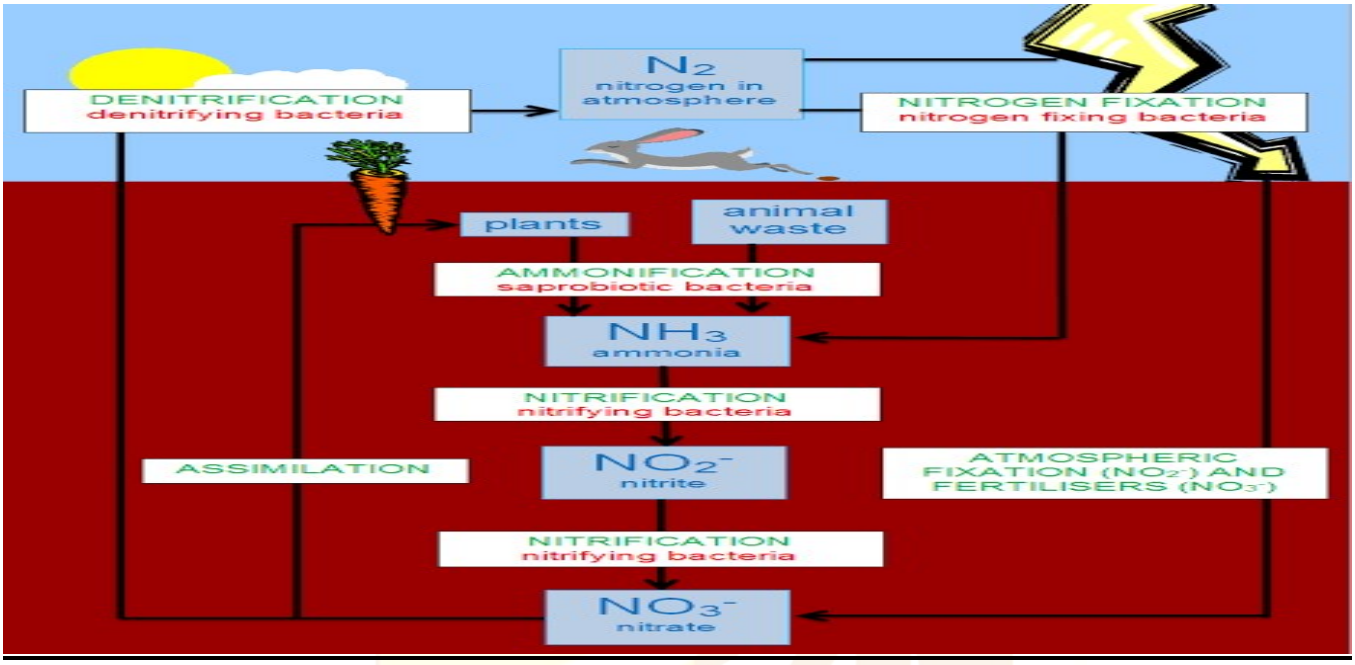
4) ***Imperfect cycle / incomplete cycle*** **– cycles in which the discharge of nutrients into reservoir pool is either incomplete or very slow so that their removal from the reservoir pool will not be readily compensated by replenishment .Eg , sedimentary cycle.**

5) ***Open cycle*** **– nutrient cycle in which nutrients are lost in considerable amounts. Eg,highly erosive environment**

6) ***Closed cycle*** **– cycle with virtually no leakage or loss of nutrients . Eg, tropical forests**

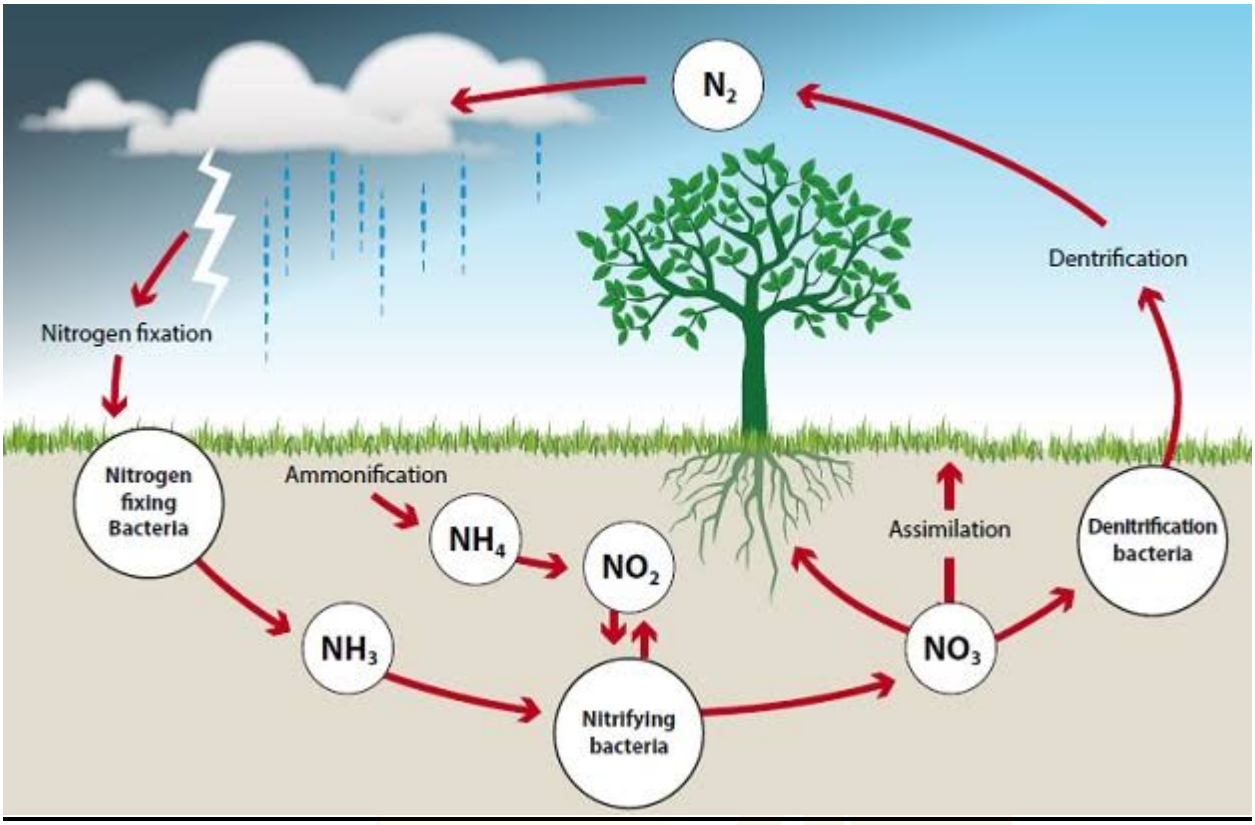
NITROGEN CYCLE

Cyclic back and forth movement of nitrogen between atmosphere and living organisms .



Stages

1. *Nitrogen fixation* - Flow of nitrogen from atmosphere to the cells of some micro organisms , known as *nitrogen fixers*
2. Flow of nitrogen from nitrogen fixers to soil in the form of nitrogenous compounds.
3. Flow of nitrogenous compounds from soil to plants , and then from plants to animals through food chain.
4. Return of nitrogenous compounds to soil from plants and animals through decomposition and excretion
5. Re-cycling of nitrogen through a new generation of plants and animals
6. Return of molecular nitrogen from soil to atmosphere.



- ***Nitrogen fixation:***

Removal and reduction of atmospheric molecular nitrogen and its subsequent incorporation with other elements to form nitrogenous compounds

- ***Denitrification:***

The release of nitrogen from nitrogenous compounds back to the atmosphere.

- ***Ammonification***

The synthesis of ammonia (NH_3) from nitrogenous organic compounds such as amino acids.

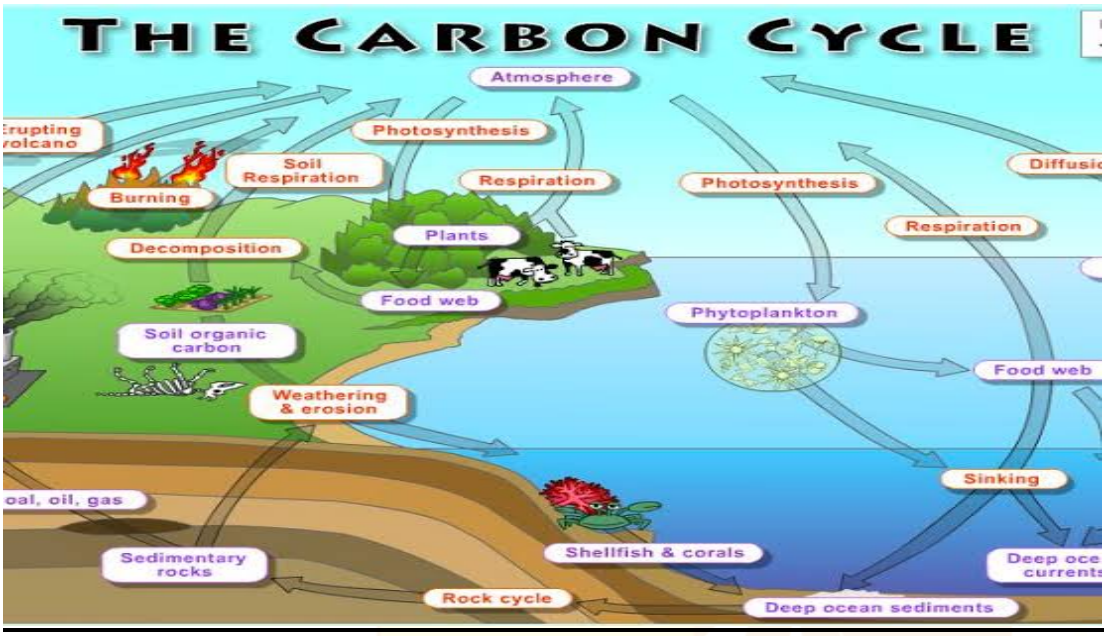
- ***Nitrification:***

The formation of nitrites (NO_2^-) and nitrates (NO_3^-) from NH_3

- ***Nitrate assimilation:***

The utilization of inorganic nitrates by organisms to synthesise their organic nitrogenous compounds

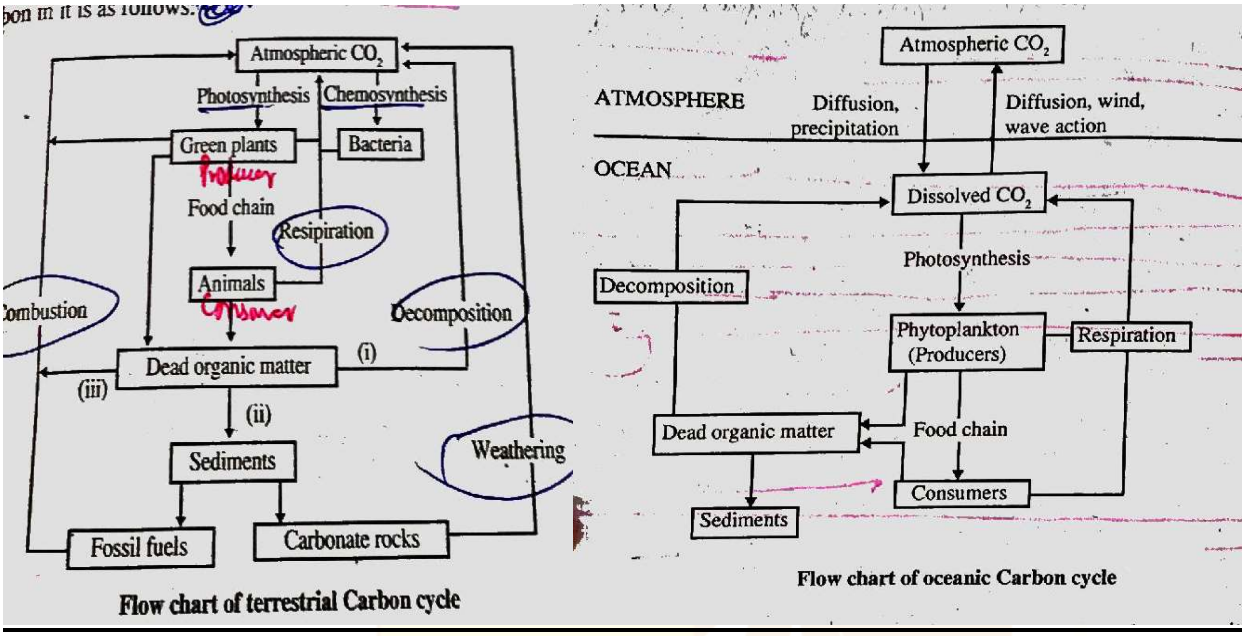
CARBON CYCLE



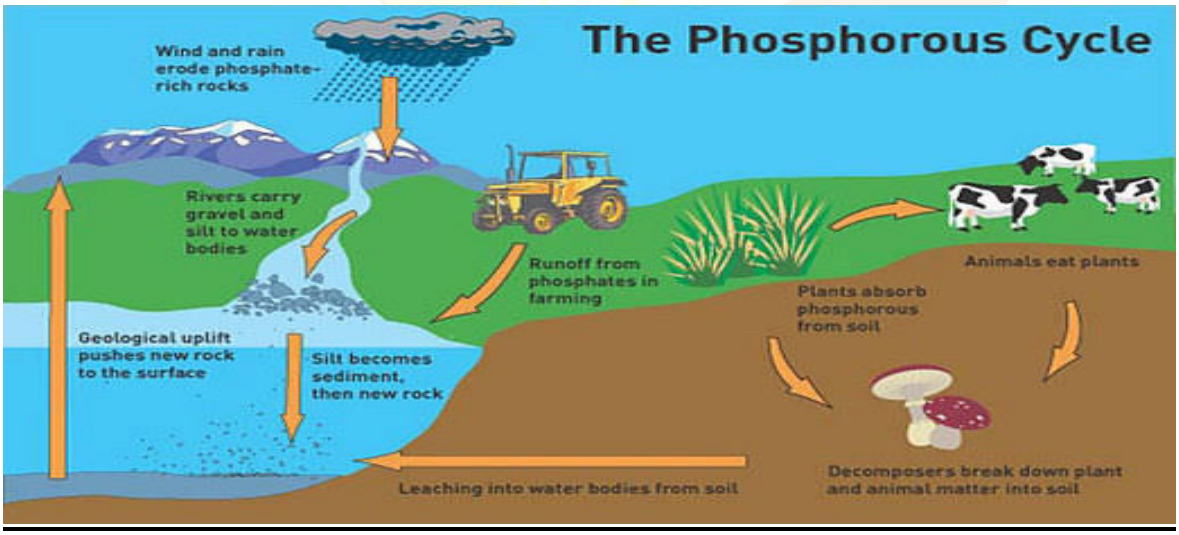
1. It is a perfect cycle because the transfers and transformations of carbon compounds are quick , and the replenishment of carbon is as fast as its removal so that no appreciable amount of carbon is lost from biospheric circulation.
2. It is a gaseous cycle because the reservoirs of all the fixed carbon include atmosphere and hydrosphere.
3. Carbon exists in the atmosphere as CO_2 ,and in the hydrosphere as carbonic acid,bicarbonate ions and carbonate ions.
4. Geological carbon content estimates to 99% of the total carbon.
5. Circulation of carbon in the biosphere involves two distinct cycles

Oceanic carbon cycle ***terrestrial carbon cycle***

Terrestrial carbon cycle ***Oceanic carbon cycle***



PHOSPHORUS CYCLE



1. Sedimentary cycle
2. Principal reservoir : phosphate rocks
3. The fossil deposits of the bones of extinct animals and the excrement deposits (guano) of fish eating sea birds are also important phosphorus reservoirs

4. Through soil erosion and running waters ,some phosphorus from these reservoirs gets distributed in the soil.this forms *phosphorus pool*
5. Plants absorb phosphorus from this pool and then phosphorus enters foodchain and reaches the animal
6. From animals small amount of phosphorus is returned to soil through their excreta
7. After the death and decomposition of plants and animals , a large amount of phosphorus is returned to the soil for re-cycling
8. From phosphorous pool,large amount of dissolved phosphorous would be lost to sea through run down transport and form shallow marine sediments
9. A small portion may be returned to land by fish – eating sea birds,which deposit excrement on the shore
10. A considerable return of phosphorus from sea to land is affected by fish harvest
11. Most of shallow marine sediments will be lost to deep sediments
12. From deep marine sediments ,phosphorus may be brought to terrestrial reservoirs only through major geological upheavels

SULPHUR CYCLE

1. Both *sedimentary* as well as *gaseous*in nature.
2. In its sedimentary phase,sulphur remains in inorganic and organic soil deposits
3. Inorganic deposits includes pyrite rocks and sulphur
4. Organic deposits includes fossil fuels
5. In the gaseous phase sulphur exists in the atmosphere as H_2S and SO_2.
6. From the sulphur deposits of the sedimentary phase,sulphur is released by weathering of rocks, combustion of fossil fuels , decomposition , volcanic eruption etc
7. Part of this released enters atmosphere and rest enters terrestrial and aquatic ecosystems
8. Initially , sulphur enters atmosphere as H_2S
9. H_2S soon gets oxidized to SO_2,which dissolves in atmospheric water vapour and forms weak H_2SO_4 .rain water brings down H_2SO_4 to the surface which partly replenishes the soil sulphur
10. From soil,plants absorb sulphur as sulphate ions

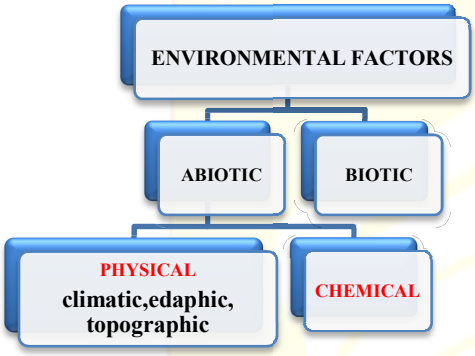
11. In plants,sulphur gets incorporated with aminoacids and proteins
12. From plants sulphur containing organic compounds enters food chain
13. Sulphur returns to the soil through excretion and decomposition.
14. Sulphur containing compounds enter detritus food chain and gets mineralized by decomposing bacteria and fungi releasing H_2S .
15. Some H_2S returns to the atmosphere , replenishing atmospheric sulphur
16. Under aerobic conditions, some H_2S gets oxidized to soil SO_4^{2-} by bacteria which either enters the plant body or enters into formation of soilmdeposits of sulphur
17. Under anaerobic conditions ,photosynthetic bacteria make use of H_2S for synthesizing carbohydrates
18. During this,theyoxidise H_2S either to elemental sulphur or SO_4^{2-}
19. Some of the elemental sulphur gets accumulated in deep sediments and still others gets oxidized to SO_4. (for the replenishment of soil sulphur)

MODULE : 4

LIMITING FACTORS

ENVIRONMENTAL FACTORS

- *Environmental conditions, influences ,forces which can regulate ,direct and influence the life of organisms .*
- Ecological factors affect the life of organisms not individually but collectively
- Some are more prominent than others
- Variations in one factor may affect the other factor also
- *They are mutually interacting and they influence the life of organisms by operating in conjunction with each other , and not in isolation from each other.*



- **Same factor may have different effects at different times and under different conditions**
- ***Environmental threshold*: the lowest quantity or intensity of any environmental factor that produces a perceptible effect on organisms**
- **Below environmental threshold,biological function fails to be normal and organisms succumb to death**
- **Above it,rate of biological functions increase rapidly until a maximum rate is attained.abovemaximum,there would be a decline in the rate of biological**

EFFECTS OF ENVIRONMENTAL FACTORS

1. ***Lethal effects*** *:* cause death of organisms

   *Example :*extreme heat

2. ***Masking effect*** *:modify or suppress the effects of some other factors.*

   Example:low relative humidity increases the rate of evaporatiobn of moisture from body surface

3. ***Directive effects****:produce an orienting response in organisms*
   Example:birds migrate from unfavourable conditions
4. ***Controlling effect:****influence rate of some physiological functions without actually involving in the reaction*
   Example:temperature influences metabolism
5. ***Deficient effects****:curtail an activity since certain essential constituents are either absent or are at low concentrations*
   Example:malnutrition

CONCEPT OF LIMITING FACTORS

- Ecological valency :every organism has a definite adaptive range of tolerance foe every ecological factor
- Organism cannot survive beyond an upper critical level (upper limit tolerance) and below a lower critical level (lower limit of tolerance)of any ecological factor
- a limiting factor is an environmental condition, or a set of conditions, whose abundance can approach or exceed the critical upper and lower limits of tolerance of organisms and slow down their life processes and growth potentials.
- Limiting factors inhibit organisms from thriving and successfully invading and colonizing new habitats
- An environmental actor is not a limiting factor so long as it is in a steady-state condition
- Limiting factors are or two main groups : physico-chemical and biologica
- Physico-chemical limiiung factors include climatic and edaphic factors, such as temperature, light, water, humidity, respiratory gases, pH,chemical nutrients, etc
- Biological limiting factors include, competition , predation, parasitism, diseases, etc

LAWS OF LIMITING FACTORS

- Two laws have been advanced to explain the role of limiting factors.
  - "Law of Minimum, proposed by Liebig (1840)
  - " Law of tolerance", proposed by Shelford

LIEBIG'S LAW OF MINIMUM

- *Liebig's Law of Minimum* is the concept that the *growth and reproduction of organisms are limited or regulated largely by the environmental factors that are needed only in minimal quantities and*

poorer qualities, and also that the minimal availability of such a single factor can itself control the organism

- the law holds that the growth of organisms is dependent on the availability of essential factors in minimal quality and quantity.
- So, according to the law of minimum, the lowest favourable level of either a single factor or a combination of factors can control or limit the functioning of organisms.
- If the availability of one of them falls below the critical minimum level, organisms fail to grow, or grow abnormally.

Subsidiary principles of Liebig's law

- *steady-state concept* : Liebig's law is strictly operational only under ideal steady-slate conditions, when the inflow of energy and matter almost exactly counter-balances the outflow
- *concept of factor interaction*. : the maximum concentration, excessive availability and the high action of some ecological factors can modify the rate or utilization and the limiting effects of some others.

The Law of Minimum upholds the following basic concepts :

- An organism is Seldom exposed exclusively to the effect of a single environmental factor, but is always subjected to the simultaneous actions of several factors.
- Of the several 1actors, some exert more influence than do the others.
- The rate of a biological process may be controlled by too much or too little of an environmental 1actor.
- The presence or abundance of an organism may be limited by a variety of environmental factors.
- The limiting effect of environmental factors may be due to the interaction of two or more factors rather than by the independent effect of a single factor.
- The functioning of an organism is controlled or limited by an essential factor or a combination of factors present in the least favourable amount. Such factors may not be continuously effective but only at some critical period of the year, or only during some critical year of a climatic cycle.

BLACKMAN'S LAW OF LIMITING FACTORS

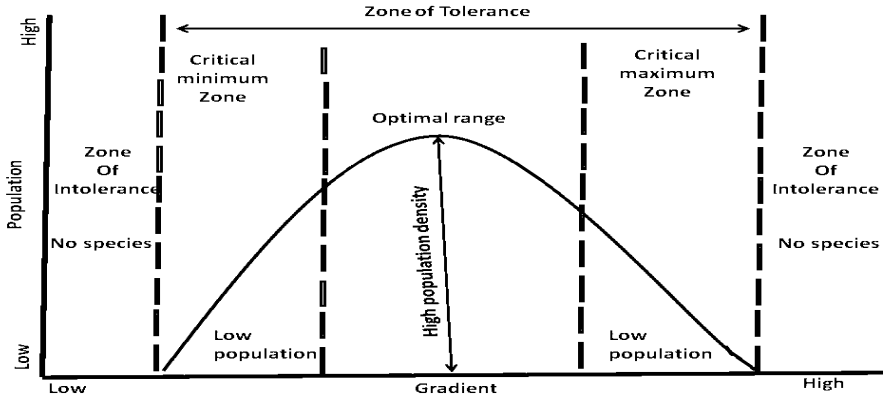
- the law of limiting factors holds that ;
    - the metabolic rate of an organism is governed by a factor which operates at a limiting intensity, and

- the rate and magnitude of a biological process, which is under the control of several factors, would be determined by the factor that is needed in minimal quantity or quality.

- So, according to Blackman' s law, the rate of a biological process is limited by the "pace of the slowest factor .The "slowest factor is the factor which is available in lesser amounts than what is actually required.
- The law of minimum and the law ot limiting factors, in combination with each other, form the *Liebig-Blackman law of ecological factors.*

SHELFORD'S LAW OF TOLERANCE

- The concept *that too much or too little of an ecological factor will have a limiting effect on the success and survival of organisms.*
- *Each ecological factor to which an organism responds will have maximum and minimum limiting effects between which lies the range of tolerance of the organism.*
- so, organisms will have ecological minimum and maximum with respect to every ecological factor, known respectively as *upper* and *lower limits of tolerance*.
- The highest level of an environmental factor above which normal life activities are not possible *:critical maximum level or critical maximum zone.*
- The lowest level of an environmental factor below which life activities may cease to occur : *critical minimum level or critical minimum zone*.
- in between these two extreme limits, lies the *favourable range or zone of tolerance*.
- Within this range of tolerance,is an optimum range or optimal zone in which the growth and functions of organisms are maximal.
- above and below the optimal range, are the *sub-optimal rangës or zones*
- Beyond the critical maximum and the critical minimum ranges, are the unfavourable *lethal zones*, or the *zones of intolerance*. Here, organisms cannot survive and hence are absent
- Shelford s law also holds that *"the presence and success of organism depend upon the qualitative and quantitative completeness of a complex of conditions, and their absence or abundance is controlled by e qualitative or quantitative deficiency or excessiveness of one or more such conditions."*



COMBINED CONCEPT OF LIMITING FACTORS

- Formulated by the combination of 1aw of minimum and Shelford's law of tolerance.
- The success and survival of an organism or a group of organisms depend upon a set of conditions anyone of which can approach exceed the upper and lower limit of tolerance to become a limiting factor
- According to the combined concept of limiting factors, organisms in nature are controlled by :
- The physical factors that are critical to organisms
- The quantity and variability of the materials that are required in minimal quantities
- The limits of range of tolerance of organisms to environmental factors.

MODULE : 5

POPULATION ECOLOGY

- Population : A group of individuals of the same or closely related species,living together in a geographical area with mutual interactions

  OR
- Assemblage of interbreeding and interacting individuals of the same or closely related species,which live together in a particular area or habitat during a specific period of time and function as a single genetic unit
- Example:human population of India in the year 2008
- It represent closely interacting and self regulating system
- It is a subordinate group of species
- Functional unit of biotic community
- Share common gene pool
- Monospecific
- Usually,haveageogaraphical boundary

- **Demes:** sub-groups or local population.it represent smallest groups of interbreeding individuals.

- Population is never static
- Each population has its own growth pattern or form

- **Societies or colonies:** specialised population with a high order of integration,interaction,interrelations,andinerdependence.

- Example:termites colony

CHARACTERISTICS OF POPULATION

1. *POPULATION DISPERSION*

   Pattern of dustribution of members of a population.

   3 types,

- ***Random dispersion*** -members are irregularly scattered and not crowded, clumped or evenly .It is very rare.It occurs only when environment is uniform and the resources are equally available all the year round

- ***Regular or uniform dispersion***-members are almost evenly or uniformly distributed all over the occupiedarea.Occurs in the populations where intraspecific competition is severe

- ***Clumped***-members are distributed in small isolated groups or aggregations called clumps.It promotes intense intraspecific competition. It may be randomly clumped or uniformly clumped dispersion.

2. POPULATION DISPERSAL

Pattern of spreading ormovement of the members into or out of a population .
3 major strategies,

- ***Immigration*** – mass movement of organisms to an uninhabited or less crowded area from the areas around

- ***Emigration***–flowing out of oraganisms either from an overcrowded area or from a region of natural calamities

- ***Migration***–seasonal or semi- annual back and forth movement of members of a population in large groups for obtaining Optimal environmental conditions all the year round.

3. POPULATION SIZE AND DENSITY

- ***Population size*** :Total number of individuals of a apecies living together in a geographical zone.

- ***Population growth*** : net decrease or increase in the total number of members pf a population

- ***Population density*** : number of individual organisms of a species living in a unit area or unit volume at a given time..expressed in biomass per unit area or unit volume.

- ***Crude density*** : total number of individuals or biomass per unit of the total space both inhabited and uninhabited

- ***Specific density*** : number of individuals or biomass per unit of the inhabited area.

Population density, $D = n/a \div t$	*Where,* *a= unit area* *t=time* *n=total number of individuals*

4. *BIOTIC POTENTIAL*

*Inherent ability of organisms to reproduce and multiply.*When biotic potential is high,population size increases,however , nature always keep a check on it through environmental resistance.
it is directionally propotional to ,

- Frequency of reproduction
- Length of the reproductive period
- Number of individuals produced
- Early onset of reproduction in life

5. ENVIRONMENTAL RESISTENCE -ER

- Natural checks and regulations on the biotic potential and infinite multiplication of organisms , and also on the unbridled growth of popolations. It represents sum total of the biotic and abiotic environmental limiting factors which prevent the biotic potential .

- When ER is high , Birth rate decreases , population density falls low
- Example :
  - Biotic :competition ,predation , parasitism , antagonism ,
  - Abiotic :Natural calamities , accumulation of waste , flood ,extreme temperature

6. NATALITY (BIRTH RATE)

The rate of production of new individuals in a population during a specific period of time. It is species –specific .

Natality can be positive or zero , but never negative.

- ***Potential natality/potential natality/maximal natality :***the highest possible natality , that can be expected or visualised under ideal or optimal and non –limiting environmental conditions.

- ***Realised natality*** : actual birth rate, under normal mnatural conditions.

7. MORTALITY (DEATH RATE)

The rate at which individuals of a population perish during a specific period of time.

- ***Potential mortality :*** lowest possible death rate , that can be expected under most ideal and non limiting conditions

- ***Realised mortality / ecological mortality/actual mortality*** : actual death rate under normal conditions

Mortality is species-specific and sex- specific

RATIO BETWEEN NATALITY AND MORTALITY : VITAL INDEX

$$\text{VITAL INDEX} = \frac{\text{NATALITY}}{\text{MORTALITY}} * 100$$

8. SEX RATIO

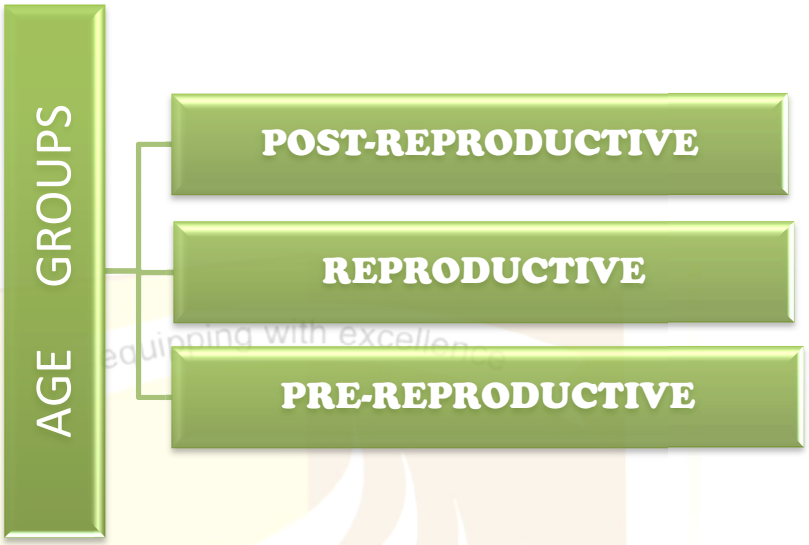
- Number of males in relation to the number of females in a population
- OR

- Ratio between the number of males and that of females in a population

- Expressed as number of males per 100 females

9. AGE DISTRIBUTION

- Ratio or percentage of the number of individuals of the different age grouos of a population
- Determined by natality and mortality

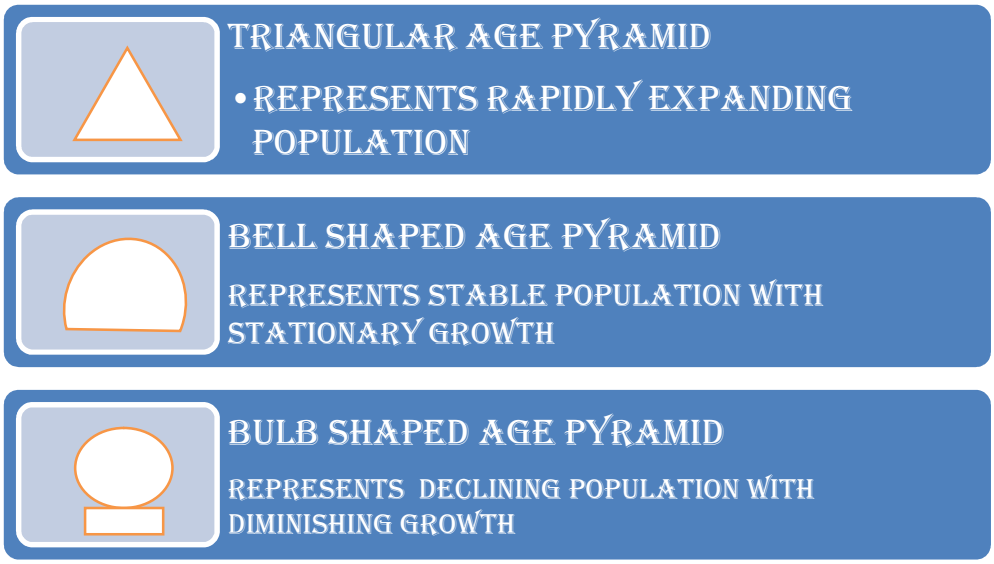


Significance

- High percentage of pre-reproductive and reproductive – rapid growth and expansion of population in future
- Low percentage of pre-reproductive and reproductive – decline in the future population growth
- Constant proportion or ratio of the 3 age groups – balanced population growth

10. AGE PYRAMID

Pyramidal graphs or models which represent the age structure of populations



11. POPULATION GROWTH

- Numerical change in the population size through a net increase or decrease in the number of individual organisms over a period of time.

- 3 types,
  - Zero growth
  - Positive growth
  - Negative growth
- Factors regulating population growth ,
  - Climatic
  - Biotic
  - Self regulating
- Population regulating factors,
  - ***Density-independent factors*** –factors whose influences on population are independent of the size and density of the population .It includes extrinsic , non - biotic and physical or climatic factors
  - ***Density-dependent factors*** –biotic factors whose influence on population depends on the size and density of the populations.It includes negative interactions like competition , predation , parasitism

$$N_t = N_0 + B + I - D - E$$

Where,

N_t = final size of the population

N_0 = initial size of the population

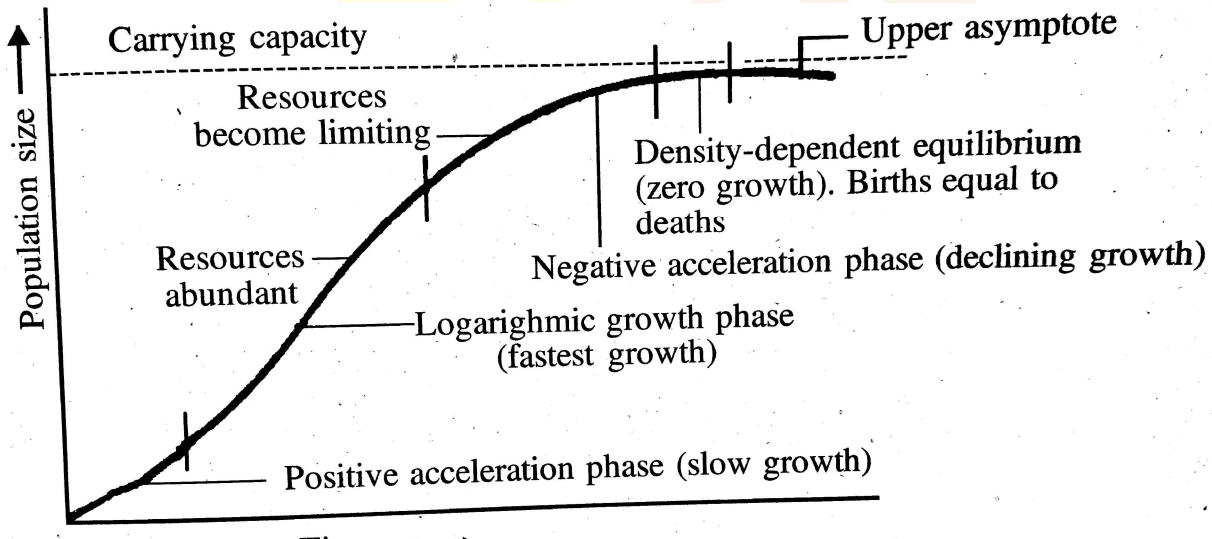
t=time interval

B=natality rate

I= immigration rate

12. GROWTH FORMS OR GROWTH PATTERNS

- Each population has its own characteristic growth pattern called growth form
- Determined by natality , mortality , immigration, and emigration



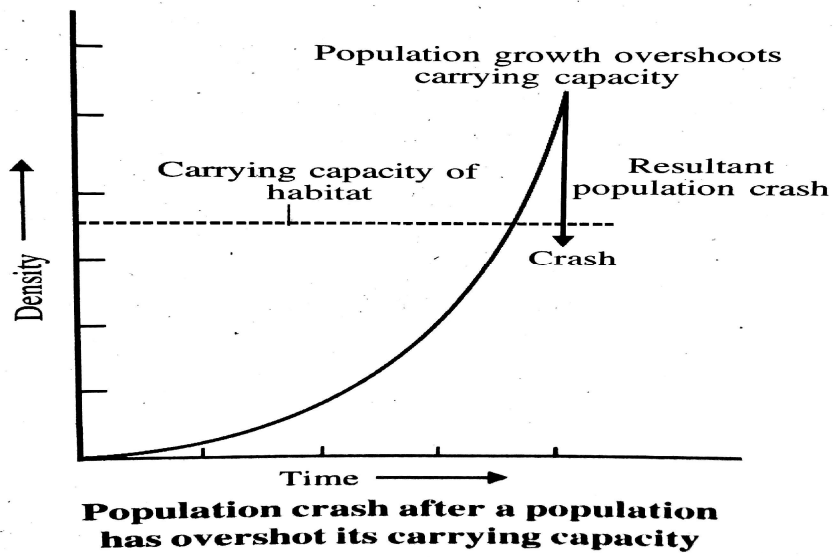
Schematic representation of generalised population growth

- 2 phases,
  - ***Positive acceleration phase or lag phase or establishment phase*** – initial stage at which the population establishes itself and grows only slowly.

  - ***Exponential or logarithmic or log phase or growth phase*** – population expands rapidly and steadily in geometrical progression and attains peak value if conditions are ideal
  - ***Deceleration or negative acceleration phase :*** growth decreases progressively until it reaches the *upper asymptote or carrying capacity*.This stage is called the negative acceleration or deceleration phase.Finally , growth comes to a standstill, characterised by zero growth

- Exponential growth cannot continue infinitely due to environmental resistance
- Beyond exponential phase , the growth pattern is different in different populations.

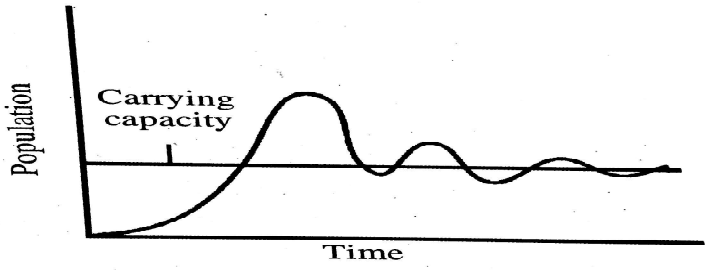
  - ***Population crash :*** growth stops adruptly and then reverses rapidly to a low level when population goes beyond exponential phase



Population crash after a population has overshot its carrying capacity

- ***Population fluctuation***: once a population has reached the carrying capacity , saturation point or equilibrium level , its density or size tends to fluctuate above and below carrying capacity

13. CARRYING CAPACITY (K)



Carrying capacity and population fluctuation

- Biological carrying capacity (K) is the maximum number of individuals of a species or the maximum population size of a species , that a particular environment or habitat can support and sustain indefinitely with its available resources
- Potentiality of an environment or habitat to indefinitely support and sustain the maximum number of individuals or populations of species with its available resources
- Upper asymptote level
- Represents saturation level
- Depends on environmental factors
- Denotes the upper limit to which an existing population can grow
- Beyond the carrying capacity , population size may fluctuate or crash

14.GROWTH CURVES

- Graphic representation of the growth pattern of a population over a unit period of time under a set of environmental conditions
- Usually plotted with time scale on the X- axis and population growth on the Y – axis
- 2 types ,
  - Exponential / J shaped
  - Sigmoid or logistic curve / S shape

J-SHAPED GROWTH CURVE (EXPONENTIAL CURVE)

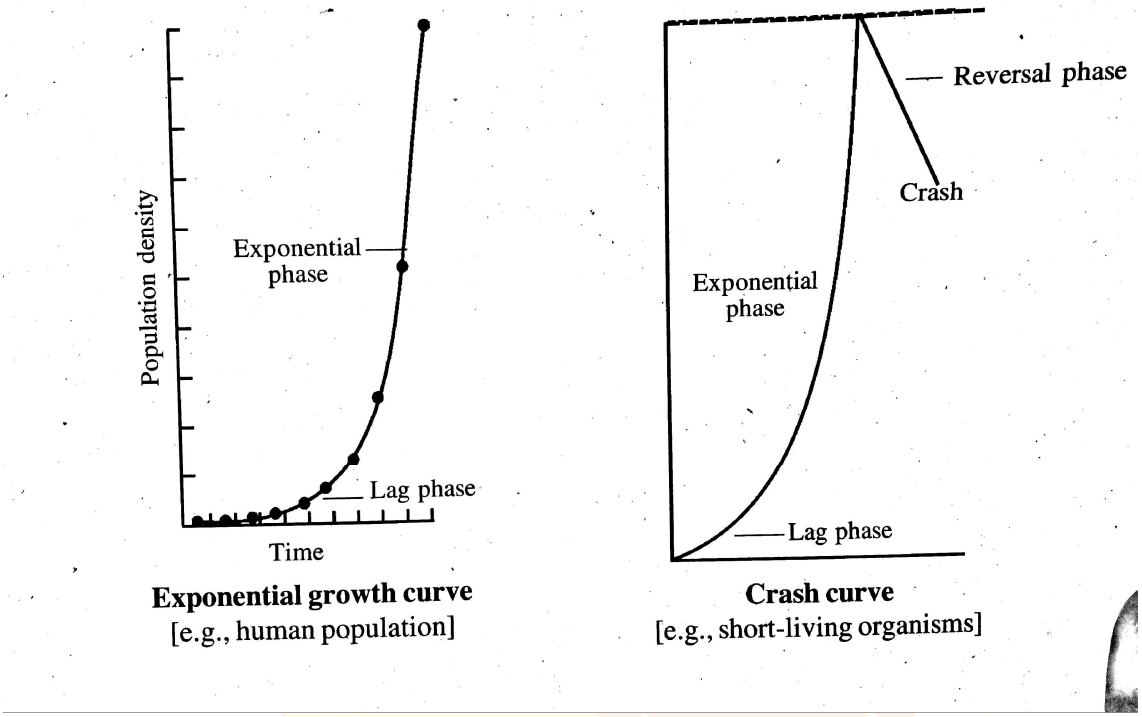
- Density – independent growth
- Depicts a population growth that is regular , rapid , unrestricted and exponential until it overshoots the carrying capacity
- After attaining peak value , growth stops abruptly so that population crashes down and either dies off or reverses steeply
- Example ; annual plants and insects
- Slow initial rise represents the lag phase and sudden rise represents the exponential phase
- Human population : J shaped curve

Equation ,

$\Delta N / \Delta t = r N$

Where,

N= population size
t = time
r = biotic potential
$\Delta N/\Delta t$ = rate of change in population size



S-SHAPED GROWTH CURVE / SIGMOID OR LOGISTIC CURVE

- Density dependent
- Depicts a population growth that is initially slow , then rapid and exponential and finally slow again until a near – constant equilibrium level is established
- Upper asymptote or the upper level of the S – shaped curve represents the carrying capacity of the environment
- Growth pattern of large sized and long living organisms with low biotic potential is characteristically S-shaped

Equation ,

$$\Delta N/\Delta t = r N \left(\frac{K-N}{K} \right)$$

Where,

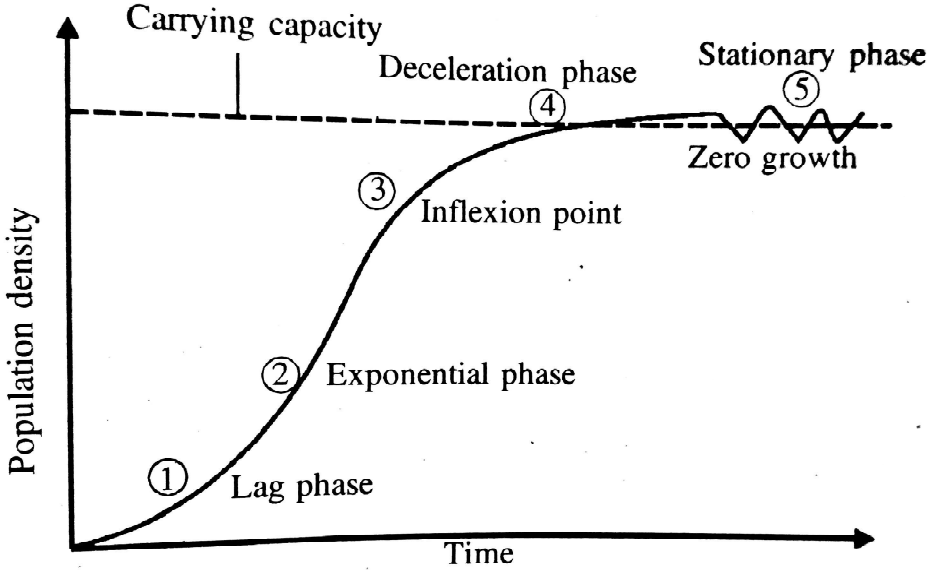
N= population size

t = time

r = biotic potential

$\Delta N/\Delta t$ = rate of change in population size

K= upper asymptote level



Sigmoid growth curve

[e.g., long - living organisms]

MODULE : 6

COMMUNITY ECOLOGY

- Also known as biocoenosis or biocoenose
- An assemblage of mutually supporting natural populations , living together in the same area or habitat with mutual tolerance , bemneficial interactions and constant fixation and dissipation of energy
  OR
- Assemblage of organisms and it functions as a distinct ecological unit
- Composed of microbial , fungal , plant , and animal populations
- Communities are habitat-specific

- Types,

MAJOR COMMUNITY

- more or less complete and self-sustaining ecological units with sufficient size and complex organisations
- almost functionally independent
- grassland , forest

MINOR COMMUNITY

- secondary aggregations within a major community
- not completely independent
- small ponds , mountain springs

- Microcommunities : some minor communities are extremely limited in extent and number of component species and populations (species inhabiting the mammal intestine

CHARACTERISTICS

1. *SPECIES COMPOSITION*

- It is the number and kinds of the constituent species of a community
- Refers to all the living things within a specific environment
- Backyard species

2. *SPECIES ABUNDANCE / SPECIES RICHNESS*

- Also called species richness
- Abundance in the number of species compared to the number of individuals in a community
- Reperesents total number pf species and not the total number of individual organisms

- Numerical abundance of species

3. ***SPECIES DIVERSITY***

- Heterogeneity or variability of the constituent species of a community
- Totality of the number of dissimilar species and their abundance in a community
- Higher the number of rare and unrelated species , the greater would be the species diversity
- Species diversity = how many species + how evenly distributed the number of each species
- Depends on species richness and species evenness
- Species evenness / species equitability : evenness , equitability or uniformity in the abundance of different species in a community
- Higher the species diversity , greater the ionteraction and more complex an d the more stable the organization of a community or an ecosystem

4. ***SPECIES DOMINANCE / COMMUNITY DOMINANCE***

- Ruling or dominant species
- Phenomenon in which one or more species in acommunity dominate over the others and control the species composition of the community
- A few species exert some regulatory influences on the functioning of community as a whole
- They control energy flow and nutrient cycling
- They can regulate the overall functioning of the community and modify environmental conditions
- They become dominant by virtue of their sheer numerical abundance , greater size , more favourable adaptations , increased activities , higher vitality , greater productivity etc
- Grassland - grass and grazing animals

5. ***KEYSTONE SPECIES***

- Species which have low abundance in the community , but have high significance and disproportionately greater influence on the community or ecosystem as a whole
- Their presence or abundance playsa vital role in controlling the relative abundance of some other species
- Number will be very few
- Their removal seriously affects the functioning of the community
- Figtrees

6. ***CO-EXISTENCE***

- Different species of a community do not live in complete isolation from each other , but always co – exist with regular interaction and mutual adjustment
- 4 types,
  - Exploitation
  - Mutualism

- Competition
- Exploitation

- Tress , shrubs and herbs compete for space , light , water , minerals

7. INTERDEPENDENCE

- Members of a community are independent to some extent
- Shade loving herbs depend on large trees for shade and moist conditions

8. TROPHIC STRUCTURE

- Hierarchial organization of a community for nutritional and energetic sufficiency
- Trophic levels : For food and energy relations , organisms of a community form successive nutritional groups
- First and lowest triohic level = producers
- Last trophic level = decomposers
- Successive series/ intermediate = consumers (herbivores , carnivores , omnivores)
- Significance of trophic organization ,
  - Ensures nutritional and energetic self sufficiency
  - Makes community a self - sustaining system
  - Maintains balance between production and consumption
  - Initiates and maintain energy – flow
  - Maintain and initiate nutrient cycling

9. GROWTH FORM AND STRUCTURE

- A community is characterized by several growth forms
- Growth forms determine the general structural pattern of the community as a whole
- Each growth form , will have several morphological variants and each variant is characteristic for a particular community
- Different growth forms of a community determine its zonation (zonation) and stratification(vertical layering)

10. PHYSIOGNOMY

- It is the growth structure and the external form and appearance of natural biotic communities
- Community specific
- Largely determined by species composition , species dominance and vegetation types

11. STRATIFICATION

- Vertical layering of organisms or environmental conditions within a biotic community
- It is the spatial distribution of organisms in vertical or horizontal planes
- 2 patterns : vertical and horizontal(zonation)

- Vertical stratification : Pond : littoral zone , limnetic zone and the profundal zone

12. COMMUNITY PERIODICITY

- Refers to the regularity and rhythmicity in the activities of organisms , in tune with some major phenomena of earth
- Periodicities are the results of some environmrnetal and physiological rhythms
- Major periodicities are,
  - Daily periodicity/ circadian rhythm
  - Seasonal periodicity
  - Lunar nd tidal periodicity

13. BIOTIC STABILITY

- Stability in the organisations and functioning of a community .
- Maintained by interaction between the constituent species of biotic communities
- Higher the number of interacting species , greater the stability of a community

14. COMMUNITY SUCCESION

- Appearance and disappearance of the biotic communities in regular succession in a particular area or habitat
- Slow , steady and continuous process
- Pioneer community : first community to colonize a bare habitat
- Sere : unstable intermediate communities
- Climax community : final stable community
- Primary succession : succession in a previously uninhabited area
- Secondary succession : succession in an area where the previous community has become completely vanished
- Hydrosere : succession in an aquatic habitat
- Xerosere: succession in dry terrestrial area
- Mesosere : succession in moist soil
- Halosere : succession in saline water

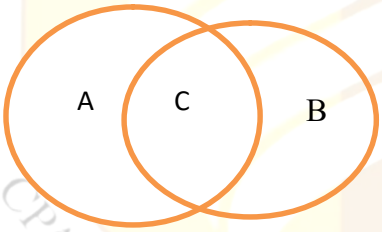
COMMUNITY FLUCTUATIONS

- Fluctuations in species abundance and number occurs due to the interplay of biotic potential and environmental resistance
- It may be regular or cyclic

- Example : predator-prey
- Usually , the number of individuals of a community fluctuates constantly around a mean value
- Sometimes , changes in environmental conditions cause the mean value to shift upward or downward
- Upward shift : species abundance
- Downward shift : decline

ECOTONE AND EDGE EFFECT

- Ecotone : fairly distinct transition zone between different overlapping communities
- Zone of integration where two or more different communities merge or overlap
- Tension belt or tension zone
- Estuaries
- Edge conditions : environmental conditions in the ecotone
- Edge community : ecotonal communities consists of,
  - Populations from adjacent major communities
  - Ecotonal populations



Where , A = SPECIES 1
B= SPECIES 2
C = ECOTONE

- Edge species : species which occur extensively or most abundantly in the ecotone , or spend most of their time in the ecotone

EDGE EFFECT : PHENOMENON IN WHICH ECOTONE IS CHARACTERIZED BY INCREDIBLE SPECIES DIVERSITY , IMMENSE SPECIES ABUNDANCE , INCREASED DENSITY OF POPULATIONS AND THE PRESENCE OF POPULATIONS THAT AREA ABSENT IN THE NEIGHBOURING COMMUNITIES

PRINCIPLE OF EDGES : AS A RULE, SPECIES ABUNDANCE AND POPULATION DENSITY ARE MUCH HIGHER IN THE ECOTONAL COMMUNITY THAN IN THE ADJACENT MAJOR COMMUNITIES.

MODULE : 7

POPULATION INTERACTIONS

- Organisms depend upon each other for food, space , shelter , growth , mating and other biological requirements.
- ***Species interactions*** *:* Interrelations of organisms for their success and survival
- ***2 TYPES :*** intraspecific and interspecific interactions
- ***Intraspecific ;*** within species
- ***Interspecific :*** between species

1.INTRASPECIFIC INTERACTIONS

2 types ,

- COMPETITION
- CO-OPERATION

a) Intraspecific competition

- Interaction in which one member of a species adversely affects another in its search for food , space ,moisture , mates , protection and other requirements
- Reason : over population ,over crowding,severe scarcity of resources
- Density dependent
- Example: plants compete for space, light , water , minerals etc
- Advantages :

1. Helps in maintaining a balance between the available natural resources and number of individuals which share them

2. Promotes favourable adaptations and specialisations

b) Intraspecific co-operation

1. Mating

Pairing of either opposite sex or hermaphroditic organisms usually for the purpose of sexual reproduction
Example : cross pollination in plants , courtship rituals in animals

2. Parental care

- Behavior pattern in which a parent invests time or energy in feeding and protecting its offspring
- Example :mammals look after their young ones until they are capable of leading an independent life

3. Group formation

Advantages

- Offensive and defensive power
- Less vulnerable to predation

- Better food finding ability
- High ability and success in hunting
- More tolerance to adverse conditions
- Chances of mating and sexual reproduction is higher
- High protection

➢ **Disadvantages**

- Severe intraspecific competition
- Waste accumulation

➢ Types ,

- *Loose aggregations*: temporary or long lasting association of organisms
- Example:schools of fishes

- *Families*: specific group of people that may be made up of partners , children , and other close ones.it may be monogamous or polygamous
- Example :humanbeings,

- *Societies* : specialized populations with high order of integration ,interaction , interrelation and interdependencies
- Example : termite colony

4. ***Altruism***

- Self sacrificing behavior of some animals for the benefit of others
- Example: workers of honey bees

5. ***Dominance hierarchies or pecking order***

- Dominant one assume the leadership in group.it is common among social organizations . generally established by threat displays , aggressive postures , and actual fights . avoid or minimize intraspecific competitions and conflicts
- Example:monkey

6. ***Territoriality***

- Is a form of defence of net sites ,food sources or other sources against other members of the same species.
- It may be fixed territory,nesting territory , feeding territory etc
- Leks – territories held by male
- Example : It is accomplished by outright aggression , threat displays ,scent marking ,song etc

➢ ***Advantages:***

- Ensures uniform dispersion and spacing of organisms
- Reduces conflicts
- Ensures normal availability and utilization of environmental resources
- Controls population growth

7. ***Communication***

- Transfer of messages or information among the members of of a species through visual , auditory , olfactory , tactile and electrical cues and signals
- Example: waggle dance in honey bees

8. ***Leadership***

- Gregarious and social animals are generally directed and guided by a prominent member called leader
- Leader never dominates or enjoys special privilages
- Matriarchial system : female leader
- Patriarchiasl system : male leader

2.INTERSPECIFIC INTERACTIONS

3 TYPES ,

1. NEUTRALISM
2. SYMBIOSIS
3. ANTAGONISM

INTRASPECIFIC INTERACTIONS

INTERACTIONS	**SPECIES A**	**SPECIES B**
Neutralism	0	0
Mutualism	+	+
Commensalism	+	0
Amensalism	–	0
Competition	–	–
Predation	+	–
Parasitism	+	–

1. Mutualism

- Symbiotic association , beneficial to both the interacting species
- 2 types,
  - Obligatory:compulsory relation with constant physical association and intimate physiological relation between the partners.

    Example:association between green algae and fungi.
  - Facultative : voluntary association which neither constant contact nor any functional association or physiological relation between the partners.

    Example :association between crocodile and crocodile bird.

2. Amensalism or antibiosis

- Antagonistic interaction between two species , harmful to one species and neutral to the other

- Example: fungus *Penicillium notatum* produces the antibiotic penicillin that inhibits the growth of a variety of bacteria.

3. Interspecific Competition

- The struggle of organisms of the same trophic level for a common resource or requirements which is short in supply .
- 2 types,
  - Resource competition :occurs when a number of the same or different species compete for the same resource which is short in supply
  - Interference competition : occurs whwn many organisms compete for the same resource adversely affecting each other , even when the resource is not short in supply

4. Predation

- Antagonistic relation in which one species preys upon the another.
- 4 types,
  - Herbivory :animals feed on algae,or on the leaves , bark , flowers,fruits , seeds, tubers etc of green plants.
  - Carnivory: animals prey upon other animals , eggs ,larvae and pupae
  - Cannibalism :predator and prey from the same or related species
  - parasitoidism : parasitic insect lays its egg on or near host insects which would be subsequently killed and eaten by the developing larvae.

- ***Advantages:***
  - Serves as the limiting factor for saving the prey population from extinction.
  - Forms a regulatory factor for keeping the prey population from overriding its resources
  - Has ecological and evolutionary importance
  - It regulates population size and there by maintains nature's balance
  - It promotes specialized adaptations in predator and prey populations
  - Restricts the distribution and reduces the abundance of populations.this maintains balance of nature
  - Together with competition, it regulates the organizations of communities
  - Serves as a major selective force in the co-evolution of adaptive features and defensive mechanisms
  - Biological pest control

*5. P*arasitism

- Antagonistic relation in which one species derives some biological requirements from another.
- Parasite: species which obtain the requirements
- Host :species which provides the requirements

6. Commensalism

- Symbiotic relationship beneficial to one species and neutral to other
- Benefited : commensal ; other : host
- No phgysiological exchange between partners
- Commensalism for transport : phoresy
- Example : association between sucker fish and large fish for phoresy

Lotka – Voltera were the first to study the way in which predation influences population growth. According to them , an increase of the predator population causes the corresponding decrease of the prey population upto a certain level.Then the process gets reversed .So, predator And prey population fluctuate with time.This forms population cycles in which the number of individuals tends to rise and fall at regular intervals and never cause the extermination of prey or the predator

MODULE : 8

MAN AND ENVIRONMENT

SUSTAINABLE DEVELOPMENT

- By World Commission On Environment And Development
- Development that meets the need s of the present without compromising the ability of future generations to meet their own needs
- Rapid , technically perfect , socially equitable , environmentally non-0degarding and ecologically planned economic growth which seeks to ensure better quality of life and higher standard of living for each and every one of the present and future generations
- Depends on balanced relation between social development , economic growth , environmental stability and abundance and availability of natural resources

RECLAMATION OF WETLANDS AND PADDY FIELDS

Major biological roles of wetlands

- Natural habitat
- Breeding grounds
- Sanctuaries
- Raise level of underground water storage
- Retain soil moisture
- Prevent draught
- Purifies polluted water (sedimentation and filtration)

SAND MINING

- Over deepening leading to the ultimate death of the river
- Stagnation of water
- Eutrophication
- Permits heavy influx of sea water on of river banks and consequent loss of agricultural lands
- Alters lotic ecosystem
- Disturb breeding ground
- Lower water table

- Leading to drought
- Forms deep water pools
- Causes diversion of direction of river flow

CLAY MINING

- Environmental degradation
- Habitat destruction
- Reduction in paddy field
- Disrupts natural drainage system
- Hydrological imbalance
- Form artificial pools – mosquito breeding ground – public health problems

DESTRUCTION OF MANGROVE ECOSYSTEM

Major causes

- Greedy extension of agricultural field
- Unplanned developmental projects in coastal areas
- Oil drilling operations
- Oil leak or oil spill
- Unplanned tourism development
- Wood chip production
- Garbage dumping
- Construction of dams

Conservation of mangroves:

- Preparation of an inventory
- Afforestation of mangroves species
- Scientific planning of coastal development projects
- Controlled and sustainable exploitation of mangrove
- Legal ban on solid waste dumping
- Weed infestation
- Controlled tourism
- Declare major mangrove forest as protected areas

ECOLOGICAL IMPACTS OF TOURISM

Positive impacts :

- Promote environmental protection, wild life conservation and reservation of natural ecosystem
- Ensure sustainable development
- Serve environmental friendly industry
- Provide opportunity to study and evaluate ecological condition and biodiversity
- Promote economic prosperity

Negative impacts :

- Habitat destruction
- Ecosystem damages
- Environmental alteration – ecological imbalance – unfavourable climatic changes
- Pollution

RIVER ENCROACHMENT

- Stops water flow
- Turns river into a narrow canal
- Water logging
- Stagnation
- Eutrophication

SECTION B : WILDLIFE CONSERVATION

Section B: WILDLIFE CONSERVATION (18 hrs)

1. Biodiversity (12 hrs)

(a)Introduction: alpha, beta and gamma diversities. Mention Shannon diversity index and Simpson's dominance index.

(b) Hot spots of biodiversity. Mention hotspots in Indian region (Western ghats and Sreelanka, Eastern Himalayas and Indo Burma)

(c) Threats to biodiversity (Habitat modification, pollution, poaching, etc.)

(d) Role of systematics in biodiversity, Extinction of species.

(e) Natural resources and conservation-Strategeies of conservation, Natural Reserves, Classification of natural resourses.

(f) Wild life conservation, Wild life (protection Act)1972,Conservation projects. Project Tiger,Elephant,Lion,Crocodile,Dolphins, Swamp deer,Blackbuck and Turtle.

(g) Endangered fauna and flora.

(h) Sanctuaries-Thattekkad bird sanctuary&Parambikulam wild life sanctuary, National parks –Eravikulam NP &Silent valley NP and Biosphere Reserves-Nilgiri BR &Agasthyamalai BR

(i) Mention IUCN categories and Red data book.

(j) Conservation of biodiversity - in situ and ex situ conservations.

Mention conservation of germplasm.

2. Global Strategy for Conservation (6 hrs)

(a) Stockholm Conference / Declaration (1972)

(b) Nairobi Conference / Declaration

(c) Rio Declaration (Earth Summit, 1992)

(d) CITES

(e) Biodiversity Convention of UNCED

(f) Kyoto Agreement (1997)

(g) Johannesburg Conference (2002)

(h) World Summit on Sustainable Development

(i) UNEP and its major strategies

(j) Protection of plant varieties and farmer's right Act (2001)

(k) Biodiversity Act 2002

(l) Seed Bill 2005

(m) Wildlife Act 1972 and its Amendments

MODULE : 1

BIODIVERSITY

INTRODUCTION TO THE WILDLIFE CONSERVATION

'Biodiversity is the immense heterogeneity or variability in form, size, structure, functions, mode of life and behavior among the biological species of an area, country, continent, or the whole biosphere'.

- It has divided into five levels or components and they are ,
  - *Genetic Diversity*
  - *Species Diversity*
  - *Community Diversity*
  - *Ecosystem Diversity*
  - *Landscape Diversity*.
- Community and ecosystem diversity further classified into
  - *alpha, beta and gamma diversities*.
- There are two indices to study,
  - Shanon Weaver Diversity Index
  - Simpson's Diversity Index.

Diversity divided into five levels,

• **Genetic diversity**	• variation of genes within and between species.
• **Species diversity**	• variety of rare, unrelated or dissimilar species in a community or area
• **Community diversity**	• diversity of each communities
• **Ecosystem diversity**	• diversity of each ecosystems. They differ from each other in many aspects
• **Landscape diversity**	• diversity of land based on form, habitat, vegetation etc

Three levels of community and ecosystem diversity

- **Alpha diversity** -diversity within a single community or ecosystem. For example number of species of ants is the alpha diversity of that habitat
- **Beta diversity** -diversity within a range of communities or ecosystems. Many alpha diversities present in it
- **Gamma diversity** -overall diversity among the different ecosystems of a region. It's count on a vast geographical area

SPECIES DIVERSITY INDEX

- Mathematical representation of species diversity in a given area.
- It's the ratio between the number of species and their biomass and productivity with reference to a particular community.

a) Shanon-Weaver Species Diversity Index(Hs)

- Formulated by E. Shanon and Norbert Wiener (1948) and published by Shanon and Warren Weaver(1949)
- Measure overall information provided by a sample community
- The total information written in entropy

$$H' = -\sum_{i=1}^{s} p_i \log_e p_i$$

H' = Value of SW diversity index.
p_i = Proportion of the ith species.
$\log_e$ = Natural logarithm of p_i.
s = Number of species in community.

b) Simpson's Diversity Index

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

Where:

- D = diversity index
- N = total number of organisms of all species found
- n = number of individuals of a particular species

- Statistical method for calculating species diversity of different ecosystems by using of relative abundance of different species
- By Edward Huge Simpson
- Number of different species and number of times each species found are required
- Ideal for small samples
- For perfect homogeneous population diversity index is 'zero', while perfect heterogeneous population it is 'one'

BIODIVERSITY HOTSPOTS

Biodiversity hotspots are region with high species richness and highly degree of endemism.

- The British biologist Norman Mayer coined the term, "Biodiversity Hotspots" In 1988 as geographic region characterized both by exceptional levels of habitat loss.
- Hotspots are selected as priority areas for the in situ conservation of biodiversity.
- The criteria for identifying hotspots,
- No. of endemic species
- Degree of threat

- There are two hotspots in India, namely,
    a) Western Ghats
    b) Eastern Himalaya.
    c) Other hotspots in the Indian sub continent are Indo- Burma and south- west

Hotspot In Indian region

1.The Western Ghats And Sreelanka

- These hills are present along the Western edge of peninsular India.
- Since they are situated near the ocean, they are likely to receive a good amount of rain fall.
- Around 77% Amphibians and 62% of reptiles found here cannot be spotted else where in the world.
- Sreelanka in South India is a country which is rich in species too. It connected to India through a land bridge which has a width of nearly K10 km.
- There are more than 6000 vascular plants here which belong to more than 2500 genus .
- 3000 plants onto of these are endemic.
- Black pepper and Cardamom all are believed to have Originated in the Western Ghats.
- Agasthyamalai hill situated in extreme south.
- 450 species of bird, 140 mammals 260 reptiles and 175 amphibians.
- Vegetation in this region was originally spread over 190,000 Square kilometres but has reduced 43,000 square kilometres today.
- Only 1.5% of the original forest is still prevent in sreelanka.

2.Eastern Himalayas and Indo Burma

- Himalayan mountain s are the highest in the world and abode to some of the highest peak of the world including mount Everest
- Some of the major rivers in the world originate from the Himalayas.
- There are almost 163 endangered species in this region including one horned rhinoceros wild Asian mater buffalo and as many as 45 mammals, 50 birds, 12 amphibians, 17 reptiles, 3 invertebrates and 36 plant species.
- Himalayan Newt is also present in this region.
- Some of the Threatened once include Cheer Pheasant, Western Tragopan, Himalayan Quail, Himalayan Vulture, White – Bellied Heron.
- Namadapha flying squirrel: almost on the verge of extinction and therefore needs immediate attention.
- 6 species of mammals have been discovered in this region recently including Large Altered Mantjac,Annamite, Manjac, Grey Shanked Donc , Leaf Deer, Saola And Annamite Striped Rabbit.
- Other species such as Monkeys, Langurs And Gibbons too can be found here with a population to less as a hundred.

- Fresh mater turtle species found in the region are endemic.
- 1300 species of birds too can be spotted here including the White Eared Might Heron, Great Crowned Crocias, Orange Necked Partridge most of which are Endangered.
- Almost 13,500 plant species can be spotted in the region half of which are endemic and cannot be found in any other place in the world.
- Burma region is quite rich in its biodiversity.

THREATS TO BIODIVERSITY

- Natural and Anthropogenic factors very seriously threaten biodiversity.
- Natural threats include flood, drought, earthquake, volcanic eruptions, landslides, wildfire, tsunamis, epidemics and drastic climate changes etc.
- Anthropogenic(man made) threats include the degradation, fragmentation, distraction of natural habitat, shifting cultivation, indiscriminate use of pesticides, environmental pollution etc.

LOSS OF BIODIVERSITY

- The major reason for this loss of biodiversity is human being.
- Many species of animals are facing extinction due to hunting and poaching.
- During the last 400 years, about 120 species of mammals and 225 species of birds have become extinct.

CAUSES FOR THE LOSS OF BIODIVERSITY

- Minimum viable area
- Alternation, loss, degradation and fragmentation
- Inbreeding
- Isolation
- Introduction of exotic species
- Over exploitation of biotic resources
- Extensive urbanization and massive Industrialization
- Environmental pollution
- Extension of intensive agriculture
- Large scale deforestation
- Heavy destruction of Coral reefs and wetlands
- Indiscriminate poaching and massacre wildlife
- Natural calamities food, drought, earthquake, volcanic eruptions and so on.

A. Modifications, fragmentation and loss of habitat

- Alternation, fragmentation, reduction degradation and destruction or loss of natural habitat for human settlement, urbanization, commercial plantation, grazing etc.. have contributed to much accelerate the species extinction and loss of biodiversity
- Large scale deforestation and desertification of forest and grassland etc…
- These activities kill organisms in large numbers.
- ***Fragmentation*** divided the large meta population into several small sub population which cannot sustain themselves.
- And it also affected the seasonal migration of some migratory species.

B. Introduction of exotic species to new areas

- Introduction of exotic non -native species in new habitat have no threats from their natural enemies such as competitor, predator and parasites which normally keep their multiplication under the check
- In this area population of exotic species increases. This growth eventually turns to be a ecological cancer or biological pollution.
- This adversely affects native species and the way for their extinction or endangerment.
- ***Dominion effect:*** It's a rare ecological impact in which goes to extinction as a consequence of extinction of another species.
  Example :In the case of Dodo, Dodo trees are rare on island, the reason is the absence of dodo birds
- The hypothesized that the seed of these trees germinate only if it is processed in the digestive tract of Dodo which feed on the fruit. Without passing through the digestive tract of the Dodo bird, the seed would not germinate

C. Over exploitation of biotic resources

- It's another cause of species extinction.
- Over exploitation of species eventually reduce their population size and to critical level.
- Over fishing, over hunting and over grazing are the over exploitation; species become extinct and endangered.

D. Environmental pollution

- All form of pollution are serious threat to biodiversity
- Environmental pollution alters weather

EXTINCTION OF SPECIES

- Species extinction is the total and irreversible extermination or disappearance of species from the face of the earth .
- More than 90% of species are extincted from the World,there is no living representative anywhere in the world.
- The type of species extinction can be divided into three,

- Natural Extinction
- Mass Extinction
- Anthropogenic Extinction

1. Natural Extinction:

- Natural extinction is a normal biological phenomenon.
- This is the spontaneous elimination of species by nature
- Nature will eliminate those species which are unfit for an successful in changing environment or struggle for existence
- Least adapted species disappear and the more adapted one survive
- It is very slow process, natural elimination of species occur in the revolutionary history of life is called the background extinction

- The main causes of natural extinction can be categorised into 4 ,
    - Population risk :- abnormal variation in natality and mortality. This variation causes the low abundant species to go extinct.
    - Environmental risk:- This includes natural variation in the abiotic and biotic environments.
    - Genetic risk:-this includes harmful genetic variation in the small population due to the unfavourable mutation, genetic drift etc .It adversely affected the survival value. So may leads to the extinction.
    - Natural extinction:-this mainly included natural catastrophes, such as wildfires, storms , volcanic eruptions and earthquakes

2. Mass Extinction:

- This is the large scale or massive geological extinction of many prominent species after many million years of successful and widespread existence.
- The popular notion is that geological catastrophes are responsible for such extinction episodes.
- The main 5 mass extinction is ordovician, devonian, permian, Triassic, and cretaceous time
- Permian mass extinction is the worst episode of mass extinction because nearly 96 % of organisms came extinct in geological short period.

3. **Anthropogenic Extinction**:

- Anthropogenic extension causes mainly due to the human activities.
- Several species extincted by depletion biological resources by human activities.

Causes of anthropogenic species extinction

Some major causes of anthropogenic express extinction is

1. Alternation, fragmentation, degradation, reduction, and loss of natural habitat due to the human settlement grazing agriculture commercial plantation industrialization.Fragmentation brought habitat loss of organism and it leads to extinction of several species.
2. Captivation poisoning, poaching and hunting of wild animals: several species become extinct by wild hunting (hunting for meat)

Example : Dodo bird and Indian cheetah

DODO BIRD AND DODO TREE

3. Introduction of exotic species to new areas:-this increases the chances for predation, habitat losses and diseases etc .

Example is water hyacinth this plant reasoned for extinction of several organism.

4. Over exploitation of biotic resources by mankind .

Example passenger pigeon, the over exploitation of meat of passenger pigeon causes extinction.

5. Epidemic and extensive environmental pollution : some organisms become extinct by environmental pollution
6. Pandemic diseases it may also leads to extinction .

NATURAL RESOURCES AND CONSERVATION

- *Natural resources are those which exist in the environment naturally, that is they are not created by Human beings*
- Includes soil,water,sunlight,wind,plants,coal etc.,
- Classified into two,
  - ***Exhaustible***
  - ***Inexhaustible***

1.Exhaustible

- They are limited and Exhausted by continuous usage
- Eg.Coal,Natural gas etc.

2.Inexhaustible

- cannot be depleted by Humans consumption
- Eg.wind power , water power etc.

Need of conservation of Natural resources

- The population rate of the world is increasing at alarming rate the consumption of natural resources also increases.Hence this resources are conserved and maintain the ecological balance and save them for next generation.
- Nature provide us with all the essential for our daily needs due to the over population and human negligence we start to over-exploit our resources.If this continue ,there will no resources for the future generations.
- The need of conservation resources are .,
  - To support life by supporting ecological balance
  - To ensure that the further generations will be able to use the resources
  - To preserve biodiversity
  - To make sure human race survives

Methods:

- Reforestation: Planting trees helps in reducing soil erosion
- Terracing: Terrace farming helps to control the fast flow of water which take away soil with it's flow it is usually practiced in hillside area
- Soil fertility: Maintenance of soil fertility is obtained by adding manure or fertilisers or even by Crop rotation
- Water :Rainwater Harvesting: It is the process of storing rainwater
- Treatment of industrial wastes: the chemical wastes must be treated before releasing them into the Water bodies
- Dams and reservoirs: Dams help to store water and supply them when needed.They also help in producing energy
- Growing flora: It helps to prevent the flow of water and makes it sink into the soil ,increasing groundwater levels
- Energy sources :Include coal ,biomass, natural gas etc.
  - Natural gas is commonly used for cooking
  - Coal is the main source of electricity
  - Petroleum products are used to run automobiles
- Promoting green technology

Eg:- solar panels and other renewable resources of energy

- Minimise the over-exploration of these non-renewable energy resources
- Spreading the awareness among people about the need for conservation

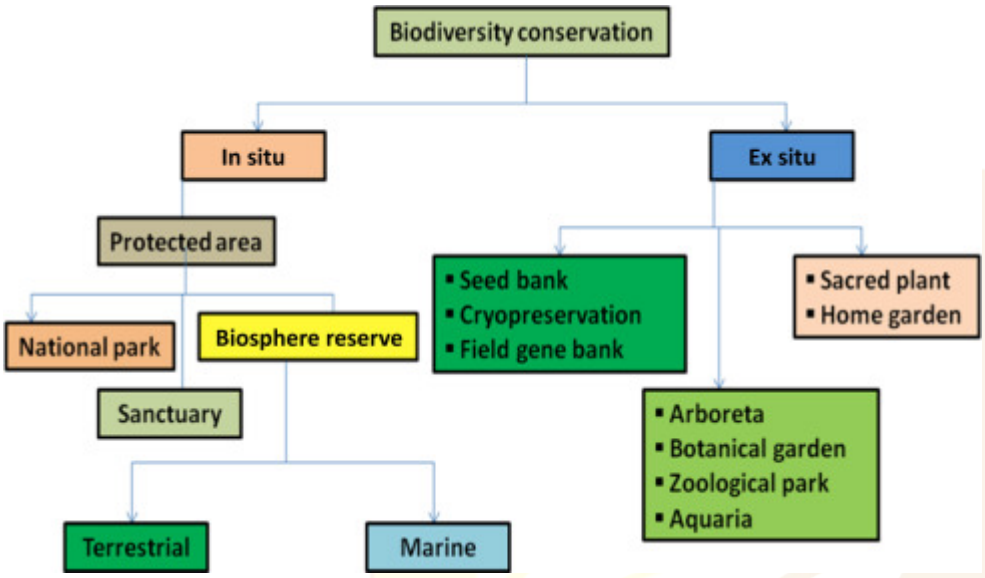
BIODIVERSITY CONSERVATION

In-situ: Protecting plants and animals within their natural habitats is called in-situ Conservation.

Eg:-National parks ,wildlife sanctuaries etc.

Ex-situ: Protecting the plants and animals outside their natural habitat is called Ex-situ Conservation.

Eg:-Seed banks, pollen banks, botanical gardens, zoo, Gene Banks etc.



CONSERVATION OF WILDLIFE

- Wildlife conservation refers to the practice of protecting wild species and their habitats in order to maintain healthy wildlife species or populations and to restore, protect or enhance natural Ecosystems.
- Major threats to wildlife include habitat destruction/degradation/fragmentation, overexploitation, poaching, pollution and climate change.
- The IUCN estimates that 27,000 species of the ones assessed are at risk for extinction.
- It's also being acknowledged that an increasing number of ecosystems on Earth containing endangered species are disappearing.
- To address these issues, there have been both national and international governmental efforts to preserve Earth's wildlife.
- Prominent conservation agreements include the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the 1992 Convention on Biological Diversity (CBD)
- There are also numerous non -governmental organizations (NGO's) dedicated to conservation such as the Nature Conservancy, World Wildlife Fund, and Conservation International.
- Harmful effect to our wildlife is due to:-
  - Habitat destruction
  - Poaching
  - Killing

- Hunting
- Pollution

WILDLIFE CONSERVATION ACT, 1972

- The Wild Life Protection Act, 1972 is an Act of the Parliament of India enacted for protection of plants and animal species.
- Before 1972, India had only five designated national parks. Among other reforms, the Act established schedules of protected plant and animal species; hunting or harvesting these species was largely outlawed.
- The Act provides for the protection of wild animals, birds and plants; and for matters connected there with or ancillary or incidental thereto. It extends to the whole of India.
- It has six schedules which give varying degrees of protection:
    - Schedule I and part II of Schedule II provide absolute protection – offences under these are prescribed the highest penalties.
    - Species listed in Schedule III and Schedule IV are also protected, but the penalties are much lower.
    - Schedule V includes the animals which may be hunted.
    - The specified endemic plants in Schedule VI are prohibited from cultivation and planting.
- Up to April 2010 there have been 16 convictions under this act relating to the death of tigers.

CONSERVATION PROJECTS

PROJECT TIGER

- Indian tiger population at the end of the 20th century was estimated at 20,000 to 40,000 individuals.
- The first country-wide tiger census conducted in 1972 estimated the population to comprise a little more than 1,800 individuals, an alarming reduction in tiger population.
- In 1973, Project Tiger was launched in the country based on a 'core-buffer' strategy.
- Project Tiger was launched in Jim Corbett National Park of Uttarakhand in 1973.
- India has more than 80 national parks and 441 Sanctuaries of which some have been declared as Tiger reserves.
- Tiger reserves are governed by the Project Tiger (1973).
- It is a Centrally Sponsored Scheme of the Ministry of Environment and Forests.
- It is administered by the National Tiger Conservation Authority.
- Aim: Protect tigers from extinction by ensuring a viable population in their natural habitats.

PROJECT ELEPHANT

- Tiger faces threat of extinction, whereas the elephant faces threat of attrition.
- The elephant numbers have not increased or decreased drastically but there is an increasing pressure on the elephant habitats.
- Project Elephant was launched in 1992.
- It is a centrally sponsored scheme.
- Objectives:
    - To assist states having populations of wild elephants and to ensure long term survival of identified viable populations of elephants in their natural habitats
    - Addressing man-animal conflict.
    - Developing scientific and planned management measures for conservation of elephants.
    - Protecting the elephants from poachers, preventing illegal ivory trade and other unnatural causes of death

SEA TURTLE PROJECT

- A significant proportion of world's Olive Ridley Turtle population migrates every winter to Indian coastal waters for nesting mainly at eastern coast.
- With the objective of conservation of Olive Ridley Turtles and other endangered marine turtles, MoEF initiated the Sea Turtle Conservation Project in collaboration of UNDP in 1999 with Wildlife Institute of India, Dehradun as the Implementing Agency.
- The project is being implemented in 10 coastal States of the country with special emphasis in State of Orissa.
- The project has helped in preparation of inventory map of breeding sites of Sea Turtles, identification of nesting and breeding habitats along the shore line, and migratory routes taken by Sea Turtles, development of guidelines to safeguard and minimize turtle mortality.
- One of the important achievements have been demonstration of use of Satellite Telemetry to locate the migratory route of Olive Ridley Turtles in the sea and sensitizing the fishermen and State Government for the use of Turtle Exclusion Device (TED) in fishing trawlers to check turtle mortality in fishing net

PROJECT CROCODILE

- The Indian Crocodile Conservation Project has pulled back the once threatened crocodilians from the brink of extinction and place them on a good path of recovery.
- To protect the remaining population of crocodilians in their natural habitat by creating sanctuaries.
- To rebuild natural population quickly through 'grow and release' or 'rear and release' technique
- To promote captive breeding,
- Captive breeding means that members of a wild species are captured, then bred and raised in a special facility under the care of wildlife biologists and other expert.
- Bringing an animal into captivity may represent the last chance to preserve a species in the wild.
- To take-up research to improve management.

- To build up a level of trained personnel for better continuity of the project through training imparted at project-sites and through the (erstwhile) Central Crocodile Breeding and Management Training Institute, Hyderabad.
- To involve the local people in the project intimately

PROJECT HANGUL

- The Kashmir stag also called Hangul is a subspecies of Central Asian Red Deer native to northern India.
- It is the state animal of Jammu & Kashmir
- In Kashmir, it's found in Dachigam National Park at elevations of 3,035 meters.
- These deer once numbered from about 5,000 animals in the beginning of the 20th century.
- Unfortunately, they were threatened, due to habitat destruction, over-grazing by domestic livestock and poaching.
- This dwindled to as low as 150 animals by 1970. However, the state of Jammu & Kashmir, along with the IUCN and the WWF prepared a project for the protection of these animals.
- It became known as Project Hangul. This brought great results and the population increased to over 340 by 1980.

PROJECT DOLPHIN

- The Ministry of Environment and Forests notified the Ganges River Dolphin as the National Aquatic Animal.
- The River Dolphin inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh.
- It is estimated that their total population is around 2,000 and they are listed in Schedule I of the Wildlife Protection Act (1972).
- The Ganges Dolphin is among the four "obligate" freshwater dolphins found in the world — the other three are the 'baiji found in the Yangtze River (China), the 'bhulan' of the Indus (Pakistan) and the 'boto' of the Amazon River (Latin America).
- Although there are several species of marine dolphins whose ranges include some freshwater habitats, these four species live only in rivers and lakes.
- The Chinese River Dolphin was declared functionally extinct by a team of international scientists in 2006.
- In India, the Ganges River Dolphin is threatened by river water pollution and siltation, accidental entanglement in fishing nets and poaching for their oil.
- In addition, alterations to the rivers in the form of barrages and dams are separating populations.

ENDANGERED FLORA AND FAUNA

Endangered species/ E- species

- These are the species at a high risk of extinction in the near future, if immediate protection is not provided.
- Their population size or number of existing members will be below the critical level and the extent of their natural habitat will be very much reduced.
- They are always under the severe threat of changing environment and mounting predation pressure.
- If the negative factors which have caused the decrease in their population size continue to operate, they are doomed to become extinct.
- Indian Rhino, Asiatic Lion, Snow Leopard, Lion Tailed Macaque of Kerala, Wild Ass of the Rann of Kutch are the Endangered Indian Animal
- The main reasons for endangered species are ;
    - Human activity : such as; hunting, harvesting, deforestation, global warming, over consumption, accidental killing, river pollution, construction of dam,pollution
    - Destroying natural habitat: the living space is being destroyed
    - Increasing population size of predator: for example; cat and mouse,population growth of predators
    - Destroying natural habitat: the living space is being destroyed
    - When sex ratio decreases then population of these species also decreases
    - Climate change: drought, storms, heat waves, warming oceans, ice melting, rising sea levels and extreme weather conditions can directly harm species
- Gymnosperms; these are the most threatened groups.
- The most threatened habitat is tropical rain forest
- More than one fifth of worlds plants face threat of extinction
- Green Pitcher-plant has been listed as endangered since 1979
- Gymnosperms (the plant group including conifers and cycads) are the most threatened group. The most threatened habitat is tropical rain forest.sep 29, 2010

Extinct Fauna:

- Due to hunting:

• Mammoths

• Caspian Tiger

• Dodo

• Passenger Pegion

- Nearly Endangered:

• Polar Bear

• Great White Sharks

- Due To Climate Change : Facing Extinction

• Koala

• Leather Back Sea Turtle

• Polar Bear

• Monarch Butterfly

- Global Warming :

• Bees

• Whales

- Due To Deforestation:

• Darwin's Fox

WILDLIFE SANCTUARIES

THATTEKKAD BIRD SANCTUARY

- First bird sanctuary of kerala.
- It was declared as a bird sanctuary on 27/08/1983.
- It covers an area of 25.16km2.
- The diversity of the avian fauna of Thattekkad is remarkable.
- Its birdlife includes forest birds, water birds and visiting birds.
- More than 200 species of birds have been reported from this area.
- The particular region of the sanctuary is known as "CUCKOO PARADISE ",because of cuckoos are seen
- there in large numbers.
- Thattekkad is a dream land of bird watchers.
- Birds are,
  - The great Indian hornbill
  - Golden oriole
  - Jungle fowl
  - Indian hill myna
  - Grey heron
  - Crow pheasant,etc.

PARAMBIKKULAM WILDLIFE SANCTUARY

- Parambikkulam WS is located in Palakkad Dist.
- It covers an area of 285km2.
- It was established on 12/02/1973.
- Parambikkulam WS is rich in floral and faunal wealth.
- The important mammals include,

- Lion-Tailed Macaque
- Bonnet Macaque
- Nilgirilangur
- Gaur
- Elephant

- The important reptiles include,
  - Cobra
  - Malabar Pit Viper
  - Flying Lizard
  - Indian Rock Python
- More than 270 species of birds, nearly 50 species of fishes have been reported.
- Birds, 134 species are listed as rare,18 species are endemic to Western Ghats.
- 17 species of fishes are endemic to Western Ghats.
- Nearly 25 species of amphibians and 125 species of butterflies have been recorded.
- The world famous and 450 years old Kannimara teak is in this sanctuary.
- It has won the Mahavriksha Puraskar,awarded by the Govt.of India.

ERAVIKULAM NATIONAL PARK

- First declared National Park of Kerala (19/05/1978).
- It is the world famous home of Nilgiri Tahr.
- It covers an area of 97 km^2.
- Its main body is a high-rolling hill plateau.
- On 31/03/1975,it was declared as a wildlife sanctuary, and in 1978 as a National Park.
- More than 50% of the global population of Nilgiri Tahr is found in Eravikkulam.
  - Barking Deer
  - Sambar
  - Tiger
  - Wild Dog
  - Leopard
  - Malabar Squirrel

SILENT VALLEY NATIONAL PARK

- Traditionally known as “Sairandhri Vanam “
- Located in Palakkad Dist.
- It was declared as a National Park on 15/11/1984,under the provisions of the Wildlife (protection)Act 34.
- It spread over an area of 89.52km^2
- It also a part of the Western Ghats World Heritage Site, recognized by the UNESCO in 2007.
- Silent Valley was first explored by the botanist Robert Wright in 1847.
- This tropical evergreen rainforest in the Western Ghats is a precious gene pool and an immensely rich reservoir of vast biodiversity which has not been fully explored so far.

- Save silent valley movement– prof.M.K. Prasad

NILGIRI BIOSPHERE RESERVE

• First established biosphere reserve in India.

- It was declared as 01/09/1986.
- It covers an area of 5520.4km2.

• 1455.4km^2	• Kerala
• 1527.4km^2	• Karnataka
• 2537.6km^2	• Tamil Nadu

- It consist of 3 eco- region,
  - Moist deciduous forests of South Western Ghats
  - Montane forests of South Western Ghats
  - Dry deciduous forests of South Deccan Plateau
- The reserve is rich in flora, fauna and tribal groups.
- More than 100 species of mammals, 550 odd species of birds, more than species of reptiles and amphibians have been reported.
- The tribal groups include,
  - Todas
  - Kotas
  - Irulas
  - Kurumbas
  - Malayans,etc.etc.

AGASTHYAMALAI BIOSPHERE RESERVE

- Located in South India, at the southern end of the Western Ghats.
- It was established in 2001.
- In 2016,it became a part of the World Network of Biosphere Reserves,and is now under UNESCO's world list of biosphere reserves.

  (Pathanamthitta,Kollam,Thiruvanthapurm– Kerala

  Kanyakumari an Thirunelveli- Tamil Nadu)

- It covers an area of 3500.36km2

• 1828km^2	• Kerala
• 1672.36km^2	• Tamil Nadu

- Three eco- regions,
  - Tropical wet evergreen forests
  - Moist deciduous forests of South Western Ghats
  - Montane rainforests

- More than 2000 varieties of medicinal plants
- Nearly 50 are rare and endangered.
- Important mammals of the area,
    - Nilgiri Tahr
    - Tiger
    - Elephant

RED DATA BOOK& RED LIST OF IUCN

- Published from Switzerland by the international Union for the Conservation of nature and Natural resources (IUCN)
- IUCN-International organization, working in the field of natural conservation and sustainable use of natural resources
- It influence and encourage societies throughout the world to conserve nature and ensure that any use of natural resources is equitable and ecologically sustainable
- IUCN is trying to create awareness about the endangered species
- Details about the extinction risk and survival status of the threatened animals and plants all over the world : red data book
- The list of threatened organisms recorded in the Red Data Book is called Red List of Organisms
- Red List provide information about the locality of the threatened species, the magnitude of the threat they face ,the ecological requirements they demand,& the conservation strategies to be adopted to avert their extinctin and almost all details about the threatened species
- The book has pink coloured pages and green coloured pages
- Pink coloured pages-List of critically endangered species which are on the verge of extinction
- Green coloured pages-list of the species which were formerly endangered but have now recovered and are no longer threatened
- In the Red list of IUCN, organisms are grouped under 9 categories,based on their current population size, range of distribution, fragmentation and segregation in distribution.

1. **Extinct species (EX)**

The species whose members have become long extinct, leaving no living representative anywhere
eg: Dodo, Golden Toad

2. **Species extinct in the wild (EW)**

Living representatives are altogether absent in the natural habitat,but are present in captivity in zoos, domestication, cultivation,ect ..or living in small areas well outside the natural range
eg:Socorro dove

3. Critically endangered species (EN)

Members are at highest risk of immediate extinction in the wild
eg: Himalayan quail

4. Endangered species (EN)

Members are at high risk of extinction in the wild in the near future
eg: Grey parrot

5. Vulnerable species (VU)

Members are at highly endangered in the wild and are the risk of extinction in a moderately distant future.
eg: Nilgiri langur

6. Near threatened species (NT)

Members are likely to become endangered in the near future
eg: Plains zebras

7. Least concern species (LC)

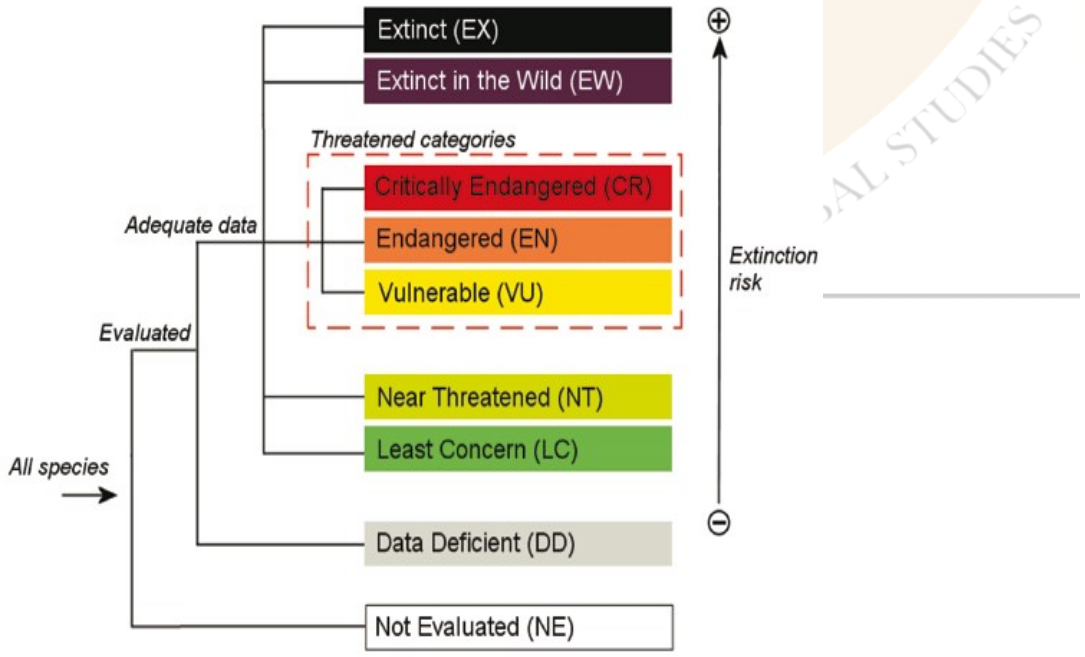
.Members are at the low risk of endangement and they enjoy wide and dense distribution
eg: African civet

8. Data deficient species(DD)

Enough data are not available to assess the risk of endangerment or extinction
eg:Colombian crate

9. Not evaluated species(NE)

The risk of endangerment has not been evaluated
eg: European Goldfinch



CONSERVATION OF BIODIVERSITY

- It is the protection, upliftment and management of biodiversity in order to derive sustainable benefit for present and future generations
- Objective of biodiversity:
  - To preserve the diversity of species
  - Sustainable utilisation of species and ecosystem
  - To maintain life-supporting system and essential ecological process

BIODIVERSITY AND IT'S CONSERVATION METHODS

- Biodiversity refers to the variability of life on earth.
- It can be conserved in the following ways ,
  - In- situ conservation
  - Ex-situ conservation

In-situ conservation :

- In-situ conservation of biodiversity is the conservation of species within their natural habitat.
- In this method, the natural ecosystem is maintained and protected
- Advantages :
  - It is cost- effective and convenient method of conserving biodiverse
  - A large number of living organisms can be conserved simultaneously
  - Since the organisms are in a natural ecosystem, they can evolve better and can
  - Easily adjust to different environmental conditions

Certain protected areas where in-situ conservation take place includes,

- National Parks
- Wildlife Sanctuaries
- Biosphere Reserves

National parks
These are small reserves maintained by government. It's boundaries are well demarcated and Human activities such as grazing, foresting, habitat and cultivation are prohibited
eg: Silent Valley National parks

Wildlife Sanctuary
These are the region where only wild animals are found. Human activities such as timber harvesting, Cultivation, collection of wood and other forest products are allowed here as long as they do not interfere with the conservation project. Also, tourists visit those place for recreation
Eg: Chinnar wildlife sanctuary

Biosphere reserves

Multipurpose protected areas where the wildlife , traditional lifestyle of the inhabitants and domesticated plantd and animals are protected. Tourism and research activities are allowed here
Eg: Nanda Devi Biosphere Reserve

Ex-situ conservation

- Involves breeding and inhabitants of endangered species in Artificial ecosystem such as zoos, nurseries, botanical Garden, gene pank, etc.
- There is less competition for food, water, space among the organisms
- Advantageous of Ex-situ conservation
    - The animals are provided with a longer time and breeding activities
    - The species bred in captivity can be reintroduced in the world
    - Genetic techniques can be used for the preservation of endangered species

Conservation of Germplasm Banks :

- Germplasm banks are the establishment , concerned primarily with the conservation of the genetic material which maybe lost through genetic erosion.
- In practices, germplasm is a plant part from which new plant is generated
- Current techniques of preservation have greatly increase the usefulness of germplasm banks
- By the application of tissue culture and cryopreservation techniques, most of the plants can be maintained in a variable state for very long period of time.
- Cryopreservation is the preservation of germplasm at an ultra low temperatures of-196°C.At such a low temperature biological activities cease to take place, cell division stop, and no genetic change would occur
- It is especially important in the conservation of Vegetatively propagating crop plants.

Strategies of conservation :

- All the economically important organism should be identified and conserved
- Unique ecosystem preserved first
- The resources should be utilized efficiently Poaching and hunting of wild and should be prevent
- Deforestation should be strictly prohibited

MODULE : 2

GLOBAL STRATEGY FOR CONSERVATION

STOCKHOLM CONFERENCE

- On June 5, an International Conference on Human Environment was held in Stockholm, Sweden, under the initiative of the UN.
- Sweden first Suggested to the United Nation Economic and social council ECOSOC in 1968.
- The idea of having a UN conference to focus on human interaction with the environment.
- The conference was attended by several world leader's including the then Prime Minister of India Smt. Indira Gandhi.
- The conference discussed economic development in terms of environmental equilibrium
- The formal statement of the conference is known as Stockholm Declaration.
- It contains 109 recommendations to implement the proposed Action Plan for Environment.
- The Stockholm conference also led to the creation of UNEP in December 1972.
- It promote sustainability and safeguard the natural environment.
- June 5th is now celebrated as the World Environment Day to commemorate the Stockholm Conference .

NAIROBI CONFERENCE / DECLARATION

- Declaration adopted in 1982.
- 10th anniversary of Stockholm
- The declaration envisaged the creation of a social commission to frame long term environment strategies for achieving sustainable developments.
- The social movement leaders and members of organizations from all corners of the world working on economic, social and cultural rights, gathered in Nairobi, Kenya, from December 1-5, in the context of the 2nd International Strategy Meeting on Economic, Social and Cultural Rights and the 2nd ESCR-Net General Assembly,
- The basic foundations for peoples' survival, livelihoods and well-being-the land, waters, forests and natural ecosystems -are under severe threat from a global economic system of unrelenting consumption and greed bio-fuels, created subsidies and tax-free provisions for this "attractive business" putting at risk our bio-diversity, food security, earth, water, and culture. These inter-linked social, economic, environmental and climate crisis pose unprecedented challenges for humanity

1)The global economic system and trade regime commodifies the earth's natural and human resources for corporate and private gain, promotes exaggerated consumerism and puts corporate profits before people, denying indigenous peoples, fisher-folk, farmers, and local communities their economic, social and cultural rights;

2) structural violence and growing militarization serve to secure, protect and perpetuate corporate interests;

3) the imbalance in power relations and deep rooted social, economic, and political structures perpetuate and further enrich the already powerful and wealthy while impoverishing the already weak and marginalized peoples

CITES

- CITES-convention on international trade in endangered species of world fauna and flora
- It is the international agreement to ensure that international trade on wild plants and animals and their product will not endanger their survival
- It is the outcome of a resolution ,adopted at the meeting of the members of IUCN in 1963
- It formally accepted in 3/March,1973
- At a meeting of the representative of eight countries ,held in Washington DC ,USA
- It came in to force on 1/July,1975
- The countries which have jointed the agreement called parties
- CITES have 171 parties
- The parties where protect the species from over-exploitation and extinction
- More than 30,000 species of plants and animals where protected

EARTH SUMMIT-1992

- Formally called United nations conference on environment and development(UNCED)
- The international conference held in Rio de Janeiro Brazil from 3to 14 June,1992
- It popularly called as Rio conference or Rio 92
- It is the third main meeting on environment and the first earth summit
- Organized by UN on 22-12-1989
- 175 countries attend the conference
- The Indian delegation was led by the prime minister Sri.p.v.narasimha Rao
- OBJECTIVES:-
- Conservation of biodiversity
- Sustainable utilization of biodiversity
- Fair and equitable sharing of the benefits derived from the utilization of genetic resources
- OUTPUTS:-
- Signed as ‘earth pledge' to protect earth and its resources
- Formulated an earth charter or declaration called Rio declaration which is an succinct document on global environmental issues
- Formulated an agenda for future actions called agenda 21 which contain the action programme for sustainable development
- Decided to hold global conventions on environmental issues such as frame work convention on climate change convention on biological diversity and desertification conventions
- Drafted a detailed statement of forest principles
- Established an institutional mechanism called commission on sustainable devolepment(CSD)

RIO DECLARATION

- It is the concluding session and it’s called ‘parliament of the planet’s
- It is the head of various states and government
- The session was presided by maurice strong

- The declaration consist of a preamble 27 articles and 27 norms of behaviour
- **Cardinal principles** :-
  - Public trust doctrine
  - Precautionary principle
  - Principle of intergenerational equity
  - Principle of intra-genarational equity
  - Subsidiary principle
  - Polluter pays principle(ppp)
  - User pays principle

- **Agenda21 :**
  - Most impressive document of earth summit
  - It is the action plan for addressing international economic and environmental problems
  - In the original version it contain 900 pages and 40 chapters arranged in four parts
- Part 1: social and economic dimensions of global problems

Eg:-poverty,consumption patterns, population,health ,integration of environment and development

Rio Declaration on Environment and Development

- Short document produce at 1992 UNCED/ Earth summit
- Consists of 27 principle intended to guide future sustainable development around the world
- The Earth Summit was inspired and guided by a remarkable document of 1987, i.e., Brundtland report.

- Part 2 : Address the problems of conservation and management of nature resources

Eg:-atmosphere,terrestrial and aquatic resources (Key issues like sustainable agriculture,biodiversity,biotechnology,and waste management)

- Part 3:the role of women,youth ,local people,farmers,business community ,trade unions,local administrations ,non-governmental organisation and scientist in implementing the programmes on environment and devolepment
- Part 4: mode of implementation of the agenda through scientific,technological,legal,educational,and institutional programmes

BIODIVERSITY CONVENTION

The Convention on Biological Diversity, known informally as the Biodiversity Convention, is a multilateral treaty.

The Convention has three main goals:

1. The conservation of biological diversity (or biodiversity) .
2. The sustainable use of its components.
3. And the fair and equitable sharing of benefits arising from genetic resources.

Its objective is to develop national strategies for the conservation and sustainable use of biological diversity, and it is often seen as the key document regarding sustainable development.

- Measures the incentives for the conservation and sustainable use of biological diversity.
- Regulated access to genetic resources and traditional knowledge, including Prior Informed Consent of the party providing resources.
- Sharing, in a fair and equitable way, the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources (governments and/or local communities that provided the traditional knowledge or biodiversity resources utilized).
- The convention recognized for the first time in international law that the conservation of biodiversity is "a common concern of humankind" and is an integral part of the development process.
- The agreement covers all ecosystems, species, and genetic resources. It links traditional conservation efforts to the economic goal of using biological resources sustainably.

Major issues :

- Access to and transfer of technology, including biotechnology, to the governments and/or local communities that provided traditional knowledge and/or biodiversity resources.
- Technical and scientific cooperation.
- Coordination of a global directory of taxonomic expertise (Global Taxonomy Initiative).
- Impact assessment.
- Education and public awareness.
- Provision of financial resources.
- National reporting on efforts to implement treaty commitment

Type	Multilateral environmental agreement
Drafted	22 May 1992
Signed	5 June 1992 – 4 June 1993
Location	Rio de Janeiro, Brazil New York, United States
Effective	29 December 1993

KYOTO PROTOCOL (1997)

- Kyoto protocol is an international agreement to considerably reduce the emission of greenhouse gases and to significantly bring down global warming.
- It came into existence 11, December, 1997. It was formed in Kyoto, Japan and signed by 191 nations.
- It can be regarded as a sequel of the 1992 Framework convention on climate change (FCCC).
- FCCC aimed at stabilizing the concentration of atmospheric greenhouse gases at the level that would not seriously interfere with climate system.
- Kyoto protocol primarily addresses the problem of anthropogenic climate change.
- Although formed on 11, December, 1997. It was open for signature from March 16, 1996 to March 15, 1999 at the UN Headquarters in New York
- During the period, the protocol was ratified by 84 signatures. Now,119 nations have ratified the Kyoto protocol
- According to the Kyoto protocol, 38 highly industrialized nations, which are responsible for nearly 73% of the CO2 release, are required to bring down their greenhouse gases emission level to 5% below the 1990 level towards the end of 2010.
- US is release the 20% of the greenhouse gases. They are initially a party to the agreement .But later on, they opposed from the agreement.
- As a result, 2011 Canada withdraw in this agreement.

WORLD SUMMIT

Introduction :

- Under the UN Commission a Summit was organised in light of sustainable development.
- In Johannesberg South Africa on 4 September 2002, followed by first earth summit
- The main purpose of this Summit was to evolve concrete policies and to setup time bound target for complete implementation of agenda 21.
- The Summit was attended by more than 190 Nations.
- The United Nations considered this Summit as the “last chance to save the planet”.

- This Summit discussed vital issues related to climatic change, trade, energy, poverty, water comma sanitization, health , agriculture and biodiversity.

World summit on sustainable development :

- In this conference some policies and time bound targets have been set by UN. This was based on climatic change, trade, energy,etc.
- The expected outcomes are :
- Reaffirmed that sustainable development is central element of fighting poverty and protecting environment.
- Establishing a link between environment and use of natural resource.
- Formulating concrete commitments and targets for effective implementation of sustainable development.
- Issues related to energy and sanitation.
- Need of world solidarity fund for eradication of poverty.
- They had to bring a sustainable development by implementing these policies that brings out the outcome.
- Expected Outcomes ;
    - Reduction in 50 percentage of poverty.
    - Production of harmless chemicals by 2020.
    - Increase in global energy supply.
    - Encouragement of sustainable development.
    - Establishment of domestic programs for energy efficiency.
- But these outcomes are not obtained, due to the issues such as the agenda was too broad to implement and reach innovations, less enthusiasm
- Of developed countries,etc. So these are not implemented. There is also reason for over exploitation of environment to become a developed country. Later lot other policies came up with same target.
- The future of summit had change to the outcome and still issues are faced by each Nations. So, the policies are rejected may lead you to economic impact on environment.

UNEP : STRATEGIES

- The United Nations Environment Programme (UNEP) is responsible for coordinating the UN's environmental activities and assisting developing countries in having environmentally sound policies and practices
- The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment.
- UNEP was founded in 1972 by Canadian businessman and philanthropist Maurice Strong, its first director.
- Its Headquarters is in Nairobi, Kenya.
- Present Executive Director is Inger Andersen (Denmark) since 2019.

- **Strategies :**
    - Addressing land-based pollution.
    - Enabling sustainable, resilient and inclusive blue economies.
    - Fighting for #CleanSeas.
    - Promoting marine protected areas.

- Protecting & restoring blue carbon ecosystems.
- Protecting coral reefs.
- Working with regional sea

PPVER

PROTECTION OF PLANT VARIETIES FARMER'S RIGHT ACT (2001) (PPVER ACT)

- The Act was passed by the Indian parliament.
- The Act received the ascent of the president of India on 30-10-2001.
- The Act for the protection of plant varieties and the rights of farmers and plant breeders.
- It is also help for the encouragement of the development and cultivation of new varieties of plants.
- The PPVER Act , 2001 grants intellectual property rights to plant breeders, farmers and new varieties developed researchers.
- Registered new variety get eligibility of the rights.
- Farmers are entitled to save, use, sow, exchange or sell their farm produces –including the seeds of a registered variety in an unbranded manner.
- They are exempted from any fee in any proceeding under this act.
- Annual fees has to be paid every year for maintaining the registration and renewal has to be paid for the extended period of registration.
- The period of protection is 15 years for crop fields, 18 years for trees and vines,15 years for the notified varieties from the date of notification.
- Farmers can claim compensation if the registered variety fails provide the guaranteed performance under the stipulated conditions.
- The rights guaranteed by this act are exclusive rights to produce, sell, market, distribute, import or export variety.
- Civil and criminal remedies are provided for the enforcement of breeders right.
- Compensation is also guaranteed for village or rural communities if the development of any registered variety involves their direct or indirect contribution.
- The procedural details and modes of implementing this act are provided in PPVER Rules in 2003.

THE WILDLIFE ACT, 1972

- The Indian Parliament enacted the Wildlife (Protection) Act in 1972, which provides for the
- safeguard and protection of the wildlife in the country.This Act provides for the protection of the country's wild animals, birds, and plant species, in order to ensure environmental and ecological security
- It extends whole of India, except Jammu and Kashmir
- The act was later amended in 1983, 1986 and 1991incorporating more provision to increase its effectiveness without loophole

Major objectives of the act

- Maintenance of life-supporting system and essential ecological process
- Conservation of biodiversity
- Sustainable use of species through the protection and conservation of wildlife

Salient features of the act

- The act consists of seven chapters and six schedules
- Chapter-I:preliminary
- Chapter -II:authorities to be appointed or constituted under the act
- Chapter-III:prevent the hunting of wildlife
- Chapter-IV:sanctuaries, national park and closed areas

- Chapter-V:regulation in trade or commerce in wildlife animal article and trophies
- Chapter-VI:prevention and detection of offences
- Chapter-VII:miscellaneous aspects

Amendments

- Wild Life (Protection) Amendment Act 1982
- Wild Life (Protection) Amendment Act 1986
- Wild Life (Protection) Amendment Act 1991
- Wild Life (Protection) Amendment Act 1993
- Wild Life (Protection) Amendment Act, 2002
- Wild Life (Protection) Amendment Act 2006
- Wild Life (protection) Amendment Act 2008
- Wild Life (Protection) Amendment Act 2013

SEED BILL

The Seeds Bill, 2004

- The Bill was introduced in the Rajya Sabha on December 9, 2004.
- It has been referred to the Standing Committee on Agriculture (Chair: Prof Ram Gopal Yadav).
- The Seeds Bill, 2004 aims to regulate the quality of seeds sold, and replaces the Seeds Act, 1966.
- All varieties of seeds for sale have to be registered. The seeds are required to meet certain prescribed minimum standards.
- The Bill does not restrict the farmer's right to use or sell his farm seeds and planting material, provided he does not sell them under a brand name. All seeds and planting material sold by farmers will have to conform to the minimum standards applicable to registered seeds.
- If a registered variety of seed fails to perform to expected standards, the farmer can claim compensation from the producer or dealer under the Consumer Protection Act, 1986.
- The Bill permits self certification of seeds by accredited agencies and allows the central government to recognize certification by foreign seed certification agencies.
- Every seed producer and dealer, and horticulture nursery has to be registered with the state government.

SECTION : C TOXICOLOGY

SECTION C : TOXICOLOGY (4 hrs)

1. Toxicants and public health hazards

(a) Toxic chemicals (pesticides, automobile emissions, heavy metals, fertilizers food additives, xenobiotics, radioactive wastes).

(b) Indian law of drug and poisons

(c] Levels of toxicity- Acute, sub acute, chronic, LD 50, LC 50

(d) Common bacterial poisoning (botulism)

(e) Behavioural Toxicology

TOXICOLOGY

- Toxicology simply means the study of poisons (toxicon =poison).
- A branch medical science concerned with the qualitative or quantitative study of detection, concentration, physical properties, chemical nature, transfers and transformations,mechanism of action and interaction, biological effects etc of exogenous poisons : *toxins*

TOXICANTS

- Toxicants are the physical, chemical, or biological agents which can cause adverse effects or responses in living organisms, seriously damaging their structure or functions or causing their death.
- They may have the potential to induce cancer, to produce long-term diseases or body damages, and to severely affect the health.
- In most cases, they cause acute discomfort and endanger life.
- Chemical toxicants are often referred to as *xenobiotics*.
- Xenobiotic is a chemical which is found in an organism, but not normally produced by an organism.
- Major toxicants :
  - Pesticides
  - Automobile exhausts
  - Heavy metals
  - Fertilizers
  - Food additives
  - Radioactive wastes
  - Xenobiotics

Sources of toxicants :

The major sources of exogenous toxicants to man and domestic animals are of two groups :

- non-point sources : includes agricultural run off from land, contaminated groundwater and bottom sediments, urban run off, atmospheric fall out, etc.

- point sources : includes industrial effluents and emissions, disposal sites of hazardous wastes, municipal waste treatment plants, etc.

Classification of toxicants

- Based on source, toxicants can be grouped under four :
  - air-borne toxicants
  - water-borne toxicants
  - food-borne
  - noise and radiation toxicants
- Based on effect :
  - Carcinogens
  - Mutagens
  - Teratogens
  - Cardiotoxicants
  - Irritants
  - Deliriant
  - Psychotropic toxicants
  - Asphyxiant toxicants
  - Immunotoxicants
  - Hepatotoxicants

TOXICITY

- Toxicity is the potentiality of a substance to produce harmful effects in living organisms.
- The degree of toxicity of a toxicant depends upon its relative concentration to produce highly toxic effects. Thus, a highly toxic substance is the substance which can produce toxicity even when it is present in very low concentrations.
- A less toxic substance is the substance which can produce toxicity only when it is present in high Concentrations.
- Toxicity appears to be a function of the concentration and the duration of exposure of toxicants.
- Based on toxicity level,toxicants can be classified into five :
  - Supertoxic or hypertoxic
  - Extremely toxic
  - Very or highly toxic
  - Moderately toxic
  - Slightly toxic.

INDIAN LAWS ON DRUGS AND POISONS

1. **The Poisons Act (1919)**

- Passed in 1919, amended in 1958, and repealed in 1960.
- It stipulates regulations for the import of poisonous substances to India, for the issue of licences for the possession of certain poisons, and also for the safe and distribution of poisonous substances.

2. **Drugs and Cosmetics Act (1940)**

- Passed in 1940, and amended in 1964.
- Deals with the manufacture, import, distribution and sale of drugs.
- According to it, the formula or the list of the ingredients of every patented or proprietary medicinal preparation should be displayed on the label of the container.

3. **The Drugs and Cosmetics Rules (1945)**

- Controls the manufacture, sale and distribution of all kinds of drugs (allopathic, homoeopathic, ayurvedic, unani and sidha), and specifies the standard and quality of each drug.
- It also emphasises that all drugs and cosmetics are to be labelled and packed

4. **The Pharmacy Act (1948)**

- Permission is accorded only to qualified and registered pharmacists for compounding, preparing, mixing, or dispensing medicines in accordance with the prescription of a registered medical practitioner.

5. **The Drugs Control Act (1950)**

- Regulates the supply and distribution of drugs and sets guidelines for fixing the maximum price of each drug.

6. **The Drugs and Magic Remedies (Objectional Advertisement) Act (1954)**

- Ensures that ethical standards are maintained in advertising the drugs.
- As per this Act, advertisements which violate decency and morality, or project exaggerated or false claims about the magical properties of the products, are punishable.

7. **The Narcotic Drugs and Psychotropic Substances Act (1985)**

- This Act was passed in 1985 and amended in 1988
- It repeals three previous Acts, namely the Opium Act (1857), the Opium Act (1878), and the Dangerous Drugs Act (1930).
- The NDPS Act prohibits the cultivation of cocaine, poppy, and cannabis plants, and the manufacture, purchase, sale, use, or transport of narcotic drugs or psychotropic substances, except for medical or scientific purposes.

TOXICOLOGICAL TEST

- Toxicological tests are the chemical tests to assess the level or concentration of toxicants, to determine the level of toxicity or the duration of exposure required to produce a criterion effect, or to evaluate the degree of a target species.
- The criterion effect in most cases is the the death of the target species.
- In toxicological tests, four levels of toxicity are considered
    - Fulminate
    - Acute
    - Chronic
    - Sub -acute

1. Fulminate

- This is the high toxicity produced by a massive dose of poison. The victim
- May collapse suddenly.
- Death may occur very rapidly, without any preceding symptom of poisoning.

2. Acute toxicity

- This is the severe toxicity produced by short-term exposure to a large single dose of poison, or by several small doses taken in quick succession over a very short period of time.
- Symptoms appear suddenly
- Death may or may not occur.

3. Chronic toxicity

- The toxicity produced by several small doses of poison, taken over a long period of time.
- Onset of symptoms is belated or insidious.

4. Sub-acute toxicity

- Toxicity characterized by the symptoms of both acute and chronic cases.
- Death is not usual.
- In any case of toxicity, the poisoned victim may manifest one or more of the following specific symptoms:
    - Impairment of consciousness.
    - Respiratory or cardiovascular depression.
    - Dehydration due to vomiting or diarrhoea.
    - Hypothermia (very low body temperature).
    - Convulsions
    - Cardiac arrythmias

TEST TYPES BASED ON THE LENGTH OF EXPOSURE

3 types ,

- Acute toxicity tests
- Sub-acute toxicity tests
- Chronic toxicity tests.

1. **Acute toxicity tests**
   - Acute toxicity tests are either single dose tests, or short-term multiple dose tests.
   - They are useful to predict the hazardous effect of a toxicant in non-target species, to assess the toxicity level in target species, to reveal the mechanism of toxic action, to observe behavioural responses in experimental animals, and so on.
   - Selected species of birds and mammals are the commonly used test animals in acute toxicity tests.
   - They are primarily meant for determining the dose or concentration of a particular toxicant, or for determining the level of a toxicant whose short-term exposure would evoke a specific response in an organism.

   - The results of acute toxicity tests are represented in three values:
     - Median lethal dose (LD_{50}),
     - Median lethal concentration (LC_{50})
     - Median effective concentration. (EC_{50}).
   - Most of the acute toxicity tests are done to determine the LD_{50} and LC_{50} values of the toxicant.
   - Acute toxicity tests are usually lethality tests.

   A. Median lethal dose (LD_{50})
   - Median lethal dose is the concentration or dose of a toxicant which can be lethal to 50% or more of the test animals.
   - So, it represents the amount of the toxicant which can cause mortality of atleast 50% of the total number of test animals.
   - LD_{50} is commonly used with non-aquatic test animals, such as rats, mice and dogs, where the toxicant can be conveniently administered by various methods
   - LD_{50} is only very rarely used in aquatic organisms.
   - Acute toxicity studies are mostly meant for determining the median lethal dose
   - They are commonly applied in the following studies :
     a) Classification of chemical toxicants based on their relative toxicity.
     b) Evaluation of the intensity of the hazard from accidental overdose
     c) Studies related to the mechanism of toxicity, the influence of age,Sex and environmental factors on toxicity, and the variations in toxicity among different species of animals.
     d) Reactivity of a particular species against a toxicant.
     e) Therapeutic trials of drugs in human beings.
     f) Detection of toxic impurities for the quality control of chemicals.
     g) Studies on acute and sub-acute toxicities in animals.

   B. Median lethal concentration (LC_{50})
   - This is the concentration of the toxicant in the medium which can be lethal to at least 50% of the test organisms, when they are exposed to it.
   - LC_{50} values are usually expressed as time-bound values, such as LC_{50} 24 hrs
2. **Sub-acute toxicity tests**
   - Also known as *short-term toxicity* or *sub-chronic toxicity tests*.

- These are multiple-dose toxicity tests which involve the administration of nearly 5 doses per day over a few to several months (e.g., 3 months in rats; 12 to 24 months in dogs).
- The concentration of the toxicant will have significant adverse effects on organisms , but they will always be sub-lethal.
- Sub-acute tests are often conducted simultaneously in two or more species.
- They are usually done to establish a specific dose of a toxicant, known as *no effect dose*, which will not have
- Any adverse effect on organisms.
- Any further increase in the dosage will be harmful to the organism.

3. Chronic toxicity tests

- These are long-term, multiple-dose tests to determine whether prolonged (chronic) exposure to toxicants will produce significant adverse effect on organisms.
- These involve repeated administration of the toxicant over a considerable period of time, which may span at least one reproductive cycle of the organism.
- The main objectives. of chronic toxicity tests are the following:
  - To study the deleterious effects of toxicants on the structure and functions of the cells, tissues and organs on prolonged exposure
  - To study the mutagenic, carcinogenic and teratogenic effects of toxicants
  - To determine the safe or no effect levels of toxicants.
  - To determine the maximum acceptable toxicant concentration

BACTERIAL POISONING – BOTULISM

- Toxic substances produced by living organisms : biological poisons
- Bacterial poisons : exotoxins
- Secreted by cell as the bacterium grows
- Symptoms typically appear 1-6 hours later depending on dosage
- Example : *Clostridium botulinum , Clostridium perfringes*
- Botulism occurs when the anaerobic bacterium *Clostridium botulinum* grows in improperly canned ,low-acid foods and produces *Botulin* , paralytic toxin
- 1 mg is lethal
- Acts by blocking nerve function and leads to respiratory and musculoskeletal paralysis
- 3 main types :
  - Infant botulism
  - Food –borne botulism
  - Wound botulism

BEHAVIOURAL TOXICOLOGY

- Investigate the outcome of specific toxic exposures in humans and animals on learning , memory and behavioral characteristics
- Behavioural toxicants : metals , solvents and pesticides
- Refers to undesirable effects of essentially therapeutic levels of medication clinically indicated for a given disorder

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