



# ECOSYSTEMS



# DEFINITION

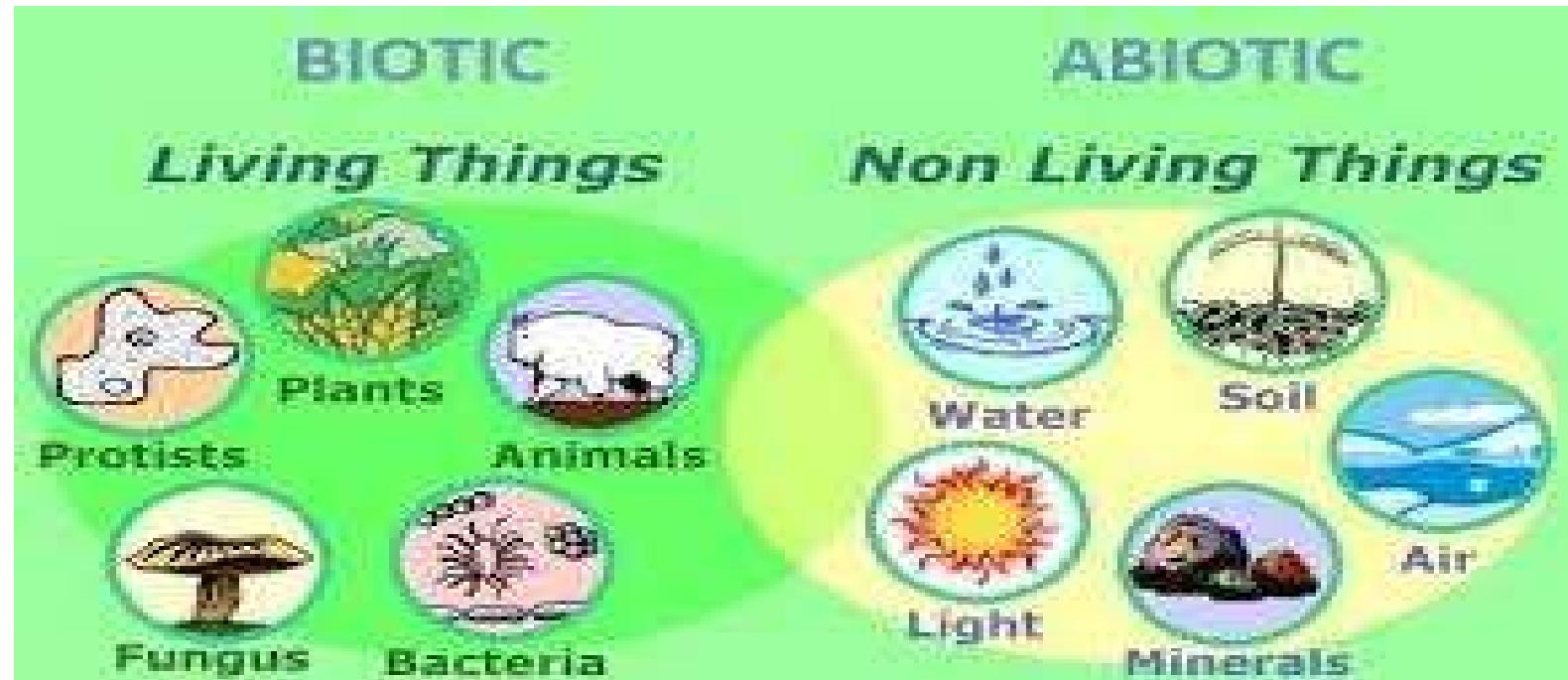
- Ecology is a science of interrelationship & deals with the relationship of living organism & non living components of environment.
- Ecosystem= Eco (Environment)+ System (Interacting and Interdependent Complex)



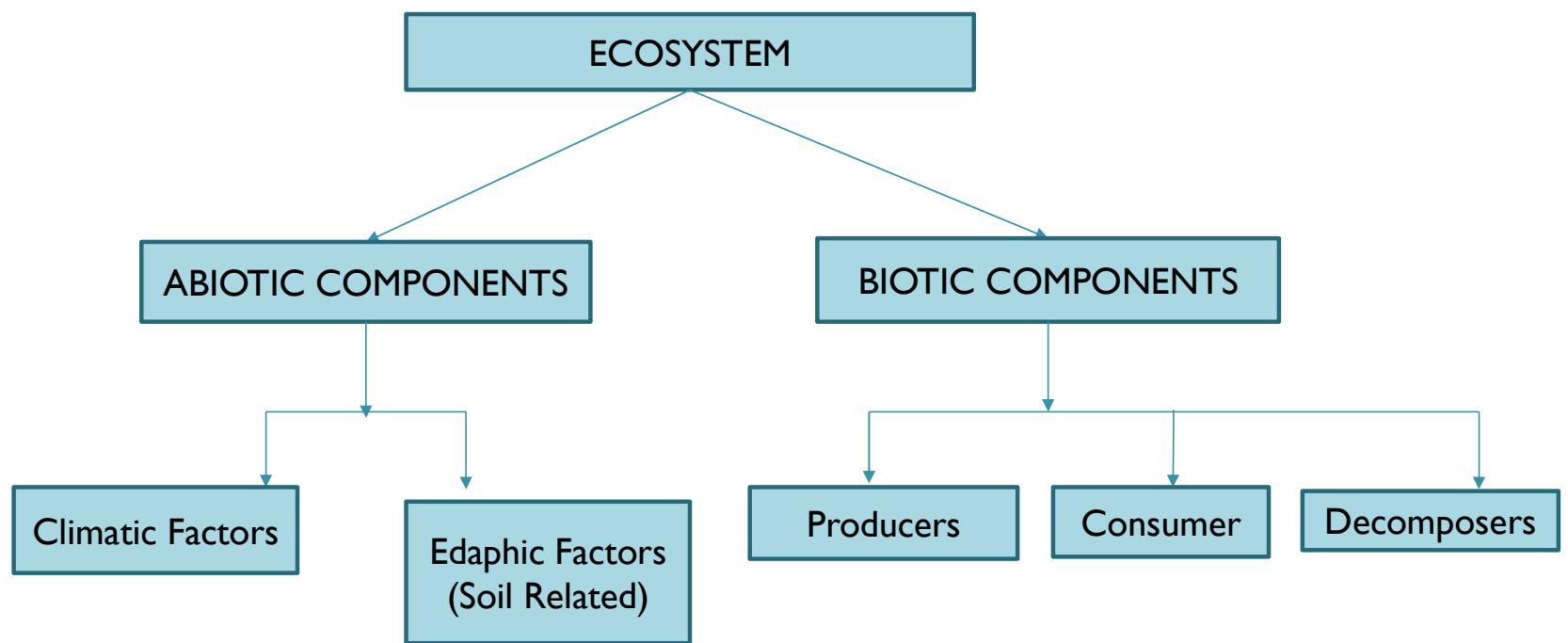
# Ecosystem -

- Ecosystem is the basic functional unit which includes organisms & non living environment; each influencing the properties of the other and both are necessary for maintenance of life as is on the earth.
- The system in which living organism & their non living environment are inseparably interrelated and interact upon each other so that the flow of energy leads to clearly defined trophic structure, biotic diversity & material cycle is called as an “ecosystem”.
- From trophic (i.e. nourishment) stand point, an ecosystem has two components an autotrophic (self nourishing) and heterotrophic (other nourishing).

# ENVIRONMENT COMPONENT



# STRUCTURE OF ECOSYSTEM





# BIOTIC COMPONENTS

- **Biotic** describes a **living component** of an ecosystem; for example organisms, such as plants and animals. All living things — autotrophs and heterotrophs — plants, animals, fungi, bacteria.
- They are divided as

**Producers (autotrophs)**

**Consumers ( heterotrophs)**

**Decomposers (detritivores)**



# Producers

- Autotrophic organisms largely green plants, which are able to manufacture food from simple inorganic substances are called producers.
- Chemosynthetic and photosynthetic bacteria, algae of various types, grasses, mosses, shrubs, herbs and trees contribute in the total production of an ecosystem.



# Consumers

- These are the heterotrophic organisms chiefly animals that eat other organisms or organic matter.
- They may be herbivores, carnivores or omnivores
- Also called as macro consumers.

# Classes of Consumers

- HERBIVORES- Primary consumer- Plants Eaters

Ex- Deer, Rabbit, Cow, Goats, Sheep etc.

- CARNIVORES- Secondary- Meat eaters- Eat Herbivorous.

Ex- Lion, Tiger & Sharks etc.

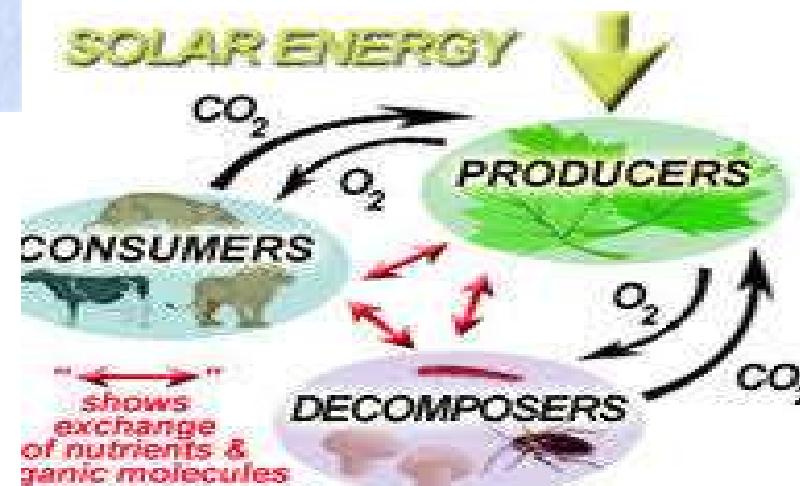
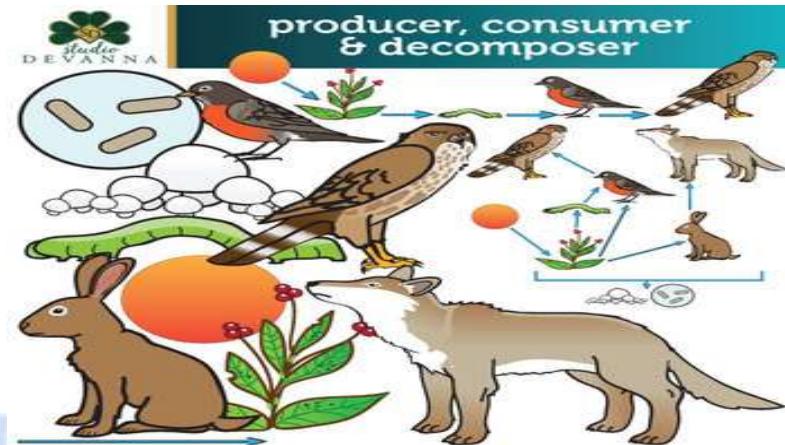
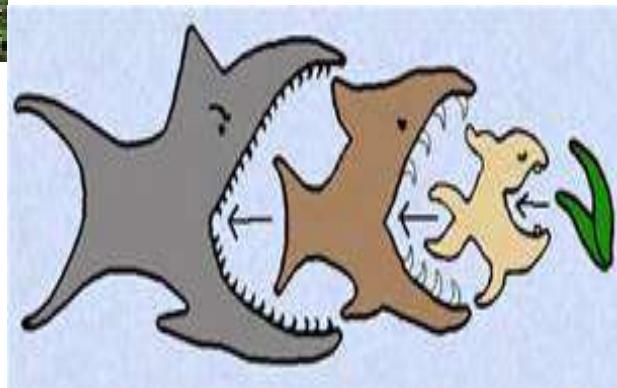
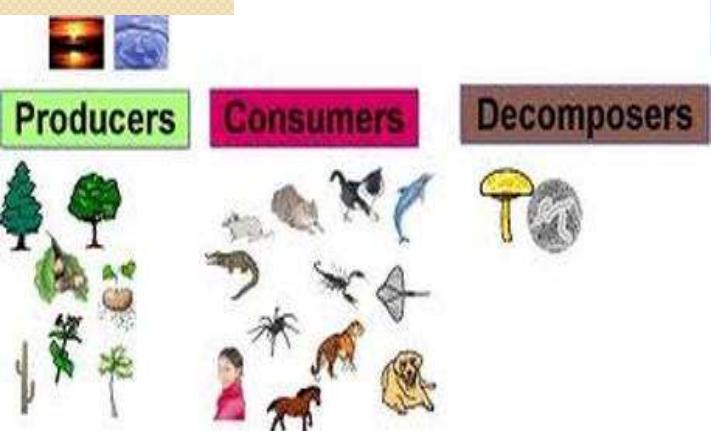
- OMNIVORES- Eat plant & Animals.

Ex- Birds, Chicken, Reptiles etc.



## Decomposers or reducers

- Heterotrophic organisms chiefly bacteria and fungi, that breakdown the complex compounds of dead protoplasm, absorb some of the products and release simple substances usable by the producers are called as decomposers or reducers.
- They are also called as micro consumers.





# ABIOTIC COMPONENTS

- **Abiotic components** or **abiotic factors** are non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems.
- The way in which plants and animals grow and carry out their different activities is a result of several **abiotic factors**.
- These **factors** are light, temperature, water, atmospheric gases, wind as well as soil (edaphic) and physiographic (nature of land surface) **factors**.

Abiotic factors:





# Functions of Ecosystem

- From the functional point of view ecosystem has two components:
  1. Autotrophs (Self nourishing)
  2. Heterotrophs (Other nourishing)



# Autotrophs ( Self nourishing)

- Autotrophs fix light energy using simple inorganic substances and build up of complex substances predominates.
- The component is constituted mainly by green plants, including photosynthetic bacteria.
- Members of the autotrophic component are known as producers.



## Heterotrophs (Other nourishing)

- In these organisms utilization, rearrangement and decomposition of complex material predominate.
- The organisms involved are known as consumers, as they consume the matter built up by the producers.



# POND ECOSYSTEM

- It comes under Aquatic Ecosystem.
- It contains both Biotic & Abiotic factors.

**Biotic Factors are,**

A. Producers-

- I. Rooted or large floating plants generally growing in the shallow water
- II. Minute floating algae- phytoplankton, when in abundance it gives greenish colour to the water,

## **B. Consumers -**

- Primary Consumers- insect larvae, crustaceans, fish, algae, fleas, tadpoles etc.
- Secondary Consumers- Snails, worms, leeches, small animals etc.
- Tertiary Consumers- Fish, frogs, turtles etc.



### C. Decomposers

Aquatic bacteria and fungi are distributed throughout the pond, under favorable temperature conditions they decompose the dead organisms and the materials are released for reuse.



## Abiotic component's are

- Water,
- Carbon dioxide,
- Calcium
- Nitrogen
- Phosphorus,
- Humus,
- Oxygen in Water,
- Light,
- Heat,
- Minerals etc.

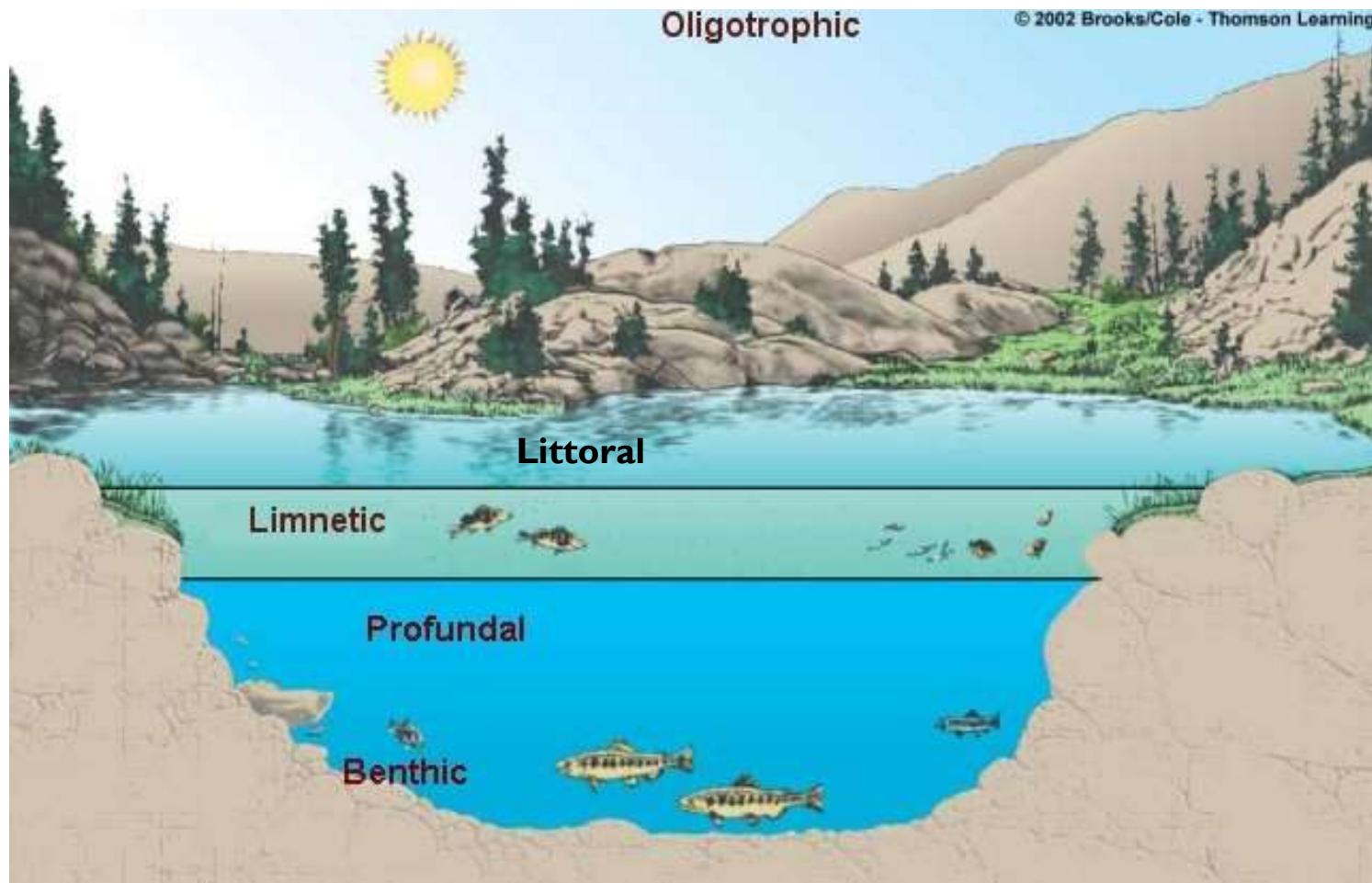


# ZONES OF POND

- Refers to Freshwater Ecosystem.
- Shallow water bodies up to 12-15 feet.

## **Light zonation of pond-**

- Littoral zone- Upper Part, Contains warm & oxygen circulating water.
- Limnatic zone- Central Part, Contains Rotifers, insects, larvae & Algae
- Profundal zone- Deep water zone, Microscopic plants, decomposers are present.



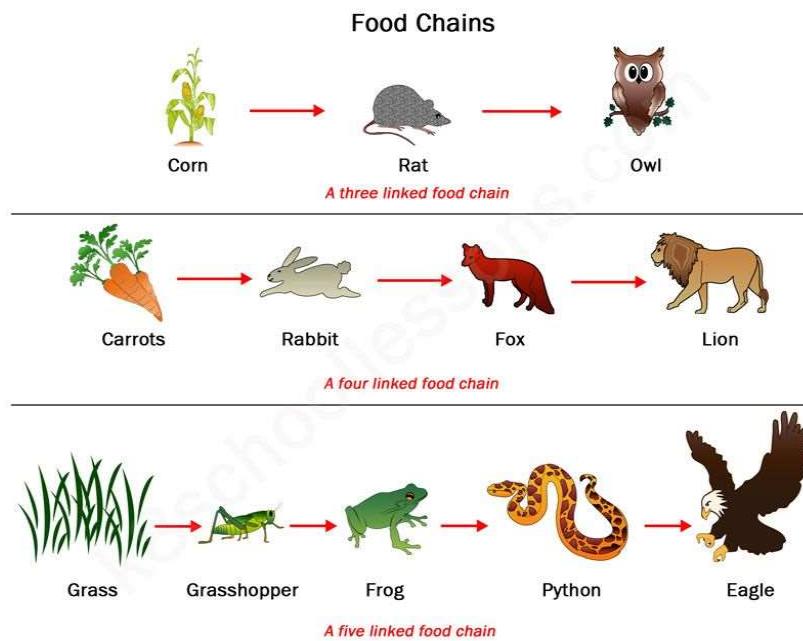
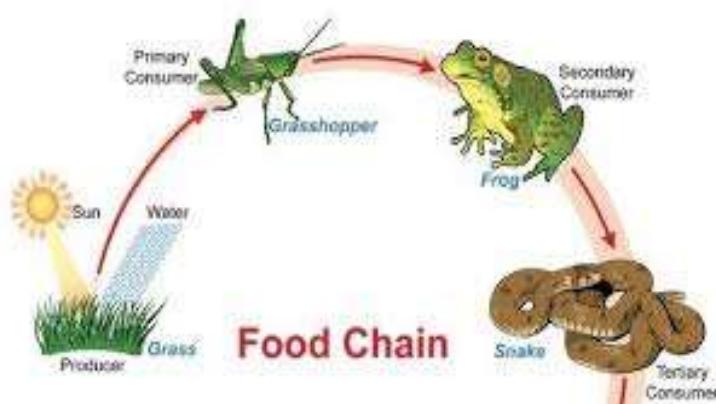


# **FUNCTIONS OF ECOSYSTEM**

- I. Food Chain & Food Web.**
- 2. Energy Flow.**
- 3. Ecological Pyramid.**

# I. Food Chain

- The transfer of food energy from the source (plants) through a series of organisms by repeated eating & being eaten up is referred to as food chain.





## IMPORTANT FACTS

- In a food chain each organism obtains energy from the one at the level below.
- Plants are called producers because they create their own food through photosynthesis.
- Animals are consumers because they cannot create their own food, they must eat plants or other animals to get the energy that they need.



# Trophic level

- In complex natural communities, organisms whose food is obtained from plants by the same number of steps are said to belong to the same trophic level. (Each successive level of nourishment as represented by the link of the food chain is known as a trophic or nourishment level).

Thus,

- The green plants (i.e. producer level) occupy the first trophic level,
- Plant eaters (i.e. primary consumer level- herbivore) the second level,
- Herbivore eaters (i.e. secondary consumer level-carnivores) occupy the third level and
- Secondary carnivore occupy (i.e. tertiary consumer level) the fourth trophic level.

# TROPIC LEVELS IN FOOD CHAIN

- PRODUCERS

- CONSUMERS

Primary Consumers

Secondary Consumers.

Tertiary Consumers.

Quaternary Consumers.

- DECOMPOSERS





# **TYPES OF FOOD CHAIN**

- Grazing Food Chain.
- Detritus Food Chain.



# GRAZING FOOD CHAIN

- The consumers utilizing plants as their food, constitute grazing food chain.
- This food chain begins from green plants & the primary consumer is herbivore.
- Most of the ecosystem in nature follows this type of food chain.

# Grazing Food Chain

**Flower**  
(producer)



**Caterpillar**  
(consumer)



**Frog**  
(consumer)



**Owl**  
(consumer)



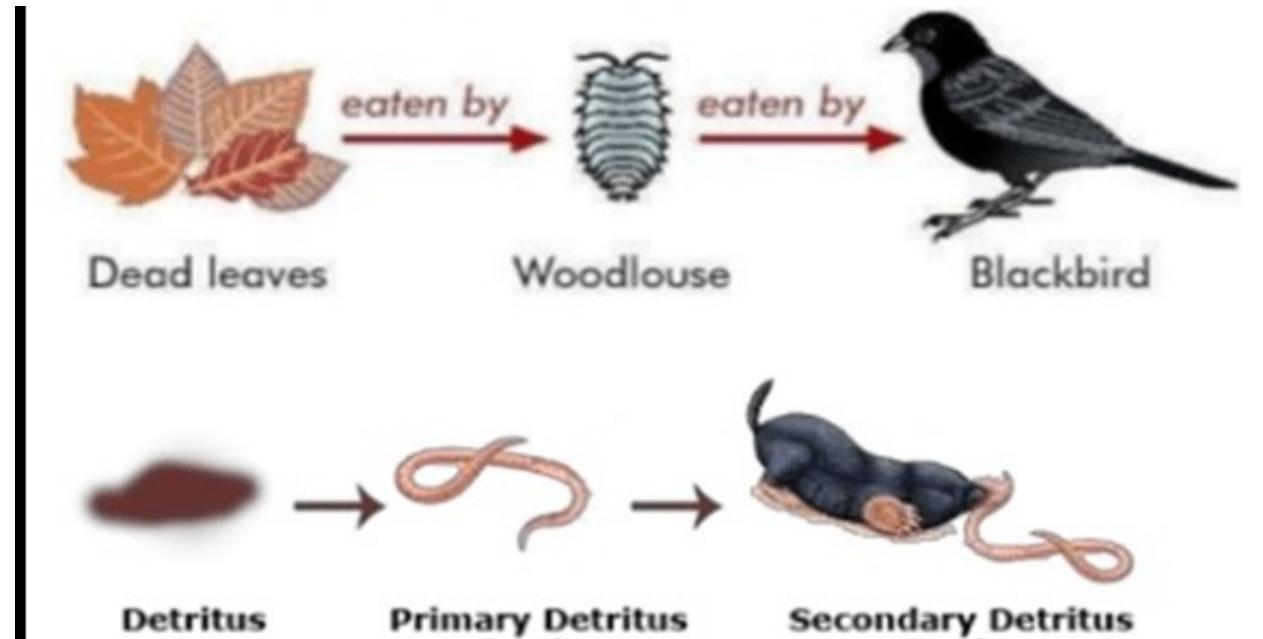
**Snake**  
(consumer)





# DETRITUS FOOD CHAIN

- Ecosystem exhibiting detritus food chain are less dependent on direct solar energy.
- It is shorter than grazing food chain.
- The primary source of energy is organic waste & dead matter obtained from the grazing food chain.
- EX. Dead animals, leaves, plant parts, etc.





# SIGNIFICANCE OF FOOD CHAIN

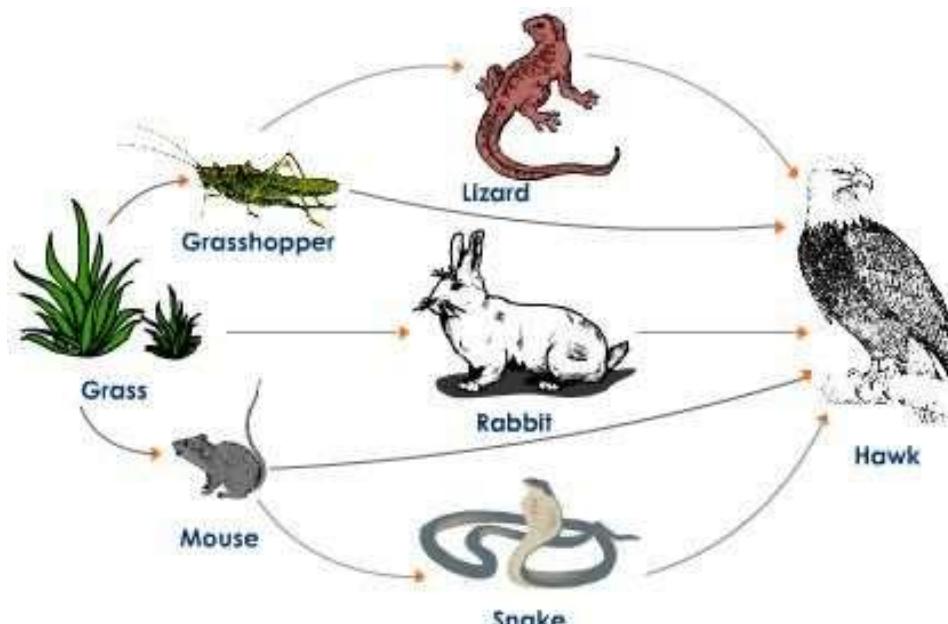
- The knowledge of food chain helps in understanding the feeding relationship as well as the interaction between organism & ecosystem.
- It also help in understanding the mechanism of energy flow & circulation of matter in ecosystem.
- It also helps to understand the movement of toxic substance & the problem associated with biological magnification in the ecosystem.



# FOOD WEB

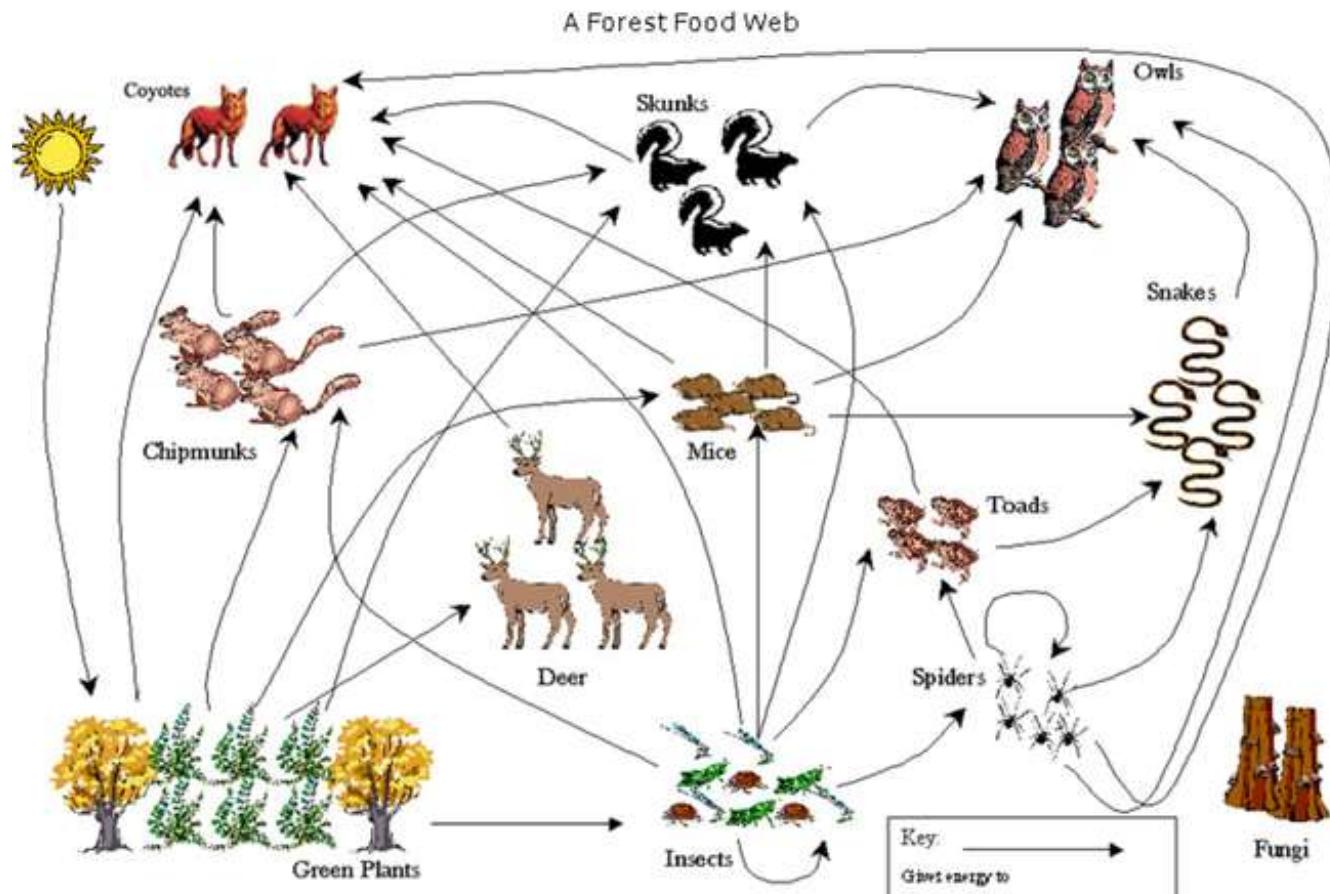
- Food Web can be defined as, “ a network of food chains which are interconnected at various trophic levels, so as to form a number of feeding connections amongst different organisms of a biotic community”.
- It is also known as consumer- resource system.

# FOOD WEB IN GRASSLAND



A Food Web in a Grassland Ecosystem With Five Possible Food Chains

# FOOD WEB IN FOREST





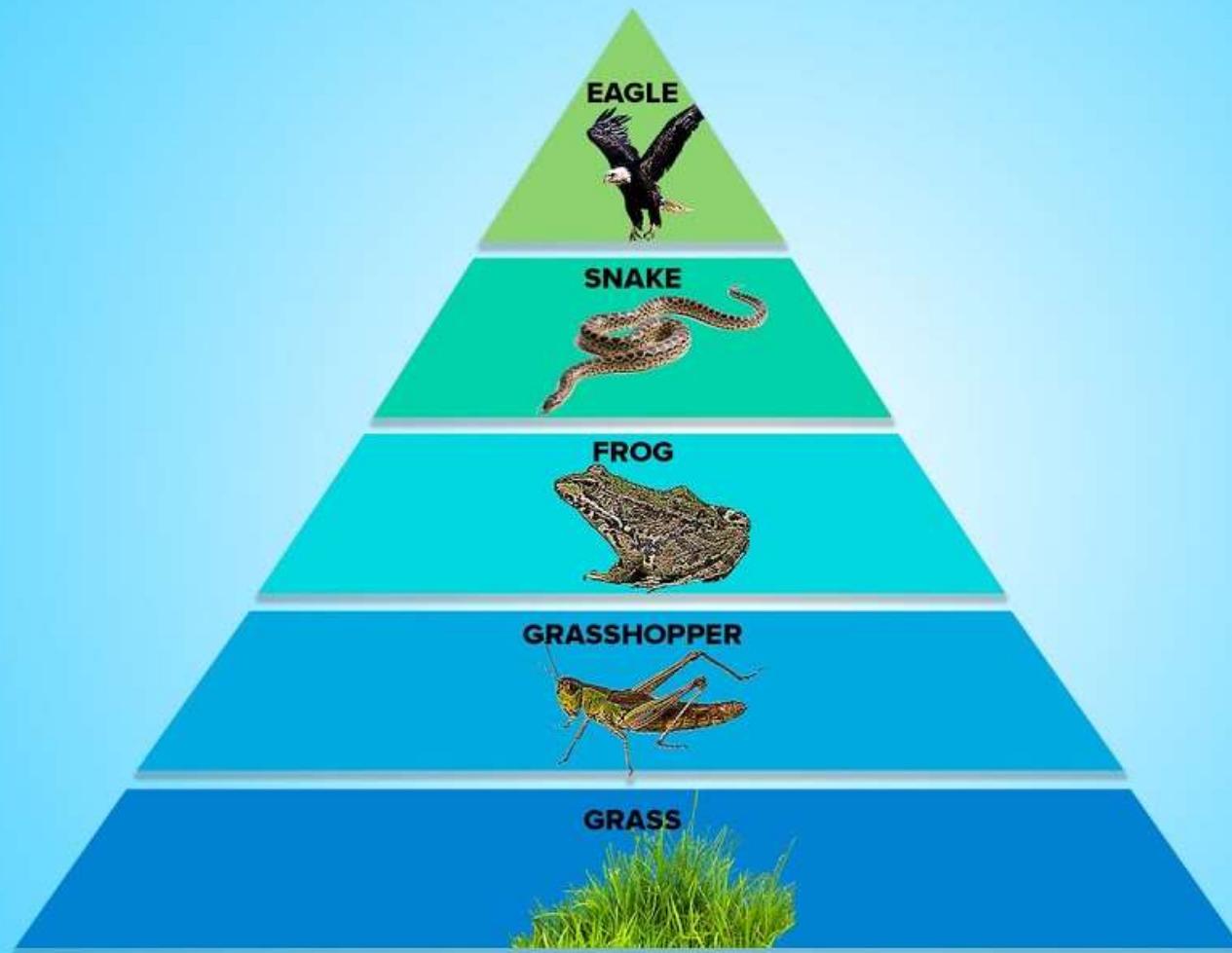
## IMPORTANT FACTS

- A node represents an individual species, or a group of related species or different stages of a single species.
- A link connects two nodes. Arrows represent links, & always go from prey to predator.
- The lowest tropic level are called basal species.
- The highest tropic level are called top predators.
- Movement of nutrients is a cyclic but of energy is unidirectional & non-cyclic.



# ECOLOGICAL PYRAMIDS

# ECOLOGICAL PYRAMID



- Ecological pyramids are graphical representations of the trophic structure of ecosystem.
- Trophic levels are the feeding position in a food chain such as primary producers, herbivore, primary carnivore etc.

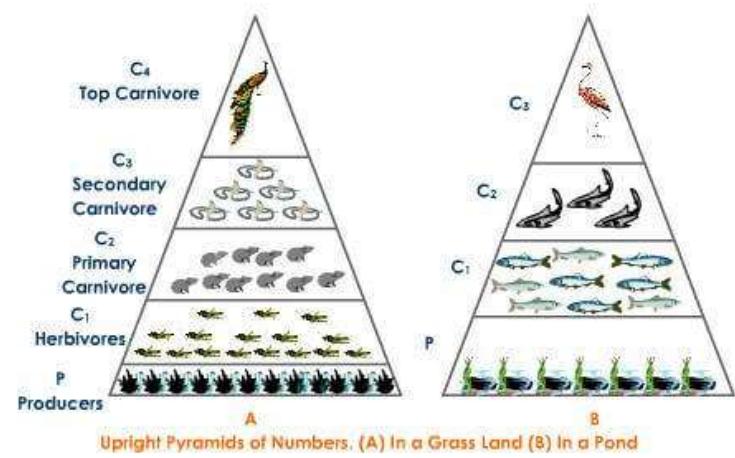


## TYPES OF PYRAMIDS

- Pyramid of Numbers
- Pyramid of Biomass
- Pyramid of Productivity

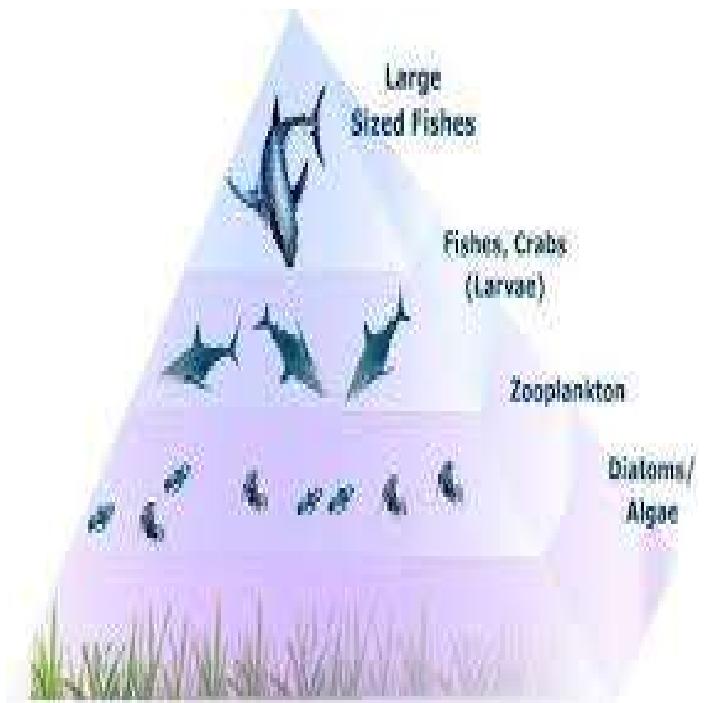
# PYRAMID OF NUMBERS

- It is the graphic representation of individuals /per unit area of various tropic levels.
- Large numbers of producers tend to form the base.
- Lower numbers of top carnivores occupy the tip.



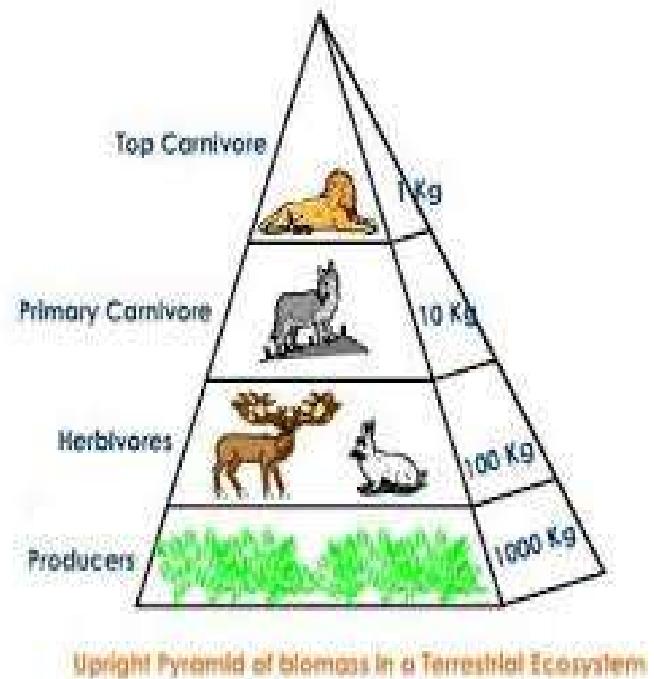
# NUMBER PYRAMID EXAMPLE

- The shape of the pyramid of numbers vary from ecosystem to ecosystem.
- In aquatic ecosystems & grassland communities, autotrophs are present in large numbers per unit area.
- They support a lesser number of herbivores, which in turn support fewer carnivores.



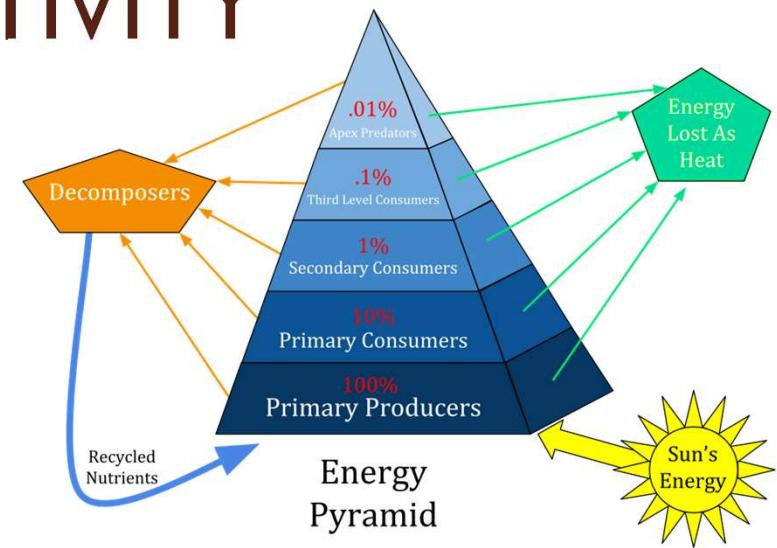
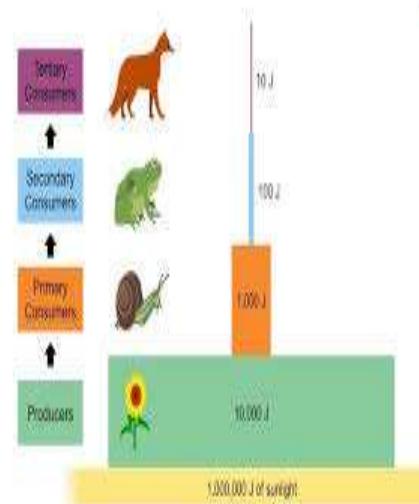
# PRYAMID OF BIOMASS

- Is the graphic representation of biomass present per unit area of different trophic levels, with producers at the base & top carnivores at the tip.
- Biomass is calculated by the mass of each individual X number of individuals at each tropic level.



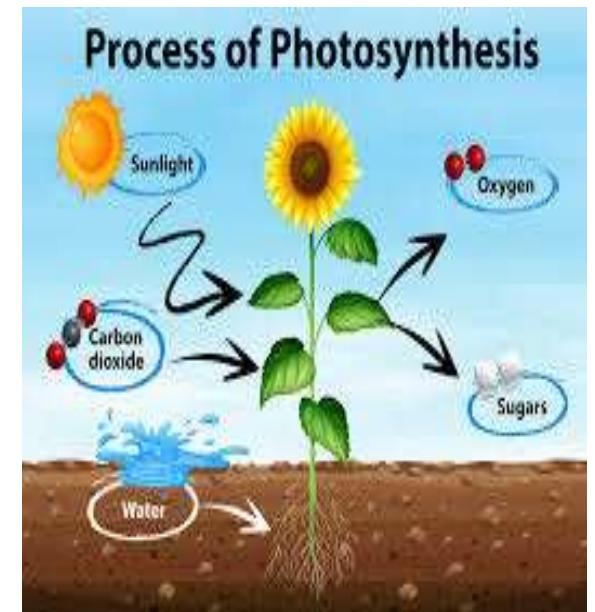
# PYRAMID OF PRODUCTIVITY

- Pyramid of productivity is a graphic representation of the flow of energy through each trophic level of a food chain over a fixed time period.
- The input of solar energy may be indicated as an extra layer at the base.



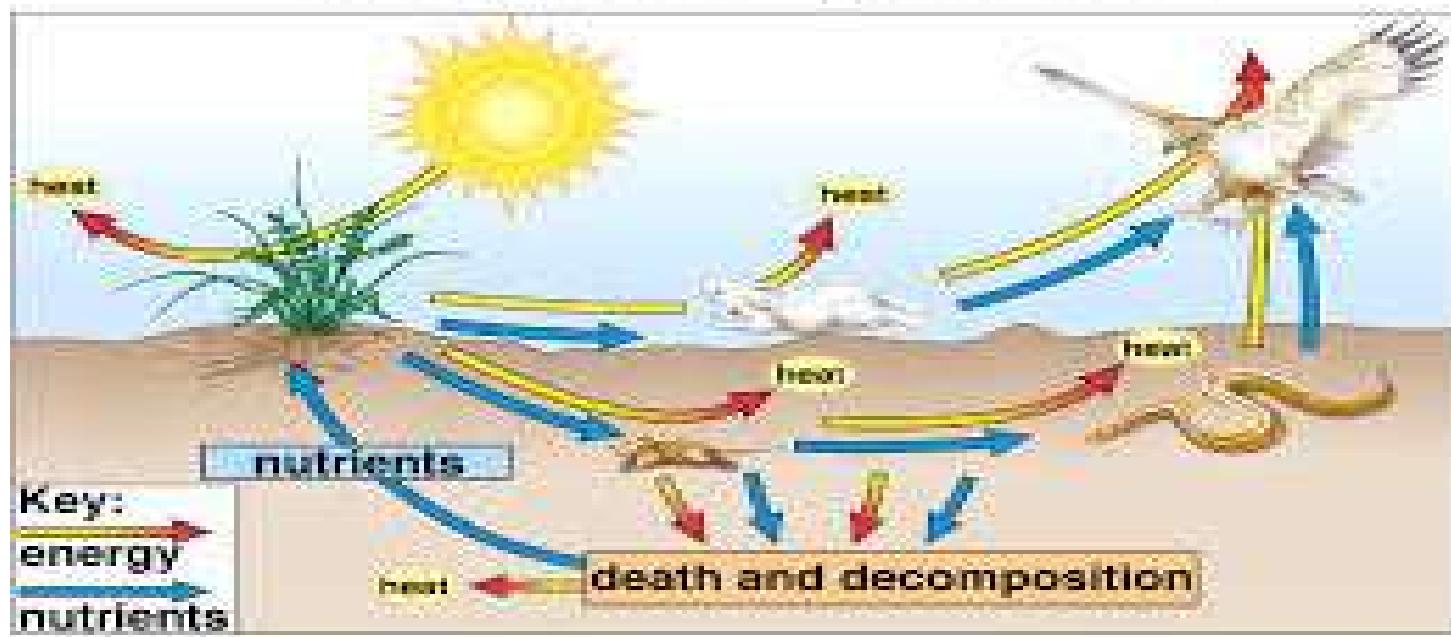
# ENERGY FLOW IN ECOSYSTEM

- Begins with Sun.
- Green plants use water, Carbon dioxide & Sun light to make glucose, through the process of Photosynthesis.



- The flow of energy is the most important factor that controls what kind of organisms live in an ecosystem & how many organisms the ecosystem can support.

## Ecosystem organization





# PRIMARY ENERGY SOURCE

- Most life on earth depends on photosynthetic organisms, which capture sunlight & convert it into chemical energy in organic molecules.
- **These organic molecules are what we call as food.**
- Organisms that make glucose during photosynthesis are called producers, & it includes plants, some kinds of bacteria etc.

# MOVEMENT OF ENERGY THROUGH ECOSYSTEM

- Producers use most of the energy they make for themselves.
- All other organisms in an ecosystem are Consumers.
- Consumers eat plants or other organisms to obtain their energy.





## **TYPES OF FLOW MODELS**

- Single channel Models
- Double channel Models (also called Y shaped Models.)

# SINGLE CHANNEL MODEL

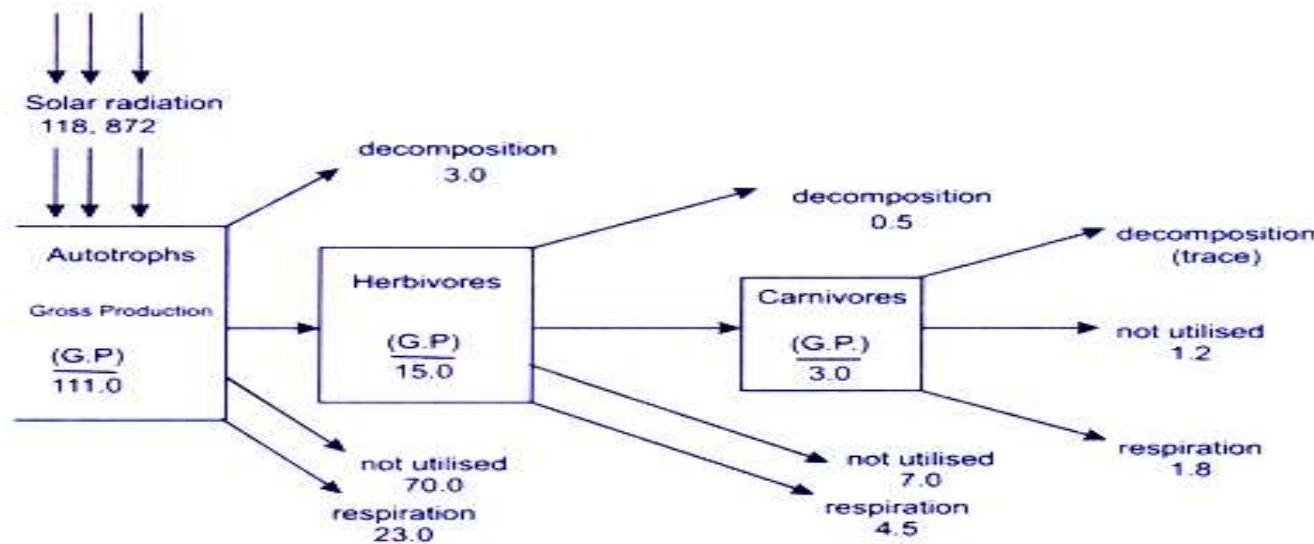


Fig. 1.3 Energy flow diagram for a lake (freshwater ecosystem) in g cal/cm<sup>2</sup>/yr

- This model explains the unidirectional flow of energy.
- Whatever the energy captured by the autotrophs does not revert back to solar input. As it moves progressively through the various trophic levels, it is no longer available to the previous level.
- The system would collapse if the primary source, the sun, were cut off.
- There is a progressive decrease in energy level at each trophic level. So, shorter the food chain, greater would be the available food energy.

# DOUBLE CHANNEL MODEL (Y Shaped model)

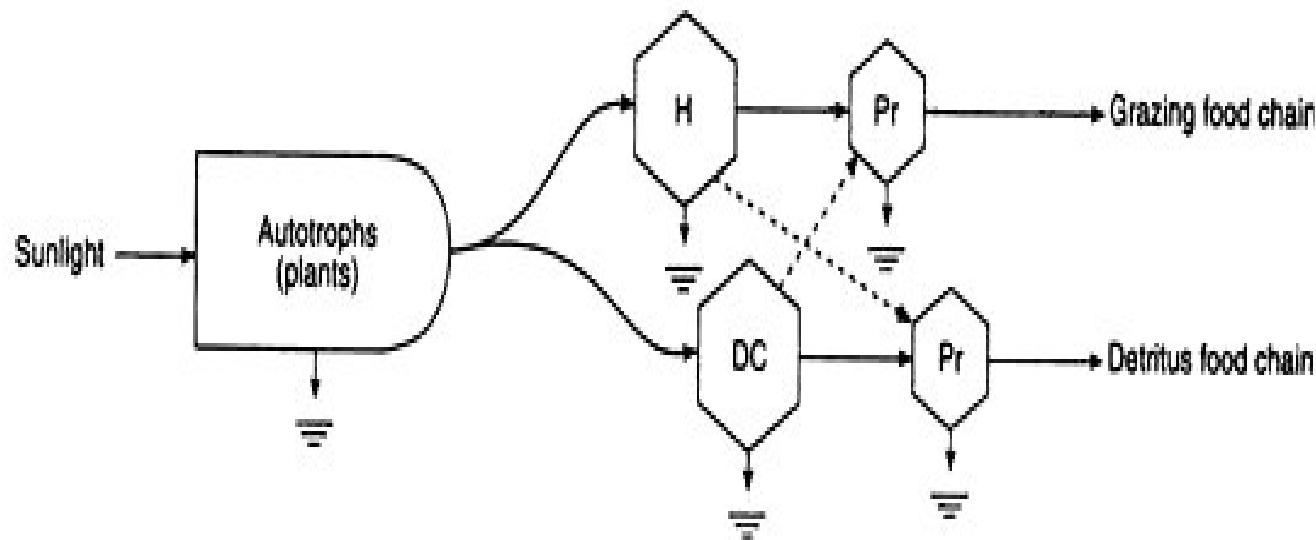


Fig. 4.5 : Y-shaped energy flow model. It shows linkage between grazing and detritus food chain (H = herbivores; DC = detritus consumers; Pr = predators)

- It is applicable to both terrestrial & aquatic ecosystem. In this energy model, one arm represents herbivore food chain & the other arm represents the decomposer (detritus) food chain.
- The primary producers are entirely different for each arms. This model also indicates that two food chains infact, under natural conditions, are not completely isolated from one another.
- It seperates the grazing & detritus food chains in both time & space.
- Micro consumers & macro consumers differ greatly in size & metabolic relations.



# ECOLOGICAL SUCCESSION

## Definition

- **Ecological succession** is the process of change in the species structure of an **ecological** community over time.
- It is a phenomenon or process by which an **ecological** community undergoes more or less orderly and predictable changes.
- The natural process by which the same locality becomes successively colonised by different groups or communities of plants.

- Succession is gradual & sequential replacement of one community by other in an area over a period of time.
- E. P. Odum (1971)- Ecological succession is an orderly process of community change in a unit area.
- It is process of change in species composition in an ecosystem over time.
- In simpler, It is the process of ecosystem development in nature.



# CAUSES OF SUCCESSION

- Initial or initiating causes
- Continuing causes or Ecesis
- Stabilising causes



# INITIAL OR INITIATING CAUSES

- Climatic factors
- Biotic factors
- Erosion
- Deposition



## Continuing causes or Ecesis

- Migration
- Competition
- Reaction
- Edaphic factors



## STABILISING CAUSES

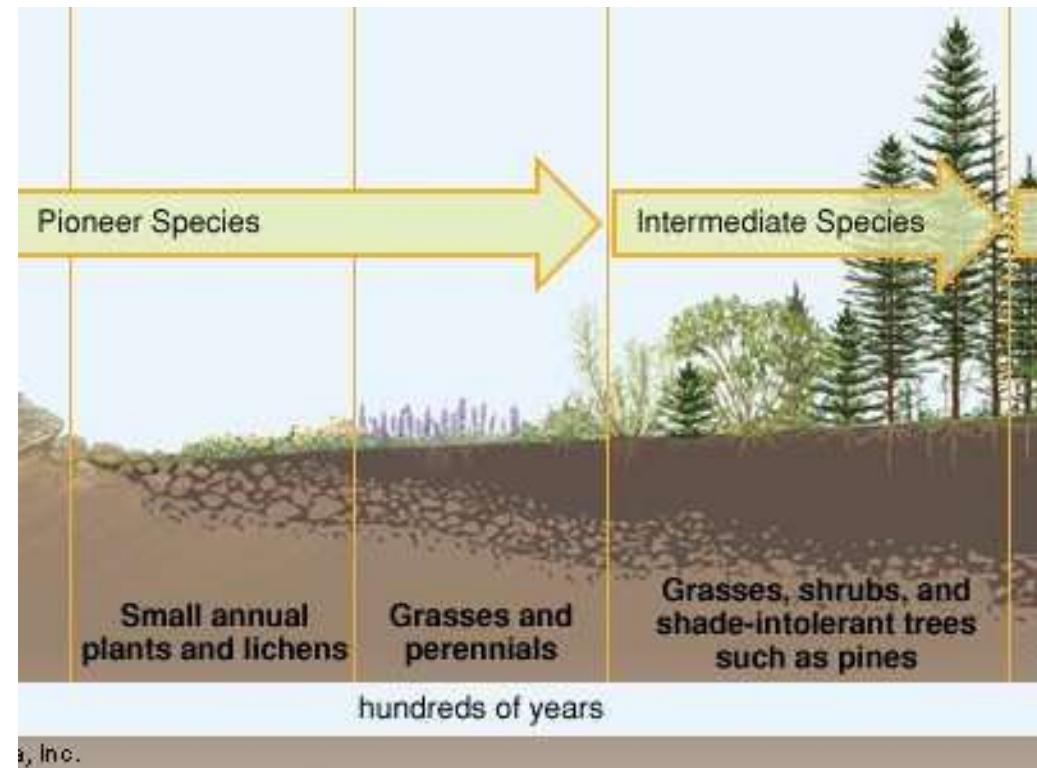
- Climate area
- Continuous changes in kind of plants & animals.
- Increase diversity of species.
- Increase in biomass & organic matter.



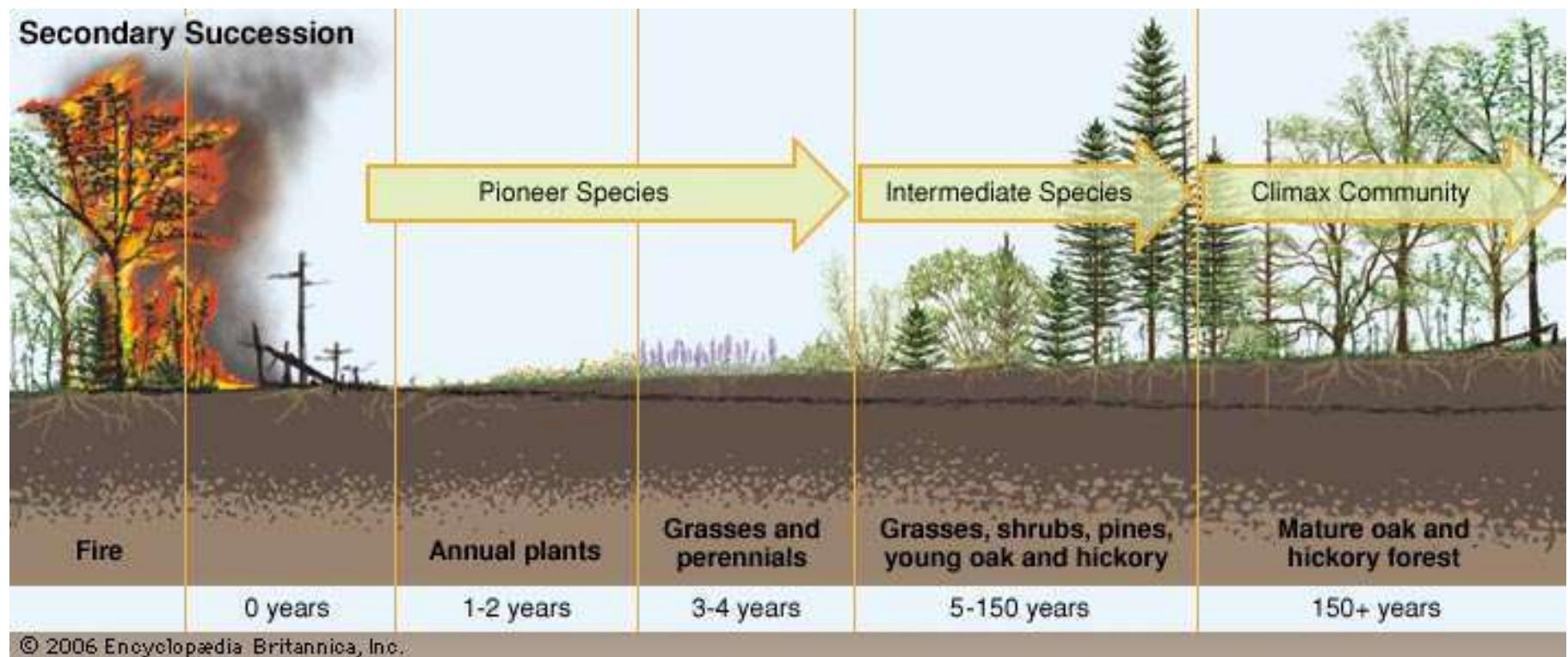
# TYPES OF SUCCESSION

1. Primary Succession
2. Secondary Succession
3. Autogenic Succession
4. Allogenic Succession
5. Autotrophic Succession
6. Hetrotrophic Succession

# I. PRIMARY SUCCESSION



## 2. SECONDARY SUCCESSION





### 3. AUTOGENIC SUCCESSION

- Community itself as result of which its reactions & environment, modifies its own environment.
- Replaced by new communities.

## **4.ALLOGENIC SUCCESSION**

- Allogenic succession occurs as a result of external agencies or changes brought about in the habitat by external forces not by existing community itself.



## 5. AUTOTROPHIC SUCCESSION

- Is characterized by early & continued dominance of autotrophic organisms.
- It begins in a predominantly inorganic environments & the energy flow is maintained indefinitely.
- This is gradual increase in the organic matter content supported by energy flow.



## 6. HETROTROPHIC SUCCESSION

- Is characterized by early dominance of heterotrophic organisms such as bacteria, fungi, animals etc.
- It begins in a medium which is rich in organic matter such as rivers, streams, which are polluted heavily with sewage.



# PROCESS OF SUCCESSION

- Ecological succession is a complex process & it may take thousands of years.
- Fredric Clements (1916) first time proposed the sequential phases of an ecological succession.
  1. Bare area- Topographic, Climatic, Biotic
  2. Invasion- Migration, Establishment, Aggregation.
  3. Competition & co-action
  4. Reaction
  5. Stabilization



## I. Formation of Bare area

- It is the first step in ecological succession.
- Causes are

Topographic- Sand deposit, Soil erosion, Landslide etc.

Climatic- Glaciers, Dry Period, Storm etc.

Biotic- Forest destruction, Agricultural epidemics

*A bare area formed by land-slide*





## 2. INVASION

- Invasion is the successful establishment of a species in the bare area.
- It is the second step in ecological succession.
- A new species reaches the newly created bare area & they try to establish there.
- The process of invasion is completed in THREE steps

Migration (Dispersal)

Ecesis (Establishment)

Aggregation.

*Lichens (pioneer community) colonized on a rock surface*



*Image source: cc Wikipedia*



### 3. COMPETITION & CO-ACTION

- Aggregation result in the increase of the number of species within a limited space.
- Competition & co- action results the survival of fit individuals & the elimination of unfit individuals from the ecosystem.
- A species with the wide reproductive capacity & ecological amplitude only will survive.

*Intra-specific Competition*



*Inter-specific Competition*



Ecological Competitions



## 4. REACTION

- It is the modification of the environment through the influence of living organism present on it.
- Reaction cause change in soil, water, light & temperature of area.
- Due to these modifications, the present community becomes unsuitable for the existing environmental conditions.
- Such communities will be quickly replaced by another community.



## 5. STABILIZATION

- It is the last stage in ecological succession.
- The final or terminal community becomes more or less stabilized for longer period of time.
- The community can maintain equilibrium with climate of area.
- This final community is called the “Climax Community”.
- The climax community is not immediately replaced by other communities.
- Example- Forest, Grassland.

## Climax Communities



*Forest*



*Desert*



*Grassland*



*Coral Reef*



# MAJOR ECOSYSTEMS IN THE WORLD



# Earth's Major Biomes

- **Biome**
  - A large, relatively distinct terrestrial region with a similar climate soil, plants, and animals, regardless of where it occurs in the world.
- **Location of each biome is primarily determined by:**
  - Temperature (varies with both latitude and elevation)
  - Precipitation
- **Biomes can also be defined by**
  - Winds, rapid temperature changes, fires, floods, etc.

- 
- 1. Forest Ecosystem**
  - 2. Grassland Ecosystem**
  - 3. Desert Ecosystem**
  - 4. Aquatic Ecosystem**



# I. FOREST ECOSYSTEMS

- A. Boreal coniferous forest.
- B. Temperature deciduous forest.
- C. Temperature evergreen forest
- D. Tropical rain forest



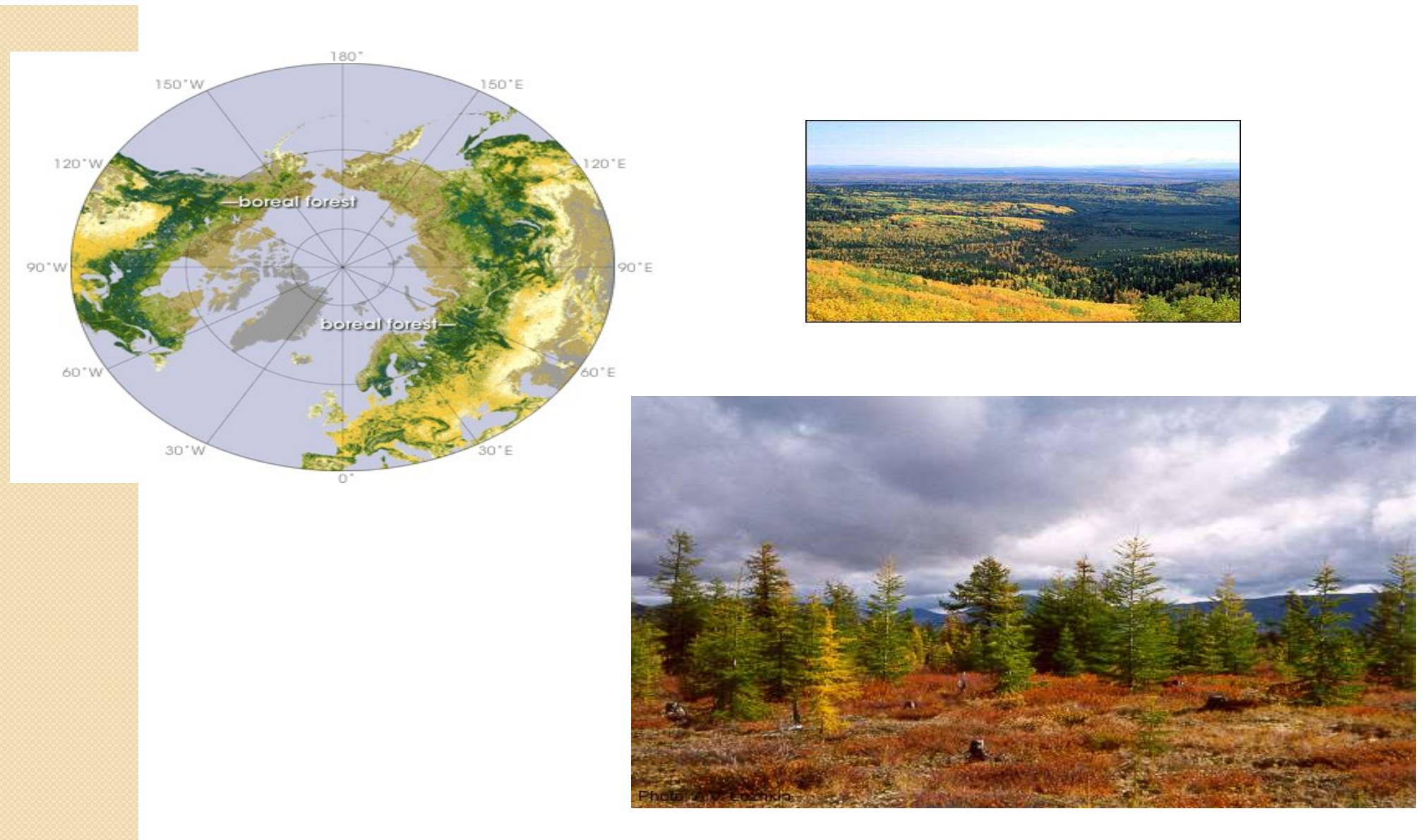
## A. BOREAL CONIFEROUS FOREST.

- A region of coniferous forests in the northern hemisphere
- Covers 11% of earth's land.
- Growing Season
  - A little longer than tundra
- Precipitation
  - ~ 50 cm/yr.

# Boreal Forests

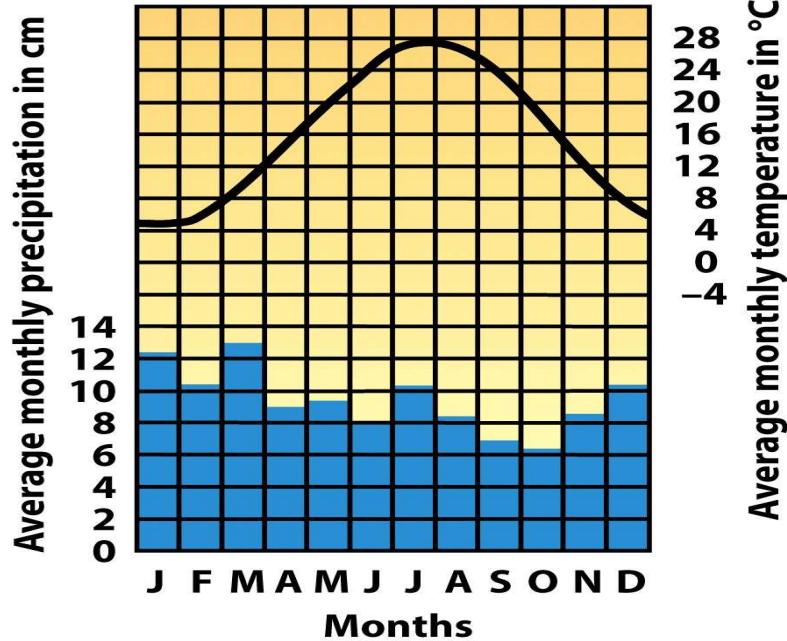
- Soils are acidic and mineral poor
- Vegetation comprises of drought resistant conifers  
White spruce,  
Balsam fir,  
Eastern larch
- Mostly characterized with small animals & migrating birds
- Some large animals are present, Wolves, bear, moose





## B. TEMPERATURE DECIDUOUS FORESTS

- Forest biome that occurs in temperate areas with a moderate amount of precipitation
- Precipitation
  - 75-150 cm/yr
- Temperature
  - Seasonality
    - Hot summers and cold winters





*Copyright G Dan Mitchell*

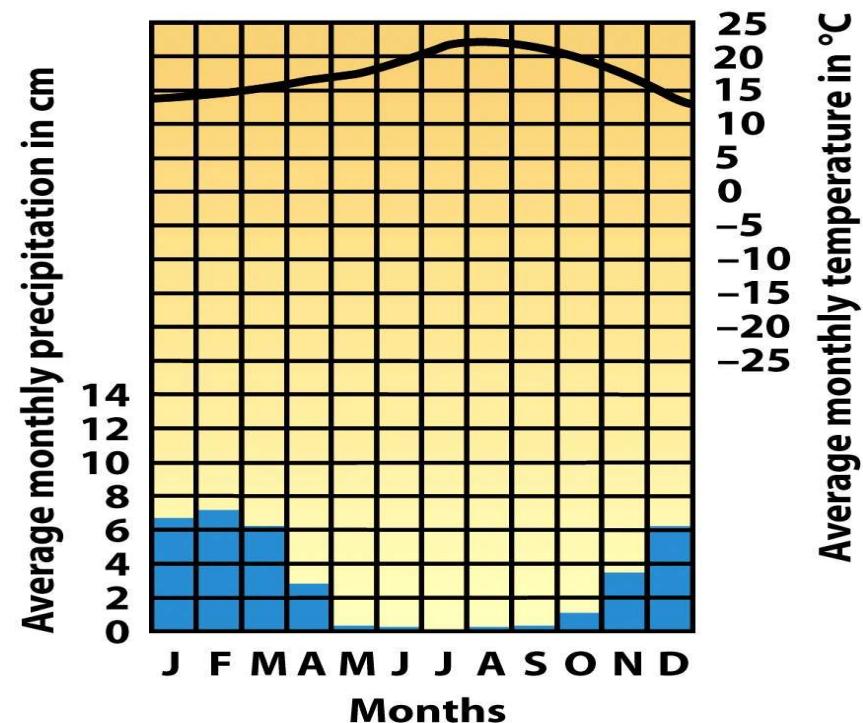
# Temperate Deciduous Forest

- Top soil is rich in organic material and underlain by clay
- Vegetation is primarily deciduous.  
Oak, maple, beech.
- Animals  
Deer, Bear, & Small animals.
- Most of the biome land area has been generated after farming & timber harvest



# C. TEMPERATURE EVERGREEN FOREST

- Also called a Mediterranean Climate
  - Ex: Southern California
  - Ex: Greece
- Temperature
  - Mild, moist winters
  - Hot, dry summers
- Frequent fires

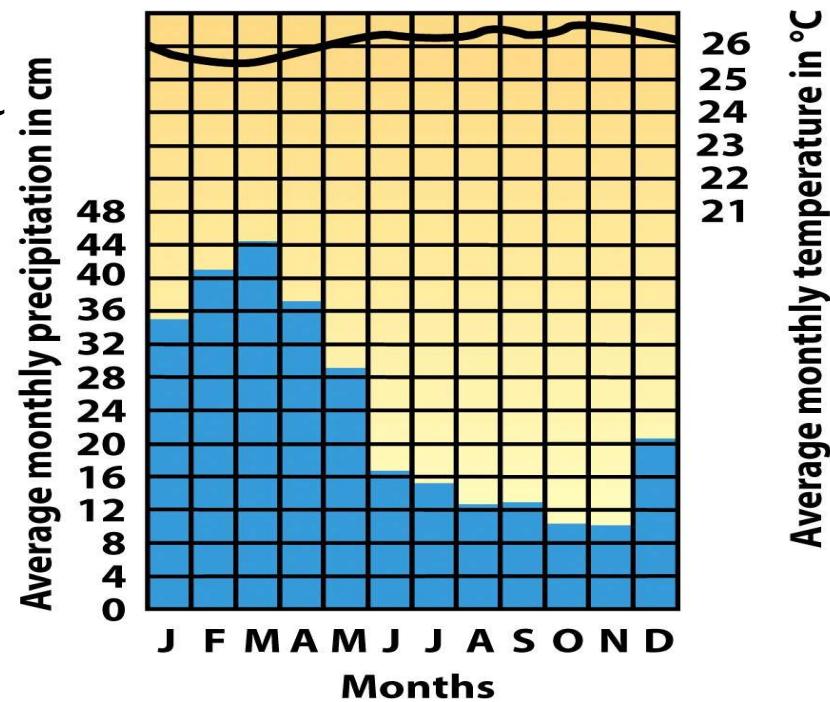




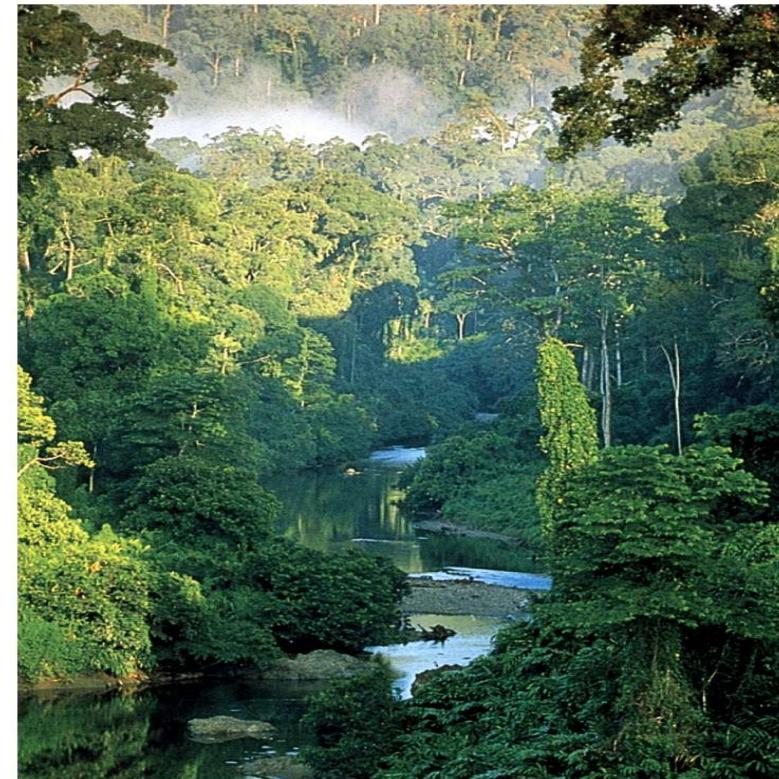
- Soil is thin and often not fertile
- Vegetation
  - Dense growth of evergreen shrubs
  - Lush during the growing season
- Animals
  - Mule deer, chipmunks, many species of birds

## D.TROPICAL RAINFOREST

- Lush, species-rich biome that occurs where climate is warm and moist throughout the year
- Precipitation
  - 200-450 cm/yr
- Very productive biome
- Most species-rich biome

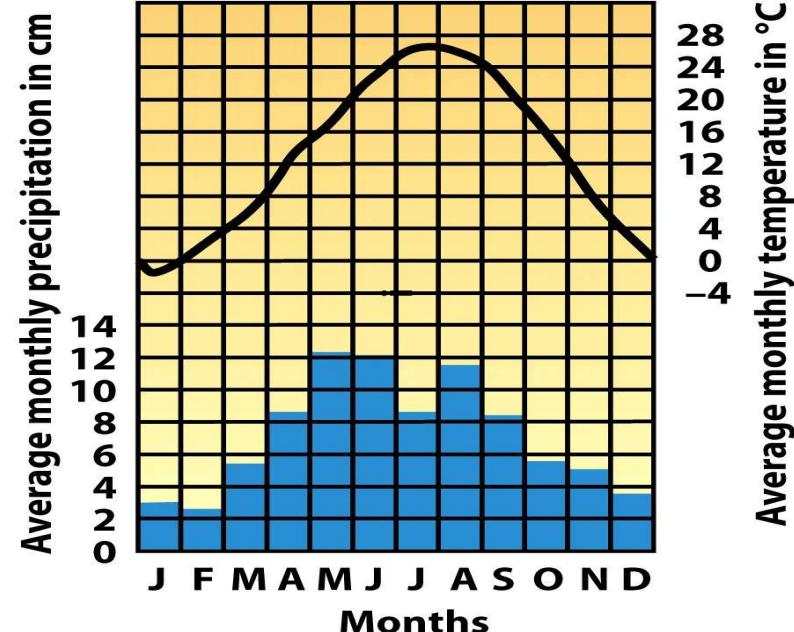


- Ancient, weathered, nutrient-poor soil
  - Nutrients tied up in vegetation, not soil
- Vegetation
  - 3 distinct canopy layers
- Animals
  - Most abundant insect, reptiles and amphibians on earth



## 2. GRASSLAND

- Grasslands with hot summers, cold winters and too little precipitation to support trees
- Precipitation
  - 25-75 cm/yr
- Tall grass prairies
- Short grass prairies
- 90% of this biome has been lost to farmland





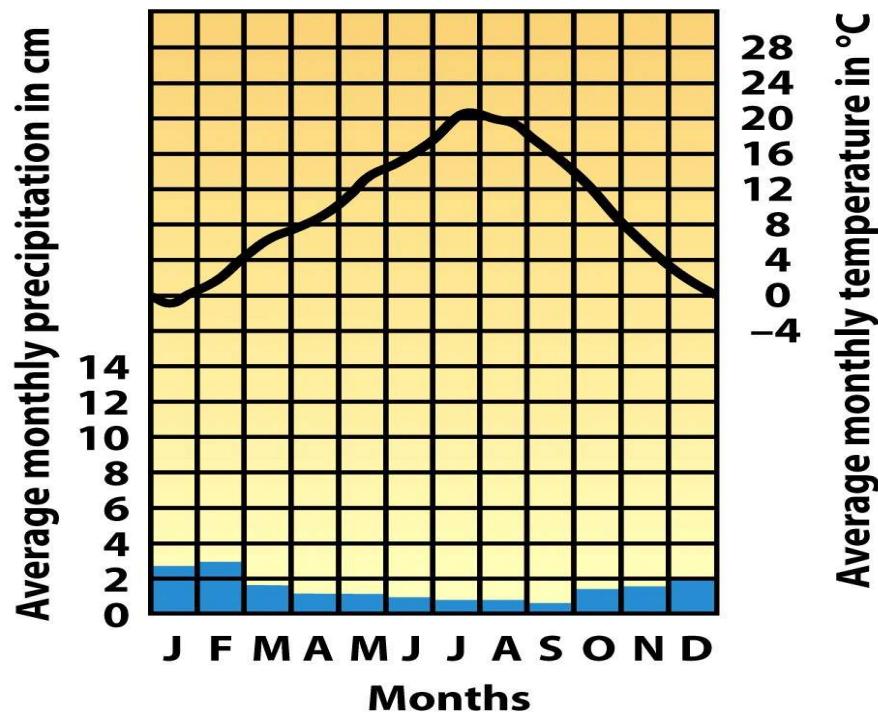
# Grassland

- Soil has thick, organic material rich organic horizon.
- Periodic fires keep the dominant vegetation
- Grassland is also known as prairies & savannas
- 25% of the Earth is covered by grassland ecosystem
- There is a grassland on each continent with the exception of Antarctica.
- Types of Grassland- Tropical & Temperate.



# 3. DESERTS

- Biome where lack of precipitation limits plant growth
- Temperature
  - Can vary greatly in 24-hr period as well as yearly (based on location)
- Precipitation
  - < 25 cm/yr



- Soils low in nutrients, high in salts
- Vegetation sparse
  - cactus and sagebrush
- Animals are very small to regulate temperature

Sonoran Desert

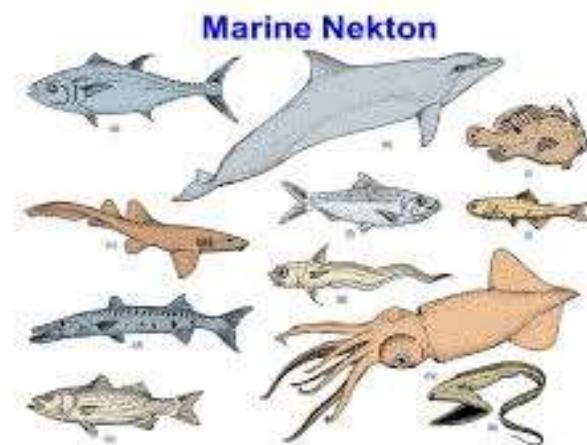


- Deserts covers about 20% of the earth.
- Sahara is largest desert of 300 million square miles.
- The plants that are able to grow in the desert biome store water in their stem. They normally grow spaced out so that their roots can extend & find water.
- Cacti have many adaption's to survive in the desert. Their spines protect them from being eaten by animals & their waxy outer covering keep moisture from escaping.
- The desert ecosystem can be found on every continent except Europe.



# 4. AQUATIC ECOSYSTEM

- Fundamental Division
  - Freshwater
  - Saltwater
- Aquatic Ecosystem is also affected by
  - Dissolved oxygen level, light penetration, pH, presence/absence of currents
- Three main ecological categories of organisms
  - Plankton- free floating
  - Nekton- strong swimming
  - Benthos- bottom dwelling





# Freshwater Ecosystems

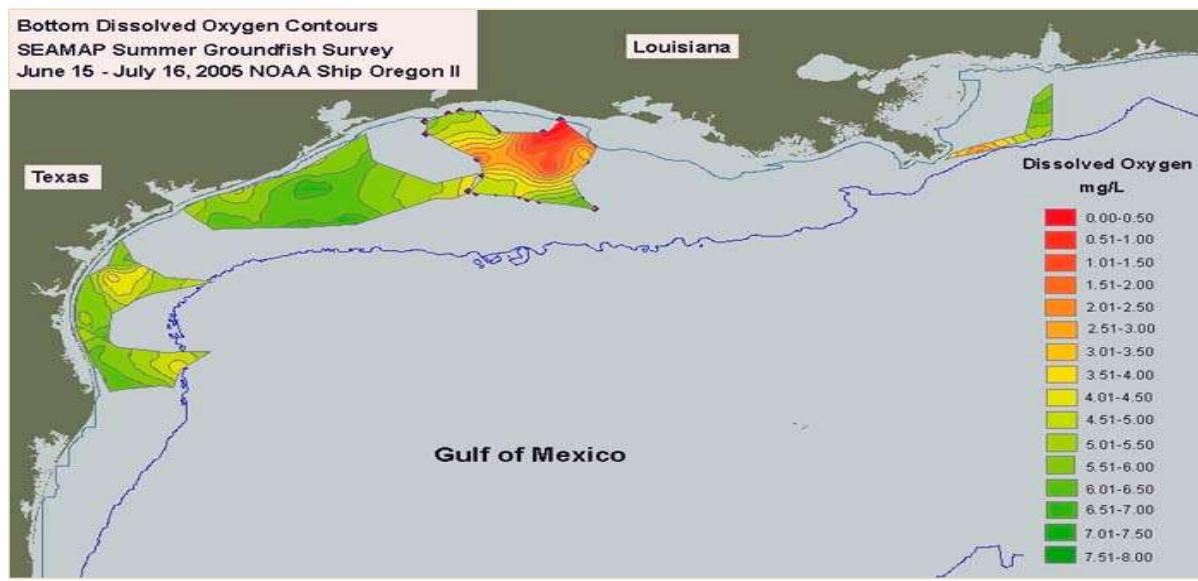
- Includes:
  - Rivers and streams
  - Lakes and ponds
  - Marshes and swamps
- Represent 2% of earth's surface
- Assist in recycling water back to the oceans (Biogeochemical Cycling)



# Rivers and Streams

- Rivers & streams provide a “lotic” habitat for communities.
- They possess definite & continuous water current.
- A **Lotic Ecosystem** has flowing waters. **Examples** include: creeks, streams, runs, rivers, springs, brooks and channels.
- A **Lentic Ecosystem** has still waters. **Examples** include: ponds, basin marshes, ditches, reservoirs, seeps, lakes, and vernal / ephemeral pools.

# Estuaries



# ESTUARIES

- Where freshwater and saltwater mix
- Highly variable environment
  - Temperature, salinity, depth of light penetration
- Highly productive
- Nutrients transported from land.
- Tidal action promotes rapid circulation of Nutrients.
- High level of light penetrates shallow water.
- Many plants provide photosynthetic carpet





# CORAL REEF

- a ridge of rock in the sea formed by the growth and deposit of coral.
- coral reef is part of the ocean biome.
- A coral reef biome is found in a shallow area of clear water within the ocean.
- The temperature in this biome is usually from 70 degrees to 85 degrees.



- It is located in a shallow, clear portion of the ocean in mostly tropical areas. These areas include the coats of East Africa, South India, Australia, Florida, Brazil.
- The great Barrier Reef is the largest coral reef ecosystem & is located in Australia.
- The Great Barrier Reef covers more than 1200 miles & contains 400 species of coral.