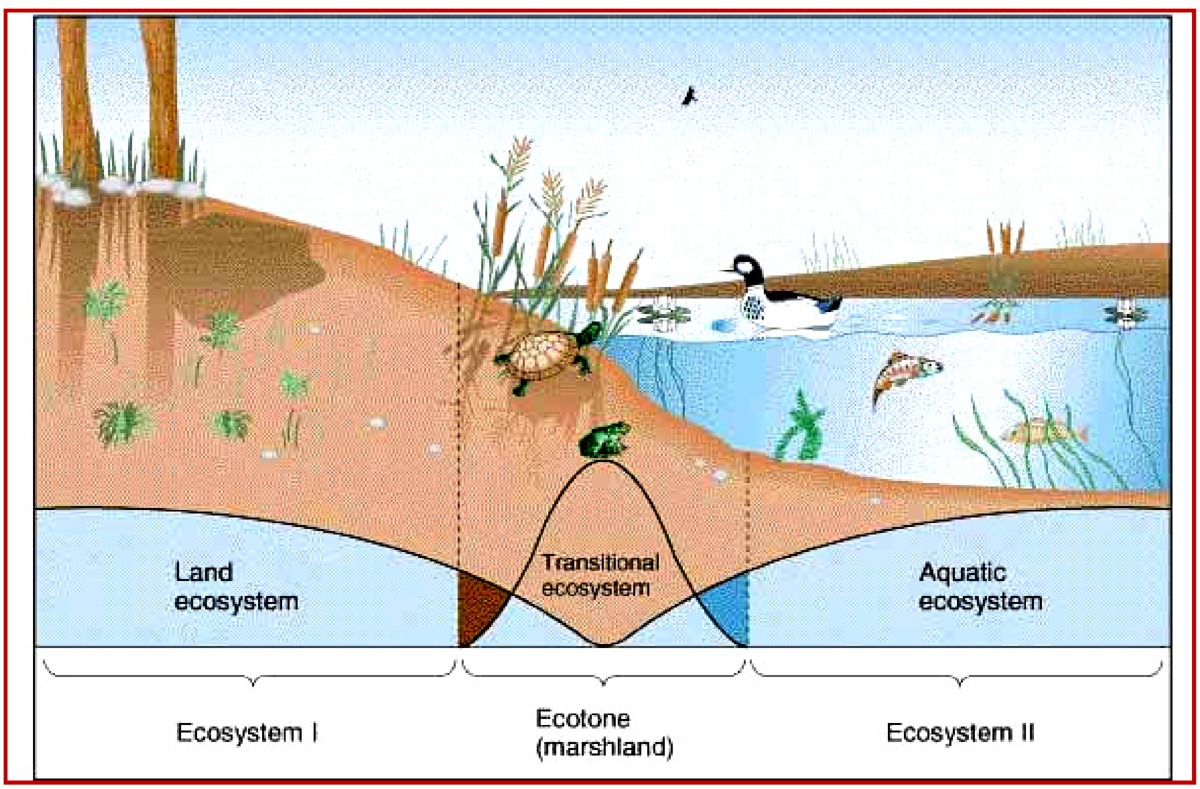
Ecotone

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

The word ecotone was coined from a combination of *ecology* plus -*tone*, from the Greek *tonos* or tension – in other words, a place where ecologies are in tension.



Features

There are several distinguishing features of an ecotone. **First,** an ecotone can have a sharp vegetation transition, with a distinct line between two communities.[For example, a change in colors of grasses or plant life can indicate an ecotone.

Second, a change in physiognomyal appearance of a plant species) can be a key indicator. Water bodies, such as estuaries, can also have a region of transition, and the boundary is characterized by the differences in heights of the macrophytes or plant species present in the areas because this distinguishes the two areas' accessibility to light.[Scientists look at color variations and changes in plant height.

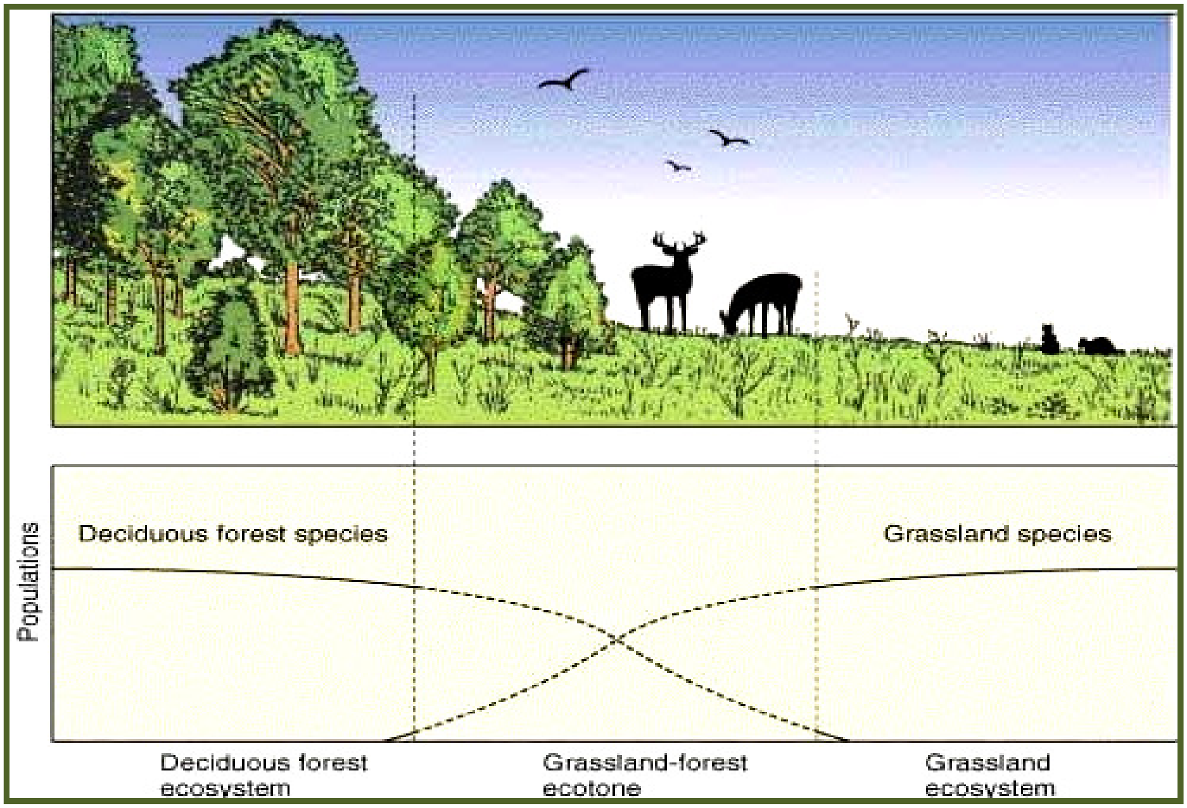
Third, a change of species can signal an ecotone. There will be specific organisms on one side of an ecotone or the other.

Other factors can illustrate or obscure an ecotone, for example, migration and the establishment of new plants. These are known as spatial mass effects, which are noticeable because some organisms will not be able to form self-sustaining populations if they cross the ecotone. If different species can survive in both communities of the two biomes, then the ecotone is considered to have species richness; ecologists measure this when studying the food chain and success of organisms. Lastly, the abundance of introduced species in an ecotone can reveal the type of biome or efficiency of the two communities sharing space. Because an ecotone is the zone in which two communities integrate, many different forms of life have to live together and compete for space. Therefore, an ecotone can create a diverse ecosystem.

Formation

Changes in the physical environment may produce a sharp boundary, as in the example of the interface between areas of forest and cleared land. Changes in the physical environment may produce a sharp boundary, as in the example of the interface between areas of forest and cleared land. Mountain ranges often create such ecotones, due to the wide variety of climatic conditions experienced on their slopes. They may also provide a boundary between species due to the obstructive nature of their terrain. Mont Ventoux in France is a good example, marking the boundary between the flora and fauna of northern and southern France. .[Most wetlands are ecotones. The spatial variation of ecotones often form due to disturbances, creating patches that separate patches of vegetation. Different intensity of disturbances can cause landslides, land shifts, or movement of sediment that can create these vegetation patches and ecotones.[

Plants in competition extend themselves on one side of the ecotone as far as their ability to maintain themselves allows. . Beyond this competitors of the adjacent community take over.
As a result, the ecotone represents a shift in dominance.
Ecotones are particularly significant for mobile animals, as they can exploit more than one set of habitats within a short distance.
The ecotone contains not only species common to the communities on both sides; it may also include a number of highly adaptable species that tend to colonize such transitional areas The phenomenon of increased variety of plants as well as animals at the community junction is called the edge effect and is essentially due to a locally broader range of suitable environmental conditions or ecological niches.



Characteristics of Ecotone

It may be narrow (between grassland and forest) or wide (between forest and desert).

It has **conditions intermediate** to the adjacent ecosystems. Hence it is a **zone of tension**.Usually, the number and the population density of the species of an outgoing community decreases as we move away from the community or ecosystem.

A well-developed ecotone contains some organisms which are entirely different from that of the adjoining communities.

Edge Effect – Edge Species

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

Ecocline

Ecocline is a zone of gradual but continuous change from one ecosystem to another when there is no sharp boundary between the two in terms of species composition.Ecocline occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).

Ecotones and ecoclines

An ecotone is often associated with an ecocline: a "physical transition zone" between two systems. The ecotone and ecocline concepts are sometimes confused: an ecocline can signal an ecotone chemically (ex: pH or salinity gradient), or microclimatically (hydrothermal gradient) between two ecosystems.

In contrast:

•an ecocline is a variation of the physicochemical environment dependent of one or two physico-chemical factors of life, and thus presence/absence of certain species.[9] An ecocline can be a thermocline, chemocline (chemical gradient), halocline (salinity gradient) or pycnocline (variations in density of water induced by temperature or salinity).

•ecocline transitions are less distinct (less clear-cut), have more stable conditions within, hence a higher plant species richness.

•an ecotone describes a variation in species prevalence and is often not strictly dependent on a major physical factor separating one ecosystem from another, with resulting habitat variability. An ecotone is often unobtrusive and harder to measure.

•an ecotone is the area where two communities interact. Ecotones can be easily identified by distinct change in soil gradient and soil composition between two communities.

•ecotone transitions are more clear-cut (distinct), conditions are less stable, hence they have a low species richness.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

REFERENCES:(Ecotone)

https://www.pmfias.com/ecological-niche-ecotone-edge-effect/

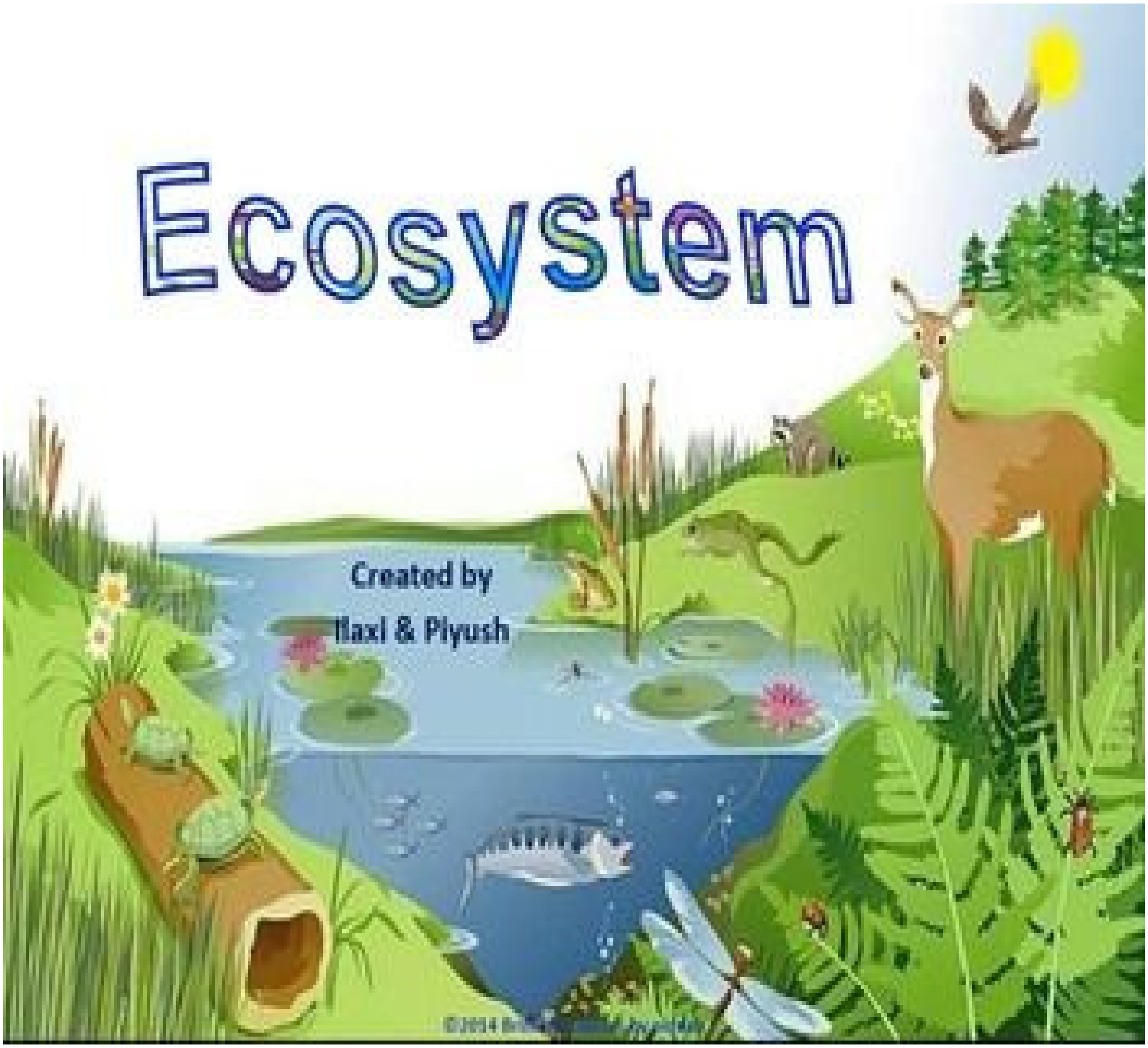
https://en.wikipedia.org/wiki/Ecotone

https://www.researchgate.net/publication/285400648_Ecotone

FOR FURTER READING:

https://www.researchgate.net/publication/278647088_Ecotones_and_Ecological_Gradients

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



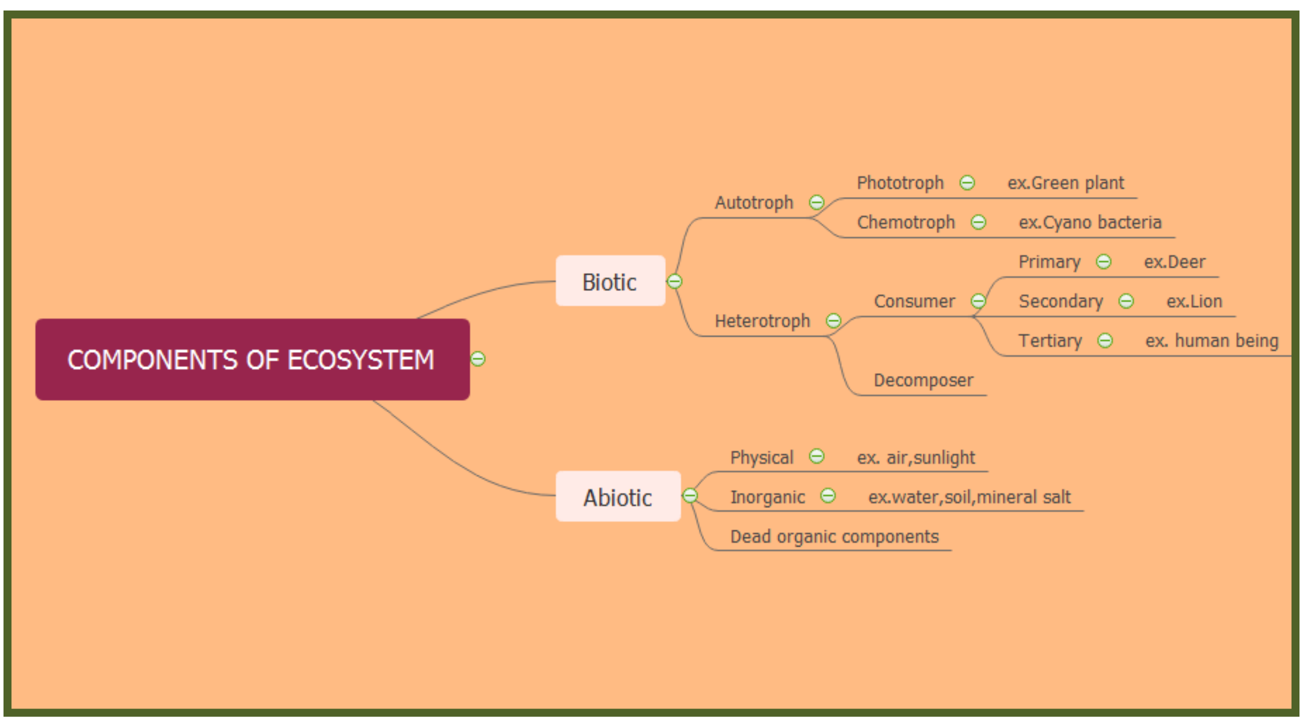
The Ecosystem

An ecosystem is a unit of nature and the focus of study in ecology. It consists of all the biotic and abiotic factors in an area and their interactions. Ecosystems can vary in size.

A lake could be considered an ecosystem. So could a dead log on a forest floor. Both the lake and log contain a variety of species that interact with each other and with abiotic factors.

When it comes to energy, ecosystems are not closed. They need constant inputs of energy. Most ecosystems get energy from sunlight. A small minority get energy from chemical compounds.

Unlike energy, matter is not constantly added to ecosystems. Instead, it is recycled. Water and elements such as carbon and nitrogen are used over and over again.



Producers

Producers are organisms that produce food for themselves and other organisms. They use energy and simple inorganic molecules to make organic compounds. The stability of producers is vital to ecosystems because all organisms need organic molecules.

Producers are also called autotrophs. There are two basic types of autotrophs:

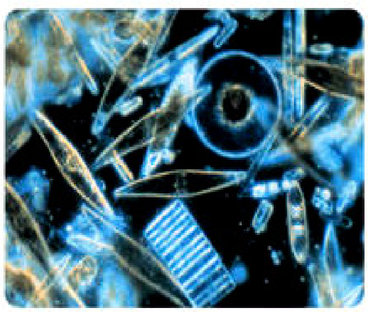
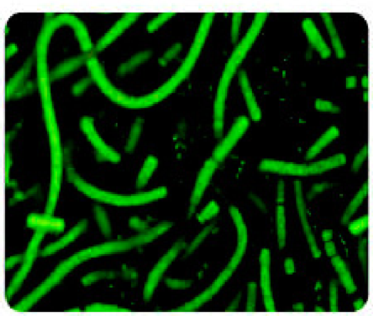
photoautotrophs and

chemoautotrophs.

Photoautotrophs use energy from sunlight to make food by photosynthesis. They include plants, algae, and certain bacteria (see **Figure** below).

Chemoautotrophs use energy from chemical compounds to make food by chemosynthesis. They include some bacteria and also archaea. Archaea are microorganisms that resemble bacteria.

Photoautotrophs and Ecosystems Where They are Found

Type of Photoautotroph	Examples		Type of Ecosystem(s)
Plants	 Trees	 Grasses	Terrestrial
Algae	 Diatoms	 Seaweed	Aquatic
Bacteria	 Cyanobacteria	 Purple Bacteria	Aquatic Terrestrial

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Consumers

Consumers are organisms that depend on other organisms for food. They take in organic molecules by essentially “eating” other living things. They include all animals and fungi. (Fungi don't really “eat”; they absorb nutrients from other organisms.)They also include many bacteria and even a few plants, such as the pitcher plant . Consumers are also called heterotrophs. Heterotrophs are classified by what they eat:

Herbivores consume producers such as plants or algae. They are a necessary link between producers and other consumers. Examples include deer, rabbits, and mice.

Carnivores consume animals. Examples include lions, polar bears, hawks, frogs, salmon, and spiders. Carnivores that are unable to digest plants and must eat only animals are called obligate carnivores. Other carnivores can digest plants but do not commonly eat them.

Omnivores consume both plants and animals. They include humans, pigs, brown bears, gulls, crows, and some species of fish.

Decomposers

When organisms die, they leave behind energy and matter in their remains. **Decomposers** break down the remains and other wastes and release simple inorganic molecules back to the environment. Producers can then use the molecules to make new organic compounds. The stability of decomposers is essential to every ecosystem. Decomposers are classified by the type of organic matter they break down:

Scavengers consume the soft tissues of dead animals. Examples of scavengers include vultures, raccoons, and blowflies.

Detritivores consume **detritus**—the dead leaves, animal feces, and other organic debris that collects on the soil or at the bottom of a body of water. On land, detritivores include earthworms, millipedes, and dung beetles (see **Figure** below). In water, detritivores include "bottom feeders" such as sea cucumbers and catfish.

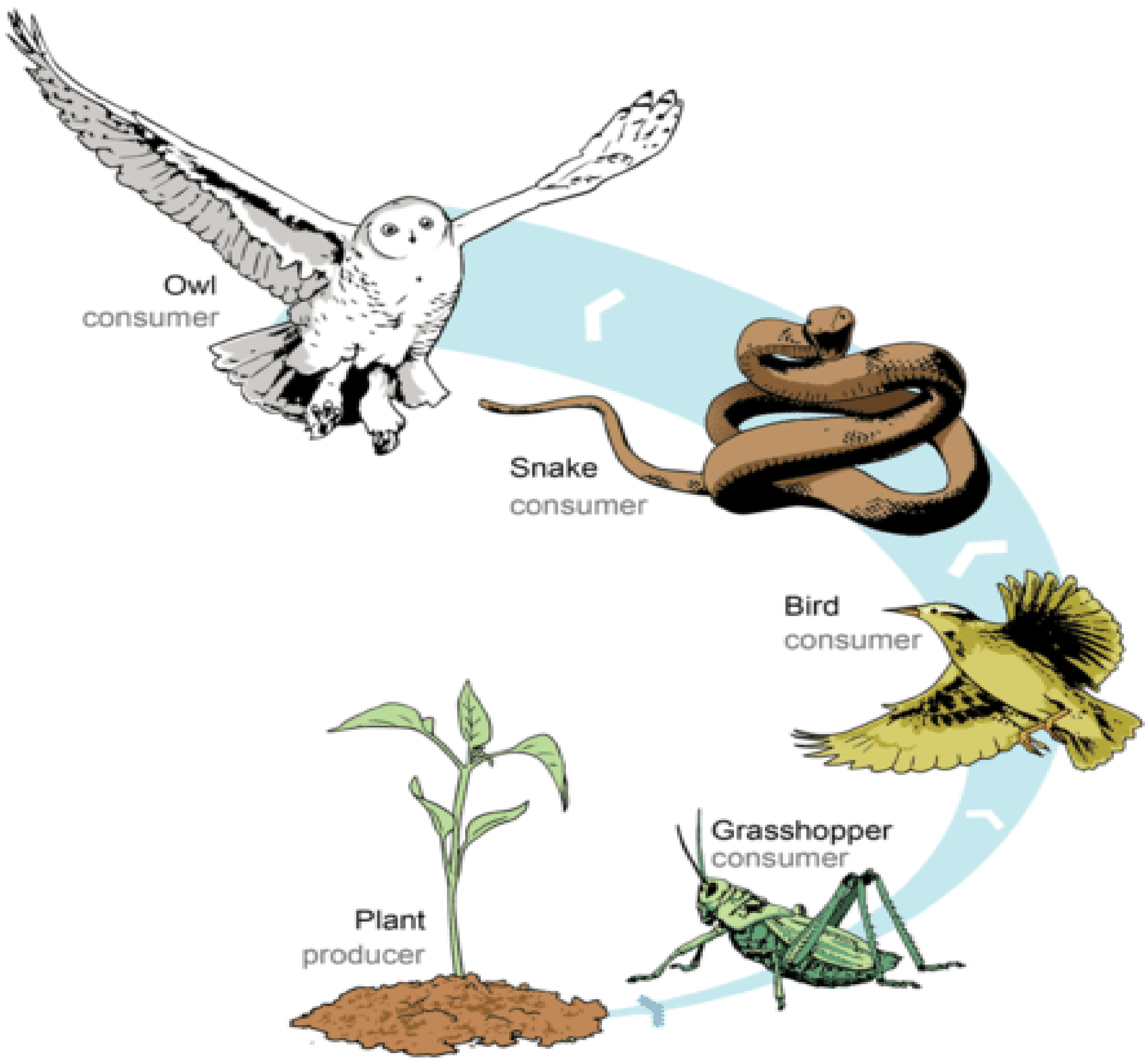
Saprotrophs are the final step in decomposition. They feed on any remaining organic matter that is left after other decomposers do their work. Saprotrophs include fungi and single-celled protozoa. Fungi are the only organisms that can decompose wood.

Dung Beetle. This dung beetle is rolling a ball of feces to its nest to feed its young.

Food Chains

A **food chain** represents a single pathway through which energy and matter flow through an ecosystem. An example is shown in **Figure** below. Food chains are generally simpler than what really happens in nature. Most organisms consume—and are consumed by—more than one species

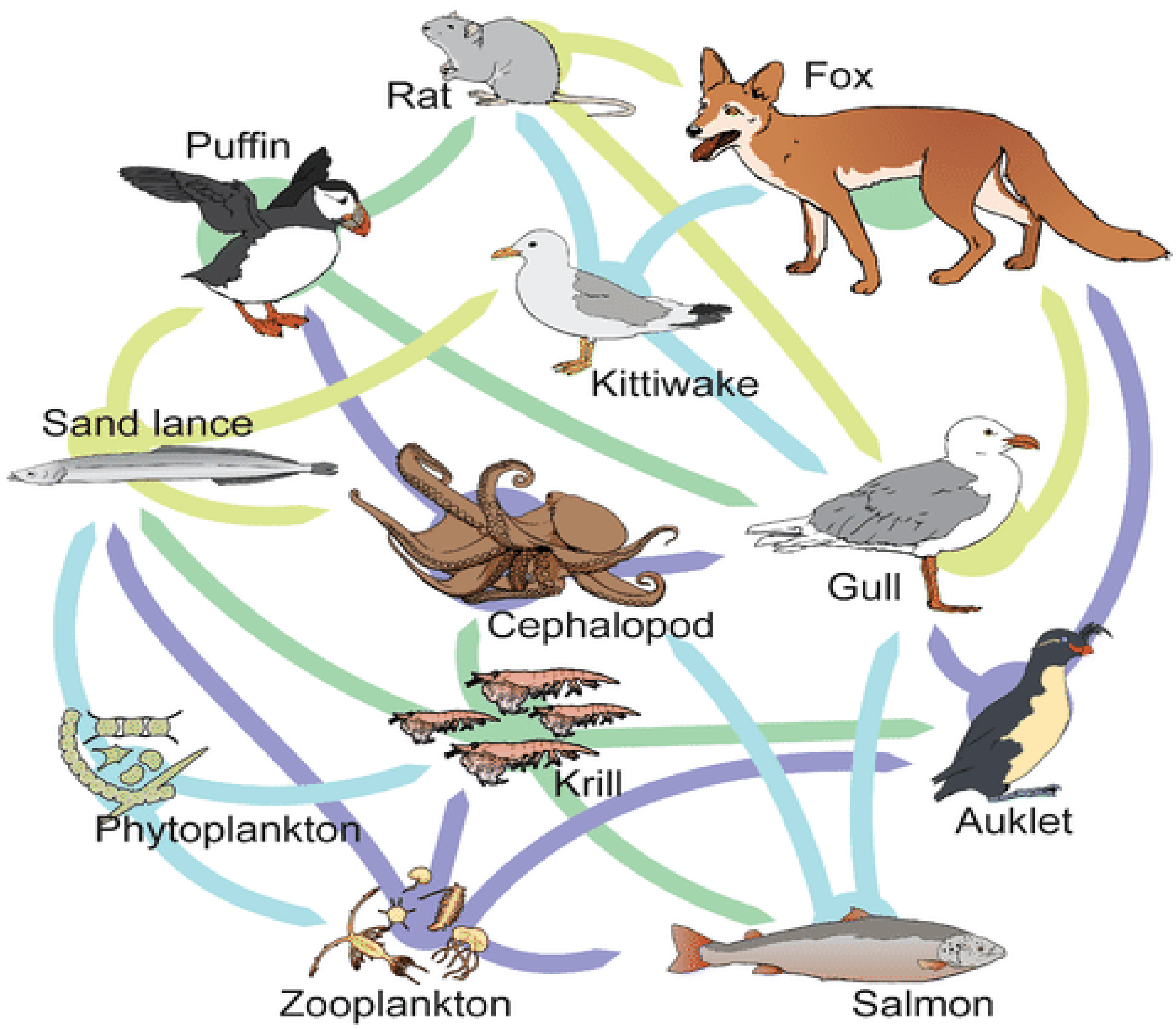
Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



A musical summary of food chains can be heard at
http://www.youtube.com/watch?v=TE6wqG4nb3M (2:46).

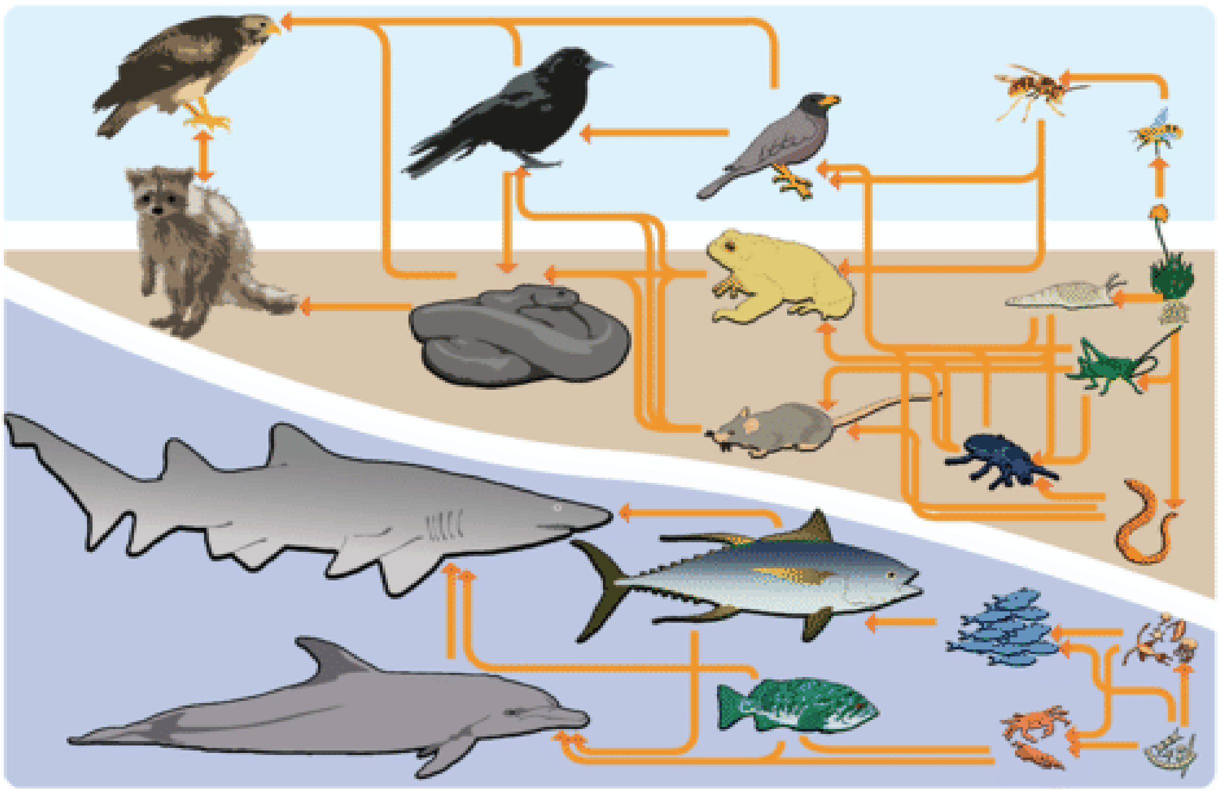
Food Webs

A **food web** represents multiple pathways through which energy and matter flow through an ecosystem. It includes many intersecting food chains. It demonstrates that most organisms eat, and are eaten, by more than one species. Examples are showinginFigures below and below.



Food Web. This food web consists of several different food chains.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Examples of food webs.

Trophic Levels

The feeding positions in a food chain or web are called **trophic levels**. The different trophic levels are defined in **Table** below. Examples are also given in the table. All food chains and webs have at least two or three trophic levels. Generally, there are a maximum of four trophic levels.

Trophic Level	Where It Gets Food	Example
1st Trophic Level: Producer	Makes its own food	plants make food
2nd Trophic Level: primary Consumer	:consumes producers	Mice eat plant seeds
3rd Trophic Level: Secondary Consumer:	Consumes primary consumers	Snakes eat mice
4th Trophic Level: Tertiary Consumer	Consumes secondary consumers	Hawks eat snakes

Many consumers feed at more than one trophic level. Humans, for example, are primary consumers when they eat plants such as vegetables. They are secondary consumers when they eat cows. They are tertiary consumers when they eat salmon.

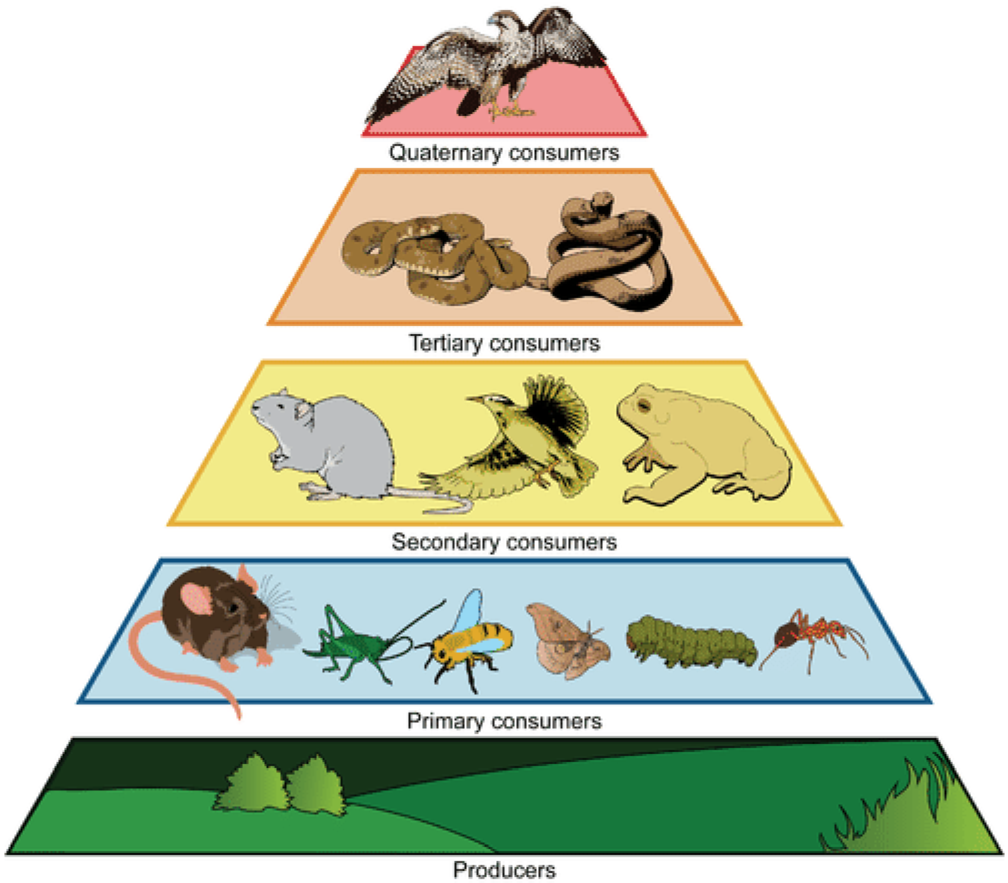
Trophic Levels and Energy

Energy is passed up a food chain or web from lower to higher trophic levels. However, only about 10 percent of the energy at onelevel is available to the next level. This is represented by the pyramidWhat happens to the other 90 percent of energy? It is used for metabolic processes or given off to the environment as heat. This lossof energy explains why there are rarely more than four trophic levels in a food chain or web. Sometimes there may be a fifth trophic level, but usually there's not enough energy left to support any additional levels.

Trophic Levels and Biomass

With less energy at higher trophic levels, there are usually fewer organisms as well. Organisms tend to be larger in size at higher trophic levels, but their smaller numbers result in less biomass. **Biomass** is the total mass of organisms at a trophic level.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Productivity within Trophic Levels

Productivity within an ecosystem can be defined as the percentage of energy entering the ecosystem incorporated into biomass in a particular trophic level. **Biomass** is the total mass, in a unit area at the time of measurement, of living or previously living organisms within a trophic level. Ecosystems have characteristic amounts of biomass at each trophic level. . For example, in the English Channel ecosystem the primary producers account for a biomass of 4 g/m^2 (grams per meter squared), while the primary consumers exhibit a biomass of 21 g/m^2.

Because all organisms need to use some of this energy for their own functions (like respiration and resulting metabolic heat loss) scientists often refer to the net primary productivity of an ecosystem. Net primary productivity is the energy that remains in the primary producers after accounting for the organisms' respiration and heat loss. The net productivity is then available to the primary consumers at the next trophic level. In our Silver Spring example, 13,187 of the 20,810 kcal/m^2/yr were used for respiration or were lost as heat, leaving 7,632 kcal/m^2/yr of energy for use by the primary consumers

Primary productivity provides energy to the ecosystem

Energy that moves through ecosystems originates from producers that either use solar energy to power photosynthesis or chemical energy for chemosythesis (e.g. bacteria living in the deep-ocean hydrothermal vents).

Gross primary productivity is the rate at which solar or chemical energy is captured and converted into chemical bonds by producers in an area. Producers use energy for their own respiration, growth, and reproduction.When energy that is assimilated by producers and converted into producer biomass in an area is called **net primary productivity** (NPP). NPP includes all energy that is not respired.

NPP = GPP - Respiration (Both GPP and NPP are expressed in units of Joules (J) / m^2 / year.)

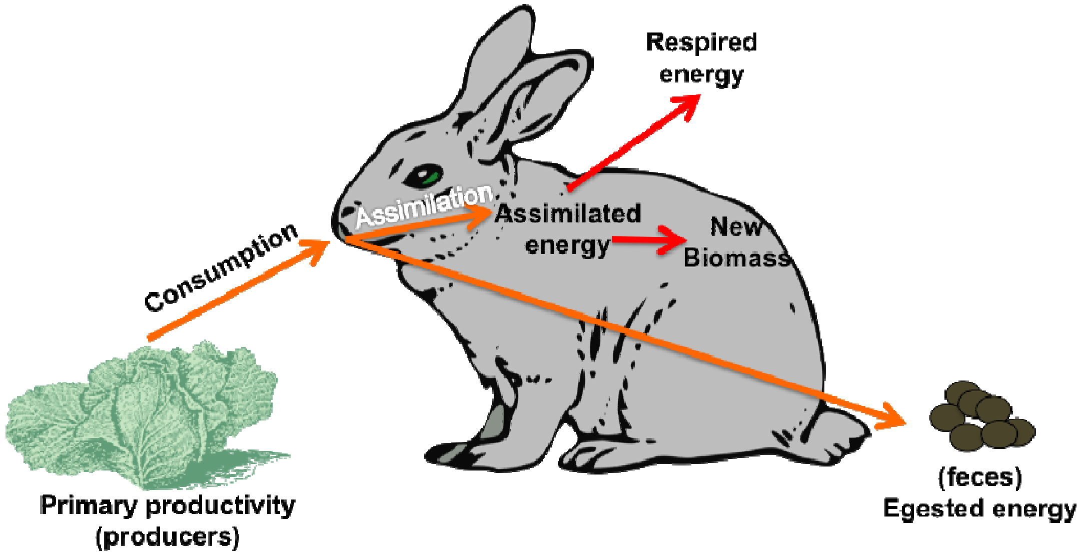
However, photosynthesis is not a very efficient process. Only 1% of solar energy is captured and used by photosynthesis, which is gross primary productivity.

Secondary production

Herbivores consume only a fraction of the total producer biomass available. They can only digest a portion of the energy they consume. **Secondary production** is the amount of assimilated energy converted into new biomass (growth and reproduction) by herbivores.

Figure showed that a rabbit consumes on the cabbage (primary production provied by the producers), a process we called **consumption**. A small protion of consumed energy that is excreted or regurgitated is the **egested energy**. The portion of consumed energy that the rabbit digests and absorbs is called **assimilated energy** (assimilation; analogous to GPP for producers). The rabbit uses a portion of assimilated energy for respiration, which is called **respirated energy**. The remaining assimilated energy can be used for *growth and reproduction*, which is called **net secondary productivity**.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



This diagram shows a rabbit (primary consumer) consumes the cabbage (producer). The consumed energy is either excreted as waste (egested energy; non-assimilated energy) or converted into assimilated energy (including respired energy and biomass- secondary productivity) (Diagram created by adapting images: Rabbit, Openclipart. CC0 Public Domain and Cabbage, Openclipart. CC0 Public Domain)

The efficiency of energy transfers within organisms

1.**Consumption efficiency** is the percentage of energy (J for joules)or biomass in a trophic level that is consumed by the next higher trophic level.

$$\text{Consumption efficiency} = \frac{\text{Consumed energy (J)}}{\text{Net production energy of the next lower trophic level (J)}}$$

Primary productivity is the energy content in producers that is available to the organisms of thenext trophic level (which is primary consumers; herbivores). **Secondaryproductivity** is theavailble evergy content in the primary consumer to the next tropic level (i.e. secondary consumer, carnivores). You will use primary productivity as "Net production energy of the next lower trophic level" in the equation above, when you are calculating the consumption efficiency for primary consumer. And you will use secondary productivity as "Net production energy of the next lower trophic level" in the equation above, when you are calculating the consumption efficiency for seconary consumer.

The percentage of consumed energy by an organims that is assimilated in the body of the consumer (i.e., material that is not egested) is called **assimilation efficiency**. It is calculated based on the amount of assimialted energy divided by the consumed energy.

$$\text{Assimilation efficiency} = \frac{\text{Assimilated energy (J)}}{\text{Consumed energy (J)}}$$

Assimilation efficiency varies among trophic levels. Primary consumers (i.e. herbivores) tend to have lower efficiencies than secondary consumers because animal tissues are more digestible than plant tissues (contain many undigestible materials, such as fibers and lignin).

production efficiency is the percentage of assimilated energy that is used for *growth* and *reproduction.*

$$\text{Net production efficiency} = \frac{\text{Net production energy (J)}}{\text{Assimilated energy (J)}}$$

Net production efficiency (NPE) allows ecologists to quantify how efficiently organisms of a particular trophic level incorporate the energy they receive into biomass. Thus, net production efficiency measures how efficiently each trophic level uses and incorporates the energy from its food into biomass to fuel the next trophic level.

REFERENCES: Date last modified: April 5, 2018.
Foundational content derived from OpenStax Biology.
Download original Biology book for free at http://cnx.org/content/col11448/latest/
Further Reading:
https://courses.lumenlearning.com/wm-biology2/chapter/energy-flow-through-ecosystems/
https://www.mrgscience.com/42-energy-flow.html
https://en.wikibooks.org/wiki/Ecology/Energy_in_ecosystems

Ecological Pyramids

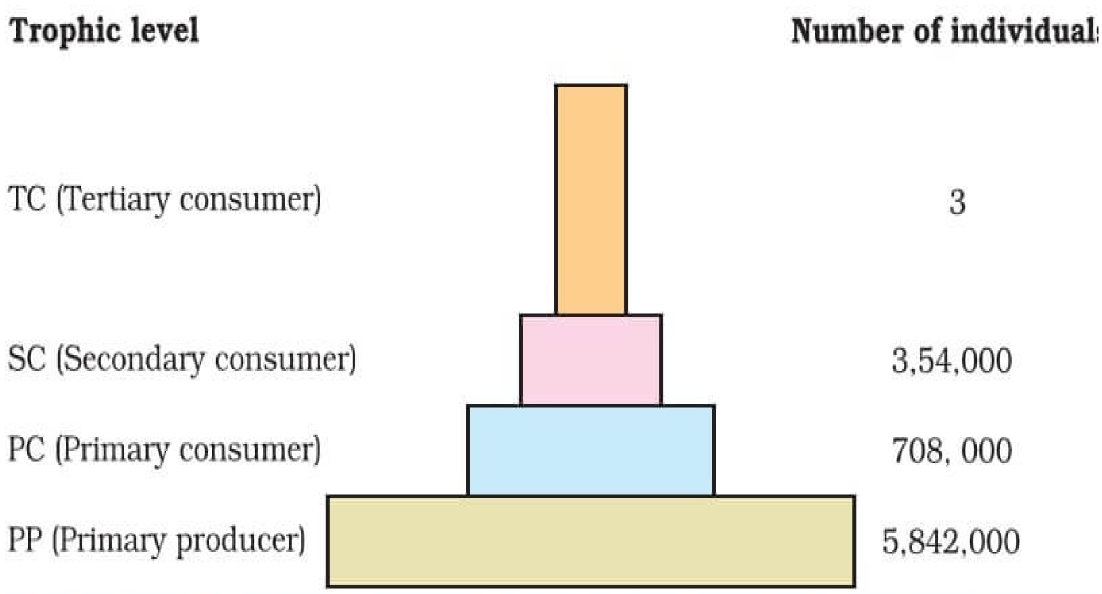
The pyramidal representation of trophic levels of different organisms based on their **ecological position** (producer to final consumer) is called as an ecological pyramid.The pyramid consists of a number of horizontal bars depicting specific trophic levels. The length of each bar represents the total number of individuals or biomass or energy at each trophic level in an ecosystem.The food **producer forms the base of the pyramid** and the top carnivore forms the tip. Other consumer trophic levels are in between.

The ecological pyramids are of three categories:

Pyramid of numbers,

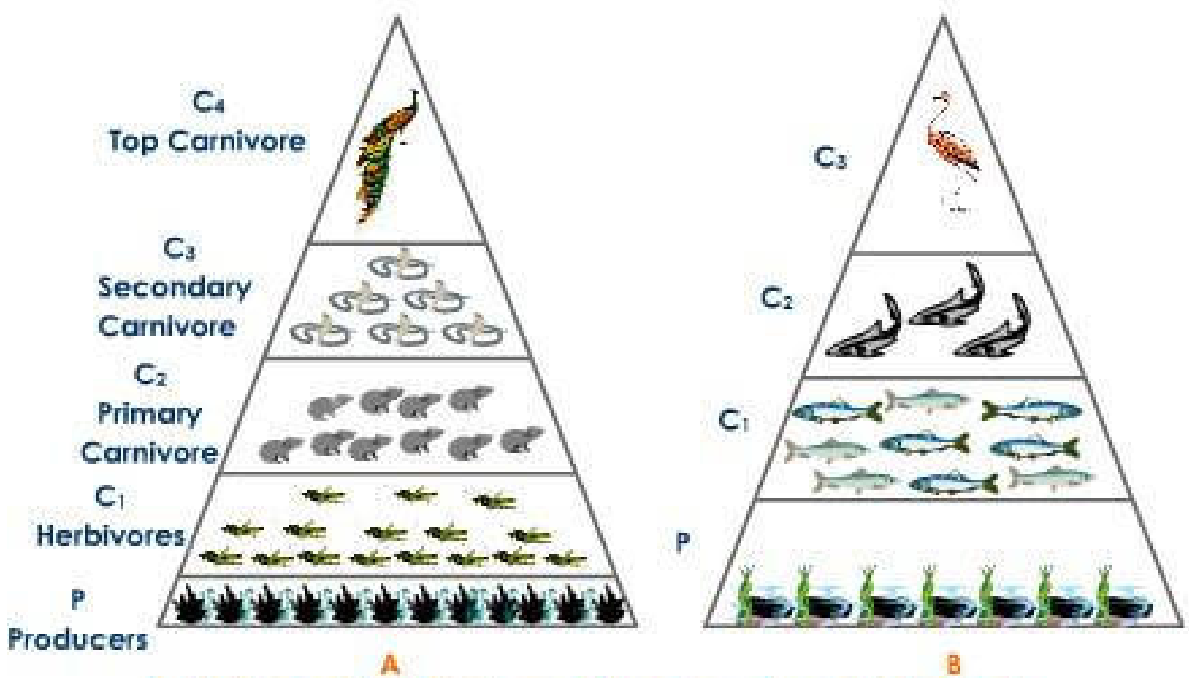
Pyramid of biomass, and

Pyramid of energy or productivity.



Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

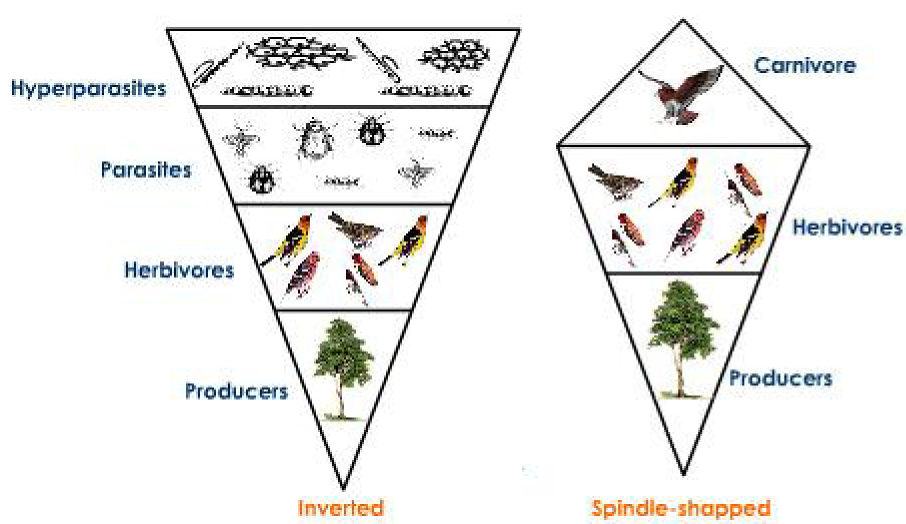
Pyramid of numbers represents the total number of individuals of different species (population) at each trophic level.
Depending upon the size, the pyramid of numbers **may not always be upright**, and **may even be completely inverted**.
It is very difficult to count all the organisms, in a pyramid of numbers and so the pyramid of number does not completely define the trophic structure for an ecosystem.
Pyramid of numbers – upright
This type of pyramid can be seen in the **grassland ecosystem** and **pond ecosystem**.
The grasses occupy the lowest trophic level (base) because of their abundance.
The next higher trophic level is primary consumer – herbivores like a grasshopper.
The individual number of grasshoppers is less than that of grass.
The next energy level is a primary carnivore like rats.
The number of rats is less than grasshoppers, because, they feed on grasshoppers.
The next higher trophic level is secondary carnivore like snakes. They feed on rats.
The next higher trophic level is the top carnivore like Hawk.
With each higher trophic level, the number of individual decreases



Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond

Pyramid of numbers – inverted

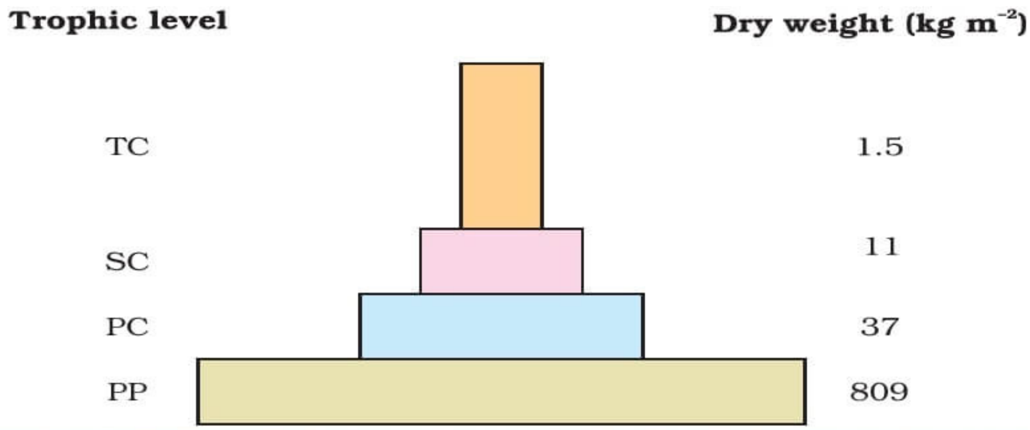
In this pyramid, the number of individuals is increased from lower level to higher trophic level. E.g. **Tree ecosystem**.



Pyramid of Numbers

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Pyramid of Biomass



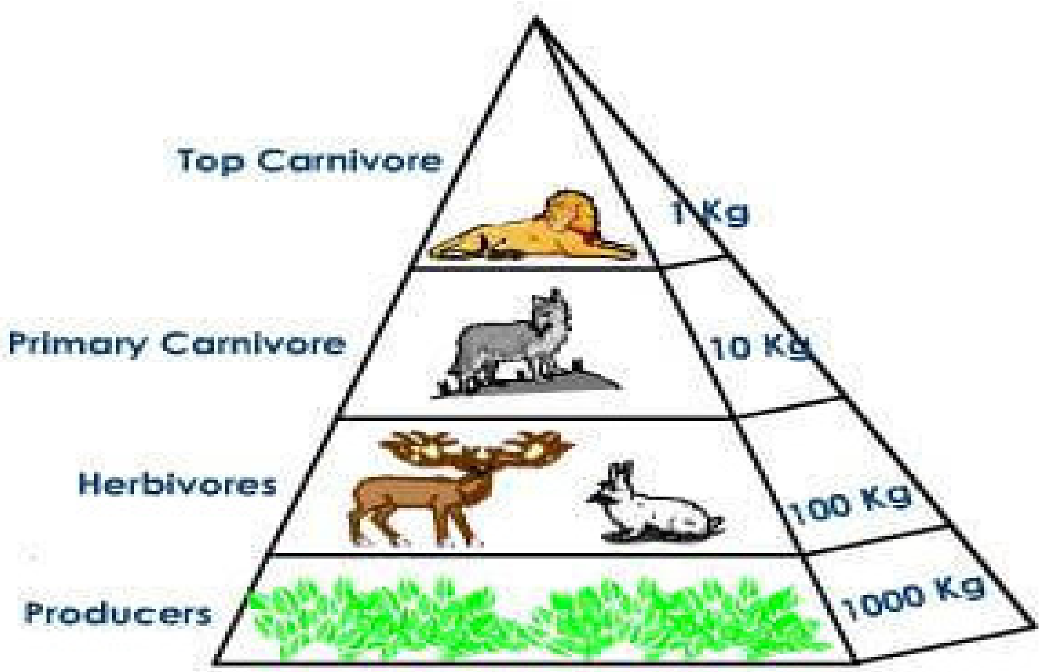
Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels

Pyramid of biomass is usually determined by collecting all organisms occupying each trophic level separately and measuring their dry weight.
This overcomes the size difference problem because all kinds of organisms at a trophic level are weighed.
Each trophic level has a certain mass of living material at a particular time called the **standing crop**.
The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.

Pyramid of Biomass – upright

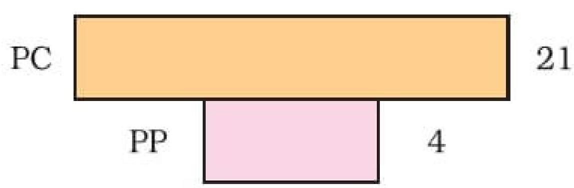
For **most ecosystems on land**, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.

The biomass of producers (autotrophs) is at the maximum. The biomass of next trophic level i.e. primary consumers is less than the producers. The biomass of next higher trophic level i.e. secondary consumers is less than the primary consumers. The top, high trophic level has very less amount of biomass.



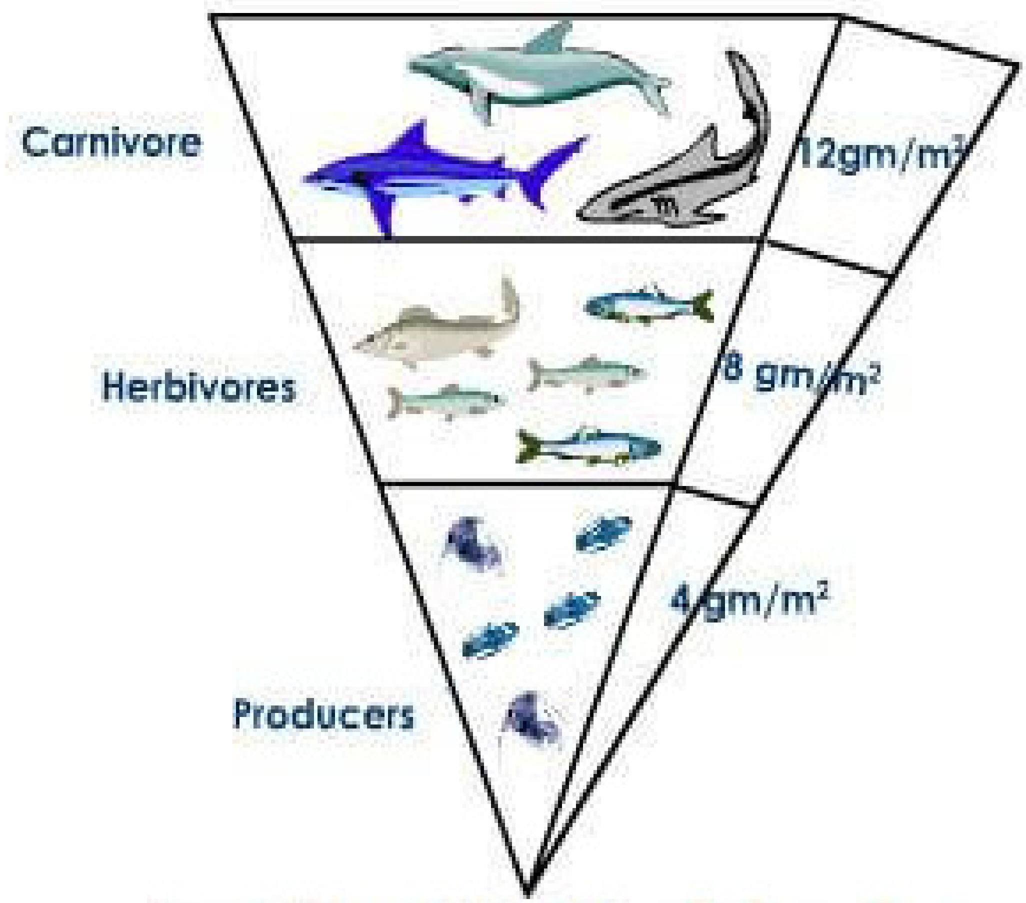
Upright Pyramid of biomass in a Terrestrial Ecosystem

Pyramid of Biomass – Inverted



Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton

In contrast, in many **aquatic ecosystems**, the pyramid of biomass may assume an inverted form. (**In contrast, a pyramid of numbers for theaquatic ecosystem is upright**)
This is because the producers are tiny phytoplankton that grows and reproduces rapidly.
Here, the pyramid of biomass has a small base, with the consumer biomass at any instant exceeding the producer biomass and the pyramid assumes an inverted shape.



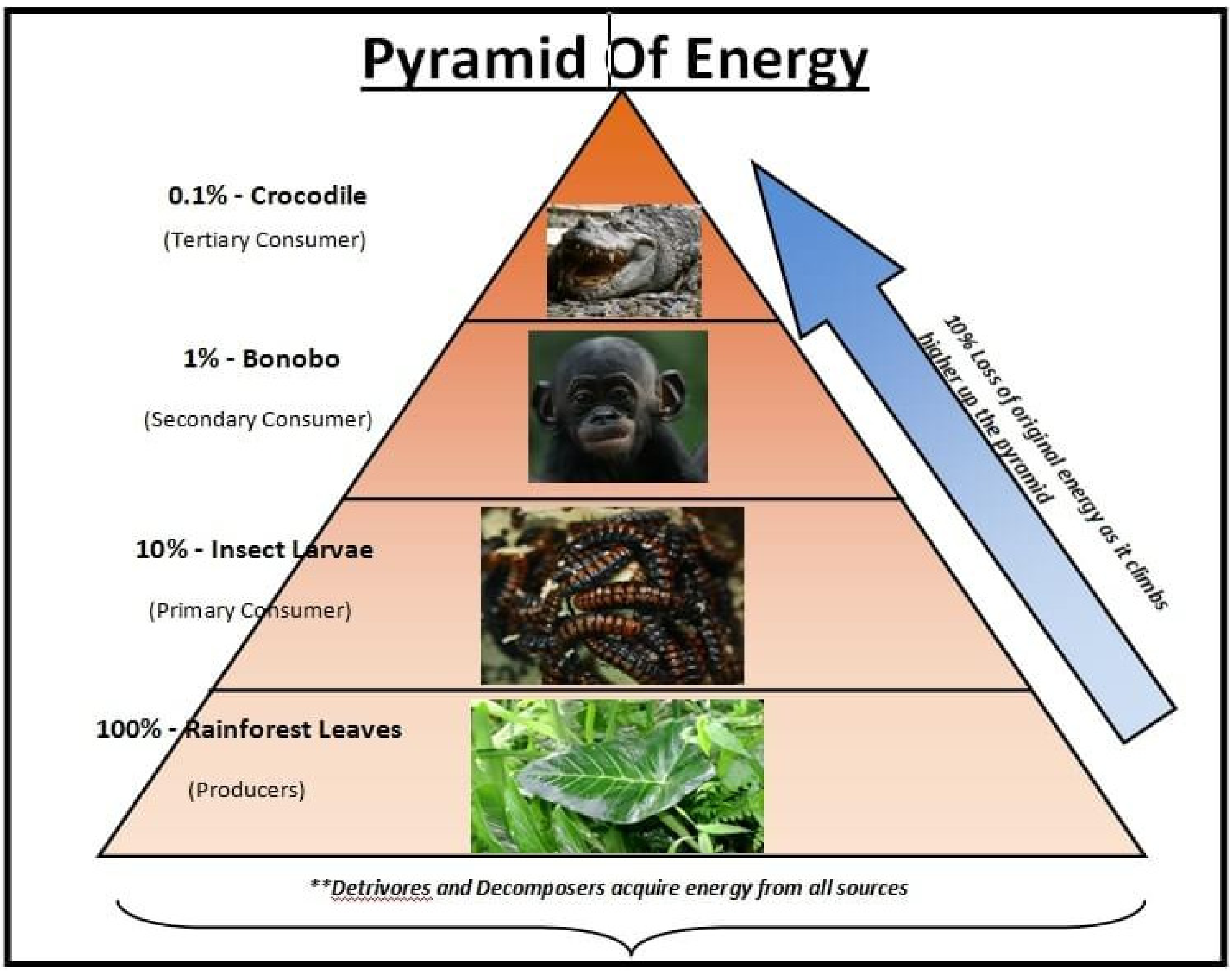
Inverted Pyramid in an Aquatic Ecosystem

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Pyramid of Energy

To compare the functional roles of the trophic levels in an ecosystem, an energy pyramid is most suitable.

An energy pyramid represents the amount of energy at each trophic level and loss of energy at each transfer to another trophic level. Hence **the pyramid is always upward**, with a large energy base at the bottom.



Suppose an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed; some is reflected to space; of the energy absorbed only a small portion is utilized by green plants, out of which the plant uses up some for respiration and of the 1000 calories; therefore only 100 calories are stored as energy-rich materials.
Now suppose an animal, say a deer, eats the plant containing 100 calories of food energy. The deer use some of it for its metabolism and stores only 10 calories as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus, usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore, the energy pyramid will always be upright.

Energy pyramid concept helps to explain the phenomenon of **biological magnification** – the tendency for toxic substances to increase in concentration progressively with higher trophic levels.

Limitations of Ecological Pyramids

It does not consider the same species belonging to two or more trophic levels.

It assumes a simple food chain, something that seldom exists in nature; **it does not accommodate a food web**.

Moreover, **saprophytes** (plant, fungus, or microorganism that lives on decaying matter) are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Pollutants and Trophic Level – Biomagnification

Pollutants move through the various trophic levels in an ecosystem.

Non-degradable pollutants (**persistent pollutants**), which cannot be broken down by detrivores, not only move through the various trophic levels but also remain in that tropic level for a very long duration.

Chlorinated Hydrocarbons (Organochlorides) arethe most damaging non-degradable pollutants that are long-lasting.

Chlorinated Hydrocarbons (CHC)

CHCs are hydrocarbons in which one or more hydrogen atoms have been replacedby chlorine E.g**. DDT(dichlorodiphenyltrichloroethane), endosulfan, chloroform, carbon tetrachloride, etc**.

Applications of Chlorinated Hydrocarbons (CHC)

CHCs are used in the production of polyvinyl chloride (a synthetic plastic polymer used to make PVC pipes).

Chloroform, dichloromethane, dichloroethane, and trichloroethane are useful solvents.

These solvents are immiscible with water (not forming a homogeneous mixture when mixed with water) and effective in cleaning applications such as degreasing and dry cleaning.

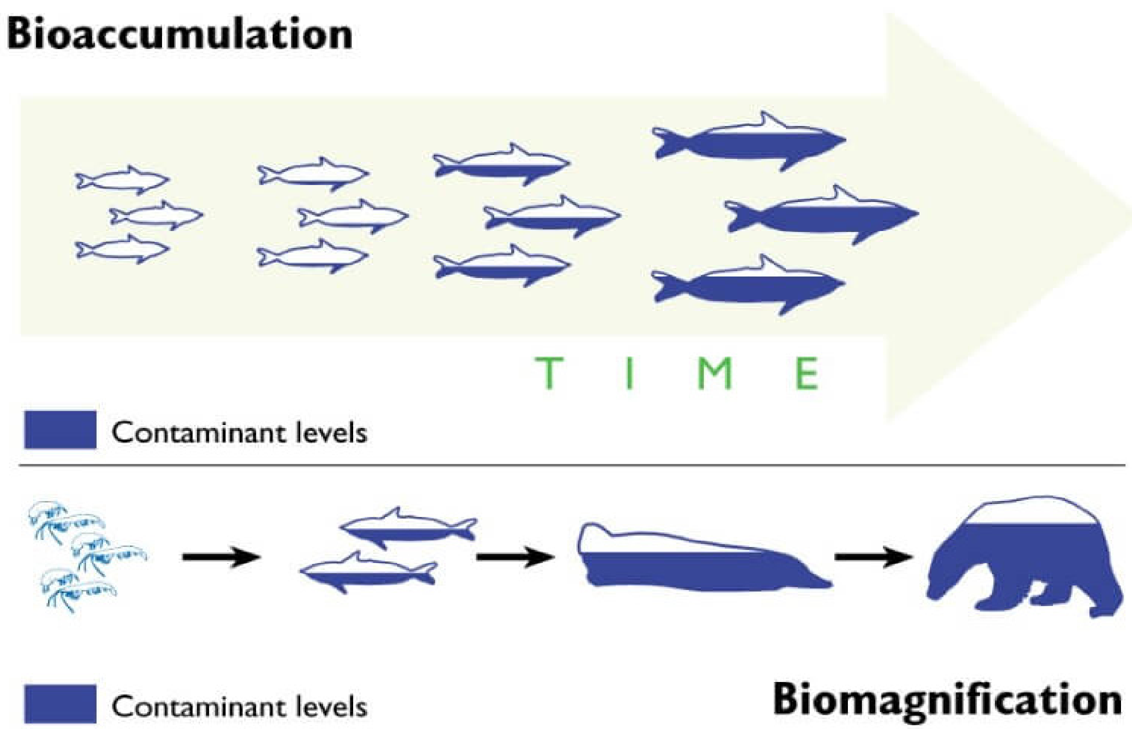
DDT, heptachlor and endosulfan are were widely used as pesticides.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Effects of CHC

Dioxins (toxic by-products produced when organic matter is burned in the presence of chlorine in industrial or natural processes such as volcanic eruptions and forest fires), and some insecticides, such as DDT, are **persistent organic pollutants**.
DDT was widely used a few decades ago as an effective pesticide and insecticide.
It was later identified as a **persistent organic pollutant,** and its usage was phased out in almost all developed countries.
It accumulated in food chains and caused eggshell thinning in certain bird species.
In India, it is still being used by civic administrations as a **mosquito repellent** (disease vector control).
In India, traces of DDT spray used three decades ago can still be found on the walls of homes.
Crops that are grown in fields that were sprayed with DDT in the last decades show substantial traces of the insecticide.
DDT residues continue to be found in mammals all across the planet.
In Arctic areas, particularly high levels are found in marine mammals.
The traces of **persistent organic pollutant** are found in human breast milk.
In some species of milk-producing marine mammals, males typically have far higher levels, as females reduce their concentration by transfer to their offspring through lactation.
Endosulfan, one of the most widely used pesticide, is an **endocrine disruptor** (enhances the effect of estrogens causing reproductive and developmental damage in both animals and humans).

Because of its threats to human health and the environment, a global ban on the manufacture and use of endosulfan was negotiated under the **Stockholm Convention in 2011**.
Movement of these pollutants involves two main processes:
Bioaccumulation
Biomagnification

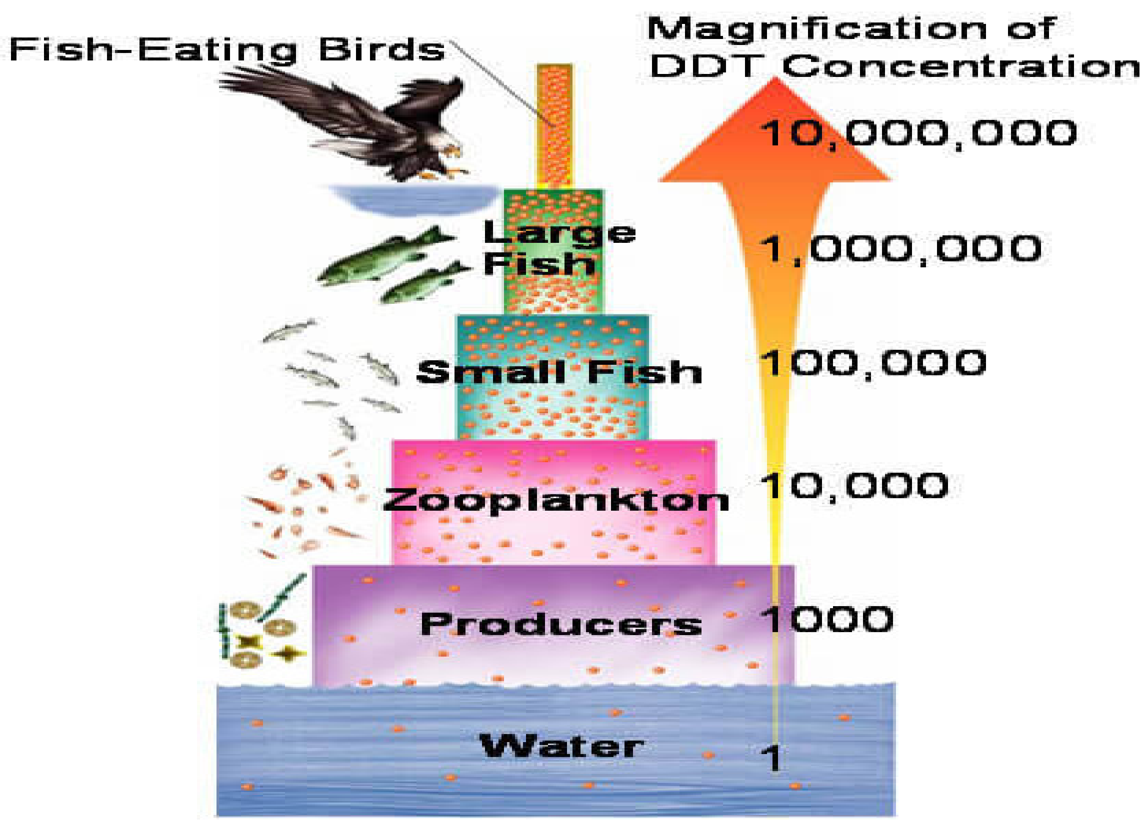


Bioaccumulation

Bioaccumulation is the **gradual accumulation of pollutants, chemicals (chronic poisoning) or other substances in an organism**. Bioaccumulation occurs when the rate of loss of the substance from the body of the organism through catabolism (breakdown of complex molecules in living organisms), or excretion is lower than the rate of accumulation of the substance.

As persistent organic pollutants like DDT are long-lasting, the risk of bioaccumulation is high even if the environmental levels of the pollutant are not high.

Biomagnification



Biomagnification refers **to progressive bioaccumulation (increase in concentration) at each tropical level with the passage of time.**
In order for biomagnification to occur, the pollutant must have a long biological half-life (long-lived), must not be soluble in water but must be soluble in fats. E.g. DDT.
If the pollutant is soluble in water, it will be excreted by the organism.
Pollutants that dissolve in fats are retained for a long time. Hence it is traditional to measure the amount of pollutants in fatty tissues of organisms such as fish.

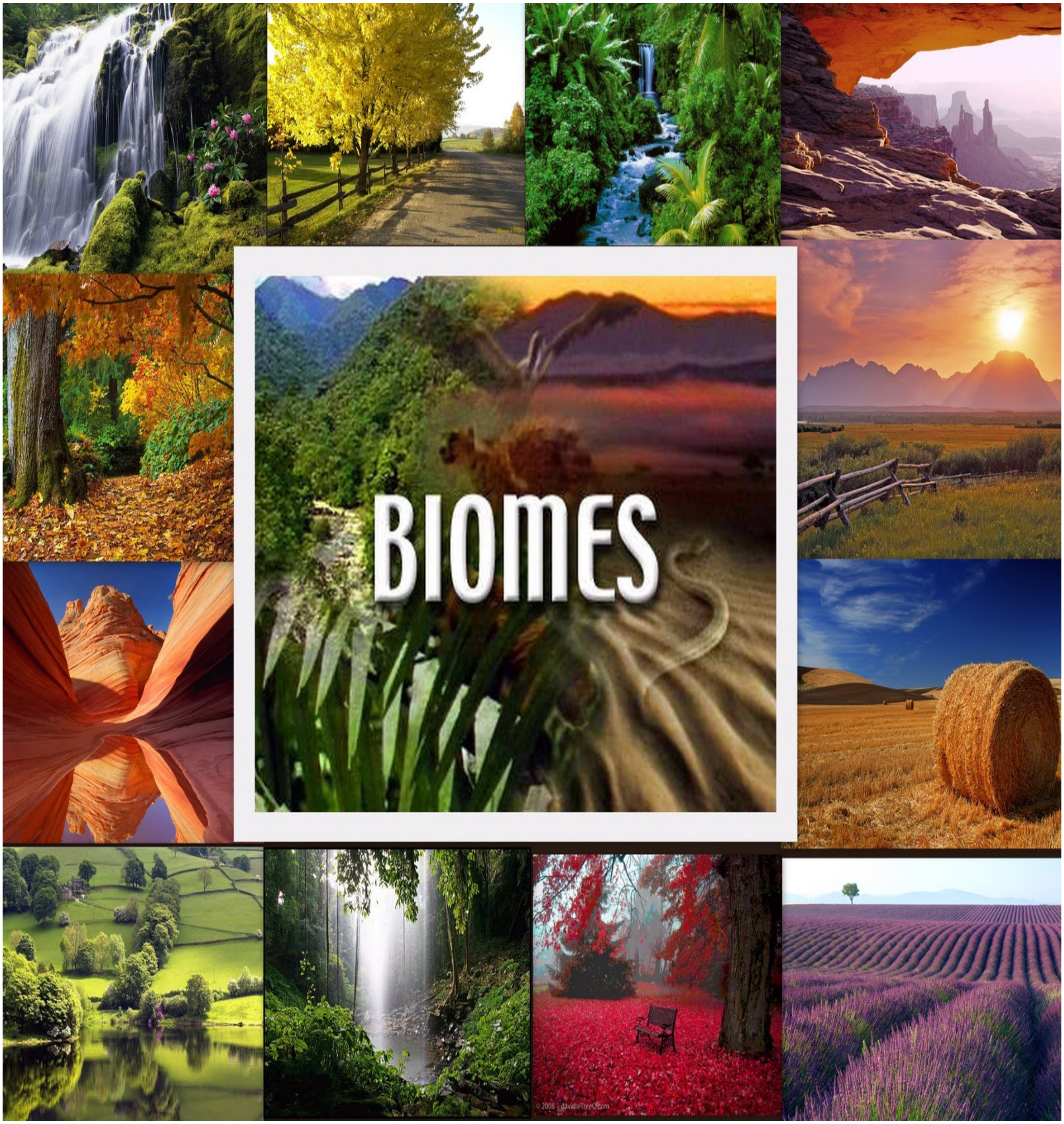
Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

- In mammals, milk produced by females is tested for pollutants sincethe milk has a lot of fat in.

- https://www.pmfias.com/ecological-pyramids-pyramid-numbers-biomass-energy/

- https://www.pmfias.com/environment-ecosystem-components-ecosystem/

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

In ecology, a **biome** is a major regional group of distinctive plant and animal communities well adapted to the region's physical environment. The concept of a biome highlights the interaction among plant and animal populations, soil, water and air. A biome is discernible at a global scale, and a *biotic area* is the geographical area occupied by a particular biome. The Earth's biomes comprise the biosphere. Biomes are defined by the global pattern of species. This pattern is influenced by regional climate, soil characteristics, substrate condition (due to periodic flooding for example), and other physical environment factors. In turn, climate and soil partly depend on latitude, altitude and slope.

A biome is composed of the climax flora and all associated subclimax, or degraded, flora, fauna and soils, but can often be identified by the climax flora type, vertical stratification or vegetation adaptation.

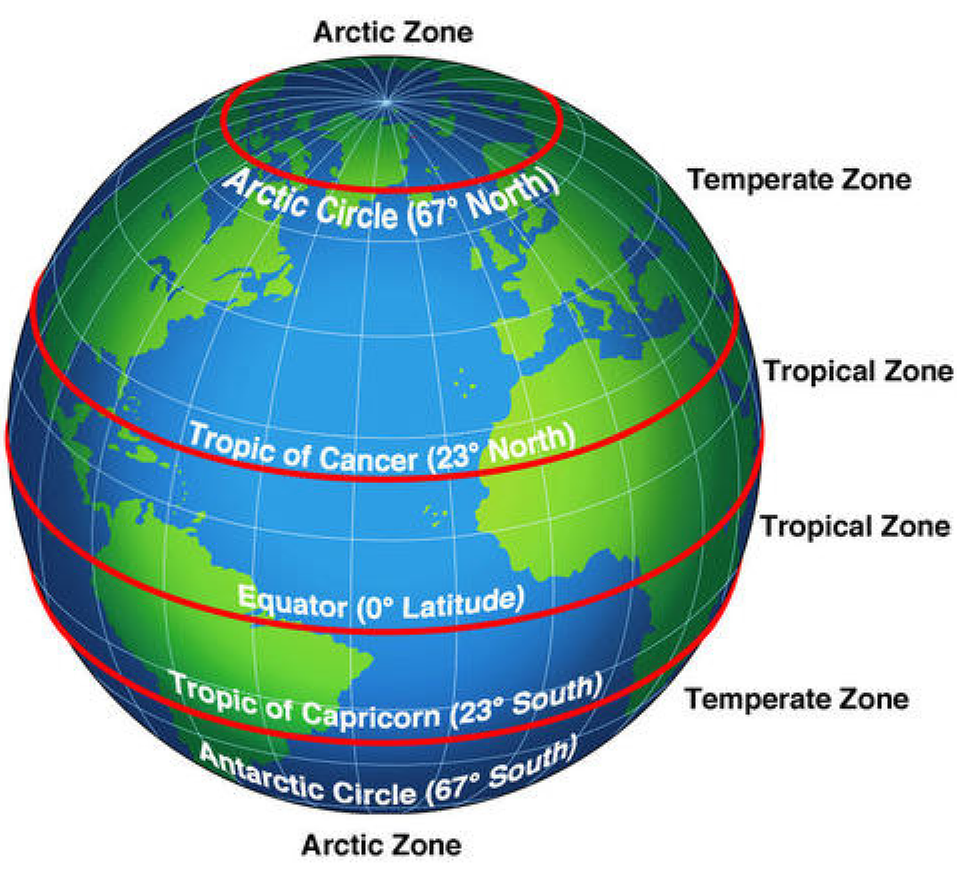
Classification of biome

- Terrestrial (also called continental) biomes and
- Aquatic biomes.

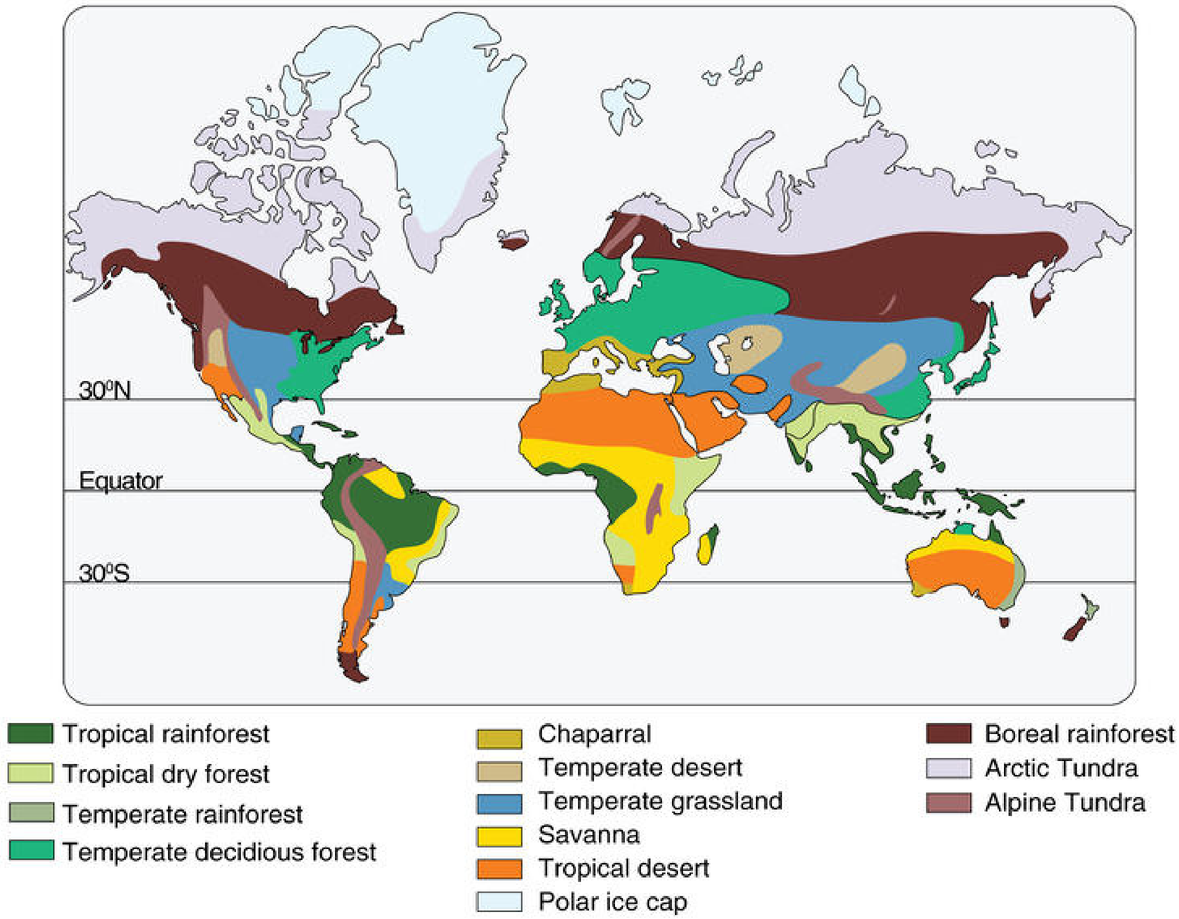
Often, a type of biome in a particular area is given a local name. For example, a Temperate grassland or shrubland biome is known as *steppe* in central Asia, *savanna* or veld in southern Africa, *prairie* in North America, *pampas* in South America and *outback* in Australia.

Latitude Classification

Latitude is a major factor defining biomes. There is a good correlation between the distribution of climates with latitude, and homogenous vegetation bands. Another major factor is humidity. This can be illustrated by the fact that biodiversity increases away from the poles towards the equator, and increases with humidity. The most widely used classification of biomes is related to latitude (or temperature zoning) and humidity :



Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Arctic or Subarctic area

[Tundra]

Subarctic and Boreal area

[taiga] or [boreal forest]

Temperate cold

[Temperate broadleaf and mixed forests]

[Temperate coniferous forests]

Temperate warm or sub-tropical

subtropical moist broadleaf forest
Subtropical dry broadleaf forests
Subtropical coniferous forests
Mediterranean forests, woodlands, and shrub, Temperate grasslands, savannas, and shrublands
Temperate deserts and xeric shrublands

Tropical

Tropical forest or Rainforest
Tropical Grasslands -- Tropical Savannas
Desert

Aquatic

continental shelf
littoral
riparian
pond
lake
coral reef
kelp forest
pack ice
hydrothermal vents
cold seeps
benthic zone
pelagic zone

Altitude and Latitude Classification

Another system of classification takes into account altitude and humidity, ignoring temperature as a factor. This classification is used to define the Global 200 list of ecoregions identified by the World Wildlife Fund (WWF) as priorities for conservation.

This classification gives the following terrestrial biomes :
Tundra
Boreal forests/taiga
Temperate coniferous forests
Temperate broadleaf and mixed forests
Temperate grasslands, savannas, and shrublands
Mediterranean forests, woodlands, and shrub
Tropical and subtropical coniferous forests
Tropical and subtropical moist broadleaf forests
Tropical and subtropical dry broadleaf forests
Tropical and subtropical grasslands, savannas, and shrublands
Deserts and xeric shrublands
Mangrove
Flooded grasslands and savannas
Montane grasslands and shrubland

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Alpine tundra in the Alps Mountains of Switzerland in Europe

Arctic tundra on the northern coast of Alaska in the United States

Tundra

Other names:
Arctic tundra (high latitudes)
Alpine tundra (high altitudes)

Climate: Arctic, acrid
Growing season: Very short
Soil quality: Very poor

Biodiversity: Very low

Plants: Mosses, grasses, and lichens; few herbaceous plants; no trees.

Animals: Insects; birds (summer only); no amphibians or reptiles; mammals such as rodents, arctic hares, arctic foxes, polar bears; caribou (summer only); mountain goats and chinchillas (alpine tundra only)

Boreal forest in central (inland) Alaska, United States

Boreal Forest

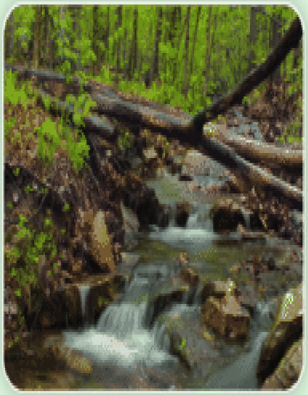
Other names: Taiga, northern conifer forest
Climate: Subarctic, semi-arid
Growing season: Short
Soil quality: Poor

Biodiversity: Low

Plants: Conifers such as cedar, spruce, pine, and fir; mosses and lichens

Animals: Insects; birds (mainly in summer); no amphibians or reptiles; mammals such as rodents, rabbits, minks, raccoons, bears, and moose; caribou (winter only)

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Temperate deciduous forest in Pennsylvania, eastern United States

Temperate Deciduous Forest

Other names: Temperate hardwood forest, temperate broadleaf forest

Climate: Temperate, semi-humid

Growing season: Medium

Soil quality: Good

Biodiversity: High

Plants: Broadleaf deciduous trees such as beech, maple, oak, and hickory; ferns, mosses, and shrubs; many herbaceous plants

Animals: Insects, amphibians, reptiles, and birds; mammals such as mice, chipmunks, squirrels, raccoons, foxes, deer, black bears, bobcats, and wolves

Temperate grassland in Nebraska, midwestern United States

Temperate Grassland

Other names: Prairie, outback, pampa, steppe

Climate: Temperate, semi-arid

Growing season: Medium

Soil quality: Excellent

Biodiversity: Medium-high

Plants: Grasses; other herbaceous plants; no trees

Animals: Invertebrates such as worms and insects; amphibians, reptiles, and birds; mammals such as mice, prairie dogs, rabbits, foxes, wolves, coyotes, bison, and antelope; kangaroo (only in Australia)

Chaparral in southern California, United States

Chaparral

Other names: Mediterranean scrub forest

Climate: Temperate, semi-arid

Growing season: Medium

Soil quality: Poor

Biodiversity: Low-medium

Plants: Shrubs and small trees such as scrub oak and scrub pine

Animals: Insects, reptiles, and birds; mammals such as rodents and deer

Desert in southern California, United States

Desert

Climate: Temperate or tropical, arid

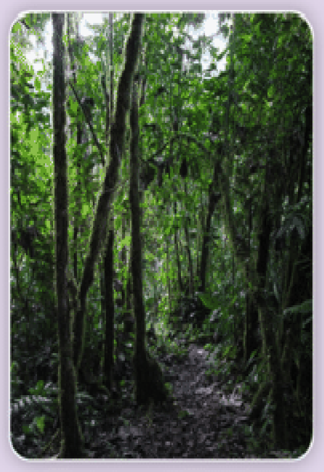
Growing season: Varies

Soil quality: Very poor

Biodiversity: None-low

Plants: Plants adapted to dryness, such as cacti, sagebrush, and mesquite; virtually no plants if extremely arid

Animals: Insects, reptiles, and birds; mammals such as rodents and coyotes



Tropical rainforest in Ecuador, South America

Tropical Rainforest

Climate: Tropical, humid

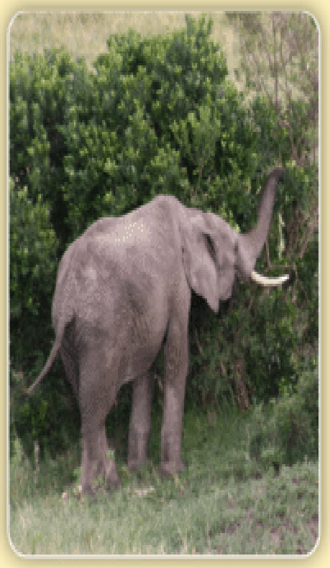
Growing season: Year-round

Soil quality: Excellent

Biodiversity: Very high

Plants: Tall flowering, broadleaf evergreen trees; vines and epiphytes; few plants on forest floor

Animals: Insects, amphibians, reptiles, and birds; mammals such as monkeys, sloths, leopards, jaguars, pigs, and tigers



Elephant grazing in its grassland ecosystem.

Tropical Grassland

Other names: Savanna

Climate: Tropical, semi-arid

Growing season: Year-round

Soil quality: Poor

Biodiversity: Low-medium

Plants: Grasses, scattered clumps of trees

Animals: Insects, reptiles, and birds; mammals such as zebras, giraffes, antelopes, lions, cheetahs, and hyenas

Aquatic Biomes

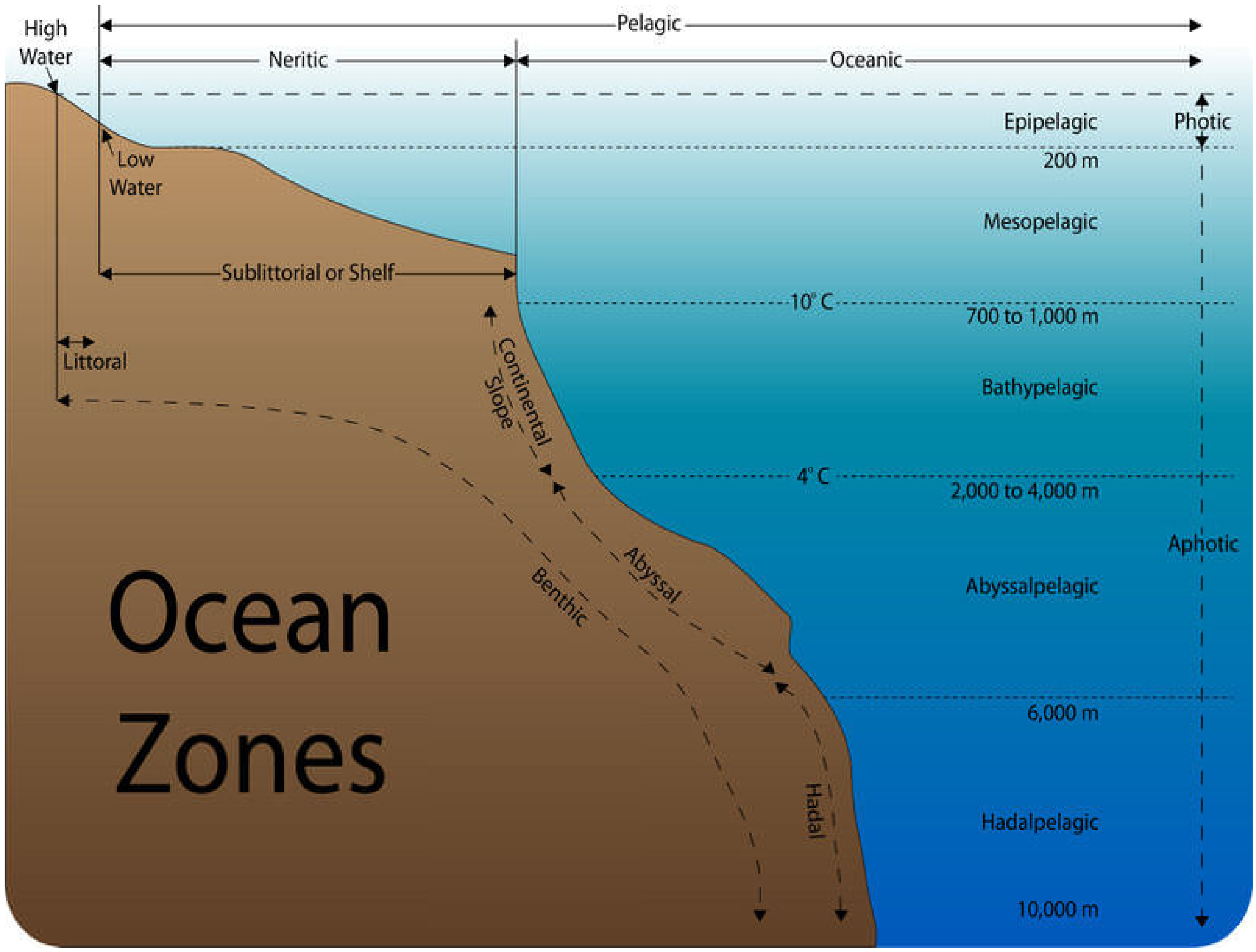
Terrestrial organisms are generally limited by temperature and moisture. Therefore,terrestrial biomes are defined in terms of these abiotic factors. Most aquatic organisms do not have to deal with extremes of temperature or moisture. Instead, their main limiting factors are the availability of sunlight and the concentration of dissolved oxygen and nutrients in the water. These factors vary from place to place in a body of water and are used to define **aquatic biomes**.

Aquatic Biomes and Sunlight

In large bodies of standing water, including the ocean and lakes, the water can be divided into zones based on the amount of sunlight it receives:

The **photic zone** extends to a maximum depth of 200 meters (656 feet) below the surface of the water. This is where enough sunlight penetrates for photosynthesis to occur. Algae and other photosynthetic organisms can make food and support food webs.

The **aphotic zone** is water deeper than 200 meters. This is where too little sunlight penetrates for photosynthesis to occur. As a result, food must be made by chemosynthesis or else drift down from the water above.



Aquatic Biomes and Dissolved Substances

Water in lakes and the ocean also varies in the amount of dissolved oxygen and nutrients it contains:

Water near the surface of lakes and the ocean usually has more dissolved oxygen than does deeper water. This is because surface water absorbs oxygen from the air above it.

Water near shore generally has more dissolved nutrients than water farther from shore. This is because most nutrients enter the water from land. They are carried by runoff, streams, and rivers that empty into a body of water.

Water near the bottom of lakes and the ocean may contain more nutrients than water closer to the surface. When aquatic organisms die, they sink to the bottom. Decomposers near the bottom of the water break down the dead organisms and release their nutrients back into the water.

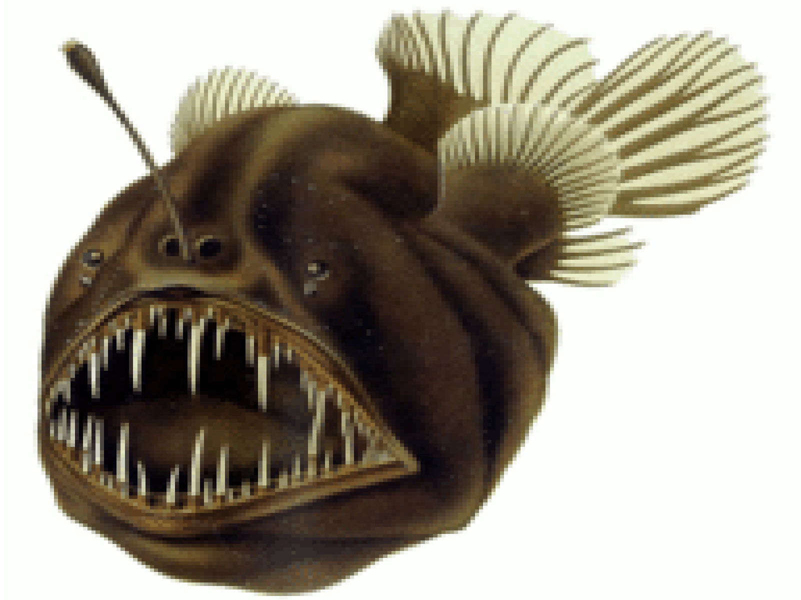
Aquatic Organisms

Aquatic organisms generally fall into three broad groups: plankton, nekton, and benthos. They vary in how they move and where they live.

Plankton are tiny aquatic organisms that cannot move on their own. They live in the photic zone. They include phytoplankton and zooplankton. **Phytoplankton** are bacteria and algae that use sunlight to make food. **Zooplankton** are tiny animals that feed on phytoplankton.

Nekton are aquatic animals that can move on their own by “swimming” through the water. They may live in the photic or aphotic zone. They feed on plankton or other nekton. Examples of nekton include fish and shrimp.

Benthos are aquatic organisms that crawl in sediments at the bottom of a body of water. Many are decomposers. Benthos include sponges, clams, and anglerfish like the one in **Figure** below. How has this fish adapted to a life in the dark?



Anglerfish. This anglerfish lives between 1000 and 4000 meters below sea level. No sunlight penetrates to this depth. The rod-like Structure on its face has a glow-in-the-dark tip. It is covered with microorganisms that give off their own light. The fish wiggles the structure like a worm to attract prey. In the darkness, only the rod-like worm is visible.

Marine Biomes

Anglerfish live in the ocean. Aquatic biomes in the ocean are called **marine biomes**. Organisms that live in marine biomes must be adapted to the salt in the water. For example, many have organs for excreting excess salt. Two ocean zones are particularly challenging to marine organisms: the intertidal zone and the deep ocean.

The **intertidal zone** is the narrow strip along the coastline that is covered by water at high tide and exposed to air at low tide (see **Figure** below). There are plenty of nutrients and sunlight in the intertidal zone. However, the water is constantly moving in and out, and the temperature keeps changing. These conditions require adaptations in the organisms that live there.

Organisms that live deep in the ocean must be able to withstand extreme water pressure, very cold water, and complete darkness. However, even here, thriving communities of living things can be found. Organisms cluster around hydrothermal vents in the ocean floor. The vents release hot water containing chemicals that would be toxic to most other living things. The producers among them aresingle-celled chemoautotrophs. They make food using energy stored in the chemicals. The tube worms in this chapter's opening photo depend on these chemoautotrophs for food.

Freshwater Biomes

Freshwater biomes have water that contains little or no salt. They include standing and running freshwater biomes. Standing freshwater biomes include ponds and lakes. Lakes are generally bigger and deeper than ponds. Some of the water in lakes is in the aphotic zone where there is too little sunlight for photosynthesis. Plankton and plants (such as the duckweed in **Figure** below) are the primary producers in standing freshwater biomes.

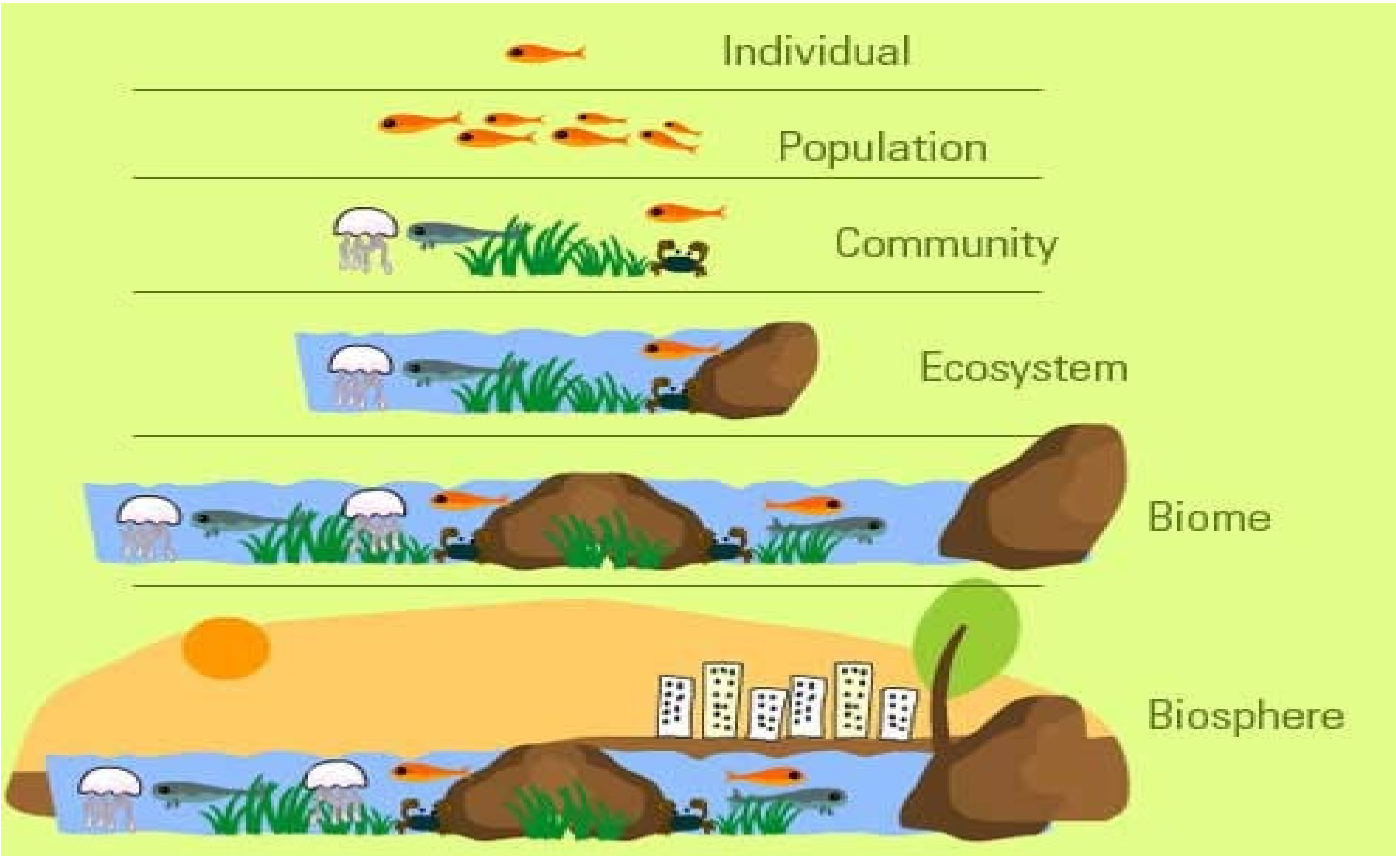
Duckweed in a pond

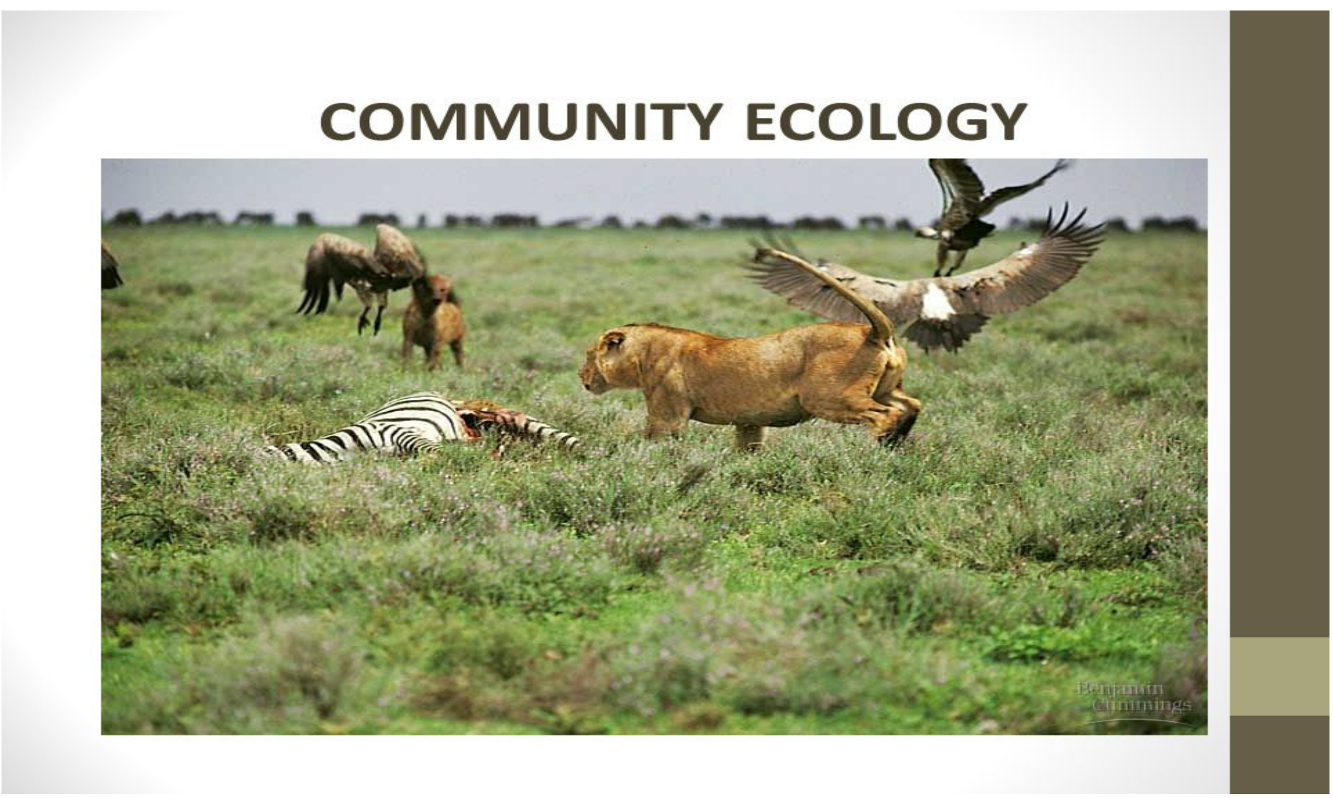
Cattails in a stream

The pond on the left has a thick mat of duckweed plants. They cover the surface of the water and use sunlight for photosynthesis. The cattails on the right grow along a stream bed. They have tough, slender leaves that can withstand moving water.

Running freshwater biomes include streams and rivers. Rivers are usually larger than streams. Streams may start with runoff or water seeping out of a spring. The water runs downhill and joins other running water to become a stream. A stream may flow into a river that empties into a lake or the ocean. Running water is better able to dissolve oxygen and nutrients than standing water. However, the moving water is a challenge to many living things. Algae and plants (such as the cattails in **Figure** above) are the primary producers in running water biomes.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar





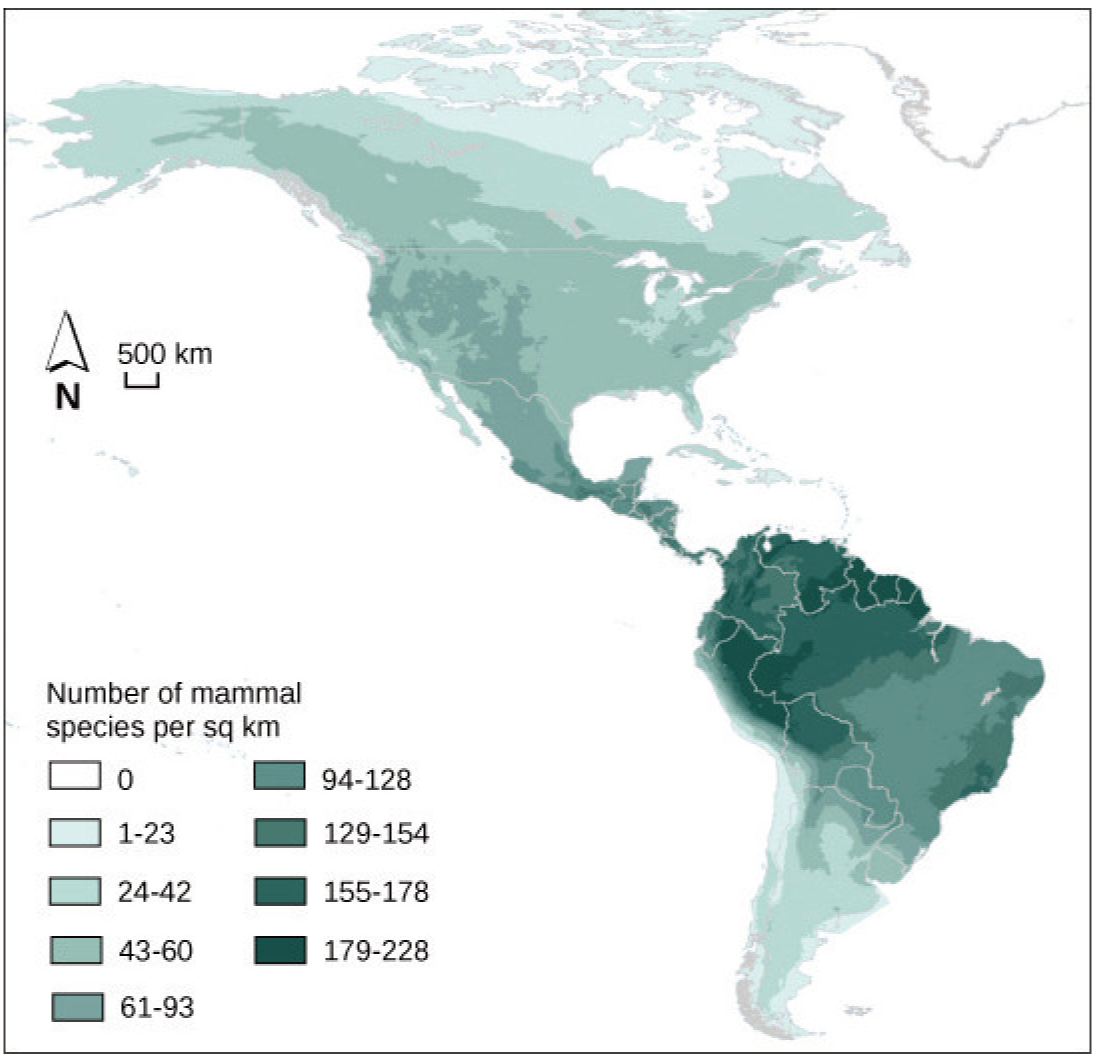
Populations typically do not live in isolation from other species. Populations that interact within agiven habitat form a **community. The number of species occupying the same habitat and their relative**abundance is known as the **diversity of the community. Areas with low species diversity, such asthe**glaciersofAntarctica, still contain a wide variety of living organisms, whereas thediversity of tropicalrainforests is so great that it cannot be accurately assessed. Scientists study ecology at the community level to understand how species interact with each other and compete for the same resources.

Characteristics of Communities

Communities are complex systems that can be characterized by their structure (the number and size of populations and their interactions) and dynamics (how the members and their interactions change over time). Understanding community structure and dynamics allows us to minimize impacts on ecosystemsand manage ecological communities we benefit from. Ecologists have extensively studied one of the fundamental characteristics of communities:**biodiversity. One measure of biodiversity used by ecologists is the number of different species in a** particular area and their relative abundance. The area in question could be a habitat, a biome, or theentire biosphere.

Species richness is the term used to describe the number of species living in a habitat

or other unit. Species richness varies across the globe (Figure 11). Species richness is related to latitude:the greatest species richness occurs near the equator and the lowest richness occurs near the poles.The exact reasons for this are not clearly understood. Other factors besides latitude influence species richness as well. For example, ecologists studying islands found that biodiversity varies with island sizeand distance from the mainland.



Relative abundance is the number individuals in aspecies relative to the total number of individuals in all species within a system.

Foundation species, described below, often havethe highest relative abundance of species.

Foundation species are considered the "base" or "bedrock" of a community, having the greatest influence on its overallstructure. They are oftenprimary producers, and they are typically anabundant organism. For example, kelp, a speciesof brown algae, is a foundation species that formsthe basis of the kelp forests off the coast of California.

Foundation species may physically modify the environment to produce and maintain habitats that benefit the other organisms that use them.Examples include the kelp described above or tree species found in a forest. The photosynthetic corals of the coral reef also provide structure byphysically modifying the environment. The exoskeletons of living and dead coralmake up most of the reef structure, which protects many other species from waves and ocean currents.

A **keystone species is one whose presence has** inordinate influence in maintaining the prevalence of various species in an ecosystem,the ecological community's structure, and sometimes its biodiversity. *Pisaster ochraceus,*the intertidal sea star, is a keystone species in the northwestern portion of the United States (Figure13). Studies have shown that when this organism is removed from communities, mussel populations (their natural prey) increase, which completely alters the species composition and reduces biodiversity. Another keystone species is the banded tetra, a fish in tropical streams, which supplies nearly all of the phosphorus, a necessary inorganic nutrient, to the rest of the community.

The banded tetra feeds largely on insects from the terrestrial ecosystem and then excretes phosphorus into the aquatic ecosystem. The relationships between populations in the community, and possibly the biodiversity, would change dramatically if these fish were to become extinct.

Invasive species are non-native organisms that, when introduced to an area out of its native range, alter thecommunity they invade. In the United States, invasive species like the purple loosestrife (*Lythrum salicaria)* and the zebra mussel (*Dreissena polymorpha) have* drastically altered the ecosystems they invaded. Somewell-known invasive animals include the emerald ash borer (*Agrilus planipennis) and the European starling* (*Sturnus vulgaris). Whether enjoying a forest hike,* taking a summer boat trip, or simply walking down an urban street, you have likely encountered an invasive species. One of the many recent proliferations of an invasive concerns the Asian carp in the United States. Asian carp were introduced to the United States in the 1970s by fisheries (commercial catfishponds) and by sewage treatment facilities that used the fish's excellent filter feeding abilities to clean their ponds of excess plankton. Some of the fish escaped, and by the 1980s they had colonized many waterways of the Mississippi River basin, including the Illinois and Missouri Rivers.

Voracious feeders and rapid reproducers, Asian carp may outcompete native species for food andcould lead to their extinction. One species, the grass carp, feeds on phytoplankton and aquatic plants. Itcompetes with native species for these resources and alters nursery habitats for other fish by removing aquatic plants. In some parts of the Illinois River, Asian carp constitute 95 percent of the community's biomass. Although edible, the fish is bony and not desired in the United States. The Great Lakes and their prized salmon and lake trout fisheries are being threatened by Asian carp.The carp are not yet present in the Great Lakes, and attempts are being made to prevent its access to the lakes through the Chicago Ship and Sanitary Canal, which is the only connection between the Mississippi River and Great Lakes basins. To prevent the Asian carp from leaving the canal, a series of electric barriers have been used to discourage their migration; however, the threat is significant enough that several states and Canada have sued to have the Chicago channel permanently cut off from Lake Michigan.

Local and national politicians have weighed in on how to solve the problem. In general,governments have been ineffective in preventing or slowing the introduction of invasive species.

Community Dynamics

Community dynamics are the changes in community structure and composition over time, often following environmental disturbances such as volcanoes, earthquakes, storms, fires, and climate change.

Communities with a relatively constant number of species are said to be at equilibrium. The equilibrium is dynamic with species identities and relationships changing over time, but maintaining relatively constant numbers. Following a disturbance, the community may or may not return to the equilibrium state.

Succession describes the sequential appearance and disappearance of species in a community over time after a severe disturbance. In primary succession, newly exposed or newly formed rock is colonized by living organisms. In **secondary succession, a part of an ecosystem is disturbed and remnants of the** previous community remain. In both cases, there is a sequential change in species until a more or less permanent community develops.

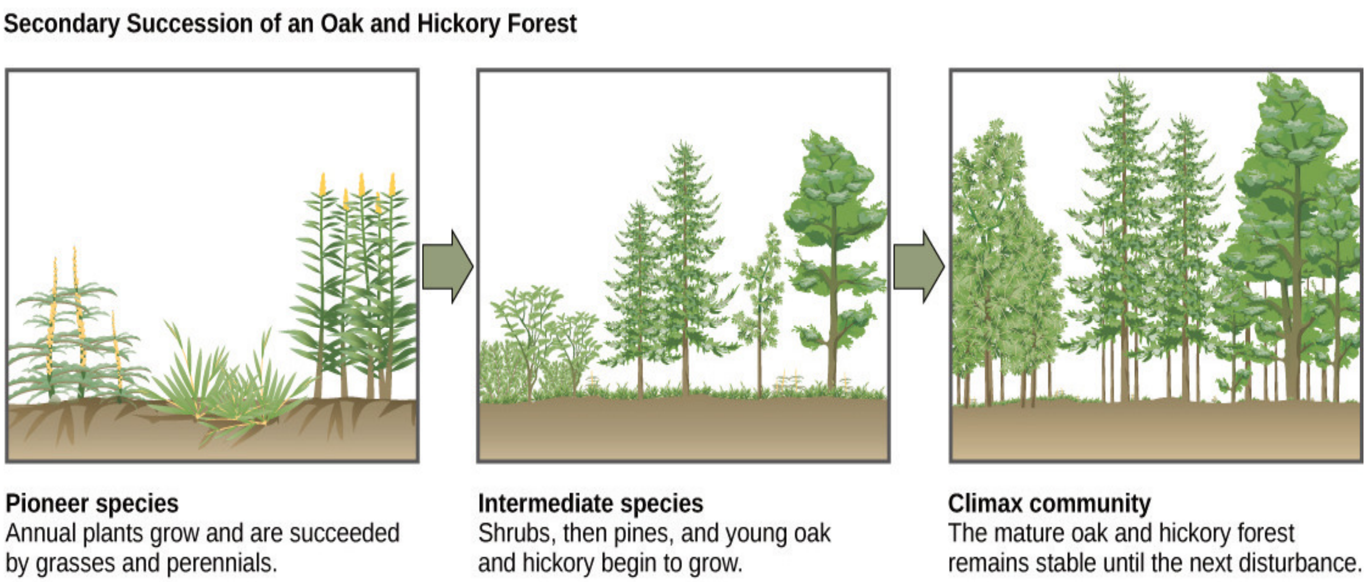
Primary Succession and Pioneer Species

Primary succession occurs when new land is formed, or when the soil and all life is removed from pre-existing land. An example of the former is the eruption of volcanoes on the Big Island of Hawaii, which results in lava that flows into the ocean and continually forms new land. From this process, approximately 32 acres of land are added to the Big Island each year. An example of pre-existing soil being removed is through the activity of glaciers. The massive weight of the glacier scours the landscape down to the bedrock as the glacier moves. This removes any original soil and leaves exposed rock once the glacier melts and retreats. In both cases, the ecosystem starts with bare rock In both cases, the ecosystem starts with bare rock that is devoid of life. New soil is slowly formed as weathering and other natural forces break down the rock and lead to the establishment of hearty organisms, such as lichens and some plants, which are collectively known as **pioneer species (Figure 14) because they are the first to appear. These species** help to further break down the mineral-rich rock into soil where other, less hardy but more competitive species, such as grasses, shrubs, and trees, will grow and eventually replace the pioneer species. Over time the area will reach an equilibrium state, with a set of organisms quite different from the pioneer Species.

Secondary succession

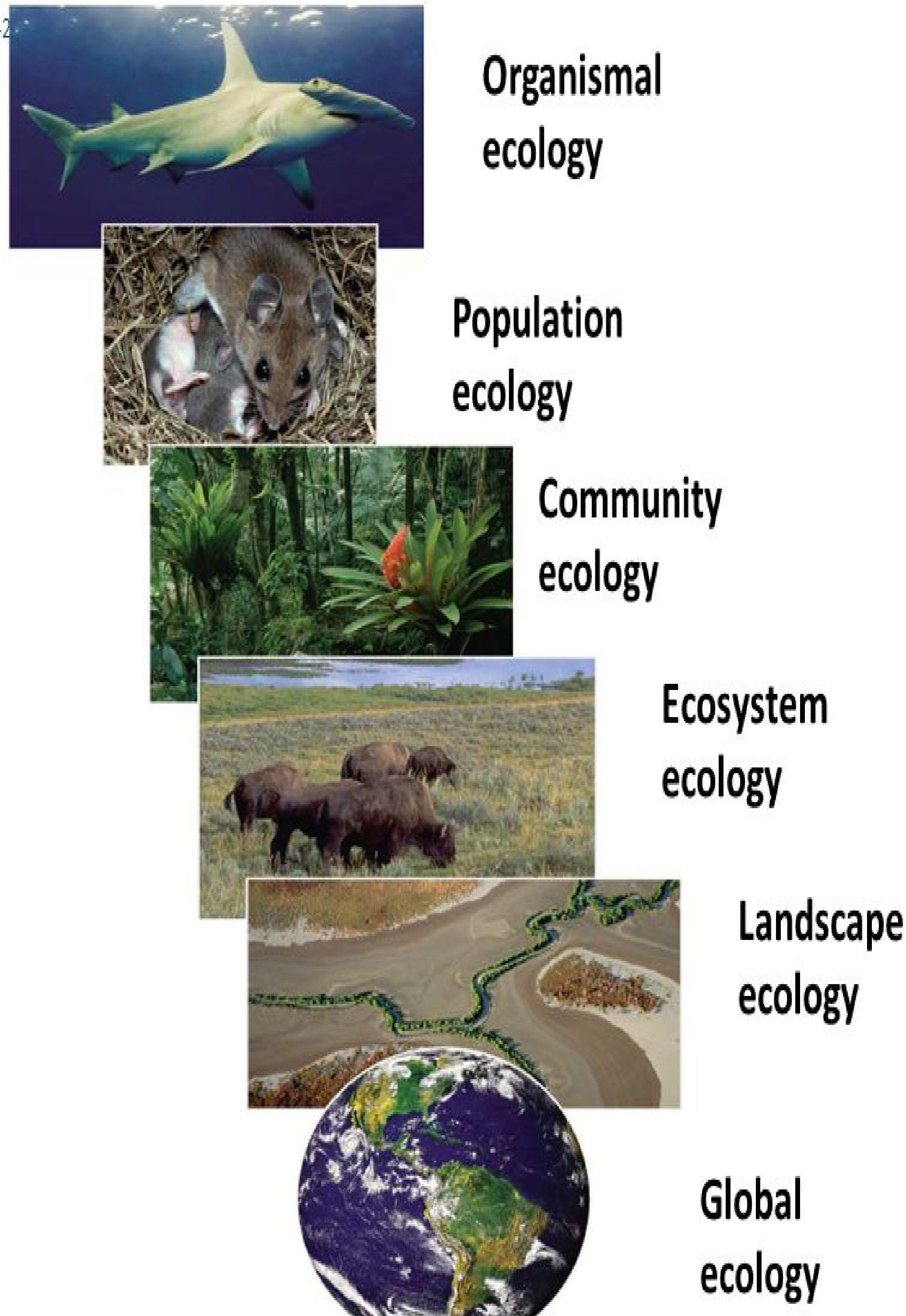
A classic example of secondary succession occurs in forests cleared by wildfire, or by clearcut logging Wildfires will burn most vegetation, and unless the animals can flee the area, they are killed. Their nutrients, however, are returned to the ground in the form of ash. Thus, although the community has been dramatically altered, there is a soil ecosystem present that provides a foundation for rapidrecolonization.Before the fire, the vegetation was dominated by tall trees with access to the major plant energy resource: sunlight. Their height gave them access to sunlight while also shading the ground and other low-lying species. After the fire, though, these trees are no longer dominant. Thus, the first plants togrow back are usually annual plants followed within a few years by quickly growing and spreading grasses and other pioneer species. Due, at least in part, to changes in the environment brought on by the growth of grasses and forbs, over many years, shrubs emerge along with small trees. These organisms are called intermediate species. Eventually, over 150 years or more, the forest will reach its equilibrium point and resemble the community before the fire. This equilibrium state is referred to as the

climax community, which will remain until the next disturbance. The climax community is typically characteristic of a given climate and geology. Although the community in equilibrium looks the same once it is attained, the equilibrium is a dynamic one with constant changes in abundance and sometimes species identities.



Secondary succession is seen in an oak and hickory forest after a forest fire. A sequence of the community present at three successive times at the same location is depicted.

Fig. 52-2


Organismal
ecology
Population
ecology
Community
ecology
Ecosystem
ecology
Landscape
ecology
Global
ecology

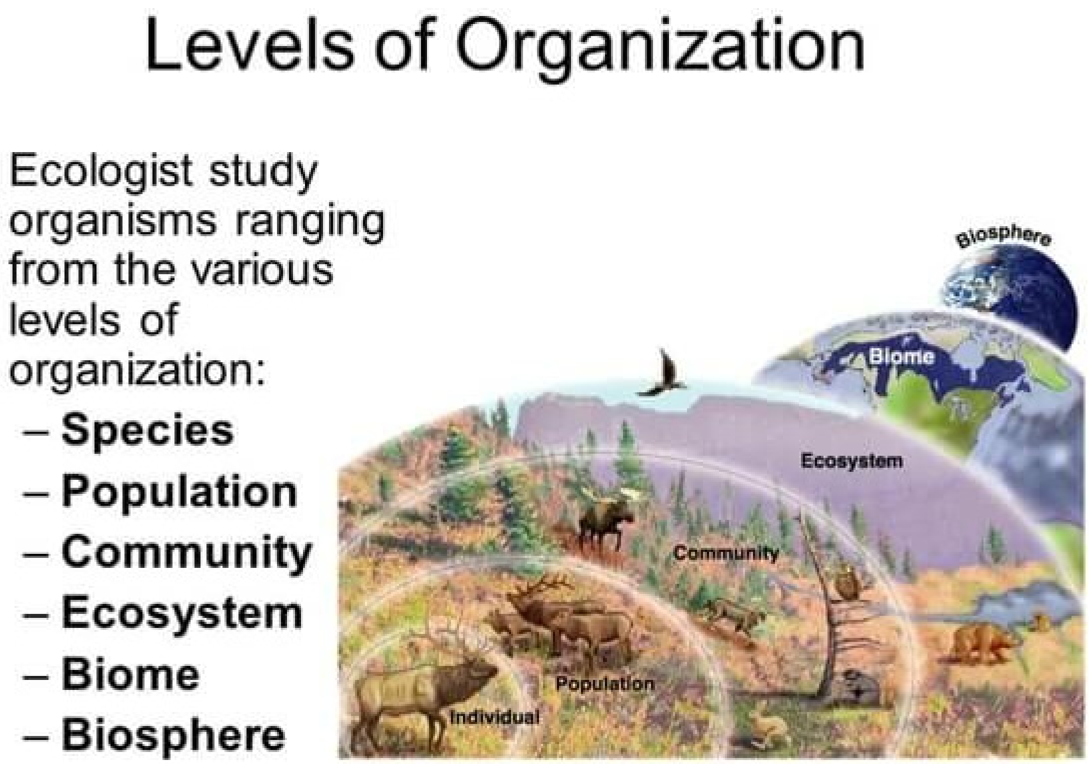
Ecology – Principles and Organizations

The term ecology was derived from two Greek words ‘Oikos’ meaning home and ‘logos’ meaning study.

Ecology is the branch of biology concerned with the relations of organisms to one another (energy flow and mineral cycling) and to their physical surroundings (environment).

Levels of Organizations in Ecology

Ecology encompasses the study of **individual, organisms, population, community, ecosystem, biome and biosphere** which form the various levels of ecological organisation.



Individual and Species

Organism is an individual living being that has the ability to act or function independently.Species are a **group** of living organisms consisting of **similar individuals capable of exchanging genes or of interbreeding**.They are considered as the basic unit of taxonomy and are denoted by a Latin binomial, e.g. *Homo sapiens*.

Population

Population is a **community of interbreeding organisms** (same species), occupying a defined area during a specific time.Population growth rate can be positive due to birth and/or immigration or negative due to death and/or emigration.In the case of large, mobile animals like tigers, leopards, lions, deer etc., the population density may be determined by counting the **pugmarks** (foot imprints) left by the animals in a defined area.Study of pug marks can provide the following information reliably:Presence of different species in the area of study.Identification of individual animals.Population of large cats (tigers, lions etc.).**Sex ratio and age** (young or adult) of large cats. (sex of tigers can be determined from pugmarks)

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Community

Communities in most instances are named after the dominant plant form.For example, a grassland community is dominated by grasses, though it may contain herbs, trees, etc.

Major Communities

These are large sized and relatively independent.

They depend only on the sun's energy from outside. E.g. **Tropical evergreen forests**.

Minor Communities

These are dependent on neighbouring communities and are often called **societies**.

They are secondary aggregations within a major community. E.g. A mat of lichen on a cow dung pad.

Ecosystem

An ecosystem is a community of organisms interacting with each other and with their environment such that energy is exchanged and system-level processes, such as the cycling of elements, emerge.

Biome

A biome is a **large naturally occurring community of flora and fauna occupying a major habitat**. E.g. Rainforest biome or tundra biome.

Plants and animals in a biome have common characteristics due to similar climates and can be found over a range of continents.

Biomes are distinct from habitats because **any biome can comprise a variety of habitats**.

Biosphere

The biosphere includes all living organisms on earth, together with the dead organic matter produced by them.

Principles of Ecology

Adaptation

An adaptation is, "the appearance or behaviour or structure or mode of life of an organism that allows it to survive in a particular environment".Adaptation may be:

Morphological – when trees grew higher, the giraffe's neck got longer;

Physiological – in the absence of an external source of water, the kangaroo rat in North American deserts is capable of meeting all its water requirements through its **internal fat oxidation** (in which water is a by-product). It also has the ability to concentrate its urine so that minimal volume of water is used to remove excretory products;

Behavioural – animals migrating temporarily to a less stressful habitat.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Examples of Adaptation

Many desert plants have a **thick cuticle** on their leaf surfaces and have their **stomata arranged in deep pits** to minimise water loss through transpiration.

Some desert plants like Opuntia, **have no leaves – they are reduced to spines,** and the photosynthetic function is taken over by the flattened stems (few leaves mean less area is available for transpiration).Mammals from colder climates generally have **shorter ears and** Mammals from colder climates generally have **shorter ears and limbs to minimise heat loss**. (This is called **Allen's Rule**.) Guess why an elephant has huge ears?

We need to breathe faster when we are on high mountains. After some days, our body adjusts to the changed conditions on the high mountain.Such small changes that take place in the body of a single organism over short periods, to overcome small problems due to changes in the surroundings, are called **acclimatisation**.

The body compensates low oxygen availability **by increasing red blood cell production, decreasing the binding capacity of haemoglobin** and by increasing breathing rate.

A **hyperthermophile** is an organism that thrives in extremely hot environments — from 60 °C. E.g. Archae bacteria flourish in hot springs and deep-sea hydrothermal vents.

Desert lizards lack the physiological ability that mammals have. They bask in the sun and absorb heat when their body temperature drops but move into the shade when the ambient temperature starts increasing.Some species are capable of burrowing into the soil to hide and escape from the above-ground heat.

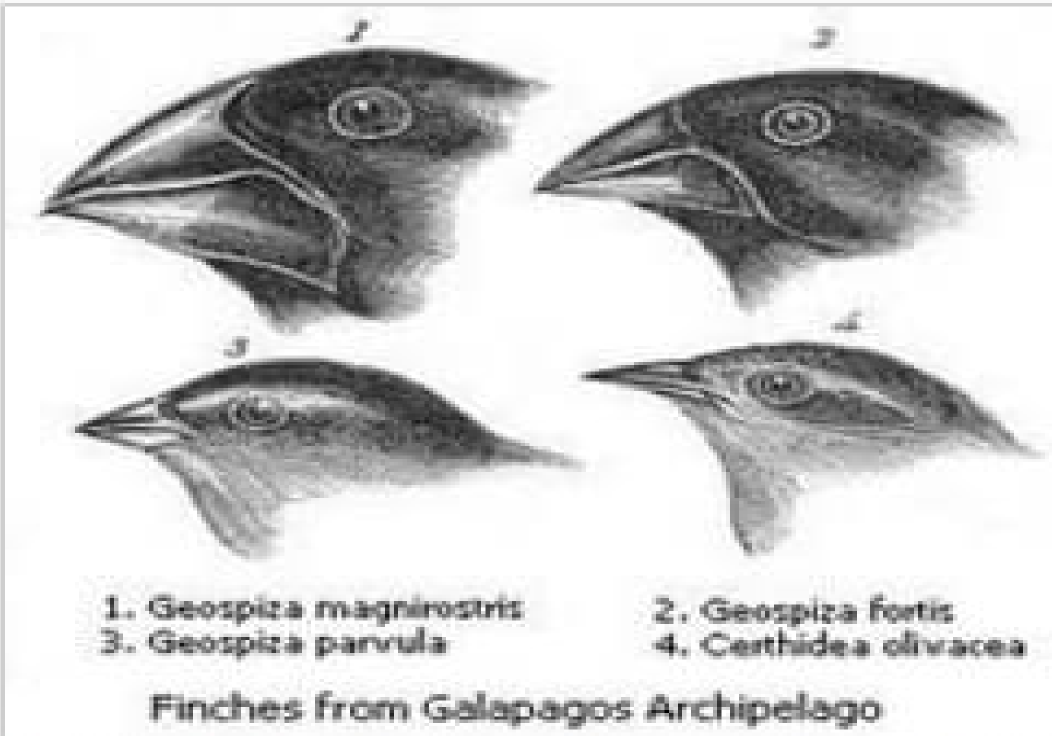
Variation

Variations are **induced by changes in genetic makeup** due to **addition or deletion of certain genes**.

Mutations, change in climate, geographical barriers etc. induce variations over a period of time.The difference in the colour of skin, type of hair; curly or straight, eye colour, blood type among different ethnic groups represents variation within human species.

Adaptive radiation

Adaptive radiation is a process in which organisms diversify from an ancestral species into a multitude of new forms when the environment creates new challenges or opens new environmental niches.



Four of the 14 finch species found on the Galápagos Archipelago, are thought to have evolved by an adaptive radiation that diversified their beak shapes to adapt them to different food sources.

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

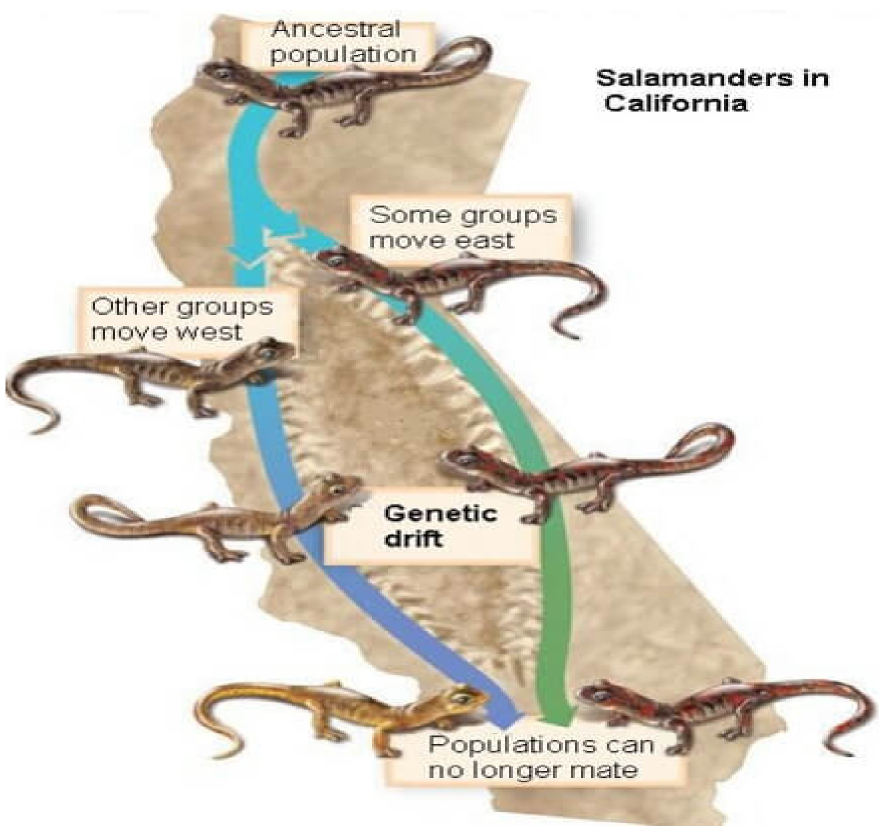
Speciation

•Speciation is the process by which **new species are formed,** and **evolution is the mechanism by which speciation is brought about**.

•A species comprises of many populations. Often different populations of a species remain isolated due to some geographic barrier such as mountain, ocean, river, etc.
Geographic isolation leads to speciation (**allopatric speciation or geographic speciation**).

•After a long period of time, the sub-populations become very different (**genetic drift**) and get isolated, reproductively, i.e. they no longer interbreed.

•Later even when the barrier is removed, the sub-populations are unable to interbreed, and thus subsequently the sub-populations become two different species.



•Mutation

Mutation (a change in genetic material that results from an **error in replication of DNA**) causes new genes to arise in a population.

Further, in a sexually reproducing population, meiosis and fertilisation produce a new combination of genes every generation, which is termed **recombination**.Thus, members of the same species show 'variation' and are not identical.

•Natural Selection

Natural Selection is the mechanism proposed by **Darwin and Wallace**.Natural selection is the process by which species adapt to their environment.It is an evolutionary force that selects **among variations, i.e. genes that help the organism to better adapt to its environment**. Such genes are reproduced more in a population due to natural selection.Those offsprings which are suited to their immediate environment have a better chance of surviving, reaching reproductive age and passing on the suitable adaptations to their progeny.

•Evolution

Evolution is the **change which gives rise to new species**.

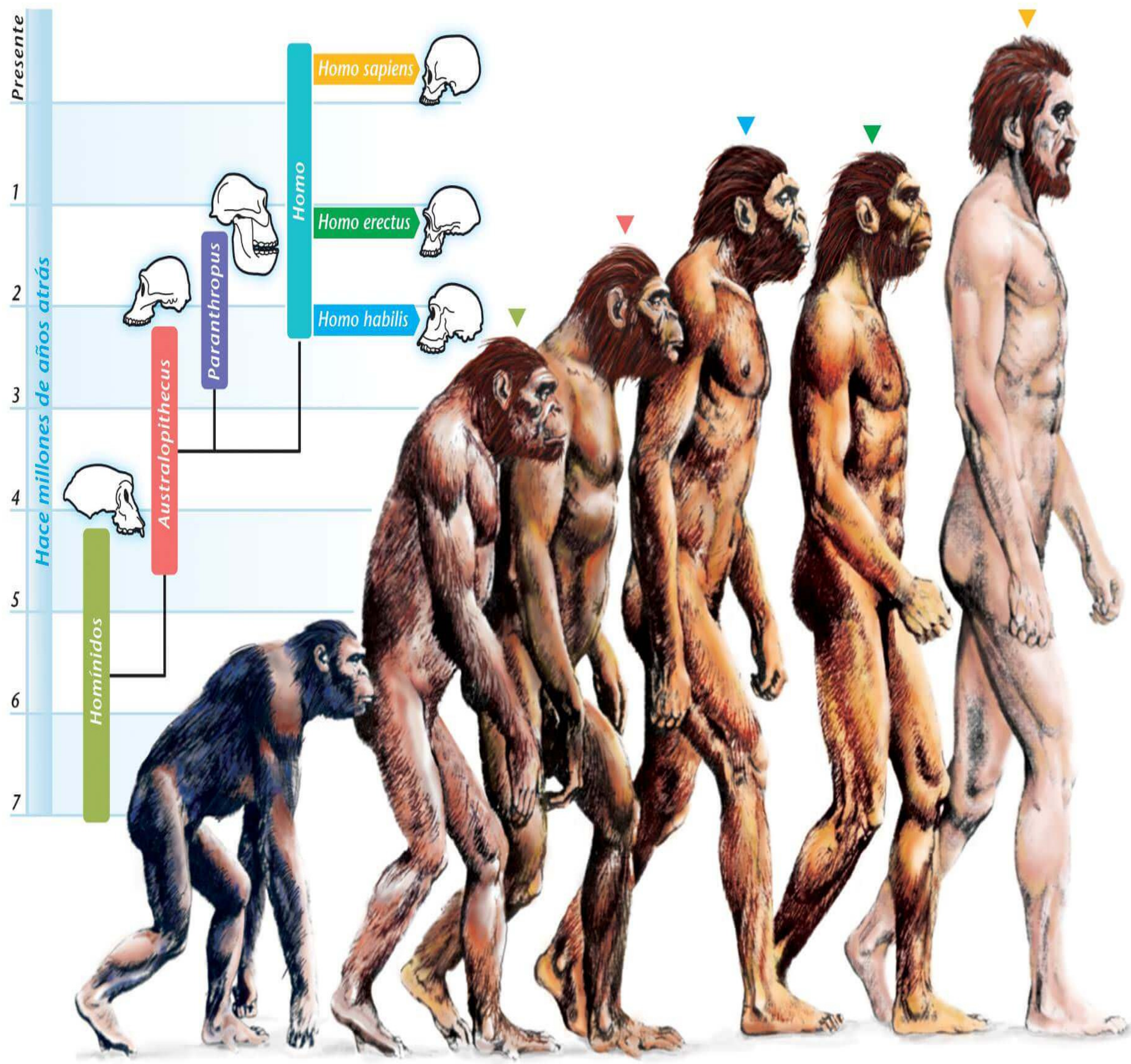
It happens in order to make the organism better suitable to the present environment.

Evolution involves the processes of natural selection, adaptation, variation etc.

A valid theory of evolution was propounded by Charles Darwin and Alfred Wallace in 1859.

This theory has been extended in the light of progress in genetics and is known as **Neo-Darwinism.**

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



•**Extinction**

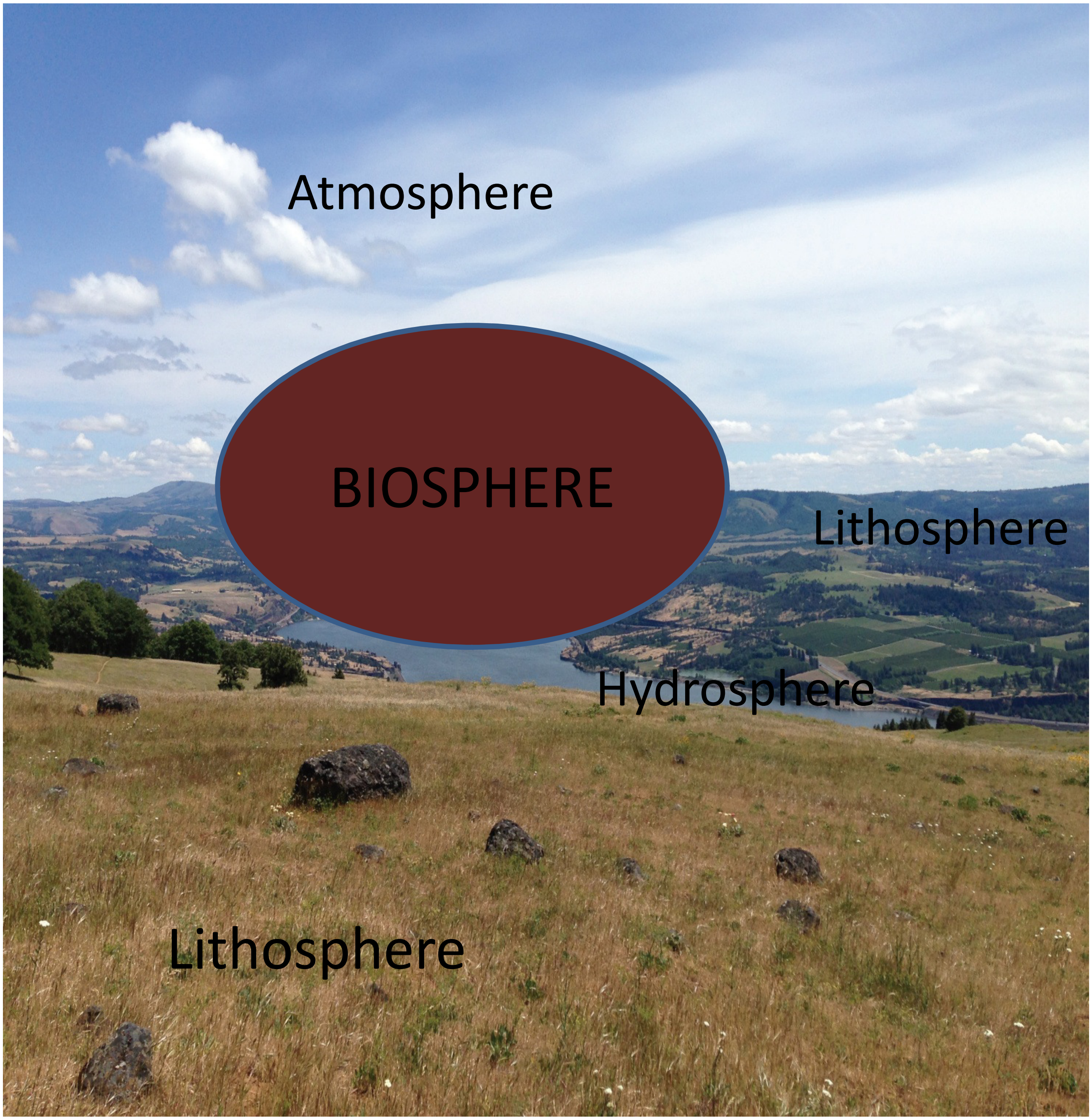
The primary reason behind extinctions is environmental change or biological competition.

Extinction occurs when species cannot evolve fast enough to cope with the changing environment.

At present, the 6th Mass Extinction (Anthropogenic Extinction – human induced) is in progress.

https://www.pmfias.com/ecology-principles-organizations/

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



BIOSPHERE

It is the total global biomass of living matter which incorporates every indiviual

Organism and series on earth.

“Bios”(Greek Word)= for life; **“Sphere”(**Latin word)=‘circuit or range of action’

Or ‘the place of action or existence’.

Literally, therefore, **Biosphere = the normal global place of existence for all**

earthly life forms.

Biosphere= The entire suite of the living organisms and the term ecosphere to decribe the environment in which the organisms live and with which they interact.

ECOSPHERE= Global ecosystem which is biosphere plus its abiotic environment.(LaMont Cole)

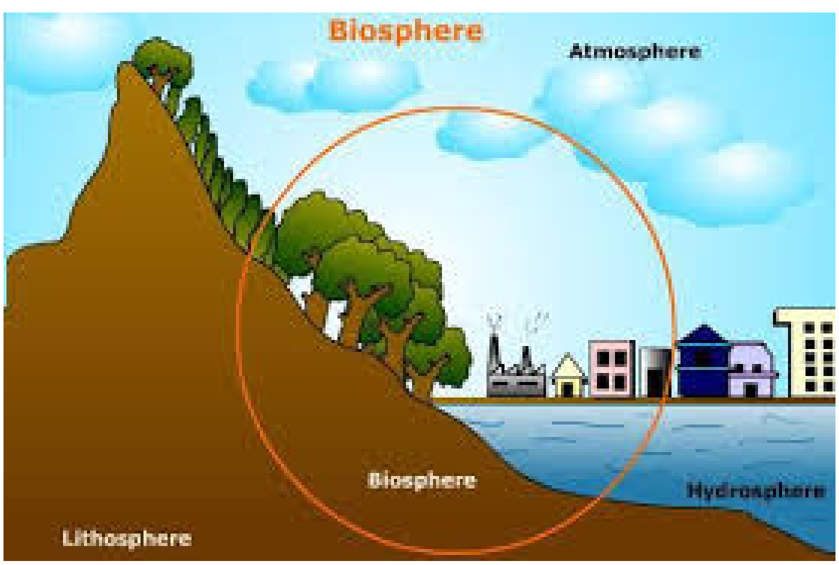
The thin layer of soil,rock,water and air that surrounds the planet earth, alongwith the living organisms for which it provides support , and which modify it in directions
That either enhance or lessen its life supporting capacity.– DASMANN

Characteristics of Biosphere:

1. It is a region in which liquid water can exist in substantial quantities;

2.It receives an ample supply of energy from an external source,the Sun,

3. Within it, there are interfaces between the liquid ,solid, and the gasseous phases of matter



THICKNESS:

Generally <30 km.The upper limit is marked by : a.Lack of oxygen

b.low pressure

c.Cold temperature

d.Lack of adequate moisture.

The lower limit is chaterised by: a.Lack of light

b.no Low or no oxygen

c. Increasing pressure

Between these limits the bulk of life is concentrated at the surface of land orOceans where the four spheres,namely,atmosphere,hydrosphere,lithosphereand biosphere blend into each other.

Uneven Distribution of Biosphere:

Over land surface:

Tropical Rain Forest – 80 m. thick

Desert or Polar regions- 3mt

Over Ocean:

Mainly concentrated in photic zone

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Biosphere Dynamics

A. Ecosystems

1. *Habitat - where an organism lives, its environment*

2. *Niche - interactions of an organism with its habitat*

3. *Ecosystem - habitat, niche and interactions between organisms*

B. Energy

1. Sun □ plants □ animals

2. First Law of Thermodynamics □ energy cannot be destroyed or created, just changes form

C. Water cycle

D. Nutrients and minerals recycled

1. Most plants require 17 elements

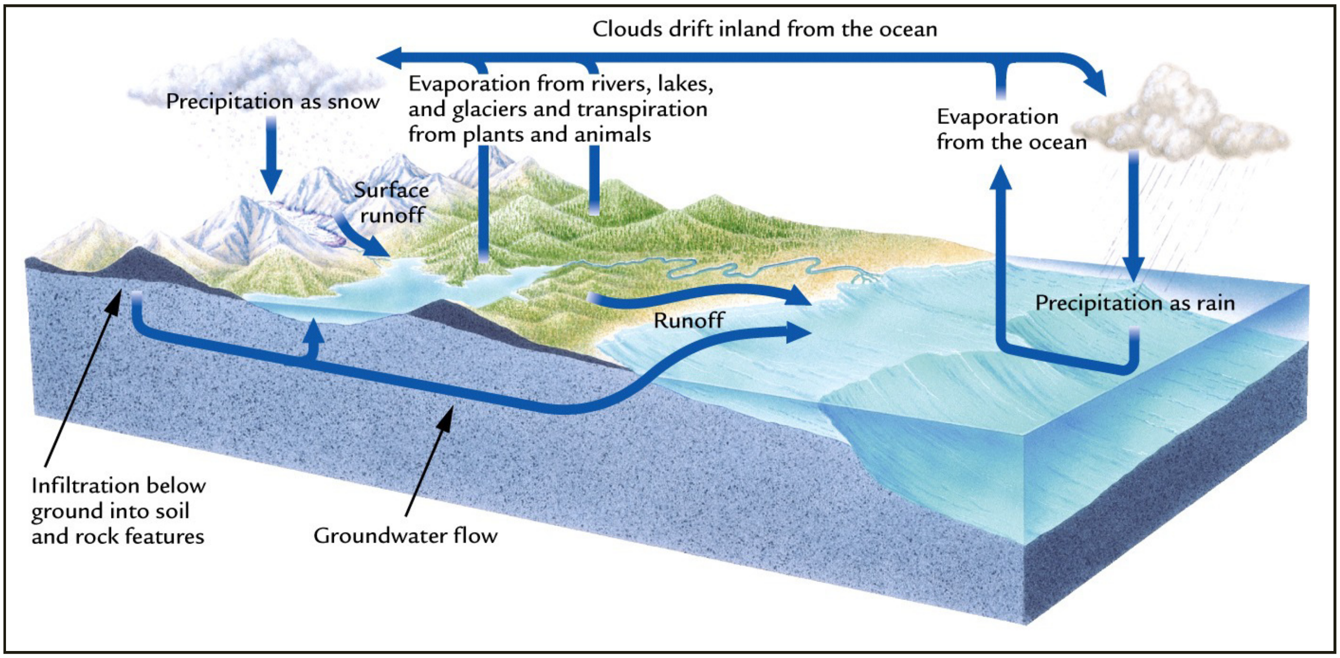
Composition of life (95%) is Carbon, Oxygen, Hydrogen, **Nitrogen, Phosphorous,**

and Sulfur.2. Elements and minerals necessary for animal functions

E. Food chain (phytoplankton → copepod → fish → squid → seal → *Orca*)

F. The biosphere pyramid (equilibrium balance / sustainable ecosystem)

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar



Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar

Vertical Dimension of Biosphere

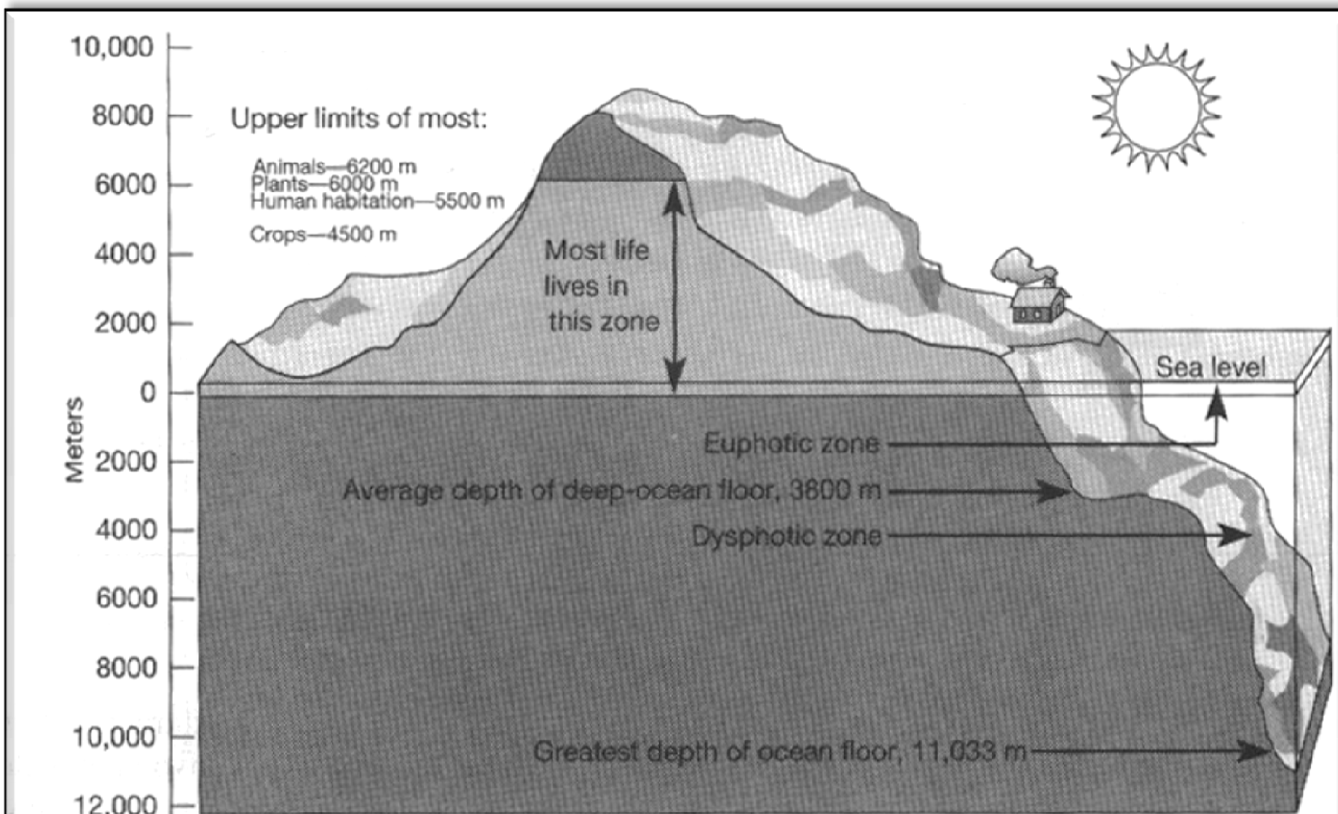
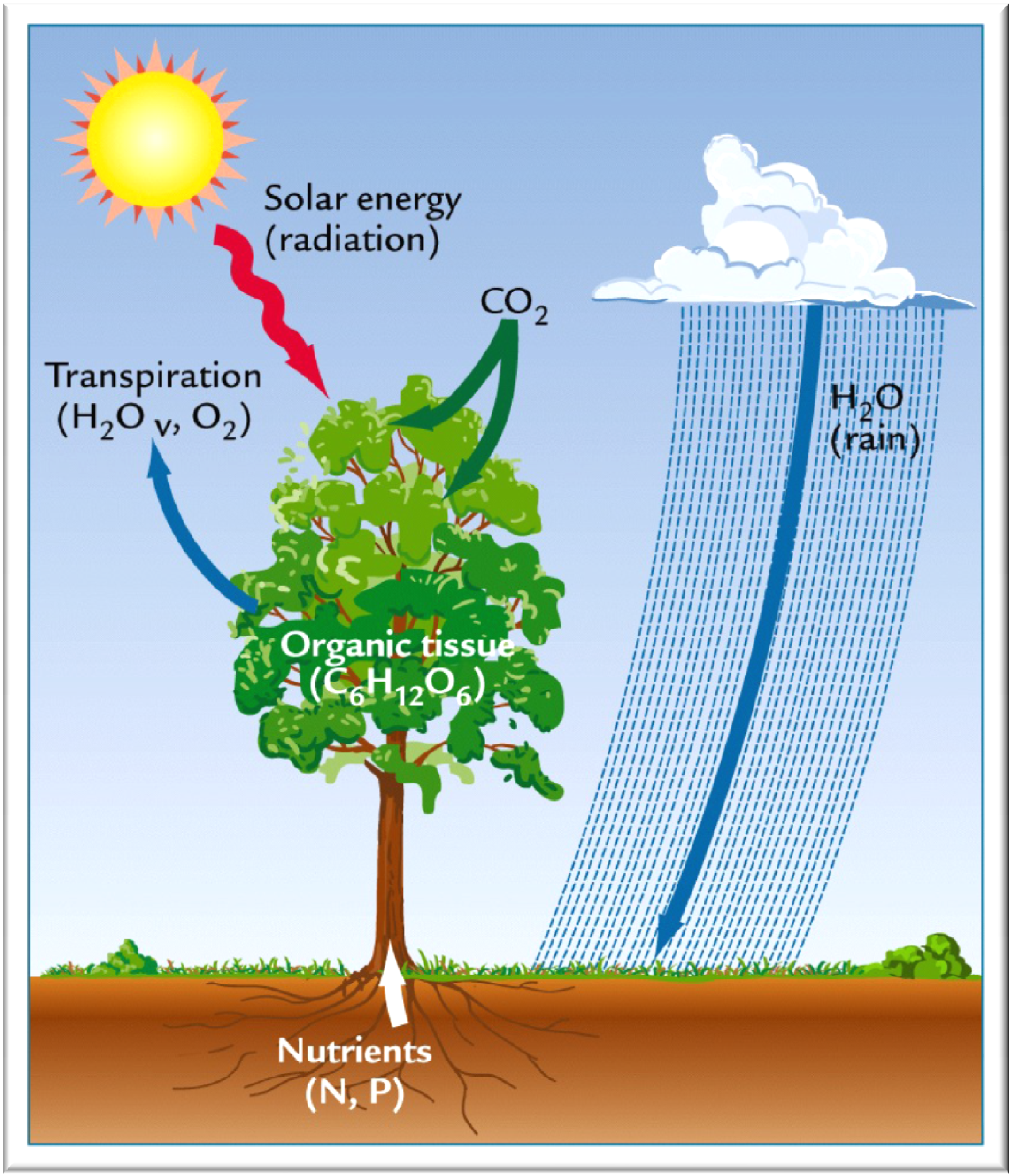
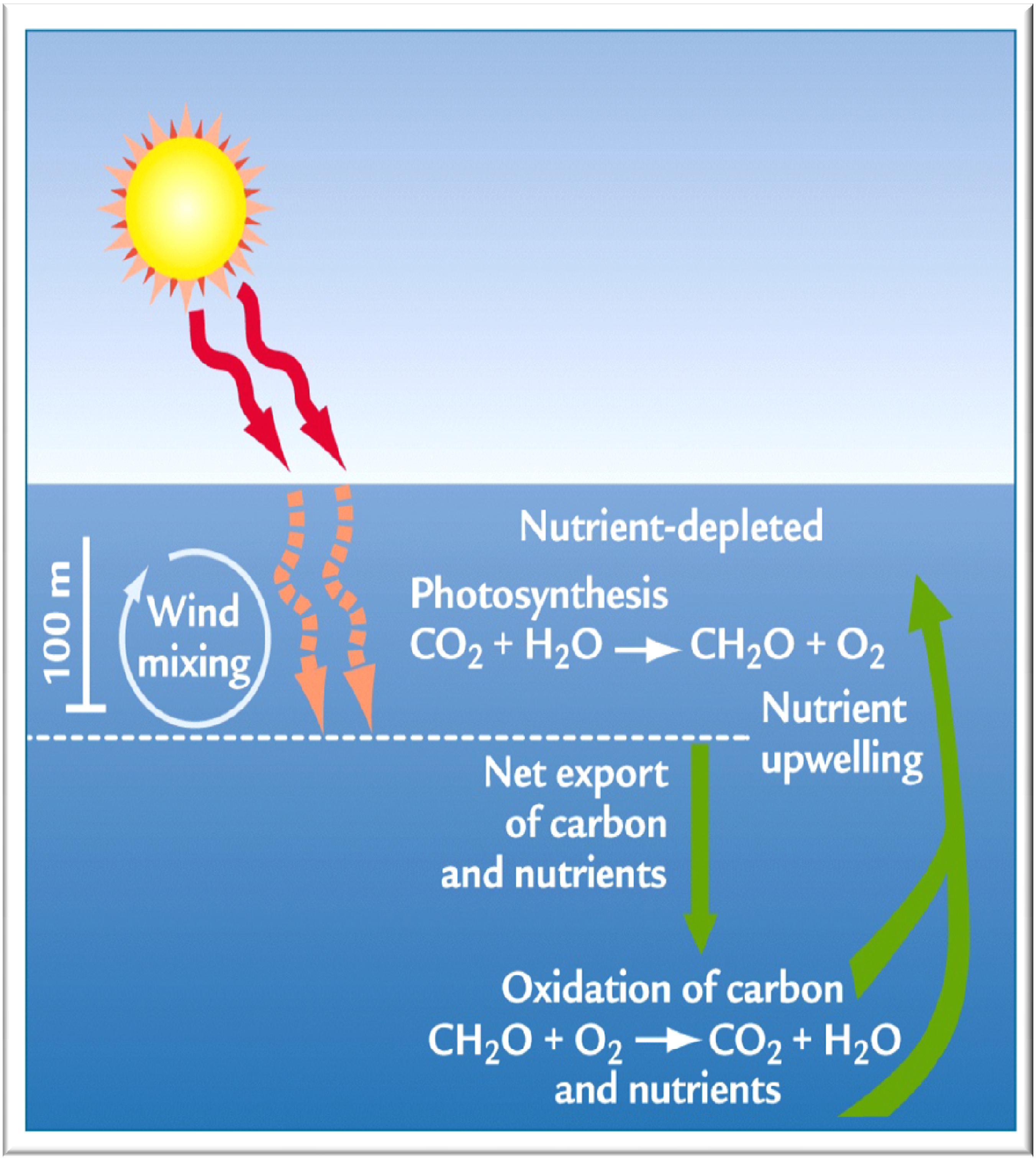


Figure 4.1 Vertical dimension of the ecosphere. Most life is restricted to the zone between 200 meters below sea level and 6000 meters above sea level. The thin euphotic zone (~100 meters) of the ocean is lighted and supports plant life, whereas the thick dysphotic zone is without the abundance of life found in the euphotic zone, although it is an important habitat for bacteria and nekton (fish).

Photosynthesis on Land

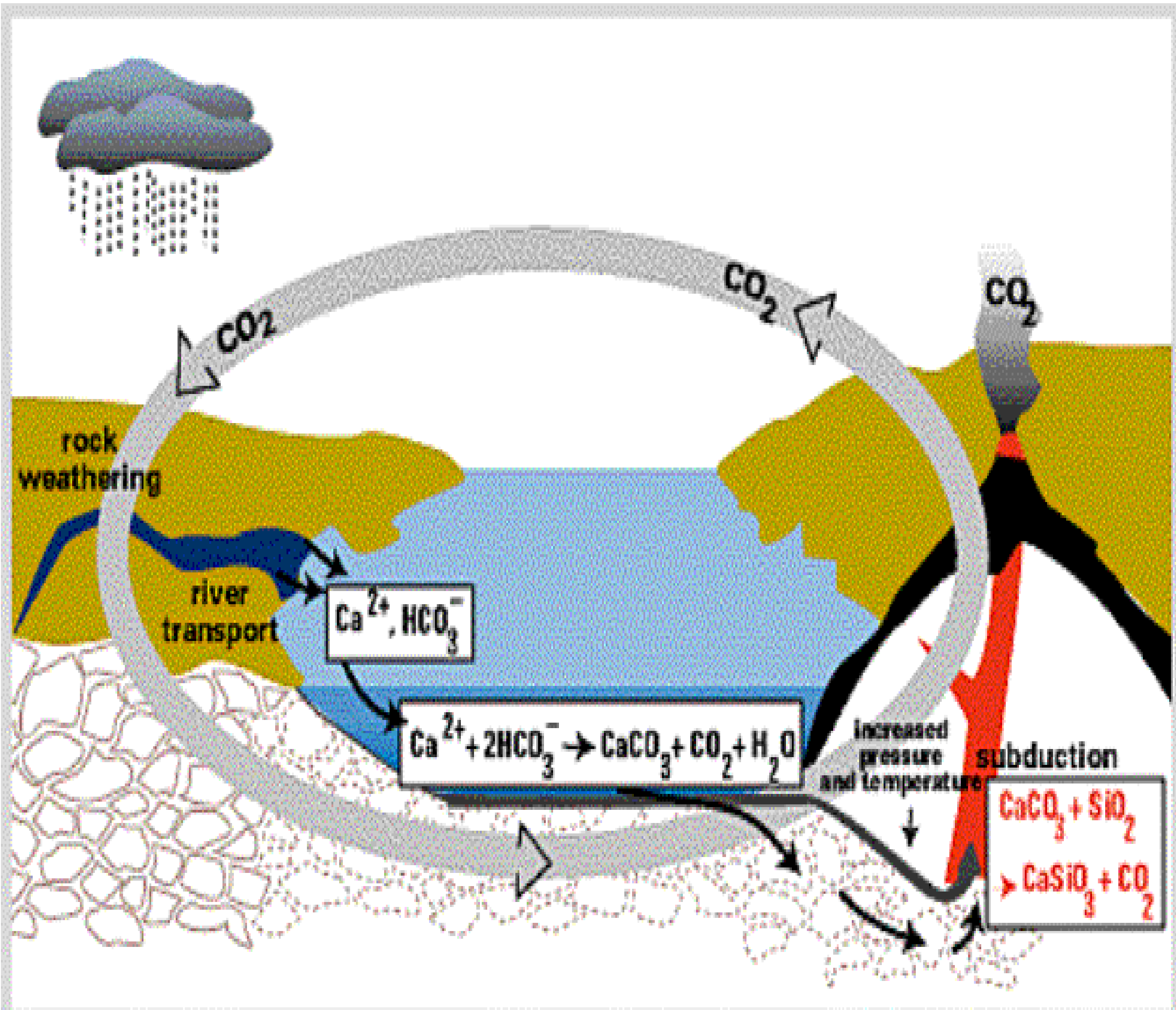


Photosynthesis in ocean



Warmer, more rainfall

Response of weathering rocks to climate regulate atmospheric CO2, in a way to stabilize climate



More rock weathering

-> remove more CO2 from atmosphere

GAIA: A New Look at Life on Earth

"... the physical and chemical condition of the surface of the Earth, of the atmosphere, and of the oceans has been and is actively made fit and comfortable by the presence of life itself. This is in contrast to the conventional wisdom which held that life adapted to the planetary conditions as it and they evolved their separate ways."

James Lovelock, 1979

GAIA – forming and regulating atmosphere?

"An awesome thought came to me. The Earth's atmosphere was an extraordinary and unstable mixture of gases, yet I knew that it was constant in composition over quite long periods of time. Could it be that life on Earth not only made the atmosphere, but also regulated it – keeping it at a constant composition, and at a level favorable for organisms?"

James Lovelock, 1991

Biosphere produces the succession of life-forms needed to keep the planet habitable.

- Supporting evidences:
- General path of biological evolution matches Earth's need for progressively greater chemical weathering. E.g., few but more primitive organisms existed in early history of the earth when it was to Earth's advantage to retain CO_2 in its atmosphere to counter the weakness of the sun. As Solar radiation strengthened, more advanced organisms formed to accelerate the rate of weathering.
- Critics:
- Life played little role in chemical weathering and carbon cycle in early earth's history (the first 4BY).

Lovelock's GAIA Contribution

Whether or not you accept the extreme versions of the GAIA hypothesis, the publication of "GAIA, A New Look at Life on Earth" (1979) has influenced the way in which scientists and the generalpublic view the Earth. It is still being hotly debated 25 years later.Raised consciousness! Holistic view of the Earth. Earth from space.Focused attention on the role of the Biosphere in Atmosphericprocesses

Biogeography : unit II Topic: 7&8 Dr. Manikuntala Kanrar