Handout-1 on Environment & Ecology by Mr. Vaishali Anand

ECOSYSTEM SERVICES

Ecosystem services are the benefits people obtain from ecosystems.

Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors.

Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions.

Provisioning Services

These are the products obtained from ecosystems, including:

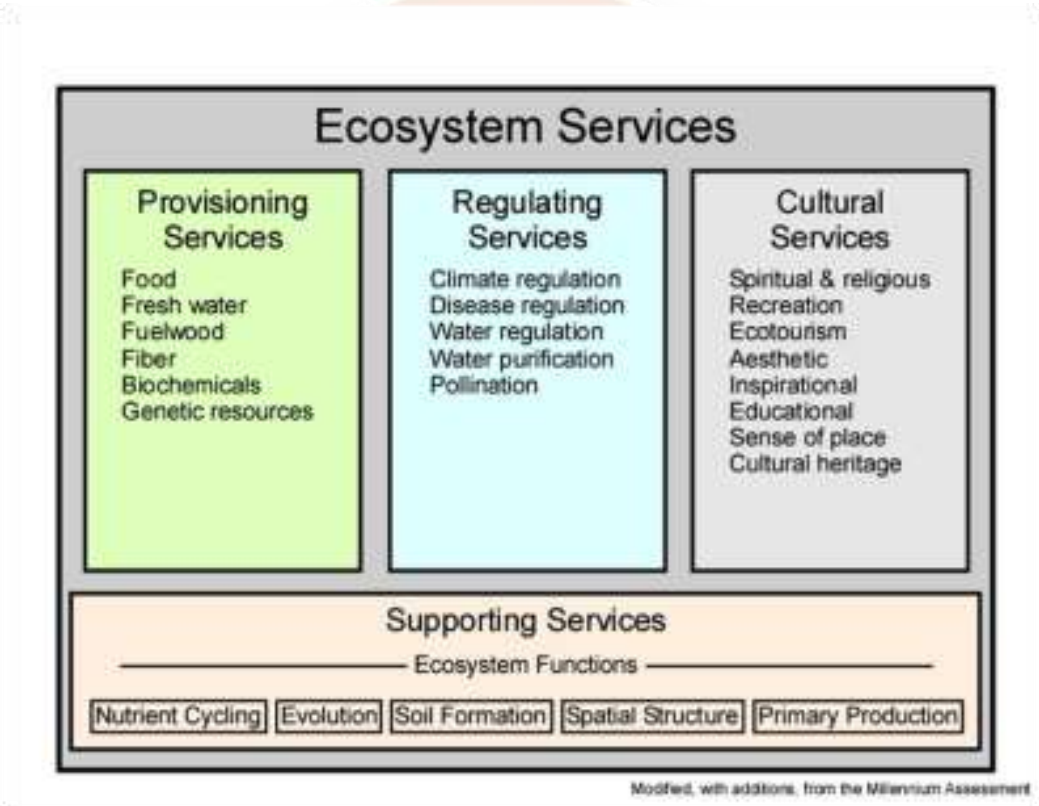
- Food and fiber. This includes the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, jute, hemp, silk, and many other products derived from ecosystems. „
- Fuel. Wood, dung, and other biological materials serve as sources of energy
- Genetic resources. This includes the genes and genetic information used for animal and plant breeding and biotechnology. „
- Biochemicals, natural medicines, and pharmaceuticals. Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems. „
- Ornamental resources. Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined. This is an example of linkages between the categories of ecosystem services. „
- Fresh water. Fresh water is another example of linkages between categories—in this case, between provisioning and regulating services.

Regulating Services

These are the benefits obtained from the regulation of ecosystem processes, including: „

- *Air quality maintenance*. Ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality.
- Climate regulation. Ecosystems influence climate both locally and globally. For example, at a local scale, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases. „
- Water regulation. The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas. „

- Erosion control. Vegetative cover plays an important role in soil retention and the prevention of landslides. „
- Water purification and waste treatment. Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems. „
- Regulation of human diseases. Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes. „
- Biological control. Ecosystem changes affect the prevalence of crop and livestock pests and diseases. „
- Pollination. Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators. „
- Storm protection. The presence of coastal ecosystems such as mangroves and coral reefs can dramatically reduce the damage caused by hurricanes or large waves.



Cultural Services

These are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including: „

- Cultural diversity. The diversity of ecosystems is one factor influencing the diversity of cultures. „

- Spiritual and religious values. Many religions attach spiritual and religious values to ecosystems or their components. „
- Knowledge systems (traditional and formal). Ecosystems influence the types of knowledge systems developed by different cultures.
- Educational values. Ecosystems and their components and processes provide the basis for both formal and informal education in many societies.„
- Inspiration. Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising. „
- Aesthetic values. Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, “scenic drives,” and the selection of housing locations. „
- Social relations. Ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies. „
- Sense of place. Many people value the “sense of place” that is associated with recognized features of their environment, including aspects of the ecosystem. „
- Cultural heritage values. Many societies place high value on the maintenance of either historically important landscapes (“cultural landscapes”) or culturally significant species. „
- Recreation and ecotourism. People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area.

Cultural services are tightly bound to human values and behavior, as well as to human institutions and patterns of social, economic, and political organization. Thus perceptions of cultural services are more likely to differ among individuals and communities than, say, perceptions of the importance of food production.

Supporting Services

Supporting services are those that are necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. (Some services, like erosion control, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people.) For example, humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production. Similarly, climate regulation is categorized as a regulating service since ecosystem changes can have an impact on local or global climate over time scales relevant to human decision-making (decades or centuries), whereas the production of oxygen gas (through photosynthesis) is categorized as a supporting service since any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time. Some other examples of supporting services are primary production,

production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

SOURCE- Report: ECOSYSYTEMS & HUMAN WELL- BEING: A FRAMEWORK FOR ASSESSMENT by United Nations

ECOLOGICAL / BIOTIC INTERACTIONS-

"No man is an island." This saying is also true for organisms in an ecosystem. **No organism exists in isolation**. Individual organisms live together in an ecosystem and depend on one another. In fact, they have many different types of interactions with each other, and many of these interactions are critical for their survival.

Table 13.1 : Population Interactions

Species A	Species B	Name of Interaction
+	+	*Mutualism*
–	–	*Competition*
+	–	*Predation*
+	–	*Parasitism*
+	0	*Commensalism*
–	0	*Amensalism*

A category of interactions between organisms has to do with close, usually long-term interaction between different types of organisms. These interactions are called symbiosis. The impacts of **symbiosis** can be positive, negative, or neutral for the individuals involved.

Organisms often provide resources or services to each other; the interaction is mutually beneficial. These “win-win” symbiotic interactions are known as **mutualism (+ +)**. For example, ants living in a tree may protect the tree from an organism that would like to make the tree its next meal, and at the same time the tree provides a safe home for the ants.

Symbiotic relationships are not always positive for both participants. Sometimes there are definite losers. In **parasitism (+ -)**, for example, the parasite benefits and the host is harmed, such as when a tick sucks blood out of a dog.

Predation (+ -) is another winner-loser relationship but it is not symbiosis. The predator benefits and the prey is harmed lethally, but it is a short-term interaction. In parasitism, the parasite does not usually kill its host, but just feeds on it for a long time while it is living.

PREDATION: ONE WINS, ONE LOSES

Predation includes any interaction between two species in which one species benefits by obtaining resources from and to the detriment of the other. While it's most often associated with the classic predator-prey interaction, in which one species kills and consumes another, not all predation interactions result in the death of one organism. In the case of herbivory, a herbivore often consumes only part of the plant. While this action may result in injury to the plant, it may also result in seed dispersal. Many ecologists include parasitic interactions in discussions of predation. In such relationships, the parasite causes harm to the host over time, possibly even death. As an example, parasitic tapeworms attach themselves to the intestinal lining of dogs, humans and other mammals, consuming partially digested food and depriving the host of nutrients, thus lowering the host's fitness.

COMPETITION: THE DOUBLE NEGATIVE

Competition exists when multiple organisms vie for the same, limiting resource. Because the use of a limited resource by one species decreases availability to the other, competition lowers the fitness of both. Competition can be interspecific, between different species, or intraspecific, between individuals of the same species. In the 1930s, Russian ecologist Georgy Gause proposed that two species competing for the same limiting resource cannot coexist in the same place at the same time. As a consequence, one species may be driven to extinction, or evolution reduces the competition.

MUTUALISM: EVERYONE WINS

Mutualism describes an interaction that benefits both species. A well-known example exists in the mutualistic relationship between alga and fungus that form lichens. The photsynthesizing alga supplies the fungus with nutrients, and gains protection in return. The relationship also allows lichen to colonize habitats inhospitable to either organism alone. In rare case, mutualistic partners cheat. Some bees and birds receive food rewards without providing pollination services in exchange. These "nectar robbers" chew a hole at the base of the flower and miss contact with the reproductive structures.

COMMENSALISM: A POSITIVE/ZERO INTERACTION

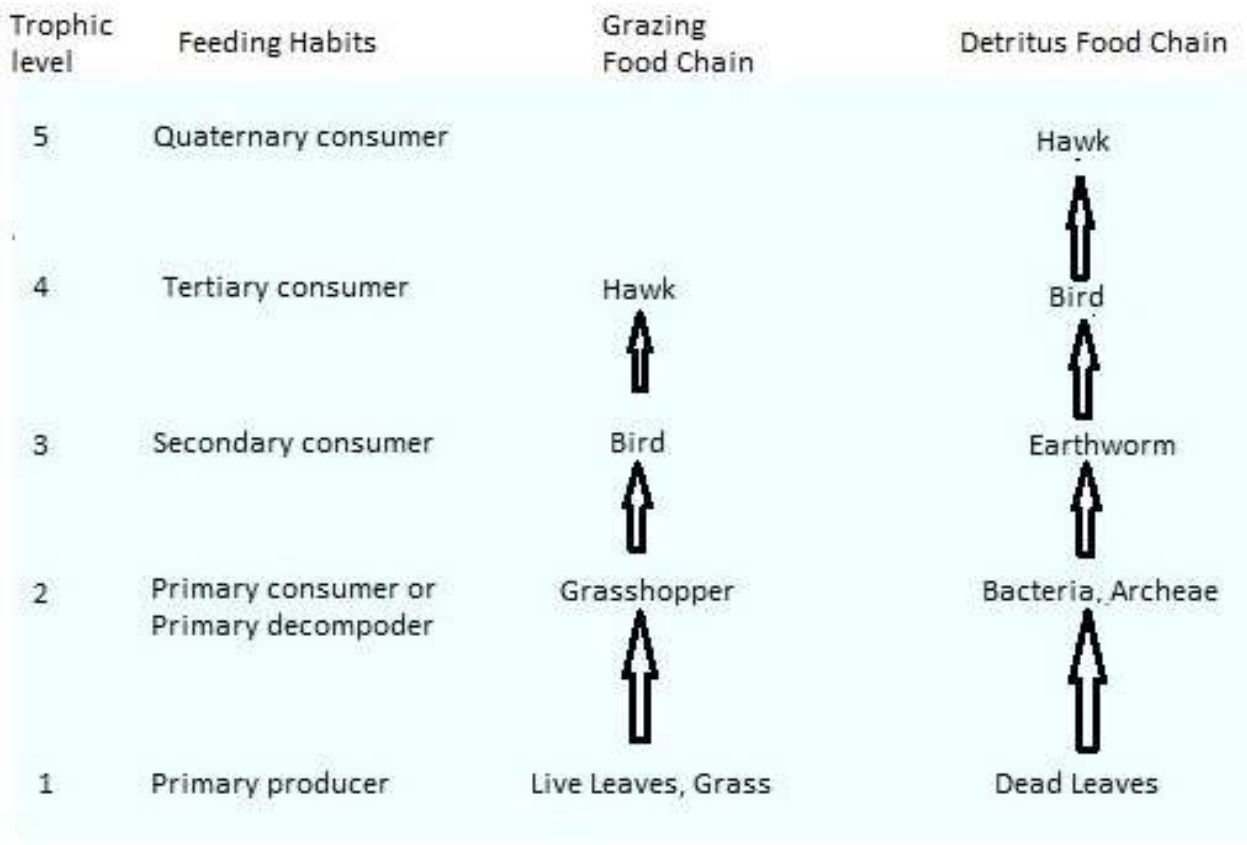
An interaction where one species benefits and the other remains unaffected is known as commensalism. As an example, cattle egrets and brown-headed cowbirds forage in close association with cattle and horses, feeding on insects flushed by the movement of the livestock. The birds benefit from this relationship, but the livestock generally do not. Often it's difficult to tease apart commensalism and mutualism. For example, if the egret or cowbird feeds on ticks or other pests off of the animal's back, the relationship is more aptly described as mutualistic.

AMENSALISM: A NEGATIVE/ZERO INTERACTION

Amensalism describes an interaction in which the presence of one species has a negative effect on another, but the first species is unaffected. For example, a herd of elephants walking across a landscape may crush fragile plants. Amensalistic interactions commonly result when one species produces a chemical compound that is harmful to another species. The chemical juglone produced in the roots of black walnut inhibit the growth of other trees and shrubs, but has no effect on the walnut tree.

FOOD CHAIN & FOOD WEB

A food chain is a linear sequence of organisms through which nutrients and energy pass as one organism eats another. In ecosystems, linear food chains don't exist. There is a complex web of food chains which make up the energy transfer possible. Food web is interconnected food chains. Basically, there are two types of food chains- Grazing & Detritus-



ECOLOGICAL PYRAMIDS

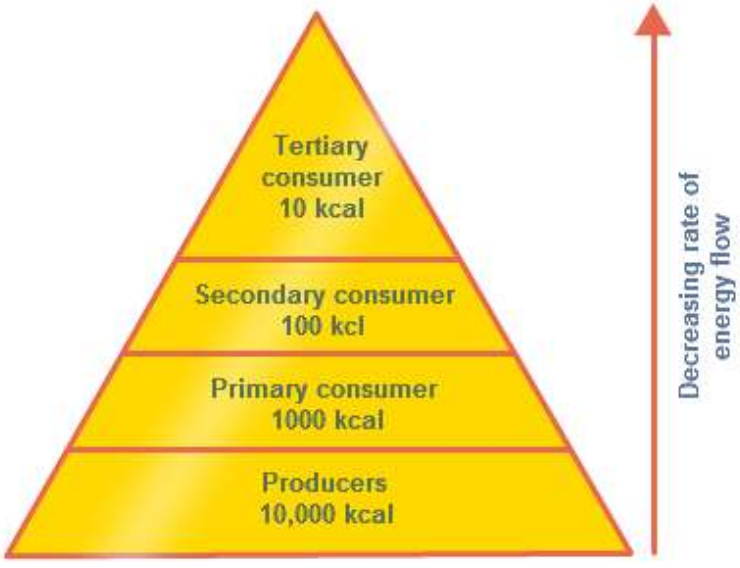
The concept of ecological pyramid was developed by Charles Elton; these pyramids are also known as Eltonian pyramids. The pyramids are a graphical representation which depicts the number of organisms, biomass and productivity at each trophic level. All ecological pyramids begin at the bottom with the produces and proceed through different trophic levels. The top of the pyramid represents the highest level in the food chain.

There are 3 types of ecological pyramids as described as follows:

1. Pyramid of energy
2. Pyramid of numbers
3. Pyramid of biomass.

1. **The pyramid of energy or the energy pyramid** describes the overall nature of the ecosystem. During the flow of energy from organism to other, there is considerable loss of energy in the form of heat. The primary producers like the autotrophs there is more amount of energy available. The least energy is available in the tertiary consumers. Thus, shorter food chain has more amount of energy available even at the highest trophic level.

- The energy pyramid always upright and vertical.
- This pyramid shows the flow of energy at different trophic levels.
- It depicts the energy is minimum as the highest trophic level and is maximum at the lowest trophic level.
- At each trophic level, there is successive loss of energy in the form of heat and respiration, etc.



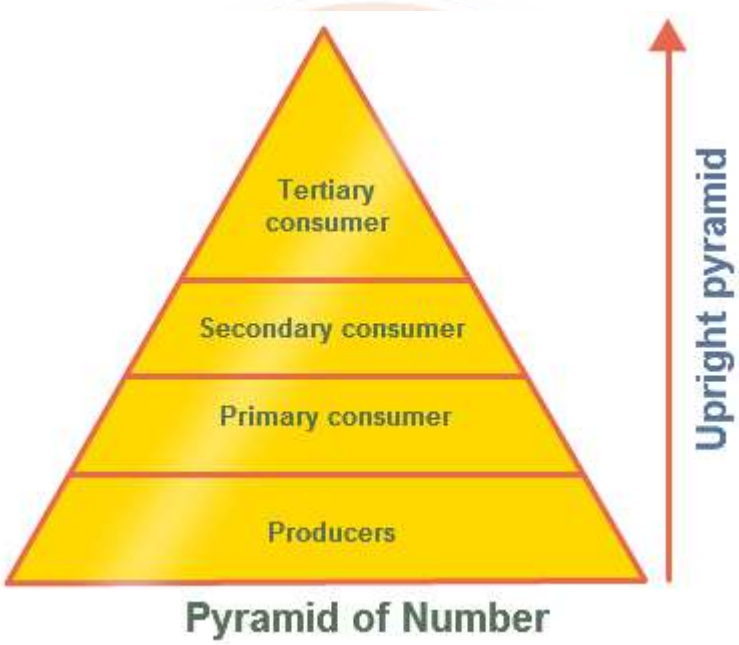
Pyramid of Energy

2. **The pyramid of numbers** depicts the relationship in terms of the number of producers, herbivores and the carnivores at their successive trophic levels. There is a decrease in the number of individuals from the lower to the higher trophic levels. The number pyramid varies from ecosystem to ecosystem. There are three of pyramid of numbers:

- Upright pyramid of number
- Partly upright pyramid of number and
- Inverted pyramid of number.

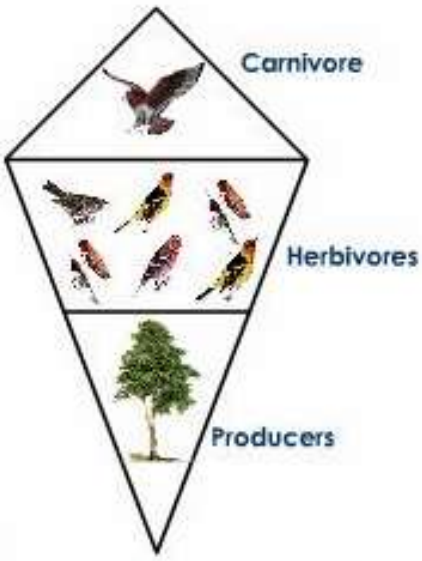
Upright Pyramid of Number-

This type of pyramid number is found in the aquatic and grassland ecosystem, in these ecosystems there are numerous small autotrophs which support lesser herbivores which in turn support smaller number of carnivores and hence this pyramid is upright.



Partly Upright pyramid of Number-

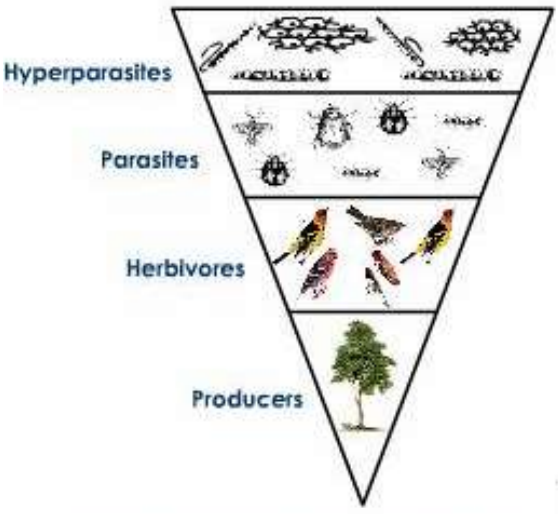
It is seen in the forest ecosystem where the number of producers are lesser in number and support a greater number of herbivores and which in turn support a fewer number of carnivores.



Partly Upright
Pyramid of Number

Inverted Pyramid of Number-

This type of ecological pyramid is seen in parasitic food chain where one primary producer supports numerous parasites which support more hyperparasites.



Inverted pyramid of number

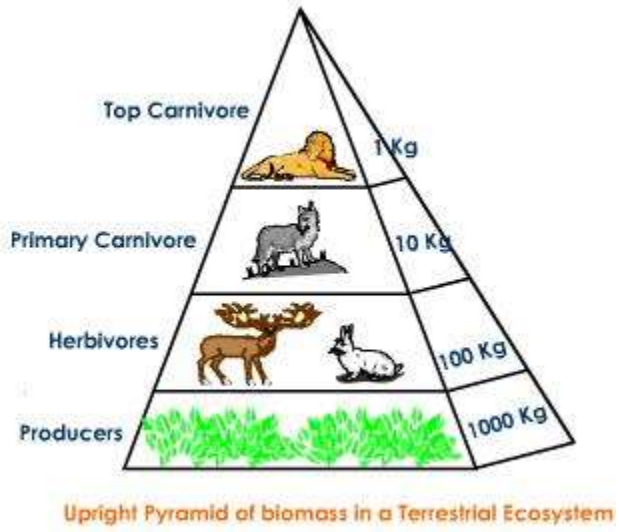
3. **The pyramid of biomass** is more fundamental, they represent the quantitative relationships of the standing crops. In this pyramid there is a gradual decrease in the biomass from the producers to the higher trophic levels. The biomass here the net organisms collected from each feeding level and are then dried and weighed. This dry weight is the biomass and it represents the amount of energy available in the form of organic matter of the organisms. In this pyramid the net dry weight is plotted to that of the producers, herbivores, carnivores, etc.

There are two types of pyramid of biomass, they are:

- Upright pyramid of biomass and
- Inverted pyramid of biomass.

Upright Pyramid of Biomass-

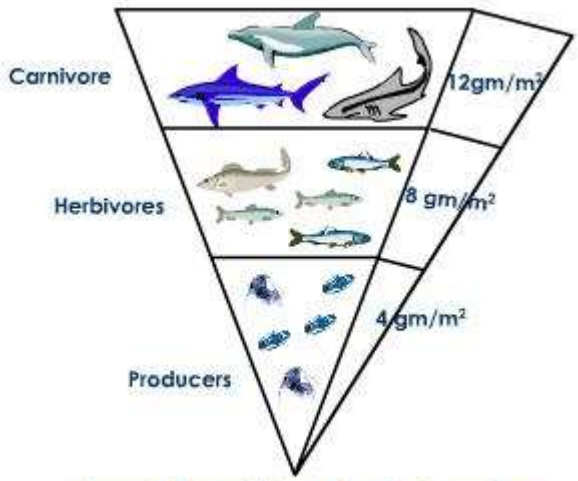
This occurs when the larger net biomass of producers support a smaller weight of consumers. Example: Forest ecosystem.



Upright Pyramid of biomass in a Terrestrial Ecosystem

Inverted Pyramid of Biomass –

This happens when the smaller weight of producers support consumers of larger weight. Example: Aquatic ecosystem. This is because the phytoplankton producers (with generally smaller biomass) are located at the base while the consumers having larger biomass are located at the top of the pyramid.



Inverted Pyramid in an Aquatic Ecosystem

Function of Ecological Pyramid- An ecological pyramid not only shows us the feeding patterns of organisms in different ecosystems, but can also give us an insight into how inefficient energy transfer is, and show the influence that a change in numbers at one trophic level can have on the trophic levels above and below it. Also, when data are collected over the years, the effects of the changes that take place in the environment on the organisms can be studied by comparing the data. If an ecosystem's conditions are found to be worsening over the years because of pollution or overhunting by humans, action can be taken to prevent further damage and possibly reverse some of the present damage.

While the three ecological pyramids are highly specific to the aspect of ecosystem they want to describe, all of them still tend to overlook important aspects. Some of these limitations are the following:

These types of pyramids only are applicable in simple food chains (and not food webs), which do not necessarily occur naturally. They also do not consider the possible presence of the same species at different trophic levels.

Other organisms like bacteria and fungi are not given specific role in the pyramids despite their vital roles in ecosystems.

ECOLOGICAL SUCCESSION-

Biotic communities are dynamic in nature and change over a period of time. The process by which communities of plant and animal species in an area are replaced or changed into another over a period of time is known as ecological succession.

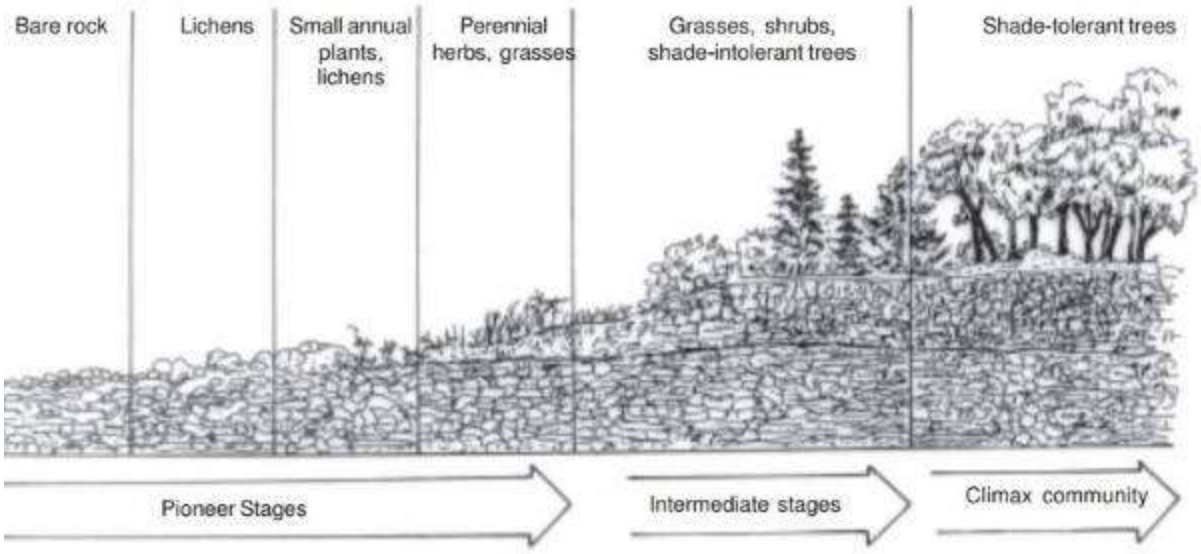


***Fig 4.15:** The orderly sequence of primary succession*

There are two types of ecological succession- **Primary & Secondary Succession**

Primary Succession is the establishment of plants on land that has not been previously vegetated or on previously uninhabited area. Primary Succession occurs where no biotic community has previously existed like newly exposed sea floor, volcanic islands, etc. The area is devoid of any organisms. It may take up to 1000 years before climax community gets established.

Secondary Succession- Successional dynamics following severe disturbance or removal of a pre-existing community are called secondary succession Secondary succession is the invasion of a habitat by plants on land that was previously vegetated. Pre-exist vegetation may be damaged by natural or human disturbances such as fire, logging, cultivation, or hurricanes.

Dynamics in secondary succession are strongly influenced by pre- disturbance conditions, including soil development, seed banks, remaining organic matter, and residual living organisms. Because of residual fertility and pre-existing organisms, community change in early stages of secondary succession can be relatively rapid.

It occurs when a biotic community has been destroyed and the surface is completely or largely devoid of vegetation. It may be due to earthquake, fire or even clearing of forest by man. As the spores, seeds, rhizomes the organs of vegetative reproduction are present beneath the soil. Often grasses, shrubs, weeds are first to appear. Secondary succession is much more commonly observed and studied than primary succession.

Particularly common types of secondary succession include responses to natural disturbances such as fire, flood, and severe winds, and to human-caused disturbances such as logging and agriculture. The same principle of primary succession applies but it occurs at a much faster.