Types of ecosystems

Ecosystems are classified into **terrestrial ecosystems** and **aquatic ecosystems**.

Aquatic ecosystems

Aquatic ecosystem is any watery environment, from small to large (i.e. from ponds to oceans), running or still (rivers or lakes) that contain a group of interacting organisms (plants, animals, microbes) that are dependent on one another and their water environment for energy and food (carbon), nutrients (e.g. N, P) and shelter.

An aquatic ecosystem is an ecosystem located in a body of water, contain communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems.

Ecosystems consisting of water as the main habitat are known as **aquatic ecosystems**. There are three kinds of aquatic ecosystems : Fresh water, saline and brackish water ecosystems. Freshwaters are again of two types, the static water ecosystems are called lentic systems and flowing water ecosystems are called as lotic systems.

Aquatic ecosystems are features in the landscape that participate in the processing and transport of materials from continents to oceans. Aquatic ecosystems are sources of biodiversity, and they sustain livelihood and economic activities around the world.

It is on the saline basis, that aquatic ecosystems are categorized into:

1) **Fresh water ecosystems:** lakes. ponds, swamps, pools, springs, streams, and rivers.

2) **Marine ecosystems**: shallow seas and open ocean. And,

3) **Brackish water ecosystems:** estuaries, salt marshes, mangrove swamps and forests.

1- Fresh water ecosystems

Freshwater ecosystems cover 0.78% of the Earth's surface and inhabit 0.009% of its total water. They generate nearly 3% of its net primary production. Freshwater ecosystems contain 41% of the world's known fish species.

Fresh water ecosystems depend on the terrestrial ecosystems for large quantities of organic and inorganic matter which are constantly added into them by the communities growing on nearby land

There are three basic types of freshwater ecosystems:

1- **Lentic:** slow moving water, or standing or basin series ecosystems. including pools, ponds, lakes. marshes etc.
2- **Lotic:** faster moving water, or running or channel series ecosystems for example streams, rivers, springs etc.
3- **Wetlands:** areas where the soil is saturated or inundated for at least part of the time, such as swamps.

1- Lentic ecosystems

1.1. Lakes

The lakes are natural or artificial inland depressions containing standing water, they preserved the water, whether from rain, streams, or springs flowing to them, they may be deep or shallow, large or small, and the quality of lakes depends on the quality of the water connected to them, so their waters may be fresh or salty, and usually the lake has one or more water inlets, while It has one exit.

The lakes are vary considerably in area and depth. The largest lake in the world, the lake Superior in North America has a surface area of 83,000 km^2 and a maximum depth of 307 meters. Whereas the deepest lake, in the world, lake Baikal in Siberia 706 meters. Fresh water lakes of this earth hold 125 x 10^3 Km^3 of water and have inflow as well as outflow. In addition they have various patterns of circulation within their boundaries and so their water is not totally static. However, they do lack the constant linear or turbulent flow of the rivers.

lakes are used for the following purposes:

1- Drinking and agriculture.
2- Reduce the dangers of rivers and torrents.
3- Generate electrical energy.

The origin of the lakes:

Lakes arise in several ways, and these depend on the ways by which the lake basin is formed, thus lakes are formed as a result of the following:

1- Earth's crust movement: the **tectonic lakes**, are formed in basins created by geological activities such as warping and faulting of the earth's crust. Most of the Himalayan lakes are tectonic in origin.

2- Volcanic activity: Some are formed in crater depressions of extinct volcanoes and are called **crater lakes**, for example lake Kounsaranag in Kashmir.

3- Ice fridge activity (glacial activity): For example most lakes of North America originated due to glacial erosions and deposition, whereby glacial abrasions of slopes in high mountain engraved basin which later became filled with melting snow and rain.

4- Landslide: Lakes may also arise by landslides blocking off streams and valley.

5- Activity of some living organisms: such as the beaver, and the dense growth of some high-end aquatic plants that retain water in a specific area of the valley.

6- Human action: Artificial lakes such as lakes formed behind dams and artificial water reservoirs.

Characteristics of Lake Ecosystems

The environment of static waters of lakes and ponds sharply contrasts with those of lotic ecosystems. Light penetration in lakes is usually up to a certain depth which is effected by turbidity. Temperature and dissolved oxygen also vary with depth.

The gradations of temperature, sunlight and oxygen are directly responsible for vertical zonation or stratification. occurring in lakes. They are also responsible indirectly for horizontal zonation of lakes as they profoundly influence the distribution of lake organisms which contribute to the characteristic horizontal zonations.

A) Thermal Stratification : Shallow lakes show no thermal stratification as their waters are well mixed, resulting in uniform temperature throughout. However lakes with depths of more than 15 meters and It is usually located in the temperate regions of the Northern Hemisphere. exhibit fairly pronounced temperature stratification.

a) ***Summer Stratification*** : Thermal stratification is fairly pronounced during the summer seasons in most lakes of the temperate (cold) regions but is rare in lakes of tropical (hot) and subtropical regions where it occurs only in very deep lakes. This is so, because the rate of mixing of layers is very fast in case of tropical lakes

whereas, the temperate lakes retain well defined layers showing different temperature. These layers do not mix rapidly. Therefore the temperate lakes exhibit clear stratification with respect to temperature.

How thermal stratification develops in water bodies and why it is maximum during the summer seasons?

In lakes the top one meter of the water surface directly absorbs around 90 per cent of the total solar radiation falling on it and is considerably more heated in the process. Consequently, the lower sub-surface layers receive progressively less radiation and remain relatively cool. Thus, the lake becomes thermally stratified, with its water forming layers due to temperature differences or thermal gradients. Thermal stratification is maximum during the summer season, primarily due to two reasons. Firstly, due to the fact that solar intensity increases during this period and it heats the surface layer greatly while the lower layers remain comparatively cool. Secondly, the thermally stratified layers offer resistance to mixing by wind. The fairly pronounced stratification of lakes developed in summer is called summer stratification or stagnation. The various stratified layers which are formed as a result can be delineated as follows:

i) Epilimnion : This forms the upper layer of the lake and consists of freely circulating warm water which is well lighted though poor in nutrients. Most of the phytoplanktons grow in the epilimnion which is well aerated both due to photosynthetic oxygen production by plants and mixing by wind.

ii) Metalimnion : This zone lies below the epilimnion and above the hypolimnion and thus forms the intermediate layer which is non-circulating. The metalimnion is characterized by steep and rapid fall in water temperature with increasing depth. Within the metalimnion is present the 'thermocline', the plane at which the temperature drops most rapidly - at least 1 Celsius for each meter of depth.

iii) Hypolimnion : This zone forms the bottom layer which is deep, cold and non-circulating. The hypolimnion is generally rich in nutrients though its oxygen content is low due to its utilization by decomposition process which generally occurs here and uses up oxygen. Temperature fall here is gentle.

Stratification of certain temperate lakes is not limited to the summer season as they undergo stagnation or stratification in winter. also which is called winter stratification or stagnation and is described below.

b) ***Winter Stratification*** : During extremes of winter the surface layer of the lake freezes or attains a temperature close to O^o Celsius. Under these conditions an inverse stratification develops. The water beneath the ice absorbs solar radiation passing through the ice and so remains relatively warm. When this worm water attains a temperature of

4°C it becomes dense and heavier. Consequently it sinks to the bottom where it mixes with bottom water of the lake which is warmed by heat conducted from the bottom mud. The result is higher temperature at the bottom, though the overall stability of water remains undisturbed. That is, the less dense-surface water in the form of ice or at O°C floats on the top of the warm, heavier water which is at an appropriate temperature of 4°C. Both of these layers remain stratified and do not mix during the winter season so that the lake is said to have undergone, winter stagnation or stratification.

Overturn :The summer or winter stratification is seasonal. Circulation of lake water occurs twice a year, in the spring and autumn (fall) seasons by a process called overturn. This circulation is important for lakes which .undergo stratification as it allows thorough mixing of oxygen, phytoplankton and nutrients within the lake. Let us now understand the process of overturn both in the spring and autumn seasons.

Spring overturn : In spring and early summer season the increased solar radiation melts the ice cover, which, as it attains a temperature of 4" Celsius, becomes dense and heavy and sinks to the bottom, displacing the lower water which moves up. This circulation of water is further helped by the prevailing summer winds and is called spring overturn.

Autumn (fall) overturn : In autumn or early winter the air temperature falls, resulting in the cooling of the surface waters. When the surface water cools to 4°C it becomes dense and heavy and sinks to the bottom displacing the bottom warm water which rises to the surface. This mixing of the surface and bottom layers is further facilitated by strong winter winds and is called 'fall overturn'.

B) Light Stratification

the penetration of light in water bodies is limited depending on the transparency of water and its ability to absorb light. On the basis of light penetration lakes become vertically stratified into two basic layers

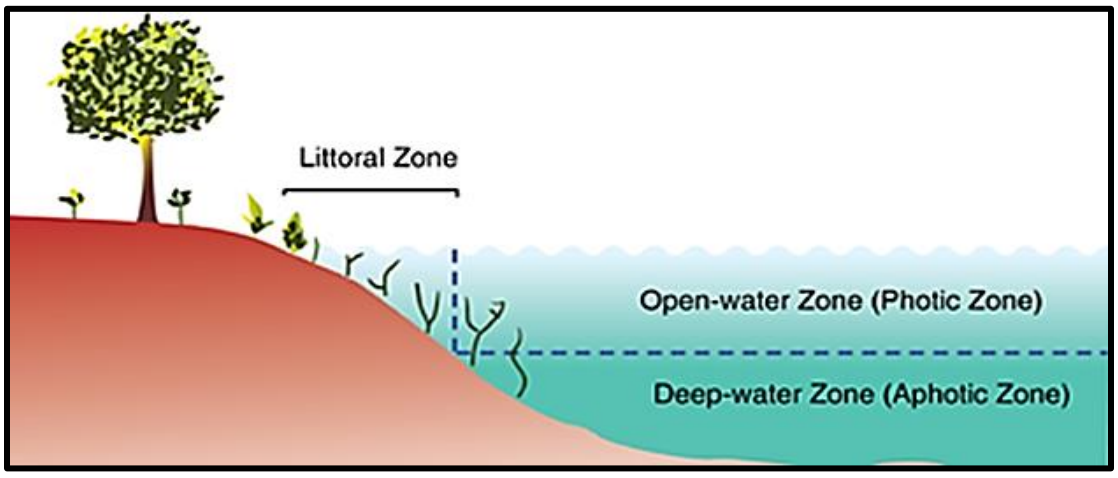
(1) upper trophogenic zone, 'corresponding roughly to the photic zone in which photosynthesis dominates and the lower, and

(2) tropholytic zone where' decomposition is most active and which corresponds to the aphotic zone .

Between these two zones is the **compensation depth** - the depth at which light intensity is such that the photosynthetic production is just enough to balance respiratory losses and beyond which light penetration is so low that it is no longer effective. Generally compensation depth occurs where light intensity is about 100 foot candles or approximately one per cent of full noon sunlight incident to the surface.

C) Oxygen Stratification

In most lakes, oxygen stratification nearly parallels that of temperature during the summer season. The amount of oxygen is greatest on the surface, gradually decreasing with depth. The surface layer has the maximum oxygen content due to two main reasons. First, being well lighted, maximum photosynthetic oxygen is produced here. Secondly, being in intimate contact with the atmosphere, it permits free diffusion of oxygen into it from the air. The oxygen content, beneath the. Surface water decreases, as both these oxygen sources disappear. At/the bottom the oxygen content decreases further due to utilization of oxygen by decomposers occurring here.



The three primary zones of a lake

The lakes can be divided into horizontal zones . This division is on the basis of life forms existing in lakes. The penetration of sunlight in the lake influences the vertical gradient of sunlight, temperature and oxygen. The horizontal gradation of lakes is affected by distribution of organisms in the waters. One common system divides lakes into three zones:

A- **littoral zone**: This is the shallow water zone, near the shore, where light penetrates to the bottom. Rooted plants can grow only in this region.

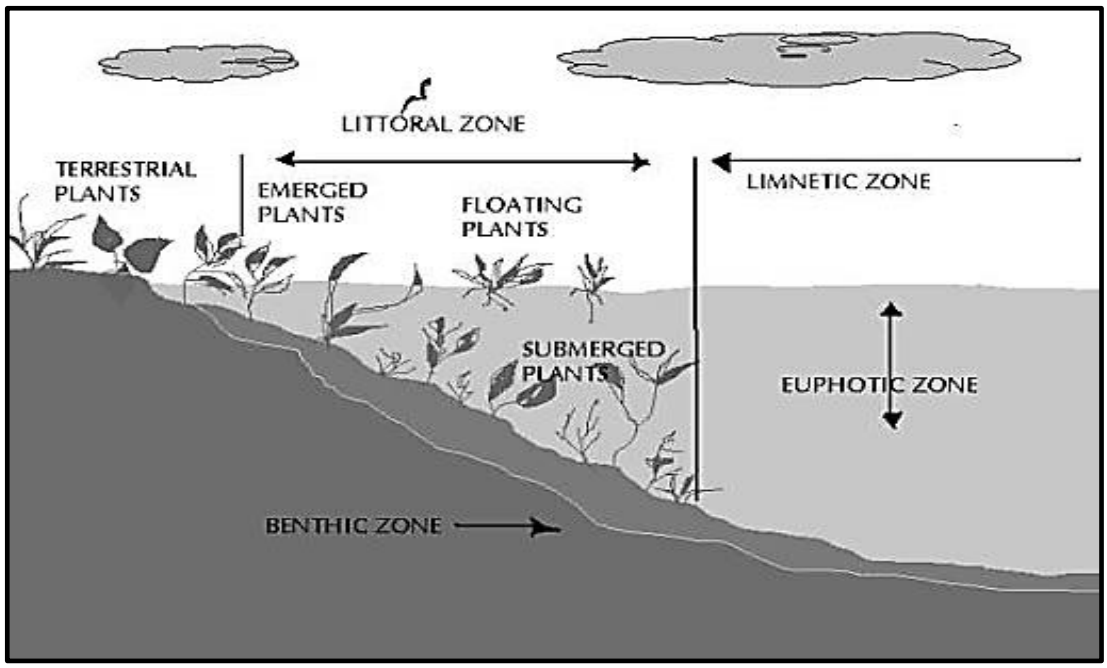
B- **Open Water Zone (pelagic zone):** This extends beyond the littoral zone and is too deep for light to penetrate till the bottom and for rooted plants to grow. This zone is divided on the basis of light penetration and distribution of organisms into:

B.1- **open water zone (photic zone** OR **limnetic zone):** In this zone sunlight supports photosynthetic algae, and the species that feed upon them.

B.2- **deep water zone**. (**Aphotic zone** OR **profundal zone**) In this zone, sunlight is not available and the food web is based on detritus entering from the littoral and photic zones.

C- **Benthic Zone** : This forms the floor of the lake and underlies the littoral and limnetic zone.

The production of the lake as a whole is the result of production from plants growing in the littoral zone, combined with production from plankton growing in the open water.



Lake zones

Littoral zone Biota

A) Plants of the littoral zone

Two types of plants occur here:

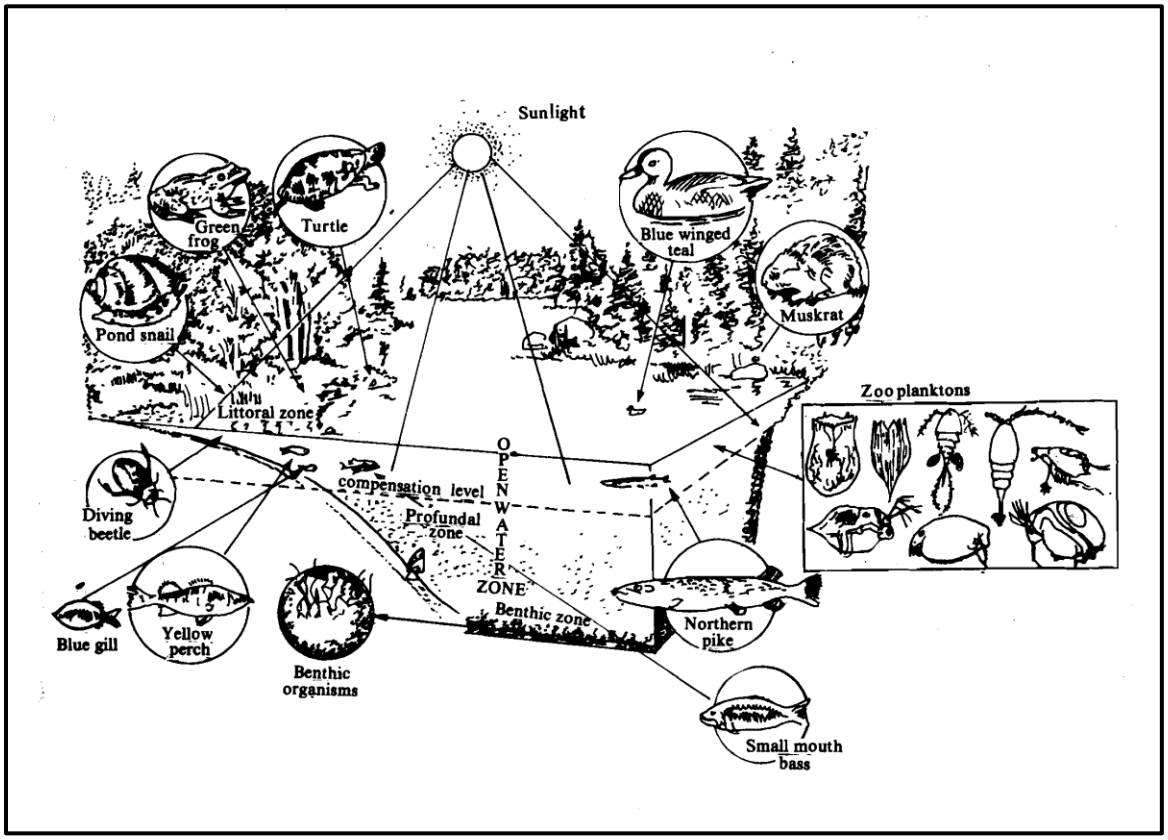
i) **Phytoplanktons** which include all kinds of algae occurring in the limnetic as well as those found only here, in addition to certain species attached to plant surfaces and are collectively called **periphyton.**

ii) **All rooted or benthic flowering plants**, attached to the substratum which occur in concentric zones within the littoral region. A general representative arrangement of rooted plants proceeding from the shallow towards the deeper lake area includes the following three sub-zones.

a) Zone of emergent plants : consisting of plants whose roots and stems remain submerged in water and whose upper leaves and stems protrude above the water level.

b) Zone of plants with floating leaves : containing plants ecologically similar to the previous types of plants though the photosynthetic area of these plants is much more wide.

c) Zone of submerged vegetation : includes plants which are completely or largely submerged in water. Plants of this zone have highly divided leaves to overcome the tearing of leaves by strong water currents for maximum absorption of nutrients as their root system is poorly developed.



B) Animals of the littoral zone

Animals of this zone may be herbivores, carnivores or detritus feeders and are as diverse as plants. Many of them such as rotifers, protozoans, insect larvae, hydras and bryozoa are neuston as they spend their lives attached to the stem or leaves of rooted plants. Others such as snails, flatworms, and many types of insect nymph and larvae spend their lives moving about the plants. Zooplankton here include species also found in the limnetic as well those that are not.

Many species of fishes like are restricted to just this zone, while others move freely between here and the open water zone. Vertebrates living on the lake shore are found here and include amphibians, e.g., frogs; reptiles, e.g., turtles and snakes and mammals like beavers and muskrat. Benthos found in or on the floor underlying the littoral zone are diverse. Most of them are detritus feeders; though some are carnivores.

OPEN WATER ZONE

A) **Plants of the open water zone**: In this zone plants are restricted to the limnetic one and generally consist of phytoplankton, such as dinoflagellates, blue green algae and green algae. Of these the single celled planktonic algae are the main producers for the lake as a whole. The profundal region of the open water zone has no green plants as it is dark and so cannot support photosynthesis.

B) Animals of the open water zone

The limnetic region of this zone contains certain **fishes** as well as a **rotifers**, **zooplankton** such as crustacean and protozoan. In the profundal zone occur chemosynthetic autotrophs as well as heterotrophs. The latter may be carnivores or detritus feeders. Further the larger fishes of the lakes are restricted to the profundal zone which also has a well-developed series of decomposer population present from top to the bottom. Benthic animals found here are larvae of several insect species.

Types of Lakes

Lakes of the world exhibit a great diversity of shape, size and combination of properties. However, on the basis of nutrient status and primary productivity they can be divided into three categories

(1) **Oligotrophic** (nutrient poor) lakes: They contain low amounts of nutrients such as N, P and Ca, so they have low productivity and biota. The lakes are very deep and the coastal area is small. The waters are of high purity and suspended matter with little water. The water is often saturated with oxygen from top to bottom and the oxygen consumption and decomposer are low.

(2) **Eutrophic** (nutrient rich) lakes: They contain a high percentage of organic matter and nutrients such as P, N, Ca, whether suspended in the water column or near the bottom of the lake, meaning that they are lakes with high productivity. Lakes are relatively shallow and have a large coastal area, containing large amounts of suspended matter. There is a significant decrease in oxygen during the summer from the upper layer of the water to the bottom, and it decreases sharply near the bottom, and the oxygen increases during the winter down to the bottom. The number of planktonic plants and plants is large and contain large quantities of organisms and chlorophyll.

(3) **Mesotrophic** (medium nutrient) lakes: These lakes have attributes or characteristics intermediate between poor lakes and rich lakes.
(4) **Dystrophic lakes**: This type of lake contains suspended and sediment organic matter and a high concentration of humus, which is washed away from the neighboring lands, especially forests, and the water color is brown, the water tends to be acidic, and the productivity of plankton is usually low. These lakes are mainly found in mountains and swamps.
(5) **Acidotrophic lakes**: lakes with little productivity and little (P, N) nutrients and pH less than 5.5.
(6) **Alkalitrophic lakes**: lakes with high productivity and basic pH.
(7) **Argillotrophic lakes**: lakes with little productivity and water with little transparency due to the large number of clay materials suspended in the water column.
(8) **Siderotrophic lakes**: lakes with low productivity and large amounts of iron in the water.

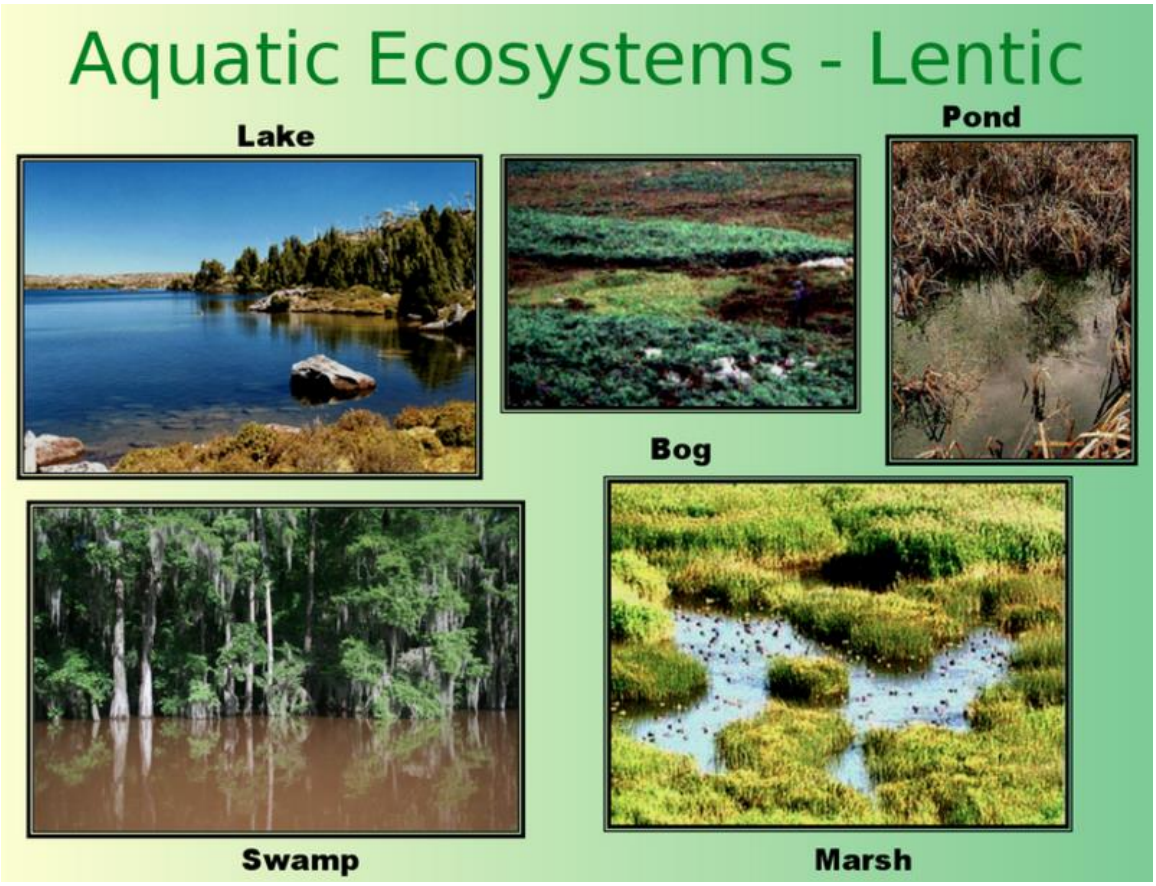
1.2. Ponds

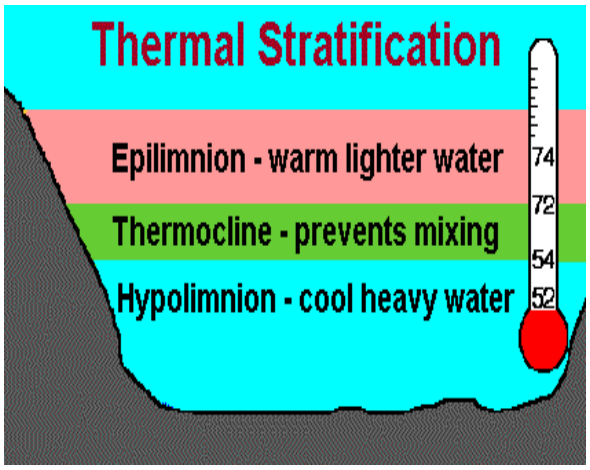
Ponds are small bodies of freshwater with shallow and still water, marsh, and aquatic plants. They can be further divided into four zones: vegetation zone, open water, bottom mud and surface film. The size and depth of ponds often varies greatly with the time of year; many ponds are produced by spring flooding from rivers. Food webs are based both on free-floating algae and upon aquatic plants. There is usually a diverse array of aquatic life, with a few examples including algae, snails, fish, beetles, water bugs, frogs, turtles, otters and muskrats. Top predators may include large fish, herons, or alligators. Since fish are a major predator upon amphibian larvae, ponds that dry up each year, thereby killing resident fish, provide important refugia for amphibian breeding. Ponds that dry up completely each year are often known as vernal pools. Some ponds are produced by animal activity, including alligator holes and beaver ponds, and these add important diversity to landscapes.

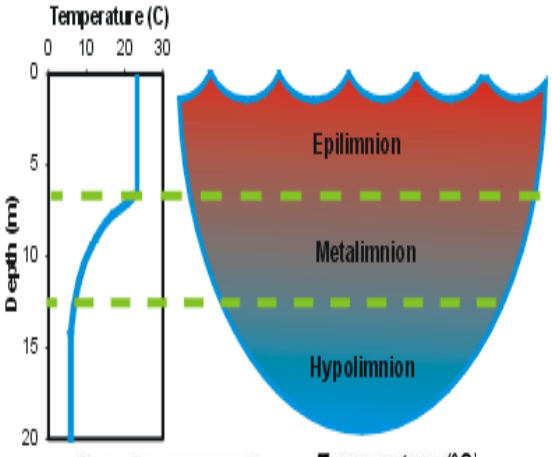
Lakes	Ponds
Its area is large and deep	its area is small and shallow
Lakes are more	the capacity of the ponds is less
The phenomenon of thermal stratification occurs in some seasons of the year	this phenomenon does not occur
The area farther from the shore of the lakes is more productive.	The area close to the shore of the ponds is more productive

Impoundments : We have so far discussed natural lakes. In addition to these there are a number of lakes both small and large artificially created by man called reservoirs or impoundments. These have been built to fulfil specific requirements - hydroelectric power generation, fisheries, water supply, irrigation, industries, recreation, control of floods, etc. Impoundments may be called offstem or onstem depending on how they have been created. Onstem reservoirs these are located in upland areas and are formed by damming a stretch of river or stream in a suitable river valley

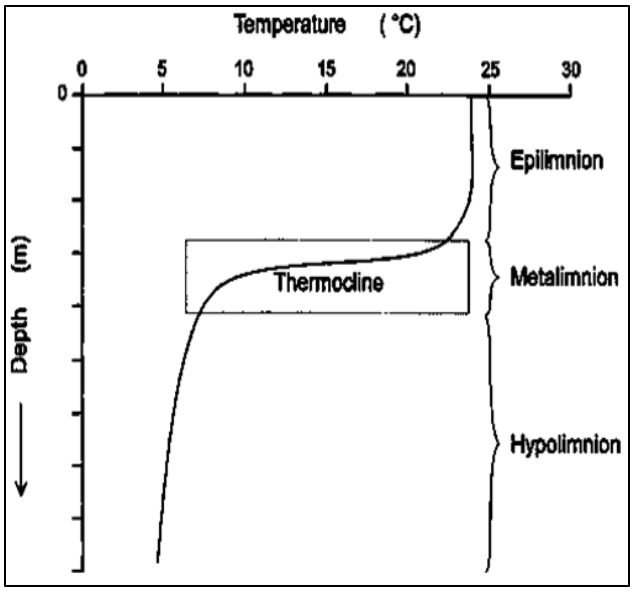
Wetlands : Wetlands are permanently or periodically water covered areas. They can be defined as submerged or saturated lands either artificially or naturally, and either periodically or permanently up to a depth of six metres by water which may be fresh brackish or saline. These wetlands may be classified into two categories Inland wetlands which occur inland and contain fresh water e.g. bogs, swamps, etc. Coastal wetlands which occur near the coast and contain saline or brackish waters, e.g. mangrove swamps, mangrove forests.

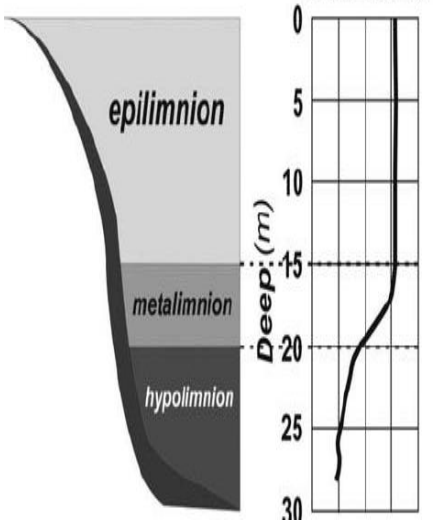


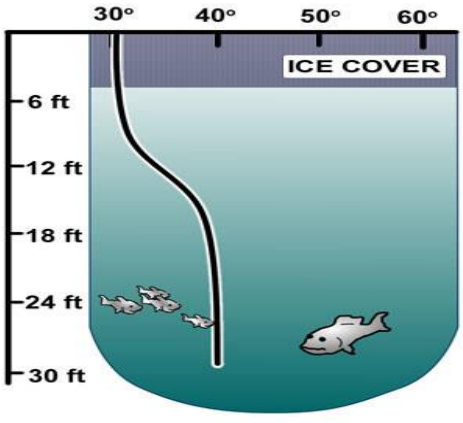




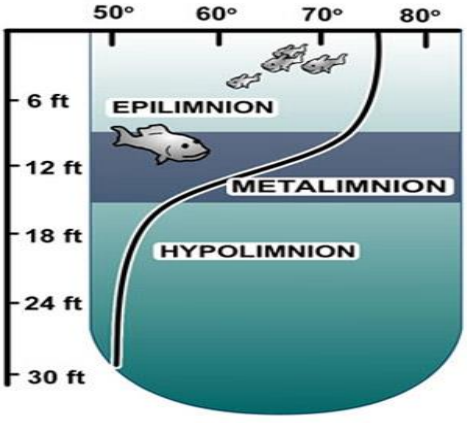
Sancho reservoir







Winter



Summer