

MAJOR ECOSYSTEMS

Structure

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3.1 INTRODUCTION

In the previous units you have studied about ecosystem and its structure. As you know the world itself is very vast, and it represents a big ecosystem called biosphere. The word ecosystem is made up of “eco” and “system”. Eco means the habitat, and system means a complex set of interconnected components, both living and non-living. Here system also indicates a functional property and hence an ecosystem can be considered as a functional unit of nature.

Ecosystems can be broadly divided into two main categories: terrestrial and aquatic. Major terrestrial ecosystems include forests, grasslands and deserts while lakes, rivers, oceans, estuaries and wetlands are collectively known as aquatic ecosystems. In this unit we will discuss various types of terrestrial and aquatic ecosystems. Besides, you will also study about the importance of the forests, grasslands and aquatic ecosystems.

Expected Learning Outcomes

After completing the study of this unit, you should be able to:

- ❖ differentiate between the major types of terrestrial ecosystems such as grasslands, forests and deserts;
- ❖ describe general features and biota of grasslands, forests and deserts;
- ❖ describe importance of forests to human welfare;
- ❖ describe aquatic ecosystems and distinguish between freshwater ecosystems, marine ecosystems and estuaries; and
- ❖ explain the difference between the biota of lakes, rivers and marine ecosystem.

3.2 FOREST ECOSYSTEM

The term taiga is applied to the northern range of coniferous forests.

Now let us see as to what a forest is. The word forest is derived from the Latin word 'foris' meaning outside, the reference being to village boundary fence that must have included all uncultivated and uninhabited land. Today a forest is any land managed for the diverse purpose of forestry, whether covered with trees, shrubs and climbers or not. The forest ecosystem includes a complex assemblage of different kinds of biotic communities. The nature of soil, climate and local topography determine the distribution of trees and their abundance in the forest vegetation. Characteristics of different types of forests (Fig. 3.1) are described below:

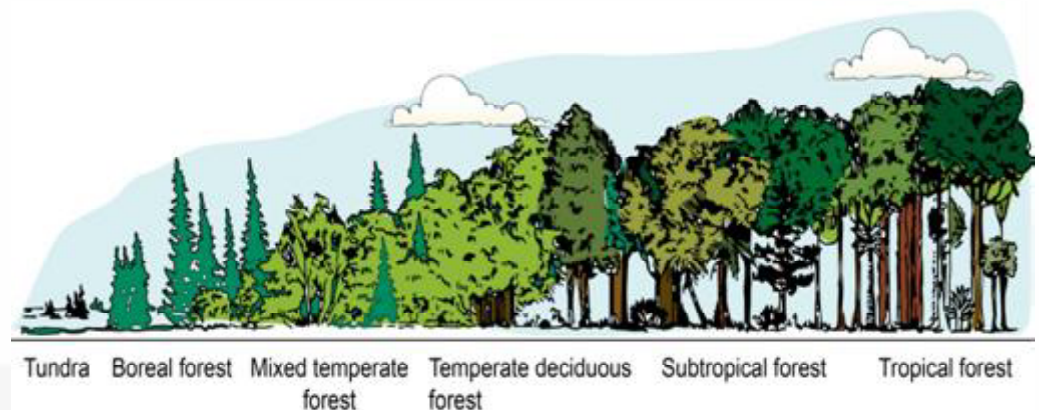


Fig. 3.1: Types of forests

- i) **Coniferous forest:** Cold regions with high rainfall and strongly seasonal climates with long winters and fairly short summers are characterised by boreal coniferous forest which is transcontinental. These forests are characterised by evergreen plant species such as spruce. (*Picea glauca*), fir (*Abies balsamea*) and pine trees (*Pinus roxburghii* / *Pinus strobes*) and by animals such as the lynx, wolf, bear, red fox, porcupine, squirrel, and amphibians like tree frogs and pond frogs.

The litter resultant from conifer needles is broken down very slowly and is not particularly rich in nutrients. These soils are acidic and are mineral deficient. The productivity and community stability of boreal forests are lower than those of any other ecosystem.

- ii) **Temperate deciduous forest:** The temperate forests are characterised by a moderate climate and broad-leaved deciduous trees, which shed their leaves in winter and grow new foliage in the spring. These forests are characteristic of North America, Europe, Eastern Asia (including China and Japan), Chile and part of Australia with a cold winter and an annual rainfall of 75-150 cm. The precipitation may be fairly uniform throughout year.

Trees are quite tall about 40-50 m in height and their leaves are thin and broad. The predominant genera of this biome are maple (*Acer*), beech (*Fagus*), oak (*Quercus*), hickory (*Carya*), basswood (*Tilia*), chestnut (*Castanea*), and cottonwood (*Populus*). In Himalayas, the temperate vegetation includes pines, cedars (*Cedrus*), fir and juniper trees along with rhododendrons and willow (*Salix*).

The common animals are deers, bears, squirrels, gray foxes, bobcats, wild turkey and woodpeckers. Common invertebrates include earthworms, snails, millipedes, coleoptera and orthoptera. Vertebrates include amphibians such as toad, salamander, cricket and frog, reptiles such as turtle, lizard and snake, mammals such as racoon, opossum, pig and mountain lion, and birds like horned owl and hawks.

- iii) **Temperate evergreen forest:** Many parts of the world have a mediterranean type of climate which is characterised by warm, dry summers and cool, moist winters. These are commonly inhabited by low evergreen trees having needle-like or broad leaves. These include hemlock, yew and maple. Shrubs may range up to 3-4m in height. The characteristic animals of temperate evergreen woodland chaparral are mule, deer, brush rabbit, wood rat, chipmunk and lizard.
- iv) **Temperate rain forest:** The temperate rain forests are colder than any other rainforest and exhibit a marked seasonality with regard to temperature and rainfall. Rainfall is high, but fog may be very heavy which may actually represent a more important source of water than rainfall itself. The diversity of plant and animals is much low as compared to their warmer counterparts.
- v) **Tropical rain forest:** Tropical rain forests occur near the equator, and are among the most diverse communities on the earth. Both temperature and humidity remain high and more or less uniform. The annual rainfall exceeds 200 cm and is generally distributed throughout the year.

The common vertebrates of tropical rain forests are the arboreal amphibian *Rhacophorus malabaricus*, aquatic reptiles, chameleons, agamids, geckos, many species of snakes and birds, and a variety of mammal such as leopard, jungle cats, ant-eaters, giant flying squirrels, monkeys and sloths.

- vi) **Tropical seasonal forest:** Tropical seasonal forests occur in regions where total annual rainfall is very high but segregated into pronounced wet and dry periods. In exceedingly wet tropical seasonal forests, commonly known as monsoon forests, the annual precipitation may be several times that of the tropical rainforests. Teak is often a major large tree in the best known tropical seasonal forests of India (central India) and South East Asia. Bamboo is also an important climax shrub in these areas.
- vii) **Subtropical rain forest:** In regions of fairly high rainfall but less temperature difference between winter and summer, broad-leaved evergreen subtropical forest is found. The vegetation includes mahogany, palms, oaks, magnolias and tamarind, all laden with epiphytes (of Pineapple and orchid families), ferns, vines and strangler fig. (*Ficus aureus*). Animal life of subtropical forest is very similar to that of tropical rainforests.

The flora of tropical rain forest is highly diversified: a sq. km area may contain 300 different species of trees - a diversity unparalleled in any other ecosystem. The extremely dense vegetation of the tropical rain forests is vertically stratified with tall trees often covered with vines, creepers, lianas, epiphytic orchids and bromeliads. Under the tall trees there is a continuous evergreen carpet, the canopy layer, some 25 to 35 metres tall. The lowest layer is an understory of trees, shrubs, herbs, ferns and palms, all of which become dense where there is a break in the canopy.

Importance of Forest

For humans, forests have been a source of multiple products, services and recreation, and basis of the development of culture and civilisation. Apart from

the source of fuel wood, they provide raw materials to various wood industries like pulp and paper, composite wood, rayon and other man-made fibres, matches, furnitures, shuttles and sport goods. Indian forests also provide many other minor products such as essential oils, medicinal plants, resins and turpentine, lac and shellac, katha and catechu, bidi wrappers and tassar silk. Forests have great biological importance as reservoirs of genetic diversity apart from playing an important role in regulating earth's climate.

Forests provide habitat, and food as well as protection to wildlife species. Forests enhance local precipitation and improve water holding capacity of soil, regulate water cycle and maintain soil fertility by returning the nutrients to the soil through litter. Forests check soil-erosion, landslides and reduce intensity of flood and droughts. Forests, being home of wildlife are important assets of aesthetic, touristic and cultural value to the society.

Forest Conservation

Urbanization, expansion of agriculture and extraction of timber pose serious threats to forest worldwide. Certain forest conservation and management processes have to be employed in the forests to maintain them. To get the desired quality of timber or pulp for paper industry, monoculture forests of fast growing trees such as poplars, certain conifers and eucalyptus have been cultivated by human. Existing forests are strongly manipulated in order to increase their yield of desired benefits. It includes weeding (the elimination of species which might compete with the seedlings of the desired species), thinning (eradication of individuals of the same species) and brashing (removal of leafless lower branches especially in conifers). Forest Management also includes the controlling of forest fire. Silviculture is a branch of forestry which is concerned with the establishment, development, care and reproduction of monocultures of valuable timber trees such as teak, sal, sheesham and kel.

We will discuss in detail about all the above and issues related to forest in Unit 5 titled Forest Resources.

SAQ 1

- a) Fill in the blanks and complete the following statements :
 - i) The forest biomes comprise a complex assemblage of different kinds of
 - ii) Forests may be evergreen or
 - iii) Tropical rain forests occur near the
 - b) What are the direct and indirect services provided by forest to us?
 - c) Write the major difference between temperate deciduous forest and temperate evergreen forest.
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3.3 GRASSLAND ECOSYSTEM

The grassland ecosystem is found where rainfall is about 25-75 cm per year, not enough to support a forest, but more than that of a true desert. Typical grasslands are vegetation formations that are generally found in temperate climates. The grass layer is sparse and consists mainly of annual grass species.

The major difference between steppes and savannas is that all the forage in the steppe is provided only during the brief wet season whereas in the savannas forage is largely from grasses that not only grow during the wet season but also have a smaller amount of regrowth in the dry season.

In arid to semi-arid tracts, active growth of vegetation is triggered each year by the advent of the monsoon during June or early July. The biomass increases to its peak value around September to October. Fruiting is completed by November and subsequently the plants dry up. In subtropical parts of India which receive winter rains, there is usually a second flux of growth in December and January.

Economic Importance

India with just 2.4 per cent of the total land area of the world supports more than half of the buffaloes, 15 per cent of cattle, 15 per cent of goats and 4 percent of sheep. The livestock wealth plays a crucial, role in Indian life. It is a major source of fuel, draught power, nutrition and raw material for village industries

Grassland ecosystems are important to maintain many domesticated and wild herbivores such as horse, mule, ass, cow, pig, sheep, goat, buffalo, camel, deer and zebra which provide food, milk, wool, hide or transportation to humans.

Overgrazing has harmful ecological effects. The mulch cover of the soil is reduced, microclimate becomes drier and the place is readily invaded by xerophytic plants. Due to absence of humus cover, mineral soil surface is heavily trampled when wetness produces puddling of the surface layer, which in turn reduces the infiltration of water into the soil and accelerates its run off.

Thus, you can realise the importance of the grassland and now after having read about this ecosystem you would like to know what desert biome is and where it occurs? But before that you try SAQ.

In the central and eastern parts of Rajasthan, where the rainfall is about 500 mm per year and the dry season is of six to eight months, dry savanna grazing ecosystems have developed. The light shade cast by the sparse population of trees like *Prosopis cineraria* favours the growth of the grasses which in the best-watered areas can reach up to a height of 100 to 120 cm.

SAQ 2

- Discuss the importance of grassland ecosystem.
- What are the harmful effects of overgrazing on the area?

3.4 DESERT ECOSYSTEM

Deserts are formed in regions with less than 25 cm of annual rainfall, or sometimes in hot regions where there is more rainfall, but unevenly distributed

in the annual cycle (Fig. 3.2). Deserts in temperate regions often lie in “rain shadows”, that is, where high mountains block off moisture from the sea. These areas thus receive meagre rainfall and along with low rainfall there are fluctuations in temperature.

Deserts are found in Australia, Arabia, Turkestan and Argentina. Thar desert in Western India and Pakistan, Gobi desert of Mongolia, and Sinai desert of Egypt are also well known deserts



Fig. 3.2: Desert Ecosystem

The perennial plant species like creosote bush (*Larrea*), organ pipe cactus, ferrocactus and spurges (*Euphorbia*) are scattered throughout the desert ecosystem. In shallow depressed areas with salt deposits sarcobatus, geesewood, seepwood and salt grasses are common. The annuals, wherever present, germinate, bloom and reproduce only during the short rainy season, and not in summer and winter. This is an adaption to desert condition.

Animals such as reptiles and some insects are adapted to deserts, because their impervious integuments and dry excretions enable them to get along on the small amount of water. A few species of nocturnal rodents, for example, excrete very concentrated urine and do not use water for temperature regulation, and can live in the desert without drinking water. Other animals such as camel must drink periodically but are physiologically adapted to withstand tissue dehydration for appreciably long periods of time.

Because water is the dominant limiting factor, the productivity of any desert is almost directly dependent on the rainfall. Where soils are suitable, irrigation can convert deserts into some of our most productive agricultural land. Whether productivity is continuous or is only a temporary ‘bloom’ depends on how well human is able to stabilise biogeochemical cycles and energy flow at the increased irrigation rates.

Among reptiles there occur two species of testudines (*Loricata*), 18 species of lizards, and 18 species of snakes. Of the lizards, some species like *Calotes versicolor* and *Uromastix hardwickii* are predatory on the desert locust inhabiting localised areas in Thar desert. Among predominant predatory birds are two species of vultures, namely, White-rumped vulture (*Gyps bengalensis*) and the White scavenger vulture, (*Neophron percnopterus*).

The mammalian fauna of Indian deserts (Box 3.1) includes many species, some of which are rat-tailed bat, longer hedgehog, Indian hairy-footed gerbil, wild boar, jungle cat and panthers.

Box 3.1: Case study: Indian Desert

The Indian desert is one of the most heavily populated desert regions of the world. According to 2011 census, population densities vary from 361 in Jhunjhunu to 17 persons/km² in Jaisalmer district. The settlement patterns are entirely compact or entirely spread. Villages are both with compact settlements and spread homesteads (dhanis). Rural people live in hamlets, small villages and dhanis or homesteads. The desert society has multitude of caste and sub-castes. By and large villages where some powerful local chieftains resided and constructed fortresses, developed into towns, which became local trade centres. The settled population in villages is mostly agro-pastoral. About three-fourth of total workers in desert are engaged in cultivation and as agricultural labour. Animal husbandry is followed as supplementary occupation.

Total livestock population recorded an increase of 9.8 million during 1956 to 1981. During 1972-1983 livestock population increased by more than 42 per cent. The enormous increase in human and livestock population has been depleting the natural resources at rapid rate.

SAQ 3

Tick mark the correct answer in the following statements.

- a) Which animal drinks water periodically and is physiologically adapted to withstand tissue dehydration for long period?
- i) Lion
 - ii) Tiger
 - iii) Camel
 - iv) Elephant
- b) Which biome experiences intense heat and strong wind with a great desiccating action during April to June?
- i) Tundra biome
 - ii) Desert biome
 - iii) Forest biome
 - iv) Grassland biome
- c) On which animal *Calotes* and *Uromastyx* are predatory in Thar desert
- i) desert locust
 - ii) desert gerbil
 - iii) desert dragon flies
 - iv) desert snakes

3.5 AQUATIC ECOSYSTEM

Global waters cover about three-quarters of the earth's surface, either as fresh water where salt content is less than 0.5 per cent or as saline water where the salt content is more than 3.5 per cent, or as brackish water where salt content is intermediate between fresh water and saline water. Because of their salt content estuaries and oceans bear different kinds of organisms. It is on this basis, that aquatic ecosystems are categorised into: (i) **Fresh water ecosystems**- lakes, ponds, swamps, pools, springs, streams, and rivers; (ii) **Marine ecosystems** - shallow seas and open ocean; (iii) **Brackish water ecosystems**- estuaries, salt marshes, mangrove swamps and forests.

3.5.1 Aquatic Organisms

The organisms in the aquatic ecosystem are unevenly distributed but can be classified on the basis of their life form or location into five groups as shown in Fig. 3.3. The five groups are given as under:

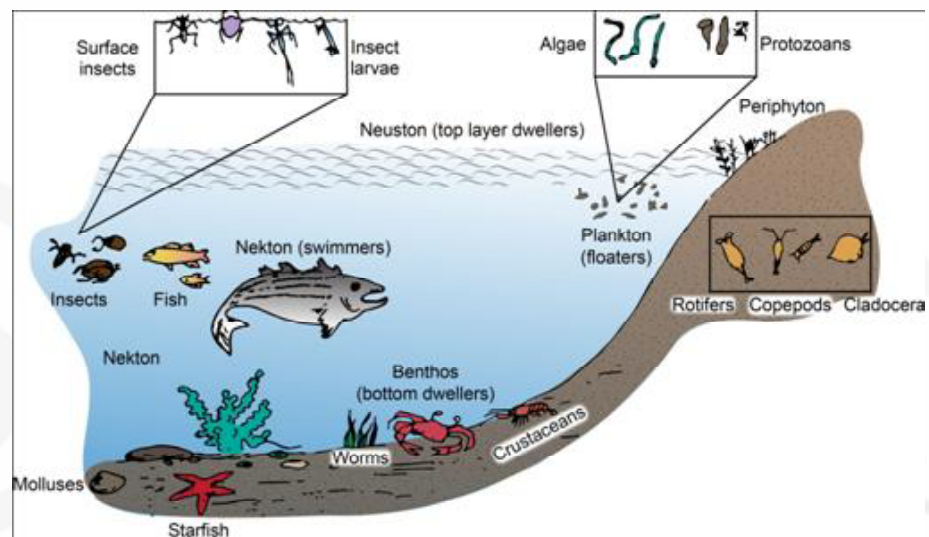


Fig 3.3: Life Styles of Aquatic Organisms

- i) **Neuston:** These are unattached organisms which live at the air-water interface such as floating plants and several types of animals (see Fig. 3.3). Some spend most of their lives on top of the air-water interface, such as water striders, while other spend most of their time just beneath the air-water interface and obtain most of their food within the water, e.g., beetles and back-swimmers.
- ii) **Periphyton:** These are organisms which remain attached or clinging to stems and leaves of rooted plants or substances emerging above the bottom mud (Fig.3.3). Usually sessile algae and their associated group of animals fall in this group.
- iii) **Plankton:** This group includes both microscopic plants, chiefly algae (phytoplanktons) and animals, primarily crustaceans and protozoans (zooplanktons) found in all aquatic ecosystems, except certain swift moving water. The locomotory power of the planktons is limited so that their distribution is controlled largely by currents in the aquatic ecosystems. Most phytoplanktons and zooplanktons are capable,

however, of at least some movement.

- iv) **Nekton:** This group contains animals which are swimmers. The nektons are relatively large and powerful as they have to overcome the water currents (see Fig. 3.3). The animals range in size from the swimming insects, which may be only about 2 mm long, to the largest animals that have lived on earth, namely the blue whale.
- v) **Benthos:** The benthos or the benthic organisms are those found living in or on the bottom or benthic region of the water mass (Fig. 3.3). They exhibit a variety of adaptations to the environment since the bottom is a more heterogeneous habitat than either the open water or the surface. Benthos includes crabs, lobsters and sponges.

SAQ 4

Match the terms used for defining groups of aquatic organisms given in column A with their definitions given in column B.

Column A

- i) Neuston
- ii) Nekton
- iii) Benthos
- iv) Plankton
- v) Periphyton

Column B

- a) The group of plants and animals which are found living in or on the bottom of an aquatic ecosystem.
- b) Plants or animals that cling to rooted water plants above the bottom mud.
- c) Animals and plants of minute size which float in the aquatic ecosystems, seas, rivers, ponds and lakes. These organisms are incapable of independent movement and depend on water currents for movement.
- d) Aquatic animals that swim strongly and are able to overcome water currents.
- e) Organisms associated with the surface film of water.

3.5.2 Freshwater Ecosystem

Fresh water ecosystem depends 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.

The fresh water ecosystems can be conveniently divided into two main divisions:

- i) Lentic (from 'lenis', calm) or standing or basin series ecosystems. Examples of this division are lakes, pools, ponds, swamps and marshes.

The largest lake in the world, the lake Superior in North America has a surface area of 83,000 km² and a maximum depth of 307 metres. The deepest lake, in the world, Lake Baikal in Siberia is nearly half the area of Lake Superior, i.e., 31,500 km². It has, however, more than twice its depth (706 metres).

Some lakes are formed in crater depressions of extinct volcanoes and are called crater lakes. Lakes may also arise by landslides blocking off streams and valley. Lakes are not evenly distributed on the earth but are grouped in certain regions called 'lake districts'

- ii) Lotic (from 'lotus', washed) or running or channel series ecosystems. Examples of this division are rivers, streams and springs.

These two fresh water ecosystems have been described in the following sections.

Lakes are inland, depressions containing standing water. They vary considerably in area and depth.

Fresh water lakes of this earth hold $125 \times 10^3 \text{m}^3$ 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 characteristic of the rivers.

Lakes, Impoundments and Wetlands

Lentic ecosystems include all those systems which have a static body of water. Lakes (Fig. 3.4) (Box 3.2), impoundments and wetlands are all lentic ecosystems. Let us see how they differ from each other.

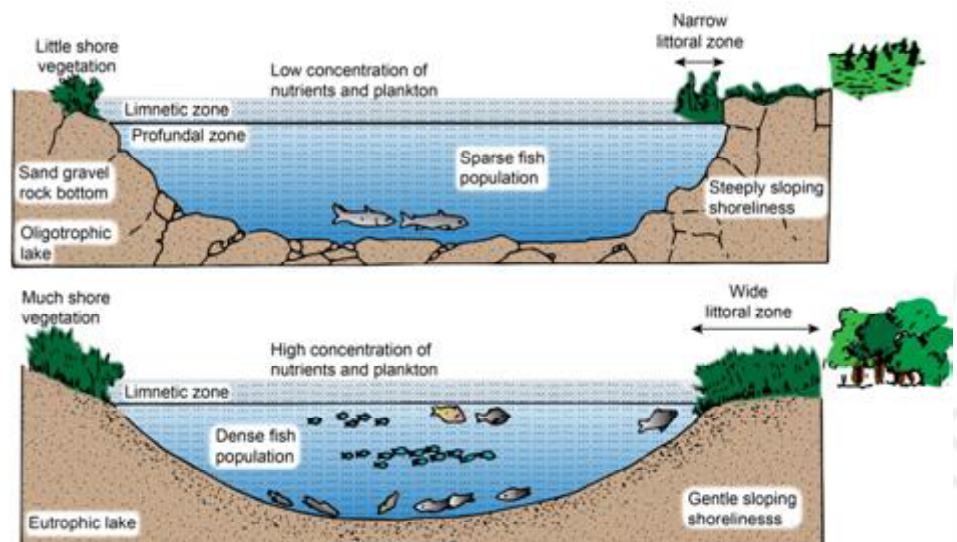


Fig. 3.4: Lake and its biota.

Lakes: Most lakes occur in regions which have recently been subjected to geological changes, say within the past 20,000 years. However, a few lakes, such as lake Baikal in Russia and Lake Tanganyania in Africa are ancient and are estimated to have originated twenty million years ago.

Box 3.2: Case Study: Loktak Lake

Loktak Lake (Fig 3.5) is situated 38 km south of Imphal city, the capital of Manipur State. The lake covers an area of about 286 sq. km. Main water body of the lake is surrounded by shallow water, which stagnates over a marsh/swamp land.

The characteristic feature of the Loktak Lake is the presence of floating islands known as Phumdis. These are heterogeneous masses of soil vegetation and organic matter, which occur in all sizes from a few centimeters to about 2.5 m. They occupy about two-third of the surface area of the lake.

Free-floating plants, such as water hyacinth and partly decomposed roots and rhizomes contribute greatly to its development. The largest single mass of phumdis occupying an area of 40 sq. km constitutes Keibul Lamjao National Park.



Fig.3.5: Loktak Lake with phumdis.

A number of streams originate from the hill ranges immediately to the west of the lake and these streams flow directly into Loktak Lake. The indirect catchment area covers catchments of five important rivers i.e. Imphal, Iril, Thoubal, Sekmai and Khuga and is spread over an area of 7157 sq. km. The Lake has been the source of water for generation of hydroelectric power, irrigation and water supply. A large population living around the lake depends upon the lake resources for sustenance. The staple food of Manipur is directly linked to Loktak Lake. The lake is rich in biodiversity and was designated as a wetland of international importance under Ramsar Convention in 1990. The Keibul Lamjao National Park, in the southern part of the lake, is home to the endangered Manipur brow, antlered deer (*Cervus eldi eldi*), locally called Sangai. The lake has been also the breeding ground of a number of riverine fishes and continues to be a vital fisheries resource. It supports a significant population of migratory and resident waterfowl.

Impoundments: They may be called offstem or onstem depending on how these 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. In India only these types of impoundments are found. Offstem reservoirs are built in low land areas by pumping water some distance from a river or from an underground source.

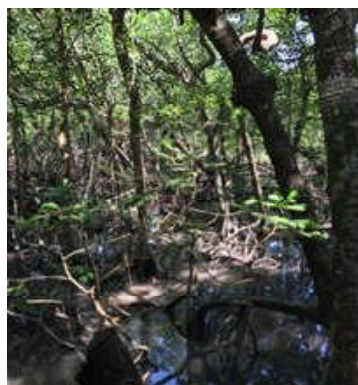


Fig. 3.6: Wetland.

Wetlands: Wetlands are permanently or periodically water covered areas (Fig. 3.6, Box 3.3). They can be defined as submerged or saturated lands either artificially created or natural, and either periodically or permanently covered up to a depth of six metres by water which may be fresh, brackish or saline.

The wetlands may be classified into two categories:

- I. Inland wetlands occur when inland is surrounded by land and contain fresh water, e.g. bogs and swamps.
- II. Coastal wetlands occur near the coast and contain saline or brackish waters, e.g. mangrove swamps, mangrove forests.

Box 3.3: Case Study: Threats to wetlands in Assam

Almost 40% of all wetlands in Assam are under threat. A survey conducted by the Assam Remote Sensing Application Center (ARSAC), Guwahati, and the Space Applications Centre, Ahmedabad has revealed that 1367 out of 3513 wetlands in Assam are under severe threat due to the invasion of aquatic weeds and several developmental activities. The wetlands of Assam form the greatest potential source of income for the state in terms of fisheries and tourism. Though the wetlands of Assam have the capacity of producing 5,000 t/ha/yr of fish, around 20,000 t of fish has to be imported to meet local demand. This is primarily due to poor wetland management.

3.5.3 Lotic Ecosystems – Rivers

The lotic or flowing water habitats include rivers, streams and brooks. The most outstanding features of such habitat is the continuously flowing water which moulds the characteristics of the water bed and influences the distribution of organisms within.

The two most important features are:

- 1) Rivers are open or heterotrophic systems, whereas lakes are closed or self contained systems except for some gains or losses from inflowing or outflowing streams;
- 2) Nutrients in a lake may be used several times, whereas in rivers, at any point, plants and animals must avail of temporarily available nutrients.

Biota of Rivers

The biota of both the rapidly flowing and the slowly flowing sections of the river are very distinct. Let us study the biota characteristic of river.

- a) **Animals:** In the exposed rock surface habitats only those organisms are found which have efficient mechanisms for staying in one place. These include fresh water limpet, larvae or water penny (riffle beetles), fresh water sponges and caddis flies.

The microhabitat formed in the spaces between rock fragments is slightly sheltered. Here stone fly and dragonfly both of which are flattened and have behavioural adaptations to hold them in place (i.e. clinging by instinct to hard surface and orienting themselves along the current) are found

In the microhabitat beneath rocks, where current is a weak, animal such as annelids, flatworms, clams, some snail species and other insect larvae are found.

In the rapidly flowing habitat, nekton occurs only in areas where current is not too strong and include cold water fish species such as trout or salmon. In areas where the current is very strong nekton are absent and in such cases, the benthos may be many and varied and may form the entire community.

- b) **Plants:** Among the plants only small, well attached forms, such as sessile algae can survive here. Thus, due to the presence of only a few plants, the nutrient base for animals here is organic detritus washed into the river from the drainage area.

3.5.4 Marine Ecosystems

A marine ecosystem is the largest and most stable system on the earth and is of great ecological significance. The sea water is salty with an average 3.5%. Sodium chloride (NaCl) is 27% of the salt while rest other important minerals are calcium, potassium and magnesium. An important factor in limiting the production and distribution of marine life is light. Temperature remains almost constant in ocean ranging from 2°C in polar region to 32°C or more in tropics.

The marine habitat is distinguishable into two different zones: (1) Benthic zone – which forms the basin or floor of the ocean, regardless of depth; (2) Pelagic zone – which represents the free water zone, filling the basin (see Fig. 3.7).

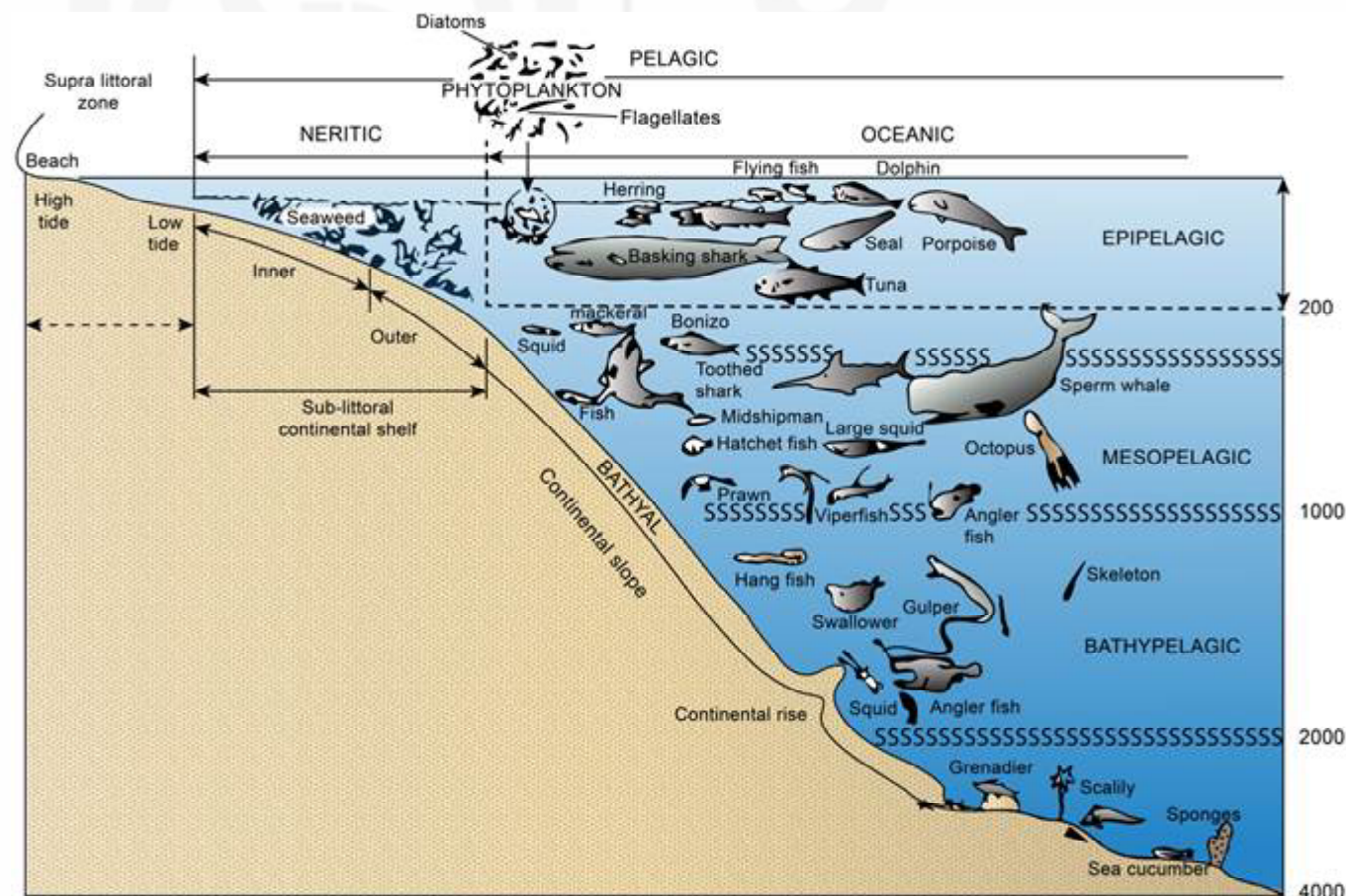


Fig 3.7: Major regions of the ocean.

Biota of Oceans

Life in the sea is not particularly abundant, though the diversity of organisms is high. Almost every major group of animals and every major group of algae occur somewhere in the oceans, with the exception of vascular plants and insects. On the basis of depth-wise differences in life forms, the expanse of marine ecosystems has been divided into littoral, neritic, pelagic and benthic zones. Let us now read about biota of each one of these.

- i) **Biota of Littoral Zone:** This zone is the shore region of the marine ecosystems and is subject to violence of waves and tides, fluctuation of water level and variability of temperature, light, salinity and moisture. In common language supra littoral zone is termed as a beach. There are few species of plants present in this zone.

Common animals found here are snails, clams, barnacles, crustaceans, annelids, sea anemones and sea urchin. The animals here exhibit zonation with respect to tides. Animals more resistant to desiccation usually occurring at higher levels than those that are less resistant.

- ii) **Biota of the Neritic Oceanic Zone:** This relatively shallow, coastal zone is rich in species and high in productivity owing to factors such as penetration of light to considerable depths and high concentrations of nutrients.

The most productive phytoplanktons are the dinoflagellates and diatoms, though red, brown and green algae attached to the bottom in the shallow regions may be significant. The zooplanktons are usually similar to those of the pelagic zone though some purely open-sea species are replaced by neritic species.

Almost all commercial species of fish as well as whales, seals, sea-otters, sea snakes and large squids are found here. Fishes are numerous and include several shark species as well as sea trout and salmon.

A wide variety of animals among which are clams, shrimps, snails, lobsters, crabs, sea cucumber, starfish, brittle stars, anemones, sponges, bryozoa, annelids and foraminifera and exhibits more diversity than those of the deeper waters.

- iii) **Biota of Pelagic Zone:** Pelagic region constitutes 90 per cent of the total ocean surface and is less rich in species and numbers of organisms than the two regions discussed before.

The most abundant pelagic phytoplanktons are still the dinoflagellates and diatoms which are the chief photosynthetic feeders, others are carnivores. Sea cucumbers and sea urchins crawl on the floor eating detritus and bacteria and serve as food for the carnivorous brittle stars and crabs.

- iv) **Biota of Benthic Zone :** It forms the floor of the ocean. Organisms here are hetrotrophic Rooted animals are sea lilies, sea fan, sponges etc. Snails and clams remain embedded in mud while starfish, sea cucumbers and sea urchins move on its surface.

3.5.5 Estuaries

All the rivers and lakes ultimately drain into the sea. However, many rivers develop a highly specialized zone before joining the proper sea. This zone is called estuary. An estuary is a transitional zone between rivers and sea representing unique ecological features and biotic communities. Estuaries are the most productive ecosystems of the world. An estuary is semi-enclosed part of the coastal ocean containing brackish water that has free connection with the sea on one side and on the other side it is connected with a river mouth and receives fresh water. In India, estuaries can be seen in plenty along the coast of Kerala or in Sunderbans.

Estuary is a very important food source and almost all the major marine fisheries of the world are totally dependent on the estuaries for their continuance, because the adult fishes often resort to estuaries for laying eggs, i.e., spawning.

Features of Estuaries

The most dominant feature of the estuarine environment is the fluctuation in salinity. Though salinity gradient exists sometime in an estuary but the pattern of gradient varies seasonally, with the topography, with the tides and with the amount of fresh water.

Biota of Estuaries

The estuarine community is a mixture of three components: Marine, Fresh water and Brackish water, but overall estuarine diversity is still lower than that of the river or marine community. This is because of tremendous variation in the estuary's physical environment. Thus, the great productivity of estuaries is built on a narrow base.

The plants of the estuary are of four basic types: (i) Phytoplankton; (ii) marginal marsh vegetation; (iii) mud-flat algae; (iv) epiphytic plants growing on the marginal marsh vegetation. Diatoms and filamentous blue-green algae found in high number are the sites of intense photosynthesis. Oysters, crabs and some sea shrimps are also found.

SAQ 5

State whether the following statements are true or false :

- The estuaries are characterised by high salt content in their substratum.
- The estuaries do not support large organisms.
- The estuaries are the most productive ecosystem of the biosphere.
- Estuaries are a nursery ground for a large number of fishes.

3.6 SUMMARY

- Forests occupy approximately 40% of the land. The forest biomes can be classified as coniferous forest, temperate deciduous forest, temperate evergreen forest, temperate rain forest, tropical rain forest, tropical seasonal forest, sub-tropical forest etc.
- Grassland ecosystems are found where rainfall is about 25-75 cm every year. Grassland ecosystems are important to maintain the crop of many

domesticated and wild herbivores such as horses, buffaloes, camels, deers, zebras which provide food, milk, wool, leather, transportation to man.

- Desert ecosystems are found in the regions where rainfall of less than 25 cm.
- 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.
- Fresh waters are again of two types. The static water ecosystems are called as lentic systems and are exemplified by various lakes impoundments and wetlands. The lotic systems are characterised by flowing water and are exemplified by rivers.
- Rivers are main channels which supply surplus rainwater from land to sea. Each river has a slow moving and a fast moving zone. In slow moving one main factor limiting the growth of organisms is the availability of dissolved oxygen. In the fast moving waters the speed of water current is the main factor limiting the growth.
- Saline ecosystems comprise all the oceans of the world and contain a major portion of the total biomass of the earth. Oceans are also the main reservoir of air and water vapour in the atmosphere.
- Estuaries are examples of brackish water ecosystems. Their salt content varies seasonally. They are the most productive ecosystems of the world. They are also the most delicately balanced ecological systems, because the factors governing the functions of estuarine ecosystems are intricately dependent upon each other. One should be careful before deciding to dump garbage, sewage or industrial wastes into such ecosystems.

3.7 TERMINAL QUESTIONS

1. Describe the importance of forests in our life.
2. Describe how desert plants and animals adapt themselves to the conditions present in desert.
3. Discuss the economic importance of grassland ecosystem.
4. Discuss which is the most dynamic ecosystem in your view and why.
5. Give a brief account of marine and estuarine ecosystem.

3.8 ANSWERS

Self-Assessment Questions

1. a) i) Biotic communities, ii) Deciduous, iii) Equator
b) See Section 3.2 Importance of forest.
c) See Section 3.2. types of forest

2. a) See Section 3.3 Grassland Ecosystem
b) See Section 3.3 Grassland Ecosystem - Economic importance
3. c, 2. b, 3. a
4. i) e, ii) d, iii) a, iv) c, v) b
5. a) T, b) F, c) T, d) T

Terminal Questions

1. See Section 3.2 Importance of forest.
2. See Section 3.4 Desert ecosystem.
3. See Section 3.3 Grassland ecosystem.
4. Describe the ecosystem which you find is most dynamic in your view and support your answer
5. See Section 3.5.4 Marine ecosystem.

3.9 FURTHER READING

1. Botkin, D. B. & Keler, E. A. 8th Ed. (2011) Environmental Science, Earth as a Living Planet, New Delhi: Wiley India Pvt. Ltd.
2. Chiras, D. D. (2016) Environmental Science – A framework for decision making, Burlington, M.A.: Jones and Barlet Learning.
3. Kormondy, E. J. (1969) Concepts of Ecology, Englewood Cliffs: Prentice Hall.
4. Odum, E. P. 3rd Ed. (1971) Fundamentals of Ecology, USA: W.B. Saunders.
5. Smith, R. L. and Smith, T. M., 9th Ed. (2015) Elements of Ecology, London, Pearson.

Acknowledgement of Figures

1. Fig. 3.2 : Desert Ecosystem https://en.wikipedia.org/wiki/Desert_ecology#/media/File:Algeria_Sahara_Desert_Photo_From_Drone_5.jpg
2. Fig. 3.5 : Loktak Lake: www.flamingotravels.com/image/loktak_big.jpg