

A PROJECT REPORT ON

**ENVIRONMENTAL STUDIES**

**ECOSYSTEM**

Submitted by

**Mr. / Ms. VAISHNAVI JAISHANKAR HIREMATH**

Exam Seat Number: ZK62688

Guided by:-

**MR. P.H. TAMGADGE**

Assistant Professor,

Management Department,

**Submitted To,**

SSBES’S

**INSTITUTE OF TECHNOLOGY & MANAGEMENT,**

**NANDED**

AFFILIATED TO,

**S. R. T. M. UNIVERSITY, NANDED**.

(2022-2023)

**INTRODUCTION:-**

An **ecosystem** is a system consisting of biotic and abiotic components that function together as a unit. The biotic components include all the [living things](https://www.biologyonline.com/dictionary/living-thing) whereas the abiotic components are the [non-living things](https://www.biologyonline.com/dictionary/non-living-thing). Thus, an ecosystem science definition entails an ecological community consisting of different populations of organisms that live together in a particular habitat. Natural sciences like ecology and geography define an ecosystem as a geographic area where organisms, weather, and landscape, work together

How about in biology, *what is an ecosystem*? In essence, the ecosystem definition in biology is that it acts as the fundamental unit of nature. Just as a living organism is made up of cells that act as the structural and functional units of life, nature also consists of fundamental units called *ecosystems*.

*What is a simple definition of an ecosystem?* An ecosystem is a community *plus* the environment. Ecology, which is the scientific study of the interactions between [populations](https://www.biologyonline.com/dictionary/population) or between organisms and the environment, can be viewed at the level of an individual, a population, a community, or an ecosystem.

Ecology at the level of individuals is concerned chiefly with the individual organism’s physiology, reproduction, and development. At the level of population, ecology deals primarily with the attributes and the various factors affecting the population. At the level of community, ecology studies the interactions between populations and community patterns. At the level of an ecosystem, ecology puts all of them together to understand how the system operates as a unit. Thus, an ecosystem ecology would be more concerned about energy flow and nutrient cycles than about individual species.

Etymologically, the ecosystem meaning and origin can be traced back to the Ancient Greek *“οἶκος”* (*“oîkos”*) for “house” and *“σύστημα”* (*“sústēma”*) for “organized body”. The term was coined in the early 1930s by the botanist, Roy Clapham, to denote the physical and biological components of an environment. However, it was the British Ecologist, Arthur Tansley, who first introduced the concept in his paper entitled “The Use and Abuse of Vegetational Concepts”.

**Ecosystem Structure**

The structure of an ecosystem consists of two major components:

(1) biotic components

(2) abiotic components

(1) Biotic components

The biotic components include all the living things. Basically, there are two major types of living things. They are the [*eukaryotes*](https://www.biologyonline.com/dictionary/eukaryote)and the [*prokaryotes*](https://www.biologyonline.com/dictionary/prokaryote). Eukaryotes are characterized by having membrane-bound organelles (such as a nucleus) inside their cells. The prokaryotes, in turn, are those lacking membrane- bound organelles. For further differences between these two groups, read this). Examples of eukaryotes are plants, animals, fungi, and protists. Bacteria and archaea represent the prokaryotes. Now, each of them has a “*job*” to do in the ecosystem.

Plants, for instance, have chloroplasts that enable them to harvest light energy. Then, they take carbon dioxide and water from their environment to convert them into sugar, a biomolecule that can be used to synthesize chemical energy. Because they are capable of producing their own food through photosynthesis, they are referred to as the [**producers**](https://www.biologyonline.com/dictionary/producer). Next to the producers are the [**primary consumers**](https://www.biologyonline.com/dictionary/primary-consumer). They feed on the producers while they serve as a food source to the higher levels of consumers (e.g. secondary and tertiary).

The animals are examples of consumers. The animals that feed on plants are called [*herbivores*](https://www.biologyonline.com/dictionary/herbivore)whereas those that feed on other animals are *carnivores*. Then, there are those that feed on both plants and animals. They are called [*omnivores*](https://www.biologyonline.com/dictionary/omnivore).

(2) Abiotic components

The abiotic components include all the non-living things, such as rocks, soil, minerals, water sources, and the local atmosphere. Similar to biotic components, the abiotic components also have their ecological role. For example, elements and compounds serve as sources of nutrients. They are essential to the growth and metabolism of an organism. Apart from providing nutrients, they also provide organisms a place to live and thrive — a *habitat*.

**Types of Ecosystems**

The four types of ecosystems are *terrestrial*, *freshwater*, *marine*, and *artificial*. The first three occur naturally in various biomes. The last one is man-made. Ecosystems vary in size — from the micro-ecosystems (e.g. tree ecosystems) to the largest ecosystems such as ocean ecosystems.

(1) Terrestrial ecosystem

ecosystems are forest ecosystems, grassland ecosystems, tundra ecosystems, and desert The **terrestrial ecosystem** is one that occurs on land. Examples of land-based ecosystems.

A *forest ecosystem* is one that consists of various plants, particularly trees. Because of the abundance of plants that serve as producers, this ecosystem abounds in life. Not only plants but also animals are teeming in a forest. They are also a great source of fruits, wood, They also help maintain the earth’s temperature. They are also a major carbon sink.

*Grassland ecosystems* are typically found in tropical or temperate regions. They are dominated by grasses. As such, the animals commonly found in this type of ecosystem are grazing animals, such as cattle, goats, and deer.

*Tundra ecosystems* are characterized as being treeless and snow-covered. The snow melts briefly in spring and summer, producing shallow ponds. During this time, lichens and flowering plants typically grow. Because of the ice that covers the land in the tundra, this type of ecosystem is important in regulating the earth’s temperature. It also serves as a water reservoir (in the form of ice or frost).

*Desert ecosystems* are the ones occurring in desert habitats. Deserts are typically arid and windy. Some of them contain sand dunes, others, mostly rock. Organisms in the desert are not as diverse as those in forests but they possess adaptations that make them suited to their environment. Plants that are commonly found in the desert are [CAM plants](https://www.biologyonline.com/dictionary/cam-plant), such as cacti. Desert animals include insects, reptiles, and birds.

(2) Freshwater ecosystems

**Freshwater ecosystems** are the aquatic ecosystems that do not contain saltwater. They are home to algae, plankton, insects, amphibians, and fish. There are two major types: *lentic* and *lotic* ecosystems.

A *lentic ecosystem* refers to ecosystems in still waters. Examples include the following: ponds, puddles, and lakes. Lakes, in particular, may form zonation. That is when it becomes very well established that different zones are formed. These zones are as follows: littoral, limnetic, and profundal. The *littoral zone* is the part that is near the shore. Here, light can penetrate up to the bottom. The *limnetic zone* is the zone in which light does not completely penetrate through. The part of the limnetic zone that is penetrated by light is the *photic zone* whereas the zone in which light cannot penetrate through, and therefore is dark, is the *benthic zone*. The plants and animals vary in these zones. For instance, rooted plants are found in the littoral zone but not in the limnetic zone. Rather, freely-floating plants are the ones commonly seen on the surface of the limnetic zone.

A *lotic ecosystem* is an aquatic ecosystem characterized by a freshwater habitat that is freely flowing. That is as opposed to the lentic that is nearly stationary. Examples include rivers and streams. Many plants and animals in these ecosystems have adaptations to help them cope with the force and the different conditions that running water brings.

(3) Marine ecosystem

A **marine ecosystem** is an aquatic ecosystem that contains saltwater. Examples are the ecosystems in the seas and oceans. The *ocean ecosystems*, in particular, are an important source of atmospheric oxygen due to the vast population of autotrophic algae that release oxygen through photosynthesis. Marine ecosystems are regarded as the most abundant type of ecosystem in the world.

(4) Artificial ecosystem

An **artificial ecosystem** is a man-made system, which can be further classified as terrestrial, freshwater, or marine. An example of an artificial ecosystem is a *terrarium*. Many man-made ecosystems are built for conservation purposes, aesthetics, and studying biology and ecology.

**Processes of the Ecosystem**

In an ecosystem, energy flows while materials are cycled. These two processes are linked and essential to the structure, function, and biodiversity of an ecosystem. Let’s take a look at the figure below to understand them further.

Energy flow

In ecology, the term productivity refers to the rate of generation of biomass in an ecosystem. It is often expressed in units of mass per volume per unit of time, e.g. grams per square meter per day (g m−2 d−1). Productivity may be primary or secondary. Primary productivity refers to the productivity of the autotrophs, such as plants, whereas secondary productivity refers to that of the heterotrophs, such as animals.

The primary production of biomass is often attributed to plants and algae performing photosynthesis. That is because virtually all energy available to organisms starts out with them. Energy from the sun is captured by the [chloroplasts](https://www.biologyonline.com/dictionary/chloroplast) (organelles containing chlorophyll, the green pigment) inside the cells of photoautotrophs. Inside the chloroplast, the light energy (in the form of photons) drives the conversion of inorganic substrates into energy reserves, like sugar molecules. In general, animals have no such pigments to capture light energy that will enable photosynthesis. Therefore, they have to rely on autotrophs and/or other heterotrophs for food.

[Photosynthesis](https://www.biologyonline.com/dictionary/photosynthesis) is a biological process through which plants manufacture their own food with the aid of light from the sun and from inorganic sources (e.g. carbon dioxide and water). They produce glucose molecules, for instance, that can be stored later as starch. The plants, in turn, serve as a food source for organisms that are incapable of producing their own food.

By feeding on these plants, the energy (as well as the nutrients) flows from the producer to the consumer. Then, it flows from one consumer to the next. Complex organic molecules in food, such as carbohydrates, fats, and proteins are rich sources of energy stored in their [chemical bonds](https://www.biologyonline.com/dictionary/chemical-bond). In the presence of oxygen, glucose (a sugar molecule), for instance, is processed to synthesize chemical energy (ATP) via [cellular respiration](https://www.biologyonline.com/dictionary/cellular-respiration). Energy stored in food molecules is released through a series of oxidation reactions. Electrons are passed on from one molecule to another until it reaches the final electron acceptor, which is oxygen. As the food molecule is fully oxidized, the final by product is carbon dioxide, which is released, for example through transpiration in plant stomata and exhalation in breathing animals. In the absence of oxygen, cells carry out [fermentation](https://www.biologyonline.com/dictionary/fermentation) wherein glucose is broken down to generate ATP and produce lactic acid. In animals, the excess energy from dietary sources is stored in energy-rich molecules, such as glycogen and lipids.

Decomposers are the last group of organisms through which energy flows through. They consume the droppings and carcasses of all living things.

Look at the figure below. It shows a simple diagram of a food chain and the flow of energy and nutrients. It starts with the producers, such as plants, that manufacture food by capturing light energy from the sun. Energy flows next to the consumers, particularly the primary consumer (insects), the secondary consumer (frog), the tertiary consumer (snake), and lastly, to the quaternary consumer (eagle). Then, the droppings or the carcass of the eagle will be broken down by the decomposers.



**Biogeochemical or nutrient cycling**

Elements, such as carbon, nitrogen, or phosphorus, enter a living organism in different ways. One example is by plants directly taking them up from their physical environment, for example via roots absorbing elements available in the soil and gases entering through stomata. In animals, these elements enter via food consumption. Droppings and decaying organic matter are broken down by decomposers, ultimately releasing these elements for nutrient cycling, or for use by other living organisms. This ecological process in which decomposers break down organic matter by decomposers is called [decomposition](https://www.biologyonline.com/dictionary/decomposition). In decomposition, these materials are neither lost nor destroyed and therefore the planet, in this regard, is a *closed system*. The elements will be cycled between biotic and abiotic states within the ecosystem.

**Community dynamics**

Ecosystems are dynamic. Their composition and structure may change over time especially when a disturbance occurs. For example, a volcanic eruption is a natural disturbance that can create a new land that is open for colonization. Oftentimes, the first species to colonize a barren land are lichens. Eventually, their biological activities will alter the condition of the environment. This will make it less harsh and more habitable for new species. The progressive replacement of one dominant type of species or community by another is called [*succession*](https://www.biologyonline.com/dictionary/succession). This succession will go on until a climax state is established, meaning the ecosystem has achieved stability and no further successions will occur unless another disturbance disrupts the ecological balance. For example, a massive flood wiped a previously stable community. The land will be open again for colonization. A succession in which the new land is colonized for the first time is referred to as *primary succession* whereas a succession in an area that was previously occupied by a community but was disturbed and replaced by recolonization is called *secondary succession*.

Take a look at the schematic diagram of succession below. You will notice that the process started as a barren land with bare rocks. The pioneer species, like lichens and moss, will grow on the rocks and will become the *pioneer species*. Then, the site is next colonized by grasses and herbaceous plants. Soon, trees will grow on this site when their seeds reach the site, for example by wind currents or by bird droppings containing undigested seeds.

**Function and biodiversity**

Ecosystems are responsible for the cycling of nutrients and for allowing the flow of energy, such as from the sun to the biotic components. The various biological, physical, and chemical systems work together in maintaining the stability of these systems on earth. Biodiversity is essential for an ecosystem to function. Biodiversity refers to the biotic components. The more diverse the biotic components are, the “*healthier*” the ecosystem will be. That is because each species has an important role to play. The more diverse the species are, the greater is the chance that the ecosystem will persist and continue to function. High diversity in an ecosystem can help improve productivity and thereby stabilize the functioning of an ecosystem.

**Examples of Ecosystem**

Examples of ecosystems described here are the following:

* **Deciduous forest ecosystem**
* **Savannah ecosystem**
* **Coral reef ecosystem**
* **Hot spring ecosystem**
* **Micro-ecosystems**

Deciduous forest ecosystem

A [deciduous forest](https://www.biologyonline.com/dictionary/deciduous-forest) is dominated by trees that shed leaves seasonally and then regrow their leaves at the start of the new growing season. They shed leaves as an adaptive mechanism against the cold season in temperate regions or to the dry seasons of the subtropical and tropical regions. The dominant trees in mid-latitude are oaks, beeches, birches, chestnuts, aspens, elms, maples, and basswoods. In the Southern Hemisphere, the dominant tree is the genus *Nothofagus* (southern beeches). The animals commonly found are snakes, frogs, salamanders, turtles, nails, slugs, insects, spiders, birds (such as warblers, owls, woodpeckers, hawks, etc.), and mammals (such as mice, moles, chipmunks, rabbits, weasels, foxes, and deer).

Savannah ecosystem

Savannahs are a mix of woodland and grassland ecosystems. The widely spaced, scattered canopy trees allow light to penetrate and reach the ground. Because of that, shrub and herbaceous layers dominated by grasses are able to grow abundantly as well. Thus, the animals commonly found here are the grazers, such as sheep, cattle, and goats. This type of ecosystem often serves as a transition zone between forest and desert or grassland.

Coral reef ecosystem

The coral reef is an ecosystem created by reef-building corals. The reefs are actually colonies of coral polyps, such as stony corals that live together in clusters. They are one of the most diverse ecosystems on earth. As such, they are referred to as the *rainforests of the sea*. Most of them are found at shallow depths in tropical waters. Some of the species that inhabit the reefs are mollusks, worms, crustaceans, echinoderms, sponges, tunicates, and fish.

Hot spring ecosystem

A hot spring is a spring with water temperatures that are higher relative to its surroundings. The water that is coming out of the spring is heated geothermally, i.e. via the heat from the earth’s mantle. Because of the high temperature, it is one of the ecosystems that contain very few types of organisms. Thermophiles are organisms that can thrive at temperatures ranging from 45 to 80°C (113 and 176 °F). Some of these organisms are thermophilic amoeba (such as *Naegleria fowleri* and *Acanthamoeba*), thermophilic bacteria (e.g. *Legionella*), and various archaea.

Micro-ecosystems

A tree with a creeping fern (epiphyte)

Ecosystems confined to small or tiny spaces and yet defined by specific environmental factors are called micro-ecosystems. Let’s take a look at a tree ecosystem. A tree creates a small ecosystem where various kinds of organisms live. For example, a tree may harbor lichens and other epiphytes (arboreal plant), invertebrates (such as insects), amphibians, and other animals. The epiphytes, themselves, provide a habitat for other organisms, such as fungi, bacteria, and myxomycetes.

**CONCLUSIONS:-**

The earth is a non-isolated system. There is almost no exchange of matter with the outer space (the earth loses a little hydrogen and receives meteorites). To be able to utilize the matter many times during the evolution or from one year and decade to the next, cycling is necessary. Cycling implies that the [ecosystem components](https://www.ecologycenter.us/population-dynamics-2/ecosystem-components-and-properties.html) are linked in an interacting network.

Ecosystems must be, as the earth, non-isolated because otherwise they could not receive the energy needed to maintain the ecosystems far from thermodynamic equilibrium and even move further away from thermodynamic equilibrium. Ecosystems are actually open systems because they need to exchange at least water (precipitation and evaporation) with their environment. In addition, it is practical that suitable solutions (for instance species with new [emergent properties](https://www.ecologycenter.us/microbiology/emergent-properties.html) that facilitate survival under a combination of new and emergent conditions) in one ecosystem can be exported to other ecosystems. Moreover, it is easy to observe that ecosystems are open systems.

**REFERENCS:-**

1. National Geographic Society. (2011, August 15). Ecosystem. National Geographic Society. https://www.nationalgeographic.org/encyclopedia/ecosystem/
2. Mathematics and 21st Century Biology. (2005). National Academies Press. https://doi.org/10.17226/11315
3. The Concept of the Ecosystem. (2017). Umich.Edu. https://globalchange.umich.edu/globalchange1/current/lectures/kling/ecosystem/ecosystem.html
4. Willis, A. J. (1997). “The ecosystem: an evolving concept viewed historically”, Functional Ecology 11:2, page 268-271.
5. Möller, D. (2020). Chemistry of the Climate System. Berlin Boston: De Gruyter.
6. Admin. (2018, March 13). Ecosystem. BYJUS; BYJU’S. https://byjus.com/biology/ecosystem/
7. 10 Examples of a Natural Ecosystem. (2017). Sciencing. https://sciencing.com/10-examples-natural-ecosystem-7836.html
8. Wikipedia Contributors. (2020, July 31). Productivity (ecology). Wikipedia; Wikimedia Foundation. https://en.wikipedia.org/wiki/Productivity\_(ecology)
9. deciduous forest | Definition, Climate, & Characteristics | Britannica. (2020). In Encyclopædia Britannica.
10. Sydney E. Everhart; Joseph S. Ely; Harold W. Keller (2009). “Evaluation of tree canopy epiphytes and bark characteristics associated with the presence of corticolous myxomycetes”.