Ecosystem and nutrients cycling

An **ecosystem** is a [community](https://en.wikipedia.org/wiki/Community_%28ecology%29) of living organisms in conjunction with the [nonliving components](https://en.wikipedia.org/wiki/Abiotic_component) of their environment (things like air, water and mineral soil), interacting as a system.[[2]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-2) These biotic and [abiotic components](https://en.wikipedia.org/wiki/Abiotic_component) are regarded as linked together through nutrient cycles and energy flows.[[3]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Odum1971-3) As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment,[[4]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Schulze400-4) they can be of any size but usually encompass specific, limited spaces[[5]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-5) (although some scientists say that the entire planet is an ecosystem).[[6]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-planet-6)

Energy, water, nitrogen and soil minerals are other essential abiotic components of an ecosystem. The energy that flows through ecosystems is obtained primarily from the sun. It generally enters the system through [photosynthesis](https://en.wikipedia.org/wiki/Photosynthesis), a process that also captures [carbon](https://en.wikipedia.org/wiki/Carbon) from the atmosphere. By feeding on plants and on one another, [animals](https://en.wikipedia.org/wiki/Animal) play an important role in the movement of matter and energy through the system. They also influence the quantity of plant and [microbial](https://en.wikipedia.org/wiki/Microbe) [biomass](https://en.wikipedia.org/wiki/Biomass_%28ecology%29) present. By breaking down dead organic matter, [decomposers](https://en.wikipedia.org/wiki/Decomposer) release carbon back to the atmosphere and facilitate [nutrient cycling](https://en.wikipedia.org/wiki/Nutrient_cycling) by converting nutrients stored in dead biomass back to a form that can be readily used by plants and other microbes.[[7]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin10-7)

Ecosystems are controlled both by external and internal factors. External factors such as [climate](https://en.wikipedia.org/wiki/Climate), the [parent material](https://en.wikipedia.org/wiki/Parent_material) that forms the soil, and [topography](https://en.wikipedia.org/wiki/Topography) control the overall structure of an ecosystem and the way things work within it, but are not themselves influenced by the ecosystem.[[8]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin11-8) Other external factors include time and potential [biota](https://en.wikipedia.org/wiki/Biota_%28ecology%29). Ecosystems are dynamic entities—invariably, they are subject to periodic disturbances and are in the process of recovering from some past disturbance.[[9]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin281-9) Ecosystems in similar environments that are located in different parts of the world can have very different characteristics simply because they contain different species.[[8]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin11-8) The [introduction of non-native species](https://en.wikipedia.org/wiki/Introduced_species) can cause substantial shifts in ecosystem function. Internal factors not only control ecosystem processes but are also controlled by them and are often subject to [feedback loops](https://en.wikipedia.org/wiki/Feedback).[[8]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin11-8) While the [resource](https://en.wikipedia.org/wiki/Resource_%28biology%29) inputs are generally controlled by external processes like climate and parent material, the availability of these resources within the ecosystem is controlled by internal factors like decomposition, root competition or shading.[[8]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin11-8) Other internal factors include disturbance, succession and the types of species present. Although humans exist and operate within ecosystems, their cumulative effects are large enough to influence external factors like climate.[[8]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin11-8)

[Energy](https://en.wikipedia.org/wiki/Energy) and [carbon](https://en.wikipedia.org/wiki/Carbon) enter ecosystems through photosynthesis, are incorporated into living tissue, transferred to other organisms that feed on the living and dead plant matter, and eventually released through respiration.[[14]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin123-15) Most mineral nutrients, on the other hand, are recycled within ecosystems.[[15]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin197-16)

Primary production: is the production of new organic matter or biomass by autotrophs in an ecosystem.The rate of primary production is the amount of biomass produced over some interval of time.Ecosystem ecologists distinguish between gross and net primary production.Gross primary production is the total amount of biomass produced by all the autotrophs in the ecosystem.Net primary production is the amount of biomass left over after autotrophs have met their ownenergetic needs.Net primary production is gross primary production minus respiration by primary producers, it is the amount of energy in the form of biomass available to the consumers in an ecosystems.

Primary production is the production of [organic matter](https://en.wikipedia.org/wiki/Organic_matter) from inorganic carbon sources. Overwhelmingly, this occurs through photosynthesis. The energy incorporated through this process supports life on earth, while the carbon makes up much of the organic matter in living and dead biomass, [soil carbon](https://en.wikipedia.org/wiki/Soil_carbon) and [fossil fuels](https://en.wikipedia.org/wiki/Fossil_fuel). It also drives the [carbon cycle](https://en.wikipedia.org/wiki/Carbon_cycle), which influences global [climate](https://en.wikipedia.org/wiki/Climate) via the [greenhouse effect](https://en.wikipedia.org/wiki/Greenhouse_effect).

Through the process of photosynthesis, plants capture energy from light and use it to combine [carbon dioxide](https://en.wikipedia.org/wiki/Carbon_dioxide) and water to produce [carbohydrates](https://en.wikipedia.org/wiki/Carbohydrate) and [oxygen](https://en.wikipedia.org/wiki/Oxygen). The photosynthesis carried out by all the plants in an ecosystem is called the gross primary production (GPP).[[16]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin97-17) About 48–60% of the GPP is consumed in plant respiration. The remainder, that portion of GPP that is not used up by respiration, is known as the net primary production (NPP).[[14]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin123-15) Total photosynthesis is limited by a range of environmental factors. These include the amount of light available, the amount of [leaf](https://en.wikipedia.org/wiki/Leaf) area a plant has to capture light (shading by other plants is a major limitation of photosynthesis), rate at which carbon dioxide can be supplied to the [chloroplasts](https://en.wikipedia.org/wiki/Chloroplast) to support photosynthesis, the availability of water, and the availability of suitable temperatures for carrying out [photosynthesis](https://en.wikipedia.org/wiki/Photosynthesis).[[16]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin97-17)

Energy flow

The carbon and energy incorporated into plant tissues (net primary production) is either consumed by animals while the plant is alive, or it remains uneaten when the plant tissue dies and becomes [detritus](https://en.wikipedia.org/wiki/Detritus). In [terrestrial ecosystems](https://en.wikipedia.org/wiki/Terrestrial_ecosystem), roughly 90% of the NPP ends up being broken down by [decomposers](https://en.wikipedia.org/wiki/Decomposition). The remainder is either consumed by animals while still alive and enters the plant-based trophic system, or it is consumed after it has died, and enters the detritus-based trophic system. In [aquatic systems](https://en.wikipedia.org/wiki/Aquatic_ecosystem), the proportion of plant biomass that gets consumed by [herbivores](https://en.wikipedia.org/wiki/Herbivore) is much higher.[[18]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin244-19) In trophic systems photosynthetic organisms are the primary producers. The organisms that consume their tissues are called primary consumers or [secondary producers](https://en.wikipedia.org/wiki/Secondary_production)—[herbivores](https://en.wikipedia.org/wiki/Herbivores). Organisms which feed on [microbes](https://en.wikipedia.org/wiki/Microbe) ([bacteria](https://en.wikipedia.org/wiki/Bacteria) and [fungi](https://en.wikipedia.org/wiki/Fungi)) are termed [microbivores](https://en.wikipedia.org/w/index.php?title=Microbivore&action=edit&redlink=1). Animals that feed on primary consumers—[carnivores](https://en.wikipedia.org/wiki/Carnivore)—are secondary consumers. Each of these constitutes a [trophic level](https://en.wikipedia.org/wiki/Trophic_level).[[18]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin244-19) The sequence of consumption—from plant to herbivore, to carnivore—forms a [food chain](https://en.wikipedia.org/wiki/Food_chain). Real systems are much more complex than this—organisms will generally feed on more than one form of food, and may feed at more than one trophic level. Carnivores may capture some prey which are part of a plant-based trophic system and others that are part of a detritus-based trophic system (a bird that feeds both on herbivorous grasshoppers and earthworms, which consume detritus). Real systems, with all these complexities, form [food webs](https://en.wikipedia.org/wiki/Food_web) rather than food chains.[[18]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin244-19)

**Decomposition**

The carbon and nutrients in [dead organic matter](https://en.wikipedia.org/wiki/Soil_organic_matter) are broken down by a group of processes known as decomposition. This releases nutrients that can then be re-used for plant and microbial production, and returns carbon dioxide to the atmosphere (or water) where it can be used for photosynthesis. In the absence of decomposition, dead organic matter would accumulate in an ecosystem and nutrients and atmospheric carbon dioxide would be depleted.[[19]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin151-20) Approximately 90% of terrestrial NPP goes directly from plant to decomposer.[[18]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin244-19)

Decomposition rates vary among ecosystems. The rate of decomposition is governed by three sets of factors—the physical environment (temperature, moisture and soil properties), the quantity and quality of the dead material available to decomposers, and the nature of the microbial community itself.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) Temperature controls the rate of microbial respiration; the higher the temperature, the faster microbial decomposition occurs. It also affects soil moisture, which slows microbial growth and reduces leaching. Freeze-thaw cycles also affect decomposition—freezing temperatures kill soil microorganisms, which allows leaching to play a more important role in moving nutrients around. This can be especially important as the soil thaws in the Spring, creating a pulse of nutrients which become available.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21)

Decomposition rates are low under very wet or very dry conditions. Decomposition rates are highest in wet, moist conditions with adequate levels of oxygen. Wet soils tend to become deficient in oxygen (this is especially true in [wetlands](https://en.wikipedia.org/wiki/Wetland)), which slows microbial growth. In dry soils, decomposition slows as well, but bacteria continue to grow (albeit at a slower rate) even after soils become too dry to support plant growth. When the rains return and soils become wet, the [osmotic gradient](https://en.wikipedia.org/wiki/Osmotic_gradient) between the bacterial cells and the soil water causes the cells to gain water quickly. Under these conditions, many bacterial cells burst, releasing a pulse of nutrients.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) Decomposition rates also tend to be slower in acidic soils.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) Soils which are rich in [clay minerals](https://en.wikipedia.org/wiki/Clay_minerals) tend to have lower decomposition rates, and thus, higher levels of organic matter.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) The smaller particles of clay result in a larger surface area that can hold water. The higher the water content of a soil, the lower the oxygen content[[21]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin61-22) and consequently, the lower the rate of decomposition. Clay minerals also bind particles of organic material to their surface, making them less accessibly to microbes.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) Soil disturbance like [tilling](https://en.wikipedia.org/wiki/Tillage) increase decomposition by increasing the amount of oxygen in the soil and by exposing new organic matter to soil microbes.[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21)

The quality and quantity of the material available to decomposers is another major factor that influences the rate of decomposition. Substances like sugars and amino acids decompose readily and are considered "labile". [Cellulose](https://en.wikipedia.org/wiki/Cellulose) and [hemicellulose](https://en.wikipedia.org/wiki/Hemicellulose), which are broken down more slowly, are "moderately labile". Compounds which are more resistant to decay, like lignin or [cutin](https://en.wikipedia.org/wiki/Cutin), are considered "recalcitrant".[[20]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Chapin159-21) Litter with a higher proportion of labile compounds decomposes much more rapidly than does litter with a higher proportion of recalcitrant material. Consequently, dead animals decompose more rapidly than dead leaves, which themselves decompose more rapidly than fallen branches.