

Lesson booklet: Ecology

Biology Year 9 · unit 4 · Example College · version September 2026

Section 1. What is ecology?

Ecology is the part of biology that deals with the relationships between organisms and their surroundings. An ecologist asks why a certain plant grows in one place and not in another, why there are many mice one year and few the next, and what happens when a species disappears.

To talk about this we use four terms that fit inside each other like boxes. An **individual** is one organism: one duck on the school pond. A **population** is a group of individuals of the same species living in the same place at the same time and able to breed with each other: all the mallards on and around the school pond. A **community** consists of all the populations in one place together: the ducks, the carp, the reeds, the water lilies, the dragonflies, the bacteria in the mud. An **ecosystem** is the community plus the non-living surroundings: the water, the soil, the light, the temperature.

Those non-living surroundings are the **abiotic factors**. Examples are temperature, light, water, wind, the acidity of the soil and the amount of nutrients in the water. The living surroundings are the **biotic factors**: other organisms that affect an organism, such as food, predators, competitors, pathogens and members of its own species.

An example. At the school pond, reeds grow thickly on the sunny south side and hardly at all on the shady side. Light is the abiotic factor that makes the difference here. Coots nest in the reeds; the reed stems give cover from the heron. For the coot, the reeds are a biotic factor, and so is the heron.

Section 2. Food chains and food webs

Every organism needs energy. Plants get that energy from sunlight: through **photosynthesis** they make glucose and oxygen from water and carbon dioxide. Because plants make their own food, we call them **producers**. Animals cannot do that; they eat plants or other animals and are therefore called **consumers**. An animal that eats plants is a primary consumer, an animal that eats plant-eaters a secondary consumer, and so on. Fungi and bacteria that break down dead remains are called **decomposers**. They return nutrients to the soil and the water.

A **food chain** shows who eats whom, in a row with arrows. The arrow points in the direction the energy goes. At the school pond: water plant → water flea → stickleback → heron. The water plant is the producer, the water flea a primary consumer, the stickleback a secondary consumer and the heron a tertiary consumer. Each step in the chain is a **link** or trophic level.

In real life hardly anything eats just one thing. The heron also eats frogs, the stickleback also eats mosquito larvae, and the water flea is also eaten by dragonfly larvae. If you draw all the food chains of a community on top of each other, you get a **food web**. A food web shows how

species depend on each other. If the water fleas disappear, both the stickleback and the dragonfly larva are in trouble, and after them the heron.

Why are food chains rarely longer than four or five links? Because at every link most of the energy is lost. An animal uses most of the energy from its food to move, keep warm and breathe; only a small part, roughly a tenth, becomes body mass that the next link can eat. After four links so little energy is left that a fifth link can barely exist. That is why there are far more plants than plant-eaters, and far more plant-eaters than predators. We draw this as a **pyramid of biomass**.

Section 3. Cycles

Energy flows through an ecosystem in one direction: from the sun, through producers and consumers, to heat that leaves the ecosystem. Matter does not. Matter goes round in **cycles**. The best known is the **carbon cycle**.

Carbon is in the air as carbon dioxide (CO₂). Plants take in CO₂ and use photosynthesis to build glucose from it, and from that all the other substances of their bodies. Animals eat plants and take in the carbon that way. Plants and animals breathe: during **respiration** in their cells CO₂ is released again. When an organism dies, decomposers break down the remains and that carbon too returns to the air as CO₂. The cycle is complete.

People have added an extra route to this cycle. Coal, oil and gas are the remains of organisms from millions of years ago; the carbon in them was locked in the ground for a long time. By burning those fuels we put a lot of carbon into the air in a short time that had not been there for ages. As a result the amount of CO₂ in the atmosphere rises, and that strengthens the greenhouse effect.

Nitrogen also goes round in a cycle. Plants need nitrogen for proteins and take it up as nitrate from the soil. Bacteria in the soil make nitrate from dead remains and from nitrogen gas in the air. Manure and fertiliser add extra nitrogen to the soil. That is useful for a farmer, but if the nitrate washes into a ditch or a pond, algae start to bloom there. That is called **eutrophication**, and it is one of the reasons the school pond sometimes turns green in summer.

Section 4. Populations and balance

How many ducks fit on the school pond? Not an unlimited number. There is a limit to the food, the nesting sites and the space. The maximum number of individuals of a species that an area can support in the long run is the **carrying capacity** of that area for that species. If a population rises above the carrying capacity, there is not enough for everyone: animals starve, have fewer young or move away, and the population shrinks again.

Factors that limit a population include food, water, space, predators, disease and the weather. Some factors act more strongly as the population grows: with many animals in a small place

a disease spreads faster and predators find prey more easily. Other factors, such as a harsh winter, hit a large and a small population equally hard.

Populations affect each other. **Competition** arises when two species need the same thing, for example the same food or the same nesting site. **Predation** is the relationship between predator and prey. When there is a lot of prey, the predators have many young; the number of prey then falls, after which the number of predators falls too. So the two populations oscillate around each other. In the week 4 practical you count water fleas in two tanks, with and without a stickleback, and see this for yourself.

An ecosystem in which the populations stay roughly the same in the long run is said to be in **balance**. That balance is not static: it fluctuates, and it can shift if a factor changes permanently.

Section 5. People and ecosystems

People change ecosystems faster and on a larger scale than any other species. We clear forest for farmland, build roads through habitats, put manure and pesticides into soil and water, and move species to places where they do not belong. Each of those interventions changes the abiotic or the biotic factors of an area, and with them the community.

Biodiversity is the variety of species in an area. An area with many species is usually more stable than an area with few: if one species drops out, others can take over its role in the food web. Few species live in a maize field; if disease wipes out the maize, nothing is left. Hundreds of species live in Example Wood; if ash dieback removes the ash trees, the wood survives, though it changes.

Example Wood is a good example of the choices people face. The council wants to build a cycle path through the wood so that students can get to school more safely. Nature lovers fear the path will cut the wood in two and that deer and badgers will no longer cross. The farmers next to the wood want the wood made smaller, because the badgers eat their maize. In week 5 we hold a debate about this. You are given a role and defend it with arguments from this unit: carrying capacity, food web, biodiversity, abiotic and biotic factors.

Conservation management is deliberate intervention in an ecosystem to preserve or restore it: mowing at the right moment, holding back water, a wildlife tunnel under a road, reintroducing a species that had disappeared. Doing nothing can also be conservation management. Which choice is right depends on what you want to achieve, and people disagree about that. Ecology does not answer the question of what you should want, but it does answer the question of what happens when you act.

Tasks

1. Give one example each from the school pond of an individual, a population, a community and an ecosystem.
2. Name three abiotic and three biotic factors that affect the reeds at the school pond.

3. Draw the food chain from section 2 and label each link as producer or consumer, and of which order.
4. Draw a food web of the school pond with at least six species from this booklet.
5. Use the concept of energy to explain why there are more water fleas than sticklebacks in the school pond.
6. Describe in four steps how a carbon atom gets from the air, via a water plant and a duck, back into the air.
7. Explain why the school pond sometimes turns green in summer and what that has to do with the farm next to the school.
8. What is the carrying capacity of an area? Name two factors that determine the carrying capacity of the school pond for ducks.
9. Draw a graph of the number of water fleas and the number of sticklebacks over time, and explain why the lines run as they do.
10. Explain why a wood with many species copes better with a tree disease than a wood with one species.
11. Choose a party in the Example Wood debate and give two arguments using terms from this unit.
12. Think of a conservation measure for the school pond and explain what effect you expect on the food web.

Glossary

Term	Meaning
Abiotic factor	Influence from the non-living surroundings, such as light, temperature, water
Biotic factor	Influence from other organisms, such as food, predators, competitors
Biodiversity	The variety of species in an area
Consumer	Organism that eats other organisms
Carrying capacity	The maximum number of individuals of a species an area can support in the long run
Ecosystem	Community plus the non-living surroundings
Eutrophication	Excess nutrients in water, causing algae to bloom
Photosynthesis	Process by which plants use light to make glucose and oxygen from water and CO ₂
Community	All the populations in one place together
Population	Group of individuals of the same species in the same place and time
Predation	Relationship between predator and prey
Producer	Organism that makes its own food, usually a plant
Decomposer	Organism that breaks down dead remains, such as fungi and bacteria

Term	Meaning
Food chain	Row of organisms that eat each other, with arrows in the direction of the energy
Food web	All the food chains of a community on top of each other