Lesson Fourteen

# Biology: Studying Ecosystems

## Aims

By the end of this lesson you should:

- know how to measure some important environmental factors
- know how to sample the plants in an ecosystem
- know how to find and count the animals in an ecosystem
- understand the importance of sample size
- be able to relate what you have learned about keys, adaptations and feeding relations to habitat studies

## Context

This lesson is the last of the three on Ecology: the study of organisms in their environments. The other two were Lesson Ten and Lesson Thirteen.

# Introduction

In Lesson Ten we learned that organisms live in **ecosystems**, each of which contains a number of habitats. In this lesson we see how **ecologists** study these ecosystems. They use three different steps:

- measuring the **environmental factors** that the organisms living there are exposed to
- identifying and sampling the **organisms** to find out what species, and how many of each, are present
- using this information, and observations of the adaptations and feeding relationships of the organisms, to find out how the **ecosystem** works

To do this completely for an ecosystem takes months, if not years, of work! However, parts of it can be done quite quickly and simply.

It will make this lesson especially interesting if you "adopt" your own ecosystem and find out about it.

# Finding an Ecosystem

It is not necessary to go off to the tropical rainforest to find an ecosystem to study! There are several interesting ones close to your home.

Here are some ideas for an ecosystem you might "adopt", with some of the different habitats each contains:

| **Ecosystem** | **Habitats** |
|---|---|
| A small wood | The woodland floor, inside the leaf litter, under fallen branches, in the soil, up in the canopy, clearings, on the tree trunks, paths |
| A stream | Fast-flowing open water, slow-flowing open water, on stones, under stones, in the mud on the bottom |
| A rocky shore at the seaside | Near the low tide mark, near the high tide mark, the middle of the shore, in rockpools, on exposed rocks, in cracks in rocks |

| | |
|---|---|
| A garden | On the lawn, in the shade, under /on walls and fences, in the compost bin, under old pots etc., uncultivated parts |
| A wall | On top, sunny side, shady side, in cracks between the stones, at the bottom where it is damp |

Life on a rocky shore

# Measuring Environmental Factors

Organisms in the wild have two things to put up with:

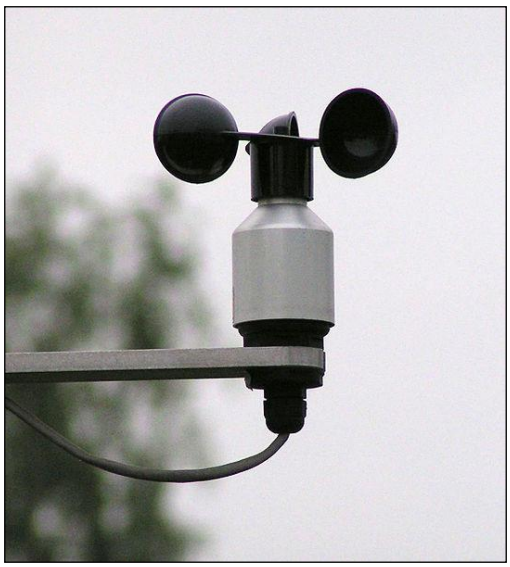
- the non-living or **abiotic** environment, and
- other organisms, that is the **biotic** environment.

The abiotic environment is made up of a whole set of different **abiotic factors**. These include temperature, amount of water and air in soil, pH of the soil or water, wind speed, humidity of the air, depth of soil and light intensity. A species will only occupy a particular habitat if it can cope with all these factors there. Not if it *likes* them, you notice, but if it can *cope* with them.

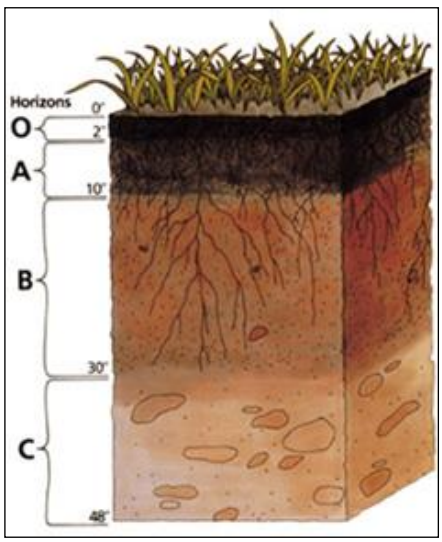
Most of the factors will have different values in the different habitats of an ecosystem, and this partly decides what species live where.

Here is a list of these factors and how an ecologist measures them. In some cases, simpler alternatives that you can use yourself have been included:

| **Abiotic factor** | **Measuring the factor** |
|---|---|
| Temperature | Use a **thermometer**. |
| Wind speed | Use an instrument called an **anemometer**. You may have seen them whirling round and round at weather stations. OR measure how far away a light object is blown before it hits the ground. |
| Light intensity | Use a **light meter**. |
| pH of water or soil | Add **universal indicator**, observe the colour change, and compare to a colour chart (see Year 7 Lesson 18.) |
| Depth of soil | Use an **augur** (like a giant corkscrew) that can be screwed in and then pulled out with a soil sample. OR dig a hole! |
| Humidity of the air | Measured using a **hygrometer**. OR see how long it takes for water to evaporate. |
| Amount of water and air in soil | Loss in mass of soil when heated to 100°C gives you the mass of water. Shaking measured volumes of soil and water together, and seeing how much volume is lost, gives you the volume of the air. |



An anemometer




A section through some soil

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*Get it right!* A species will only live in a particular habitat provided it is able to cope with *all* the abiotic environmental factors found there.

## Activity 1

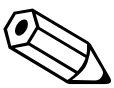
For this activity you will need access to a garden.

1. Having asked permission, dig a hole. How far down does the soil go? Does it stay the same colour as you go down? The blacker earth near the top contains humus (dead plant material), and is much more fertile.

2. Collect some soil and place in a baking tray. Weigh the soil and tray. Now bake for 2 hours in a cool oven at 100°C. Allow to cool and reweigh. How much water was in your soil? **Safety: hot metal does not look hot!**

3. Half fill a kitchen measure with loose soil and put to one side. Now half fill the measure with water. Add the soil and stir. Notice the bubbles of air escaping. You will have less than a full measure of mixture, and the missing volume is the air that was in your soil.

**Safety: wash your hands after handling soil or animals.**



# Sampling the Plants

All ecosystems contain plants, because only plants are **producers** (see Lesson Thirteen).

Unlike animals, it is easy to find and count the plants in an ecosystem. This is because:

- they can't hide, because they have to be in the light for photosynthesis, and
- they don't move around.

## Why sample?

If you are studying a large ecosystem, it would simply take too long to count all the plants. Imagine trying to count the grass plants on a football pitch, for example!

For this reason, ecologists **sample** plants. This means taking only a few small areas of the ecosystem, counting the plants there, and assuming that the rest of the ecosystem is much the same.

## Quadrats

A quadrat is used for sampling plants. It is a square frame, usually made out of plastic, wire or wood, which has a convenient size, like 1 metre along each side.

A quadrat in use on a sand dune ecosystem

To sample the plants in an ecosystem, place their quadrat down a few times, and accurately count the number of each species inside. For each species, apply the formula:

Total population Size = average number of plants in one quadrat × number of quadrats that fit in the whole ecosystem

Of course, this assumes that the ecosystem is the same all over – that the unsampled bits have the same number of plants as the sampled bits.

When using quadrats, it is important to put them down at **random**. It is no good selecting the most interesting-looking bits to sample, or your sample will not properly represent the whole ecosystem.

| **Activity 2** | For this activity you need access to a lawn.<br><br>Improvise a quadrat, perhaps by bending a wire coat hanger into a square.<br><br>Place the quadrat at random on the lawn, and count the number of grass plants in your quadrat. Repeat five times and take an average.<br><br>Work out the area of your quadrat (length × breadth), and the area of the lawn (length × breadth).<br><br>Calculate the number of grass plants on the lawn, and be grateful you didn't have to count them all! |
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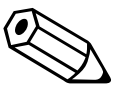
|  | |

## Sample Size

When using quadrats, there are two important decisions to make:

1. How big should each quadrat be?

2. How many times should I put my quadrat down and count what is in it?

Both these things affect the **sample size** – the percentage of the whole ecosystem that is actually counted. In both cases a compromise is struck between the amount of work involved and the accuracy of the results. Obviously the most accurate result is obtained by counting all the plants in the whole ecosystem, but that would take for ever!

1. Quadrat size: The rule here is to make the quadrat big enough so you "capture" most of the different plant species in the ecosystem each time. But no bigger.

2. Number of quadrats: What ecologists do is to perform the calculation above after every few quadrats, and stop when their answer settles down rather than jumping up and down with each new quadrat.

Some of the different plants to be sampled in a grassland ecosystem

# Sampling the Animals

Animals are much trickier to sample than plants, because they move about and they hide. Indeed, on looking at a new ecosystem you may not see any animals at all. But they'll be there somewhere!

For those animals which stay fixed, for example limpets on a rocky shore, the quadrat system can be used as for plants. For others there are a variety of techniques available. The one used depends on the size and behaviour of the animals being sampled.

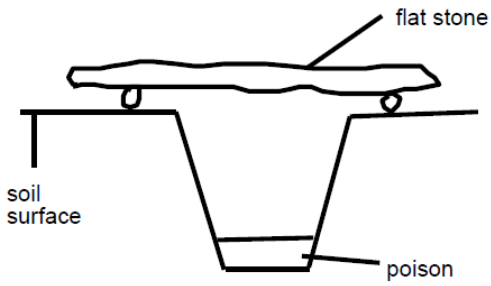
Limpets on a rocky shore


## Pitfall Trap

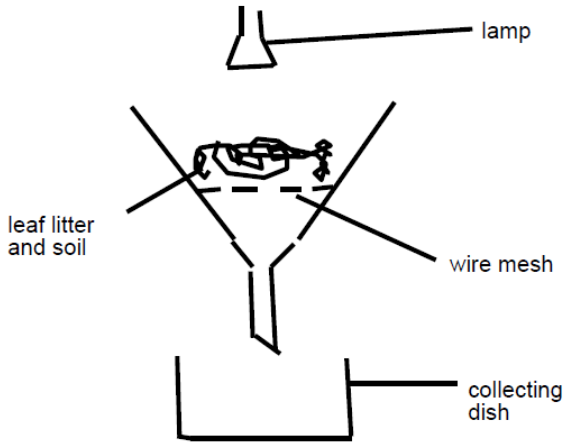
This works for small animals which crawl over the soil surface at night, e.g. beetles. You set the trap at dusk and return at dawn. The animals fall into the poison in the trap and are killed before they can climb out. The stone over the top stops other animals eating the bodies before you find them. The poison also stops the carnivores eating the herbivores in the trap – otherwise you might find just one big carnivore the next morning!

## Tulgren Funnel

This is used to extract the small animals hiding in soil and leaf litter. The heat from the lamp drives them downwards, and they fall through the wire mesh into the collecting dish.




A pitfall trap




A Tulgren funnel

## Nets

Neither of these systems will capture the lively insects flying or hopping about in long grass, or the animals in a stream. For these you must use a net. Either a large **sweep net** to swish through the grass, or a smaller net to place in a stream to catch animals dislodged as you shuffle about upstream of it.

**Activity 3**

**Under supervision**, collect some leaf litter from a garden park or wood. Improvise a Tulgren funnel using an anglepoise lamp or similar as a heat source. Did you catch any animals?

**Safety: Do not any electrical equipment for investigations without adult supervision.**

# The Ecologist's Quandary

You may have noticed a problem with the methods used for sampling animals: they either kill the animals, destroy a bit of the ecosystem, or both.

This is a serious issue in ecology, and it catches ecologists in a bind. The more intensively they study an ecosystem, and so the more they know about it, the less the ecosystem they studied is still there in one piece!
For example, let's say you want to draw a pyramid of biomass for a wood. To do this you have to dig up all the trees, dry

them and weigh them, and then catch, dry and weigh all the animals. At the end you have a fine pyramid of biomass – for an ecosystem that no longer exists!

## Putting it all together

Once ecologists have identified and sampled all the organisms in their ecosystem, and measured the abiotic factors there, they try to work out how the ecosystem functions. They will:

- construct food webs and pyramids to describe the feeding relationships,
- explain adaptations in terms of the environmental factors, and
- try to see how the organisms depend on each other as well as compete with each other.

This is a very long job. Serious ecologists are very dedicated people!

**Activity 4**

Go to skoool.co.uk at

http://lgfl.skoool.co.uk/keystage3.aspx?id=63, and investigate sections 60 – 62 and 65 – 68.

**Extension Activity**

Select one of the ecosystems listed in the table under "Finding an ecosystem". Make sure it is one you can easily visit several times.

Using equipment you can make at home, and a good dose of wit, cunning and initiative, work through the techniques in this lesson, applying them to your ecosystem as far as you can.

Then write up a report on your own personal ecosystem, and show it to your admiring public!

If you do this carefully, you will possibly know more about your ecosystem than anyone else in the whole world!

**Keywords**

| | |
|---|---|
| **Ecosystem** | **Anemometer** |
| **Habitat** | **Light meter** |
| **Sampling** | **Hygrometer** |
| **Abiotic** | **Augur** |
| **Biotic** | **Universal indicator** |
| **Quadrat** | **Pitfall trap** |
| **Random** | **Tulgren funnel** |
| **Sample size** | **Sweep net** |

## Self-Assessment Activities

1. Say whether each of these statements is true or false. If they are false, correct them:

   (a) When sampling an ecosystem, you should choose where to place your quadrats carefully.
   (b) In rockpools, and in cracks in rocks, are both habitats found on a rocky shore.
   (c) A hygrometer is used to measure wind speed.
   (d) Plants always grow where the abiotic conditions suit them best.
   (e) You can sample animals which do not move or hide using a quadrat.
   (f) The larger the sample size, the more accurate your estimate of the population size.
   (g) You could sample a population of woodmice using a tulgren funnel.
   (h) Producing a pyramid of numbers for an ecosystem should be less destructive than producing a pyramid of biomass.
   (i) If a quadrat has a side of 0.4m, its area is $0.4m^2$.
   (j) The more of a species of plant found in a quadrat, the bigger the whole population should be.