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A local ecosystem
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Welcome to the Biology module ‘A local ecosystem’!

During this unit you will focus on a local ecosystem. You will use your existing knowledge about your surroundings to study the interactions that occur between the living and the non-living parts of the ecosystem.

An important part of this module is to go into the field and study a local terrestrial or aquatic ecosystem. To help you with this task there is a field study scaffold attached to the first part of the module. The scaffold helps you to complete the report of your field study in a scientific style. Throughout the module you will be asked to fill in the tables that are within the field study scaffold. You will need to have the field study scaffold handy for every part of the module. Hopefully, using this method, writing the final report will not be such a daunting task.

Outcomes

This module increases students understanding of the nature, practice and application of biology.

Indicative time

This module is a designed to take twenty hours. There is a large practical component. The field study will take a minimum of fours hours to complete. It may take longer depending on the area you decide to use. The module has been divided into four parts that should take a week each to complete.
Resources

You will need to gather resources for your field study (see part 4). Access to a computer is a useful resource for your Biology course.

For Part 1 you will require
• a 4 metre length of string
• four wooden pegs or a quadrat

Icons

The following icons are used within this module. The meaning of each icon is written beside it.

The hand icon means there is an activity for you to do. It may be an experiment or you may make something.

You need to use a computer for this activity.

There is a safety issue that you need to consider.

There are suggested answers for the following questions at the end of the part.

There is an exercise at the end of the part for you to complete.

Field study. You may need to go outside or away from your desk for this activity.
# Glossary

The following words, listed here with their meanings, are found in the learning material in this module. They appear bolded the first time they occur in the learning material.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>abiotic</td>
<td>relating to non-living things</td>
</tr>
<tr>
<td>abundance</td>
<td>the number of individual organisms in an area</td>
</tr>
<tr>
<td>allelochemicals</td>
<td>a secretion of a plant that retards the growth of another plant</td>
</tr>
<tr>
<td>allelopathy</td>
<td>the inhibition of one species of another by the secretion of chemical substances</td>
</tr>
<tr>
<td>amino acid</td>
<td>nitrogen containing basic building block molecule of proteins</td>
</tr>
<tr>
<td>aquatic</td>
<td>relating to water, describes an organism that lives or grows in water</td>
</tr>
<tr>
<td>autotrophic</td>
<td>describes organisms that can produce their own nutrients from non-living sources, such as light, water and carbon dioxide</td>
</tr>
<tr>
<td>biomass</td>
<td>the total mass of the organisms in an area</td>
</tr>
<tr>
<td>biotic</td>
<td>relating to living things</td>
</tr>
<tr>
<td>buoyancy</td>
<td>the tendency of a material to keep an object afloat</td>
</tr>
<tr>
<td>calicivirus</td>
<td>a disease that affects groups of organisms, including rabbits</td>
</tr>
<tr>
<td>canopy</td>
<td>the cover provided by the leaves and branches of the vegetation in an area</td>
</tr>
<tr>
<td>carnivores</td>
<td>an organism which only feeds on animals</td>
</tr>
<tr>
<td>chemosynthesis</td>
<td>obtaining energy from inorganic substances</td>
</tr>
<tr>
<td>chlorophyll a/b</td>
<td>green substances in a plant's chloroplasts that absorb light energy in photosynthesis</td>
</tr>
<tr>
<td>commensalism</td>
<td>a relationship between two species in which one benefits while the other is not disadvantaged</td>
</tr>
<tr>
<td>competition</td>
<td>the interaction between organisms trying to obtain resources such as food, water, shelter, mates, nesting sites in an area</td>
</tr>
<tr>
<td>condensation</td>
<td>physical process resulting in the change of state from gas to liquid</td>
</tr>
</tbody>
</table>
consumer | any organism that eats another organism
---|---
cristae | a fold in the inner membrane of a mitochondrion
datalogger | instrument used to record information called data
decomposer | bacteria or fungi that bring about the decay of organic material
deforestation | to strip or remove trees in an area
denitrifying bacteria | micro-organisms that convert nitrate back into gaseous nitrogen
distribution | the region inhabited by an organism
dorsal | relating to an organ or tissue that is located on an organism's back
ecosystem | a self-sustaining set of organisms and their non-living surroundings
electron microscope | a very powerful microscope that uses beams of electrons focused by electron lenses instead of light
enzyme | a highly specialised cellular protein that reduces the amount of energy required to initiate a chemical reaction, thereby increasing the speed of reaction
eutrophication | process by which pollutants cause a body of water to become over-rich in organic and mineral nutrients, so that algae grow rapidly and deplete the oxygen supply
evaporation | a physical change describing the change of state from liquid to gas
food chain | depicts a sequence of organisms arranged in such a way that demonstrates the transfer of energy from one trophic level to another
food web | a map depicting the feeding relationships within an area, consisting of a number of food chains
fungus | an organism that does not possess chlorophyll and absorbs all its nutritional requirements through special structures called hyphae
habitat | that part of the environment that is occupied by an animal or plant
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>herbivores</td>
<td>describes the group of animals that eat only plant matter</td>
</tr>
<tr>
<td>heterotrophic</td>
<td>any organism that eats other organisms in order to satisfy it's nutritional requirements</td>
</tr>
<tr>
<td>host</td>
<td>an organism on which a parasite lives</td>
</tr>
<tr>
<td>lichen</td>
<td>an organism formed from the symbiotic relationship between an algae and a fungus</td>
</tr>
<tr>
<td>magnification</td>
<td>to increase the size of something</td>
</tr>
<tr>
<td>membrane</td>
<td>a thin sheet of tissue</td>
</tr>
<tr>
<td>metabolism</td>
<td>all the chemical reactions in an organism</td>
</tr>
<tr>
<td>metabolite</td>
<td>each step of the metabolic pathway is catalysed by a different enzyme, the end product being called a metabolite</td>
</tr>
<tr>
<td>mitochondrion</td>
<td>the cell organelle that is the site of respiration</td>
</tr>
<tr>
<td>micro-organism</td>
<td>an organism that is microscopic in size</td>
</tr>
<tr>
<td>mutualism</td>
<td>the close relationship between organisms of different species in which both benefit</td>
</tr>
<tr>
<td>myxomatosis</td>
<td>a highly infectious viral disease of rabbits</td>
</tr>
<tr>
<td>nitrogen fixing</td>
<td>conversion of atmospheric nitrogen into nitrates</td>
</tr>
<tr>
<td>nitrates</td>
<td>a type of salt composed of nitrogen and oxygen</td>
</tr>
<tr>
<td>omnivores</td>
<td>an animal which feeds on both plants and animals</td>
</tr>
<tr>
<td>organelles</td>
<td>a specialised microstructure or area within a cell</td>
</tr>
<tr>
<td>ozone</td>
<td>a form of oxygen containing three atoms of oxygen found in the atmosphere</td>
</tr>
<tr>
<td>parasitism</td>
<td>the relationship in which an organism lives in or on an organism and feeds from it</td>
</tr>
<tr>
<td>pH</td>
<td>a measure of the acidity or alkalinity of a substance, its relative concentration of hydrogen ions in solution</td>
</tr>
<tr>
<td>photosynthesis</td>
<td>the chemical process by which chlorophyll containing plant cells use light to make organic compounds from inorganic ones</td>
</tr>
<tr>
<td>photomicrograph</td>
<td>the picture or photograph of a microscopic object taken through a microscope</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>phytoplankton</td>
<td>microscopic aquatic plants</td>
</tr>
<tr>
<td>predator</td>
<td>an organism that eats other organisms, usually thought of as involving the consumption of animals by animals but it can also mean the eating of plants</td>
</tr>
<tr>
<td>protozoan</td>
<td>any organism belonging to the phylum Protozoa, usually unicellular</td>
</tr>
<tr>
<td>producer</td>
<td>see autotrophic</td>
</tr>
<tr>
<td>protein</td>
<td>a large complex molecule composed of amino acids joined together</td>
</tr>
<tr>
<td>quadrat</td>
<td>an area of ground surface, used as a sampling unit in population studies</td>
</tr>
<tr>
<td>random</td>
<td>occurring without a regular or predictable pattern</td>
</tr>
<tr>
<td>resolution</td>
<td>property used in microscopy in which points can be seen as discrete entities</td>
</tr>
<tr>
<td>respiration</td>
<td>a series of chemical reactions which leads to the breakdown of carbohydrates using oxygen and releasing energy</td>
</tr>
<tr>
<td>salinity</td>
<td>the amount of dissolved salt in water</td>
</tr>
<tr>
<td>secchi disc</td>
<td>device used to measure turbidity of water</td>
</tr>
<tr>
<td>species</td>
<td>a group of organisms that can interbreed under natural conditions to produce fertile offspring</td>
</tr>
<tr>
<td>sustainable</td>
<td>utilisation of environment without depletion of natural resources</td>
</tr>
<tr>
<td>symbiosis</td>
<td>a close association between organisms of different species</td>
</tr>
<tr>
<td>terrestrial</td>
<td>relating to the land as opposed to water</td>
</tr>
<tr>
<td>transect</td>
<td>a straight line cross-section of an area</td>
</tr>
<tr>
<td>transpiration</td>
<td>the evaporation of water through leaf stoma</td>
</tr>
<tr>
<td>trophic</td>
<td>relating to nutrition or feeding</td>
</tr>
<tr>
<td>turbidity</td>
<td>describes the opaque condition of a liquid containing suspended particles such as muddy water</td>
</tr>
<tr>
<td>understorey</td>
<td>lower level growth in forests, such as plants and seedlings protected by the canopy</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>unicellular</td>
<td>consisting of one cell</td>
</tr>
<tr>
<td>viscosity</td>
<td>the tendency of a material to resist movement through it</td>
</tr>
</tbody>
</table>
A local ecosystem

Part 1: Abiotic and biotic factors
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Introduction

You are about to start a module on ‘A local ecosystem’. In this first part of the module you will be looking at the living and the non-living parts of the ecosystem and how we measure them.

You will need the following items for the practical exercises in this part.
• a 4 metre length of string
• four wooden pegs or a quadrat

In this part you will be given opportunities to learn to:
• compare the abiotic characteristics of aquatic and terrestrial environments
• identify the factors determining the distribution and abundance of a species in each environment
• examine trends in population estimates for some plant and animal species within an ecosystem.

In this part you will be given opportunities to:
• process and analyse information obtained from a variety of sampling studies to justify the use of different sampling techniques to make population estimates when total counts cannot be performed

We live in a world of finite resources. We have used the natural environment of the Earth as if we are the only species to have the right. Our increasing population has stretched the Earth’s resources to a point where we must look at our uses of the environment and ensure that our activities are sustainable. We would like future generations to have equal access to the natural resources of the Earth.

In this module of your Biology course, you will be looking at your own local ecosystem. It is here that you can have the most effect. You will be able to draw on your existing knowledge of a local ecosystem and expand your understanding of biological concepts. An important part of this work is to carry out a field study. Throughout the unit you will carry out exercises that will prepare you for this activity. When you are about to do an activity that forms part of your field study you will see this icon.

Have a look at the field study scaffold that is included with this week’s work. This scaffold helps to set out the written report in a scientific style. You will be filling in the tables of the report as you go through the module.

Start thinking about an area that you can study. Choose one that is convenient for you and one that is safe to visit. Write a short paragraph describing your initial thoughts of this local ecosystem.
What is an ecosystem?

Let’s start with a definition of an ecosystem.

An ecosystem is made up of groups of organisms and the non-living environment interacting together as a complex self-sustaining natural system.

The four important points of this definition are
• groups of organisms
• the non-living environment
• interacting together
• self-sustaining.

We study ecosystems because they allow us to investigate major interactions, cycles and living populations. However you might notice that the most difficult part of this definition is the term self-sustaining. There is always a degree of interaction between ecosystems. Some examples of ecosystems are rainforests, heathland, grassland, mangrove swamps, ponds, lakes, forests, and deserts. The photographs below show examples of different ecosystems.

Heathland
Look closely at the photographs above. Each has a group of organism that are interacting together with the non-living environment and they are mostly self-sustaining.
Your backyard can be considered an ecosystem especially if you don’t add extra water and fertiliser.

The photograph above shows a small backyard pond. It has a group of organisms living in it and it is interacting with the non-living environment. It is self-sustaining. It therefore fits the definition of an ecosystem. This would make a suitable small ecosystem to study. When deciding on your study area consider the possibility of working on a small ecosystem as well as the more obvious larger ecosystems.

**Biotic and abiotic factors**

Another way of naming the organisms and the non-living environment is with the terms *biotic* and *abiotic*.

You may recall the terms biotic and abiotic (‘a’ means ‘without’) from your previous studies. If not try to predict the meaning of the terms in the space below.

Biotic: ________________________________________________

____________________________________________________

Abiotic: _________________________________________________

____________________________________________________
Answer: Biotic: the living organisms in the ecosystem, such as plants and animals
Abiotic: the non-living part of the ecosystem for example, soil, light, heat, and air.

The environment of any organism consists of both biotic and abiotic factors interacting.

Let’s have a look at more examples of biotic and abiotic factors.

Here is a list of some abiotic and biotic factors of ecosystems.

- Chemical factors – water, oxygen, nitrogen, carbon dioxide, pH, salinity
- Physical factors – light, temperature, humidity, tide, wind
- Plants – grasses, algae, shrubs, trees
- Animals – micro-organisms, fish, birds, reptiles, mammals
- Fungus – yeast, mushrooms, toadstools
- Bacteria – Rhizobium sp, Escherichia coli

Place these factors into the table to indicate whether they are biotic or abiotic. The first one is done for you.

<table>
<thead>
<tr>
<th>Biotic</th>
<th>Abiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>salinity</td>
</tr>
</tbody>
</table>

Answers: Abiotic: Chemical (water, oxygen, nitrogen, carbon dioxide, pH, salinity) and physical factors (light, temperature, humidity, tide, wind)
Biotic: Plants, animals, fungus, bacteria.
By now, you will have a good understanding of what biotic and abiotic factors are. Think about your local ecosystem study and list some of the biotic and abiotic factors that you could look for on the lines below.

Abiotic: _________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________

Biotic: __________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________

Below is a drawing showing some of the factors within a pond ecosystem.

The drawing shows biotic and abiotic factors. Indicate with a tick in the table below whether they are biotic or abiotic.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Biotic</th>
<th>Abiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>air and water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water beetle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dissolved oxygen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>microscopic algae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water bird</td>
<td></td>
<td></td>
</tr>
<tr>
<td>frog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>presence of water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dragonfly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answers: Abiotic: Air and water temperature, pH, light, dissolved oxygen, presence of water
Biotic: Fish, water plants, water beetle, microscopic algae, water bird, frog, dragonfly.

Other abiotic factors in this pond are:

- **viscosity** ‘thickness’ of the medium
- **buoyancy** upthrust of the medium
- **pressure** weight of medium pressing down
Abiotic factors of ecosystems

We can divide ecosystems into two basic types, aquatic (water) and terrestrial (land). As is often the case in Biology when we make a sweeping distinction there are always exceptions to the rule. There are ecosystems that are difficult to classify as terrestrial or aquatic such as mangrove swamps and rock platforms.

As you have seen, important abiotic factors are:

- water and dissolved ions
- light
- temperature
- pH
- gases such as oxygen and carbon dioxide
- viscosity
- buoyancy
- pressure
- salinity

Now you will examine how each of these is different in a terrestrial and aquatic environment.

Living on land has many challenges. Firstly there is the problem of **support**. In an aquatic ecosystem the buoyancy (uplift) of water means that aquatic animals and plants do not need a rigid support system. A water plant has less supporting tissue than a land plant. The backbone of a land mammal is greater than a similarly sized aquatic mammal.

Water is more **viscous** (thicker) than air. If you have walked through water you would have found it hard going compared to walking through air. Aquatic animals have a streamlined shape to overcome the viscosity of water.

The next challenge is obtaining **water**. Water is necessary for life. In the aquatic environment the organism is surrounded by water, while on land this may be in short supply. The amount of water is dependent on rainfall, wind, temperature, and humidity. Many terrestrial animals have adaptations to overcome the lack of water in their ecosystems.

**Temperature** varies greatly in a terrestrial environment, during the day, through the seasons, as well as with altitude and latitude. In an aquatic environment the changes in temperature are less. Large bodies of water
experience small changes in temperature. A small puddle or a rock pool would have a greater range of temperature as they heat up during the day.

Water transfers heat faster than air. When swimming you will notice how cold you get after a period of time in water. This is why divers wear wet suits. Aquatic mammals have blubber to retain the heat in their bodies.

*Pressure* is not a problem for terrestrial animals. If you climb a mountain, you do have to take into account both the reduction in oxygen and the reduction in air pressure. In the aquatic environment there are rapid increases in pressure with depth. Even if you go to the bottom of a diving pool you can feel the effect of pressure on your ears. Organisms need special adaptations to survive the pressure in the depths of the ocean.

*Light* and *gases* are more readily available in the terrestrial environment than in the aquatic environment. There is no shortage of carbon dioxide and oxygen in the terrestrial ecosystem but in water a shortage of oxygen can be a problem. In water, the amount of oxygen that is available depends on water temperature and whether the water is fresh or salt. As the temperature of water increases, the amount of dissolved oxygen decreases. There is often more oxygen at the surface of water than at the bottom. Light is reduced as you go deeper in water both in quantity and quality.

The *pH* scale is a measure of the acidity of a substance. Most organisms live in a neutral pH of around 7. Acid rain on land and the effect of acid sulfate soils on water can produce conditions that can kill organisms.

**Summary of abiotic factors of terrestrial and aquatic ecosystems**

<table>
<thead>
<tr>
<th>Abiotic factor</th>
<th>Terrestrial</th>
<th>Aquatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>water and ions</td>
<td>Varies greatly from deserts to swamps. Some soils are rich others, poor.</td>
<td>Readily available</td>
</tr>
<tr>
<td>light</td>
<td>Readily available</td>
<td>Intensity and wavelength varies with depth of the water</td>
</tr>
<tr>
<td>temperature</td>
<td>Very varied both as you move through the seasons and through latitude and altitude</td>
<td>Less variation in oceans, decreases with depth</td>
</tr>
<tr>
<td>gases (oxygen and carbon dioxide)</td>
<td>No shortage of gases Availability decreases with altitude.</td>
<td>Oxygen availability is low and gas solubility decreases with an increase in temperature</td>
</tr>
<tr>
<td>viscosity</td>
<td>Less than water</td>
<td>High viscosity</td>
</tr>
<tr>
<td>buoyancy</td>
<td>Little support from the air</td>
<td>Water supports body weight</td>
</tr>
<tr>
<td>pressure</td>
<td>Decreases with altitude</td>
<td>Greatly increases with increasing depth</td>
</tr>
</tbody>
</table>
Biotic factors of an ecosystem

You have examined some of the abiotic factors of an environment. Now you will focus on the biotic factors.

Animal and plant species are not found scattered randomly throughout the environment. Each species has a preferred part of the ecosystem. This distribution of animals and plants is dependent on the conditions that prevail. To survive in any ecosystem an organism must be adapted to cope with the physical conditions. A fish cannot survive for long out of water. A rainforest plant cannot survive long in a desert environment. A desert or an estuary has extreme conditions that few species can live in while a forest has many different species competing for resources. The distribution of an organism depends on the requirements for living that each species possess.

Abundance is a term used to describe how many organisms are in the population at a certain time and in a certain place.

Populations will increase in number until they are confronted by a limiting factor. Limiting factors include:

- lack of space
- predators
- disease
- competition for food between members of the same species
- competition from members of other species
- physical factors (weather conditions).

For each limiting factor there is a zone of optimum characteristic. This is the preferred zone for an organism. Moving away from the optimum, there is a zone where the organism would be under stress. Further from the preferred zone there is death or avoidance. For example, many organisms have a preferred temperature. Most of the organisms would be found in the area with the optimum temperature. There would be some living on the fringes with limited survival. This would decide the distribution (range) of the species. The distribution of a species is where it is found. A species can have a high abundance and a small distribution, an example in the garden might be high numbers of stinkbugs on a citrus tree. Alternatively, the distribution can have low abundance but a large distribution—for example, small numbers of blue whales in the ocean.
The abundance of a species is often not a random occurrence. It is a result of the abiotic and biotic factors interacting in the ecosystem.

**Distribution and abundance**

To illustrate this you will focus on examples from a terrestrial and an aquatic ecosystem that show how abiotic factors determine the distribution and abundance of a species.

**Terrestrial environment**

The example that you will study is the distribution and abundance of plants in a rainforest and in the marine ecosystem.

**Photosynthesis** is the source of energy for most ecosystems.

Plants capture sunlight through chlorophyll molecules and use this energy to drive the series of chemical reactions that split water and form carbohydrates. It is these carbohydrates that all animals use as a source of energy input for the process of **respiration**.

To carry out photosynthesis a plant requires carbon dioxide, water, light and mineral ions. Usually carbon dioxide, light and mineral ions are easily
obtained from the terrestrial environment. The limiting factor is often water. In this example of a rainforest light may be the limiting factor.

If you have ever visited a rainforest you will know that it is dark and damp. There is plenty of water and carbon dioxide and there is a cycling of mineral ions. The struggle for existence is seen in the competition for light. In the canopy, trees have access to light and grow rapidly. On the forest floor the light reaching the plants is filtered by the leaves above. The plants at ground level use different photosynthetic pigments to the plants of the canopy. In the canopy the main pigment used is chlorophyll a. In the understorey the main pigment used is chlorophyll b. The forest floor in a rainforest is often fairly bare. If you look at the plants that grow on the forest floor you will notice they have large dark leaves. These are designed to capture as much of the available light as possible. If a tree falls allowing light to reach the forest floor there is a rapid growth of plants to use the available light. Light is the limiting factor for plants growing on the floor of a rainforest.

In the table on the next page is a summary of the abiotic factors in a rainforest.
Summary of abiotic conditions in a rainforest

<table>
<thead>
<tr>
<th>Part of rainforest</th>
<th>Light (as %)</th>
<th>Wind (km/hr)</th>
<th>Humidity (as %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest floor</td>
<td>0</td>
<td>0</td>
<td>98</td>
</tr>
<tr>
<td>Understorey</td>
<td>15</td>
<td>6</td>
<td>80</td>
</tr>
<tr>
<td>Sub-canopy</td>
<td>50</td>
<td>10</td>
<td>70</td>
</tr>
<tr>
<td>Canopy</td>
<td>100</td>
<td>18</td>
<td>65</td>
</tr>
</tbody>
</table>

From the information above describe the different conditions that occur at the four levels of a rainforest in terms of light, wind and humidity.

Forest floor: ________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Understorey: _______________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Sub-canopy: _______________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Canopy: ___________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Check your answers.
The abiotic conditions that occur in a rainforest control the distribution of plants in that environment. Many plants grow as epiphytes. This means that they grow on another plant. They are adapted to low light. Examples of epiphytes are orchids and ferns. Bird’s nest fern (*Asplenium australasicum*) is a shade tolerant species that is found in the branches of trees in rainforests.

![Bird’s nest fern (*Asplenium australasicum*)](image)

**Aquatic environment**

In an aquatic environment the majority of plants are microscopic algae called **phytoplankton**. These plants form the basis of life in the oceans. Plants capture sunlight through chlorophyll molecules and use this energy to drive a series of chemical reactions that split water and combine with CO₂ to form carbohydrates.

Plants in an aquatic environment have plenty of water, mineral ions and carbon dioxide. Their main limiting factor is light. As you go deeper into the ocean, two things happen to the light.

- The amount of light or the intensity of the light decreases.
- Different wavelengths of light are absorbed.

If you have ever gone underwater, you will know that as you go deeper the amount of light at the surface quickly begins to diminish. If you were to go deep enough you would reach a point where no light penetrates. At this point plants can no longer carry on photosynthesis.
This is reflected in the distribution of phytoplankton. Phytoplankton are found in the surface waters of the oceans to a depth of about one hundred metres. Some algae have been recorded at depths of 150 metres but their rate of growth is slow.

The depth to which plants can grow in aquatic environments is determined by the light penetration. The light has to be sufficient to allow photosynthesis to occur. Different species of plants require different amounts of light.

To illustrate this you will draw a graph of photosynthetic rate against light intensity. Below are some guidelines for drawing a graph.

**Drawing a graph**

Data can be presented in different ways to make interpretation easier. Tables are useful to bring information into an ordered form. Graphs are useful to give a visual representation. Choosing the correct graph type can make the information easier to understand.

A line graph is used when one of the variables (the *independent* variable) affects the other, the *dependent*, variable. The independent variable is often time. In the example below, the independent variable is time and the dependent variable is the population.
Hints on drawing a graph

Look at the graph above and tick off the following points below to make sure that the graph is drawn correctly:

1. Labelling is important. Make sure the graph has a title and that both axes are named and include the units that were used for measurement. The axes should be linear.
2. Unless asked to, do not extrapolate (add extra numbers beyond the graph that you have not measured).
3. If there is a direct relationship between the two variables and there are no outlying points, then draw a line through the points.
4. If the points are scattered but there is an overlying relationship, use a line of best fit.
5. The independent variable should go on the horizontal (x) axis.
6. The dependent variable should be on the vertical (y) axis.

Now it’s your turn.

Graphing exercise

Graph the relationship between light intensity and the rate of photosynthesis from the table below.

<table>
<thead>
<tr>
<th>Light intensity (Units of light intensity)</th>
<th>Rate of photosynthesis (mm$^3$CO$_2$/cm$^2$/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>80</td>
</tr>
</tbody>
</table>
Graph showing rate of photosynthesis against light intensity

From your graph at what light level does the rate of photosynthesis level off?

Drawing a graph is a useful skill. Scientists use computer programs to draw graphs for their research reports but understanding how to draw a graph by hand is still useful.

You have examined the distribution of plants in two different environments. In both the aquatic and terrestrial environments you have seen that light can be the abiotic factor that determines distribution of plants. In the aquatic environment phytoplankton are found only in the surface waters where light is available for photosynthesis. In rainforests some plants can live on the shady forest floor or in the branches of trees because they can photosynthesise in reduced light conditions.

Each species inhabits an area that it can tolerate. Once conditions change past the level of tolerance, the species can no longer live in that area.

If you look around a garden you will notice that certain plants grow only in certain areas. Some plants live in full sun; others are found in damp shady areas for example, mosses.
If you want to find slaters or worms, you need to look in dark shady areas. These animals will actively avoid areas of full sunlight.

Have a break now and go outside and see if you can find an example of a plant and animal that is found only in a particular part of the garden. Examine the plants. Look for any evidence that the plants have been eaten and look for diseases such as spots and galls. You thought about an area to study at the start of this module. Go back now and read what you wrote and decide if your choice was appropriate.
While it is useful to list the biotic and abiotic factors of the ecosystem a major part of this module is how to measure the abiotic and biotic factors.

**Measuring abiotic factors**

When you investigate your local ecosystem, you will have to measure some of the abiotic factors. The photograph below shows a datalogger.

![An example of a datalogger attached to a graphic calculator](image)

A datalogger is a useful instrument that you can take on a field study. It will gather data that can be taken back to a computer and analysed.
The datalogger can have different probes attached. Each probe collects
data on a specific feature. Most dataloggers can have several probes to
collect data simultaneously. For example, you could program your
datalogger to measure the abiotic factors:

- water temperature
- dissolved oxygen
- pH.

The datalogger can gather information as often as you like. You can leave
the datalogger in your ecosystem collecting data while you are away. A
datalogger makes it easy to collect data on abiotic factors. Other methods
of gathering information on abiotic factors will be discussed later in the
unit.

When recording abiotic data it is important to record the units of
measurement. Without the correct units the results are meaningless.

Measuring biotic factors

Sampling

When studying a population it is important to determine the size of the
population (abundance) and the distribution (range) of the population.
How can we measure a population?

The answer is not to count every individual but to sample the population.

A population can be defined as the number of organisms living in a
certain area at a certain time.

Justification for using sampling

The numbers of organisms in a population is always changing. Although
we talk about an ecosystem being balanced, we should be thinking in
terms of a dynamic (changing) equilibrium. The numbers of organisms in
an ecosystem would be changing each time that an organism had a meal.

It is important to be able to monitor the fluctuating numbers in a
population. As it is nearly impossible to count every organism in an
ecosystem, there are several methods that are used to estimate the population. Sampling is carried out when it is not possible to count every individual in a population. A small area is counted in detail and then multiplied to get an estimate for the whole area.

**Methods of sampling**

We will look at the following methods of sampling

- transects (lines)
- random quadrat (squares)
- capture/recapture (capture-marking-recapture).

**Transects**

A **transect** is a straight line. Usually a string is laid across an area and the organisms along the line are recorded. A transect is used to sample plant populations but can also be useful for animals especially if they are attached to one spot, for example, barnacles on a rock platform.

Barnacles and Nudilittorina (Small periwinkle)

The organisms that lie on the transect line or string are recorded. There are three ways of recording the organisms along the transect:

- Points are marked off at regular intervals and the organisms that touch the string at that point are recorded.
- Continuous sampling along a transect records every organism that touches the string.
- The transect can be a designated width either side (for example, a 1 metre strip) of the line transect.

Transects are particularly good for studying the changing distribution of plants. As the abiotic factors change so does the vegetation. A transect is a good way of monitoring the change.

Example of point sampling

![Example of point sampling](image)

Example of continuous sampling

![Example of continuous sampling](image)

Another example of using the transect method is spotlighting along a track for possums and gliders.
Random quadrats

This is a useful method for estimating the numbers of plants. It suits any population that does not move around. If you wanted to estimate the number of dandelion plants on an oval, it would be a waste of time to physically count every plant. To overcome this problem you can make an estimate using a quadrat (pronounced kwod-rat).

As the name suggests, a quadrat is usually a square but it can be any shape. A good size is a metre by a metre. The size depends on the organisms that you are counting. You can make one of these with four wooden stakes and some string.

A quadrat is placed randomly in an area and the number of organisms is counted in the square. This is then repeated several times and an average is taken. Then the size of the whole area is measured and multiplied by the average from the quadrat results. The quadrats are placed at random. You can count the actual numbers of each plant or work out a percentage cover for each species. It is necessary to take enough samples to have a reasonable estimate of the population.

Sample size

When studying an area you have to make a decision on

- the size of your quadrat
- the number of quadrats that you take.
The more quadrats that you take, the more accurate your results will be—but the effort to take the sample increases. There has to be a balance between the two, effort and accuracy. In the field, you can pre-sample to decide on the best size for a quadrat. If you try different-size quadrats, you can test for any significant difference between the sizes. This will help you to decide on the best quadrat size.

Before you start counting you have to decide on the criteria for counting.
- You can count the organisms that are completely within the quadrat.
- Only count along two edges of the quadrat.
- Count an organism if any part of it lies within the quadrat.

Here are three quadrats taken from a lawn. Count the number of small plants in each and record in the table below.

Answer: 5, 8, 10, 23
Average

Work out the average by dividing the total number by the number of samples.

Average = \( \frac{23}{3} = 7.7 \) plants per square metre.

The total area of the three samples is 3 square metres. The total number of plants is 23. Therefore, the average is 23 divided by 3, which is 7.7. Therefore, there are 7.7 plants per square metre.

If the entire lawn measured 10 metres by 10 metres, the total area for the lawn would be \( 10 \text{ m} \times 10 \text{ m} = 100 \text{ sq metres} \)

If the average per square metre was 7.7, for the whole lawn you would estimate that there were;

\( 7.7 \times 100 = 770 \) small plants

This is an estimate for the number of small plants for example, dandelions in the lawn.

Practical activity

Now I want you to carry out the above experiment.

Estimating using the random quadrat method

You will need a 4 metre length of string and four wooden pegs or a quadrat.

If you have a garden available, use the lawn for the following practical.

1. Select at random a spot on the lawn. You can do this by throwing a stick over your shoulder and starting one of your corners of the quadrat from where the stick lands.

2. Select a plant that you can recognise, such as dandelion, bindi-eye, clover. (It doesn’t matter if you don’t know the name just as long as you can recognise it.)

3. Make your quadrat using the four pegs and the string. A good size is a metre x a metre but a smaller quadrat is acceptable. Whatever size you use, make sure that you can work out the area of your quadrat.

4. Count the number of your chosen plants in the square.

5. Repeat so that you have 10 measurements.

6. Work out the average number of your plant in your samples.
<table>
<thead>
<tr>
<th>Quadrat number</th>
<th>Number of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Total number of plants =
Average number = \[ \frac{\text{Total number of plants}}{10} \]
This gives you the density of your plants.

You can now work out the total number of plants in the lawn by multiplying the density by the total area. Measure or estimate the size of your area (multiply the length by the breadth).

Length of area =
Width of area =
Area in square metres =
Multiply the area by the average number of plants in a quadrat.
This will give you an estimate of your chosen plant.

Chosen plant per square metre =
Write an experimental report on this practical exercise. Include in the conclusion of the report how good an estimate you have made. You may like to use the format for your report that is on the next page.
Report Title

Write a name for the experiment

---------------------------------------------

Aim:

What did you set out to achieve?

---------------------------------------------

---------------------------------------------

Method:

What you actually did.

---------------------------------------------

---------------------------------------------

---------------------------------------------

---------------------------------------------

Results:

What did you find out?

---------------------------------------------

---------------------------------------------

---------------------------------------------

---------------------------------------------

Conclusion:

Did you achieve your aim?

---------------------------------------------

---------------------------------------------

---------------------------------------------

---------------------------------------------

---------------------------------------------
Answer Exercise 1.2

**Percentage cover**

In some cases when you are investigating an ecosystem it is more useful to record the percentage cover rather than the actual number of organisms. A very small but dense plant is very difficult to count.

Again you can use a quadrat to estimate the abundance of this type of plant or animal. This time the quadrat is divided into a grid using string.

To work out the percentage cover you have to count the number of squares that are covered by the plant. If the plant doesn’t cover an entire square, you have to estimate the percentage of squares covered.

Work out the percentage cover of the small plant from the following plan diagram.

![Small plant diagram](image)

- total number of squares =
- number of squares covered =
- percentage cover $= \left( \frac{\text{number of squares covered}}{\text{total number of squares}} \right) \times 100$

$$= \times 100$$

$$= \%$$
Capture/recapture

While it is relatively easy to count the number of trees in an area, counting animals presents different problems. Animals move around. If you sat and counted animals you could easily be counting the same animal more than once. By tagging and marking animals it is possible to work out an estimate of the population. During this module the term capture/recapture will be used. You should be aware that the term capture/tag/recapture can also be used.

Fish not only move around but also are difficult to see from the surface. If you caught every fish in an area you would know the population exactly, but you would have many dead fish. Using capture/recapture, large numbers of fish can be tagged and then released back into the population. If you know how many fish you have tagged, you can work out the total number of fish by looking at the number you recapture each time.

For example, in a lake 30 fish are tagged and then released. After time for the fish to disperse the fish are recaptured. If there are 10 tagged fish out of every one hundred fish caught, the total number in the population can be estimated using the following formula:

\[
\text{Population size} = \frac{\text{number of animals tagged} \times \text{number of animals recaptured}}{\text{average number of tagged animals recaptured}}
\]

or

\[
N = \frac{M \times n}{m}
\]

where

- \(N\) = the population size
- \(M\) = number of captured tagged and released organisms
- \(m\) = the average number of tagged animals recaptured
- \(n\) = number sampled the second time (tagged and untagged)

\[
N = \frac{30 \times 100}{10} = 300 \text{ fish in the total population}
\]
There are problems with this method. If you are not careful with your tagging method you could cause the death of the animals that you tag. The tag may make the animal more likely to be caught by a predator. This could then affect your result. When using traps to catch small mammals such as marsupial mice some of the animals become trap-shy and will not return to be captured. Others ‘enjoy’ the experience and return often to take the bait offered.

Other examples of tagging methods are leg bands on birds, paint spots on shellfish, colouring fur, and ear tags.

For the next activity you will need:
- two colours of beads or lollies, approximately thirty of one colour and ten of the other
- a container to hold them

Practical activity

Model of capture/recapture

Aim

The aim of this experiment is to model the method of capture/recapture.
**Method**

To do this you will need to collect two sets of different-coloured beads, buttons or lollies. You will need 10 of one colour (this represents the tagged animals) and about 30 of the other colour (untagged animals).

Place the beads into a container together and make sure they are mixed up. Next draw out 10 beads and record how many of colour 1 you have in your sample. Return them and then repeat your sampling so that you have ten samples.

**Results**

Record the results in the table below.

<table>
<thead>
<tr>
<th>Number of first colour</th>
<th>Number of second colour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

Population size = \( \frac{\text{number of animals tagged} \times \text{number of animals recaptured}}{\text{average number of tagged animals recaptured}} \) or

\[ N = \frac{M \times n}{m} \]

where

\( N = \) the population size
\( M = \text{number of captured tagged and released organisms} \)

\( m = \text{the average number of tagged animals recaptured} \)

\( n = \text{number sampled the second time (tagged and untagged)} \)

- Calculate the average number of the first colour.

To do this add the total of each colour and then divide by ten.

Total of first colour =

Average of first colour \((m)\): \(\frac{\text{total of first colour}}{10} = \)

- Calculate the total population using the formula.

\[ N = \frac{M \times n}{m} \]

Where \( M = 10 \)

\( n = 10 \)

- Count the actual number of beads to check your estimate.

**Conclusion**

How close were you to the correct answer? ______________________

________________________________________________________

If you weren’t close can you think of any reasons why? ____________

________________________________________________________

________________________________________________________

________________________________________________________

Name an animal population you could count by this method. ______

________________________________________________________

________________________________________________________

Could you count a plant by this method? ________________________

Answer Exercise 1.3

For a look at some virtual environments go to the Biology Website under the heading Virtual ecosystems.

http://www.lmpc.edu.au/science
Advantages and disadvantages of sampling methods

The main advantage of a sampling method is that often it would be impossible to count every organism in a population. Even in the cases when it would be possible to count every individual, it would be time-consuming and expensive to do. It could also be a disruptive process to a population.

The disadvantages to this method are that the accuracy can never be 100%. Some methods of sampling lead to the death of the organism thus the act of sampling can have an effect on the population. Organisms move out of the area that you are sampling and would therefore never be recaptured.

Draw a table showing the advantages and disadvantages of sampling methods. Use the information above and try to think of some other disadvantages. Think about your own experiences and add these as well.

<table>
<thead>
<tr>
<th>Advantages of sampling</th>
<th>Disadvantages of sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table you have created, write an exposition.

The title of the exposition will be that sampling is a good method of estimating population numbers. Following there is a scaffold for an exposition. Use this or if you feel confident write an exposition without the scaffold.

Exposition scaffold

The function of exposition is to influence or persuade the reader.

State your position:

Sampling is a good method of estimating a population when total counts cannot be performed.
Examining trends in a population

When you examine trends in a population you can see if the population is increasing or decreasing. An example of a population that has shown varying trends is a species of fish called gemfish. During the 1970’s the gemfish fishery was developed. Throughout the decade the number of fish caught increased. Gemfish was a popular and inexpensive fish to buy during this period. Gemfish were caught while they were aggregating for
migration and spawning. They are a large fish that grows to a length of 1.3 metres.

The catch peaked at over 5000 tonnes per year but falling catch rates and fish sizes made it necessary to set a zero total allowable catch (TAC) in 1993. This stopped all fishing for this species. The population is slowly recovering but is thought to be 40% of the level it was during the 1970s.

This example shows how important it is to examine population trends.

Animals are not the only organisms that show trends in population estimates within an ecosystem. An example of a plant that has shown trends in population estimates are seagrasses. These plants are unusual because they live in saltwater but they are not algae. They are flowering plants. The population estimates of seagrasses are based upon their distribution. By mapping seagrasses on the coast of NSW it is possible to see that there has been a reduction over time in the population of these plants. Aerial photographs are a good way of estimating the population and recording differences over time.

Answer Exercise 1.4

Optional

In the syllabus, you are asked to examine trends in population estimates for some plant and animal species within an ecosystem.

The local area that you are studying changes during the year and changes with time. If you could study the same area in twenty years time, you would find differences. At different times of the year, you would find different organisms present. For example, some insects have breeding cycles that only occur during the summer.

This could be your open-ended investigation for the Preliminary course. Estimate a population in your local area and then return and repeat the sampling later.
An ecosystem is made up of groups of organisms and the non-living environment interacting together as a complex self-sustaining natural system. It is made up of abiotic (non-living) and biotic (living) factors.

Examples of abiotic factors are:

- Chemical factors – water, oxygen, nitrogen, carbon dioxide, pH, salinity
- Physical factors – light, temperature, humidity, tide, wind.

Examples of biotic factors are:

- Plants – grasses, algae, shrubs, trees
- Animals – micro-organisms, fish, birds, reptiles, mammals
- Fungus – yeast, mushrooms, toadstools
- Bacteria – *Rhizobium* sp, *Escherichia coli*

Distribution and abundance of organisms are controlled by the biotic and abiotic factors. Measuring abiotic factors can be done with a datalogger. Measuring biotic factors is done by sampling. Methods of sampling are transects, quadrats and capture/recapture. There are advantages and disadvantages to using sampling. Monitoring trends in populations is an important activity.
A local ecosystem
Characteristics of a rainforest

From the information above describe the different conditions that occur at the four levels of a rainforest in terms of light, wind and humidity.

**Forest floor**  High humidity 98%, low light 0% and no wind 0%.

**Understorey**  Receives 15% of light, the wind is low at 6 km/hr and the humidity is high at 80%

**Sub-canopy**  A reasonable amount of light, 50%, high wind at 10 km/hr and a lower humidity of 70%

**Canopy**  Very high light 100%, high wind 18 km/hr and low humidity 65%.

**Percentage cover**

Rough estimate

total number of squares = 10 x 10 = 100

number of squares covered = 3 + 2 + 2.5 + 4 = 11.5

percentage cover = \[
\frac{\text{number of squares covered}}{\text{total number of squares}} \times 100
\]

= 11.5/100 x 100

= 11.5 %
Environmental factors

Exercise 1.1

Aquatic and terrestrial ecosystems have different abiotic characteristics. Choose three of the following and say how they are different in the two environments: light, temperature, viscosity, buoyancy, water and ions, pressure, gases.
**Exercise 1.2**

a) When ecologists study a population of plants or animals they often want to know the abundance of the population being studied. This is especially true when studying endangered species. Different methods of sampling are used to estimate populations. Name three methods of sampling and then justify the use of sampling to make population estimates.

_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

b) You are studying a rock platform and it is your job to estimate the number of barnacles on the rock platform. You take 10 quadrats randomly and get the following results: 2, 4, 19, 3, 8, 6, 10, 7, 8, 9.

If the rock platform is 10 000 square metres in area, what is your estimate for the population of barnacles?
Exercise 1.3

Capture/recapture

An ecologist wants to know the possum population in a nearby eucalyptus forest. She captures 30 possums and tags them. She releases them and after a two-week period she takes 3 samples of 20 possums. The results of the re-sampling are below

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tagged possums</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

a) Calculate the size of the total population.

Predict what would happen if you:

i resample immediately

ii wait a year to resample
b) List four ways to tag an animal.

_________________________________________________

_________________________________________________

_________________________________________________

_________________________________________________

c) On a rock platform an ecologist wants to estimate the number of barnacles per square metre. Ten random quadrats were selected and counted. The results are below.

<table>
<thead>
<tr>
<th>Quadrat</th>
<th>No of barnacles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>114</td>
</tr>
<tr>
<td>6</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

Work out the density per square metre (average).
Exercise 1.4

A fish species is commercially harvested. The following statistics for the population were gathered.

**Gemfish catch/year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Gemfish (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>500</td>
</tr>
<tr>
<td>1977</td>
<td>700</td>
</tr>
<tr>
<td>1978</td>
<td>750</td>
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<tr>
<td>1979</td>
<td>2000</td>
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<td>1980</td>
<td>2100</td>
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<tr>
<td>1981</td>
<td>5100</td>
</tr>
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<td>1982</td>
<td>4500</td>
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<tr>
<td>1983</td>
<td>4500</td>
</tr>
<tr>
<td>1984</td>
<td>4000</td>
</tr>
<tr>
<td>1985</td>
<td>3200</td>
</tr>
<tr>
<td>1986</td>
<td>2900</td>
</tr>
<tr>
<td>1987</td>
<td>500</td>
</tr>
<tr>
<td>1988</td>
<td>0</td>
</tr>
</tbody>
</table>

Examine the trend in the population estimate. Would you suggest that the fishing of this species should continue? Explain.

_________________________________________________________
_________________________________________________________
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_________________________________________________________

Graph the table of gemfish catch.
A local ecosystem
A local ecosystem

Field study scaffold

Incorporating October 2002 AMENDMENTS
In any scientific project, one of the most important parts of the process is the writing of a report. The following should serve as a scaffold for your report. If you have access to a word processor, it is a good idea to type the report.
Title Page

On this page, you should state the name of your project, the date and your name. If you have a diagram or a photograph of the study area, you can include it here.

Abstract

This short summary states what you did and what you found out. Reading the abstract should be a good indication of what is in the rest of the report.

Contents

As your report may be long, a page of contents will enable your reader to find the section they are interested in.

Introduction

Literature review. When you study an ecosystem there maybe previous writers to consult. You can increase your background knowledge by consulting textbooks and reading scientific journals. A literature review is not required for this report.

Aims and objectives of the study. This should be a short account of what you were setting out to do in your study.

A map of the location of the study site

Method

General observations of the study site including a profile diagram and a plan sketch.

Describe how you measured the abiotic features of your site.

Describe how you estimated the size of your plant and animal population.
Describe how you looked at the interactions between the species. Describe your experimental design. Include how you decided on sample size and the validity of the results.

Results

Present the tables of results here for the two abiotic features that you measured, (salinity, oxygen, temperature). Include a mean and range for your results.

Graph of abiotic data.

Table of animals and plants you observed, Table 1 and 2.

Write up the interactions that you found in your local ecosystem. Table of trophic interactions of two plants and two animals, Table 3.

Record producers and consumers, Table 3.

Record any predator prey interaction, Table 4.

Record examples of allelopathy, mutualism, parasitism and commensalism, Table 4.

Show the flow of matter through the ecosystem using food chains and food webs, Table 5a and 5b.

Note any human interactions you observed, Table 6.

Describe the adaptations to the ecosystem of a plant and an animal, Table 7.

Outline the role of decomposers, Table 8.

Record the distribution of an animal and a plant. Sampling one transect.

Record your estimate for a plant and an animal species. Sampling two quadrats.

Discussion

Discuss your findings.
Describe any difficulties that you had.

Conclusions and recommendations

A short statement that relates directly to the aim of the report.

Any recommendations to come out of your report including suggestions for further research.

Acknowledgments

Record here any help that you had to complete the report.

References

Give the title, author, year and publisher for any reference material you used.
Citing References

There are certain standard ways of writing a reference list. Here are some suggestions:

**For a book**
- List the reference alphabetically by the author's surname
- Use initials for the author's other names
- Follow this with the date of publication in brackets
- Put the title of the book in italics (if typed) or underline the title if handwritten
- List the publisher
- Give the pages that were useful

Example


**Internet sites**
- As these are constantly changing you should give as much information as you can.
- Give the web address, the author and the date where possible

Example


**Scientific Journals**
- Author's surname and initials
- The date of publication in brackets
- Name of the article
- Name of the journal underlined
- The volume and series of the journal
- The page numbers.

Example

Field study for ‘A local ecosystem’

Title
Abstract
Contents

Optional

Introduction

Aims and objectives of the study
Introduction

Location Map
Method

General observations of the study site.

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Method

Profile diagram

Scale:
Method

Plan sketch
Method

Description of how you measured the abiotic features of your site.

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Method

Description of how you estimated the size of your plant and animal population.
Method

*Description of how you observed the interactions between the species.*

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Method

Describe your experimental design include how you decided on your sample size and the validity of the results.
Results

*Abiotic factors measured.* Present information in a table and a graph.

Table

Graph
Results

Table 1 Animal observations

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Abundance (few, common, many)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Results

Table 2 Plant observations

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Abundance</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(few, common, many)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Results

Table 3 Trophic interactions

<table>
<thead>
<tr>
<th>Interactions</th>
<th>Examples from local ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producers</td>
<td></td>
</tr>
<tr>
<td>Herbivores</td>
<td></td>
</tr>
<tr>
<td>Omnivores</td>
<td></td>
</tr>
<tr>
<td>Carnivores</td>
<td></td>
</tr>
<tr>
<td>Decomposers</td>
<td></td>
</tr>
</tbody>
</table>
### Results

#### Table 4 Interactions

<table>
<thead>
<tr>
<th>Interactions</th>
<th>Examples from local ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutualism</td>
<td></td>
</tr>
<tr>
<td>Commensalism</td>
<td></td>
</tr>
<tr>
<td>Parasitism</td>
<td></td>
</tr>
<tr>
<td>Allelopathy</td>
<td></td>
</tr>
<tr>
<td>Predator/prey</td>
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</tr>
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</table>
## Results

### Table 5a Food Chains, webs

<table>
<thead>
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<th>Name of organism</th>
<th>Eats</th>
<th>Eaten by</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
Results

Table 5b  Food Chains, food webs, pyramids of biomass

Food chains

Food web
Pyramid of biomass
Results

Table 6

Human impact on the ecosystem

Tick off the human impacts that you have observed in your local ecosystem.

<table>
<thead>
<tr>
<th>Human impact</th>
<th>Present</th>
<th>Absent</th>
<th>Human impact</th>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearing</td>
<td></td>
<td></td>
<td>Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
<td>Air pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture improvement</td>
<td></td>
<td></td>
<td>Water pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monoculture</td>
<td></td>
<td></td>
<td>Land pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td>Siltation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduced species</td>
<td></td>
<td></td>
<td>Smog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilisers</td>
<td></td>
<td></td>
<td>Heavy metals</td>
<td></td>
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<tr>
<td>Pest control</td>
<td></td>
<td></td>
<td>Mining</td>
<td></td>
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<tr>
<td>Machinery</td>
<td></td>
<td></td>
<td>Erosion</td>
<td></td>
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<tr>
<td>Urbanisation</td>
<td></td>
<td></td>
<td>Weed infestation</td>
<td></td>
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<td>Transport</td>
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<td>Die-back</td>
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<td>Industry</td>
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<td>Salination</td>
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<tr>
<td>Fishing</td>
<td></td>
<td></td>
<td>Sand-mining</td>
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<td>Population expansion</td>
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<td>Landfill</td>
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</tbody>
</table>
Results

Table 6

Human impact on the ecosystem  (continued)

Human impact on the local ecosystem is

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## Results

**Table 7 Adaptations**

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<thead>
<tr>
<th>Drawing or photograph</th>
<th>List of adaptations observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td></td>
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<tr>
<td>Plant</td>
<td></td>
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</tbody>
</table>
Results

Sampling 1 quadrats

Plant abundance

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<tr>
<th>Quadrat No.</th>
<th>Count</th>
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Results

Sampling 1 quadrats

Animal abundance

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<th>Quadrat No.</th>
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<tr>
<th>Quadrat No.</th>
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</table>
Results

Sampling 2 Distribution of a plant

Transects

Scale:
Results

Table 8

Outline the role of decomposers. List any decomposers that you find.

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Discussion

Discuss your findings. Relate the distribution of the animal and the plant that you have estimated to the abiotic factors that you have measured.
Discussion

Describe any difficulties you had.

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Conclusions and recommendations

A short statement that relates directly to the aim and any recommendations or suggestions for further research.
Acknowledgements

Record any help you had here.
References

*Any material you used for reference.*

This is to be returned to your teacher with Part 5 of the module.
A local ecosystem

Part 2: Energy and interactions
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In this part of the module you will be examining the two processes of photosynthesis and respiration. As well as this you will be aware of the interactions that occur between the living parts of the ecosystem. The relationship between the biotic parts of the ecosystem is the focus of this part of the module.

You will need to have your field study scaffold handy for this part of the module.

In this part you will be given opportunities to learn to:

• describe the roles of photosynthesis and respiration in ecosystems
• identify the general equation for aerobic cellular respiration and outline this as a summary of a chain of biochemical reactions
• identify uses of energy by organisms
• identify examples of allelopathy, parasitism, mutualism and commensalism in an ecosystem and the role of organisms in each type of relationship
• describe the role of decomposers in ecosystems
• explain trophic interactions between organisms in an ecosystem using food chains, food webs and pyramids of biomass and energy
• describe and explain the short- and long-term consequences on the ecosystem of species competing for resources
• outline factors that affect numbers in predator and prey populations in the area studied.

In this part you will be given opportunities to:

• gather information from first-hand and secondary sources to construct food chains and food webs to illustrate the relationships between member species in an ecosystem.

Living things need energy to survive. Without energy they cannot grow, reproduce or stay alive.

Where does this energy come from? Plants use the energy from sunlight and change it into chemical energy, through the process of photosynthesis. This energy is then stored in glucose molecules. The minerals from the soil are combined to make molecules such as chlorophyll, proteins and fats. This process is driven by energy. In order to grow and reproduce, plants require a constant supply of energy. Plants only use a small proportion of the Sun’s energy.

Animals gain their energy by eating plants or other animals. They use the raw materials they get from their food to create the materials that they need to survive and reproduce.
The process that captures the energy in sunlight is called photosynthesis. Photosynthesis is an important process because the energy from the Sun is converted into chemical energy stored in glucose. Glucose is required for respiration which provides energy for animals.

**Respiration**

Most of you would have heard of ‘artificial respiration’. Respiration is often used to mean breathing. In this module, the term respiration refers to aerobic cellular respiration. Cellular respiration is a series of chemical reactions that occur in every cell. It is the breakdown of carbohydrates (eg. glucose, fats, protein) using oxygen (aerobic). The process releases energy that can be used to drive the **metabolic** processes that take place in the organism.

**Inputs**
- oxygen
- glucose

**Outputs**
- carbon dioxide
- water
- energy released

Respiration inputs and outputs

The process of respiration takes place in a series of controlled step-by-step reactions. There are more than thirty small steps in the process. A similar reaction to respiration is combustion or burning. Respiration releases the energy stored in food in a slow, controlled manner.

The word equation for respiration is:

\[
glucose + oxygen \xrightarrow{\text{many steps}} \text{carbon dioxide} + \text{water} + \text{energy}
\]

This equation is a summary of all the steps that are involved in respiration. Glucose is completely broken down in the presence of oxygen and energy is released. Carbon dioxide is given off as a waste product. Enzymes increase the reaction rate of these steps.

Below is the balanced chemical equation for cellular respiration.

\[
C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}
\]
The two reactions allow energy to enter and move through the ecosystem. Photosynthesis uses light energy to produce sugars such as glucose. Respiration releases the energy stored in sugars. Photosynthesis occurs only in plants, while respiration occurs in every living cell, both plants and animals.

Complete the table following to summarise the inputs and outputs of respiration and photosynthesis.

<table>
<thead>
<tr>
<th>Process</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>photosynthesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>respiration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Check your answers.

Energy is used for all the processes that occur in an organism. When energy is converted from one form to another, there is a loss of energy in the process. At each step energy is lost as heat. Energy is not recycled in the environment—it is stored, used or is lost as heat. It flows through the ecosystem.

The energy that is produced during respiration can be used for:

- movement
- keeping warm
- growth
- reproduction
- repair.

Complete Exercise 2.1.
In an ecosystem, there must be a flow of energy occurring. The sun is the ultimate source of energy but at each level energy is stored used and lost. These levels are called *trophic levels* (from the Greek *trophos* meaning ‘food’).

The sun supplies the energy to plants. The process of photosynthesis captures the energy contained in sunlight and produces carbohydrates. The plant gains the energy that it requires to power its metabolism through the production of sugars. Starches are formed which make up plant tissue. When an animal eats a plant, it uses the energy stored in the plant to form its own body cells. At this level most of the energy is lost in the conversion from plant tissue to animal tissue. Only 10% moves up to the next *trophic level*. This means that at each level most of the energy is lost.

All feeding relationships in an ecosystem show a one-way flow of energy. The energy is not recycled. The sun provides a constant source of energy. No energy is returned to the sun however energy may be trapped in fossil fuels such as coal and oil.

Energy flows through an ecosystem from the Sun to plants and animals. Briefly describe the path or flow of energy through an ecosystem.

_________________________________________________________

_________________________________________________________

_________________________________________________________

Check your answer.
There are a large number of ways that organisms can interact. Classification of these interactions makes studying them easier. **Symbiotic** relationships occur when organisms live in close association with each other. In particular, you will be looking at:

- allelopathy
- parasitism
- mutualism
- commensalism.

You may already know the meanings of these words. Write down definitions of these terms in the space below.

Allelopathy ____________________________________________

Parasitism ____________________________________________

Mutualism ____________________________________________

Commensalism _________________________________________

Check your answers with the following explanations on the next pages.
Allelopathy

Allelopathy is a plant relationship. A plant produces chemicals that can be harmful or give benefit to another plant.

For example, fern fronds produce chemicals that prevent pine seeds from germinating. What benefit would this be to the fern?

Suggested answer: The fern would germinate and produce new plants while preventing the germination of a plant that would soon outgrow the fern and use the available materials.

Many Australian plants produce allelochemicals. These substances are released by the plants and concentrate in the soil. They inhibit the growth of other plants in the area and give the plant a competitive advantage. Examples that may occur in your local ecosystem are eucalypts and casuarinas. Allelopathy can be used in agriculture as a natural form of weed control.

The photographs below show a eucalypt and a casuarina. These are good examples of plants that show allelopathy in many parts of NSW.

Eucalyptus gumnuts. Observe gum trees in their environment as an example of allelopathy.
Flowers on a casuarina. Another example of a common plant that shows allelopathy.

Allelopathy is difficult to observe. If you can, list any examples of allelopathy that you have observed in your local ecosystem. Put these in Table 4 in your Field study scaffold.

Parasitism

Parasitism is the close relationship between two organisms where one is benefited and the other is disadvantaged. The organism benefiting lives on or within the body of the disadvantaged organism (called the host). Although the host is harmed, it is not usually killed by the parasite. If the parasite kills its host, it then has to find another host. Examples of parasites are tapeworm, flea, and disease-causing microorganisms like bacteria and viruses. Mistletoe and strangler figs are examples of plant parasites.
A strangler fig growing on a eucalyptus tree

If you look around your ecosystem you may observe spots and galls on leaves. This is a good example of parasitism for your field study.

Galls growing on Eucalyptus stem
List any examples of parasitism that you have observed in your chosen ecosystem (Table 4 in your Field study scaffold).

**Mutualism**

Mutualism is the relationship between two organisms where both organisms benefit from the relationship. Neither can live without the other.

A common example of mutualism is **lichen**. Lichen is a close relationship between a fungus and algae. The fungus gains nourishment from the photosynthetic algae. The algae are provided with a substrate to live within. If you look around your study area you will find lichen growing on rocks, trees and buildings.
Another example of mutualism is the relationship between termites and the protozoan that lives in the termite’s gut. You may recall that a protozoan is a one-celled organism. The protozoan depends on the termite for shelter and food. The termite is unable to digest the tough cellulose found in wood. Termites rely on the protozoan to reduce the wood to a form that the termite can digest. Both benefit from the relationship. Termites are very common. If you look in your study area you may find a termite nest in a tree.
Plants such as legumes have special nodules on their roots, which contain nitrogen-fixing bacteria. These bacteria change atmospheric nitrogen into nitrates that are released into the soil.

This legume has root nodules that contain nitrifying bacteria of the genus *Rhizobium*. *Rhizobium* ‘fix’ nitrogen. They change nitrogen gas ($N_2$) into ammonia ($NH_3$). Ammonia changes into ammonium ions ($NH_4^+$) in soil water which can be taken up by plant roots. The bacteria supply the plant with nitrogen. Bacteria gain their sugar supplies from their plant host. A good example of mutualism.

Legumes can grow well in areas that have soils poor in nitrogen.

In your local ecosystem there are many examples of Australian native plants that show this form of mutualism. Examples are casuarina, acacia (wattles), macrozamia (a cycad) and members of the pea family (for example, the egg and bacon plants).
Gompholobium sp. is a common native plant that is a legume.

Egg and bacon plant

List any examples of mutualism that you have observed in your ecosystem. (Table 4 in your Field study scaffold).
Commensalism

Commensalism is a loose relationship where neither organism is disadvantaged but one may be advantaged.

An example of commensalism is a remora attached to a shark. A remora is a small fish with suckers (modified dorsal fins) on its head. It attaches to a shark and is carried around by the shark. The remora can feed on any scraps of food that the shark misses. The shark does not seem to be affected by this.

The lichen mentioned growing on a tree trunk show a common form of commensalism. The lichen gets a place to attach off the ground and the tree is not affected by the lichen.

You may find bird nests in your field study: A bird nesting in a tree is another example of commensalism. The bird gains a place to raise its young and the tree is not affected.

List any examples of commensalism that you have observed in your chosen ecosystem. (Table 4 in your Field study scaffold).

Fill in the table below and then check your answers.

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Type of relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shark and remora</td>
<td></td>
</tr>
<tr>
<td>Strangler fig on eucalypt</td>
<td></td>
</tr>
<tr>
<td>Bee and flower</td>
<td></td>
</tr>
<tr>
<td>Giardia in the human gut</td>
<td></td>
</tr>
<tr>
<td>Insect larvae and scribbly gum</td>
<td></td>
</tr>
</tbody>
</table>
Classifying organisms by what they eat

As well as the special interactions that we have seen above we can classify organisms by what they consume or eat.

- **Producers**: make their own food
- **Consumers**: use other living things
- **Decomposers**: break down living things and their wastes

**Herbivores**

**Carnivores**

**Omnivores**
**Producers**

Plants are the **producers** in a community and provide food for all other organisms. They absorb the sun’s energy and use it to produce carbohydrates using water, carbon dioxide and minerals as the raw materials. They are called **autotrophic** or self-feeding organisms.

Look around your local ecosystem and list at least five producers. (Table 3 in your *Field study scaffold*).

**Consumers**

Animals and some parasitic plants are **consumers**. They are **heterotrophic** or different feeders. They eat other organisms to get a supply of energy.

A sundew, a carnivorous plant.

A sundew is a carnivorous plant. Insects are trapped in the sticky hairs on the leaves. Although it is autotrophic it also catches insects and digests them. It grows in swampy areas that are poor in nitrogen salts. Nitrogen is an essential element for plant protein and chlorophyll. The sundew makes up for lack of nitrogen by catching and digesting insects and using the protein in the insect’s body.
Consumers can be divided into:

- **herbivores**
- **carnivores**
- **omnivores.**

**Herbivores (plant eaters)**

These animals may be small (snail) or large (kangaroo). It takes a large amount of plant material to supply the energy to keep a herbivore alive. Because of this, herbivores spend most of the day eating. They are more numerous than carnivores, and it takes many herbivores to keep one carnivore alive.

Many birds, such as this cockatoo, are herbivores.
A small herbivore such as this snail is often seen feeding on plants.

Write down five examples of herbivores from your local ecosystem (Table 3 in your *Field study scaffold*).

**Carnivores (animal eaters)**

Carnivores eat other organisms. If they eat herbivores they are called first order consumers. If a carnivore eats a first order consumer, it is called a second order consumer and so on.

```
producer → first order consumer → second order consumer → third order consumer
```

Third order consumers can also be called tertiary consumers.

Carnivores need to be careful that they don’t expend more energy catching an organism than they will receive from eating it. The food that carnivores eat is a good supply of energy, so carnivores do not have to spend as long catching their prey.

Using the terms herbivore and carnivore there is an alternative naming system.

```
producer → herbivore → first order carnivore → second order carnivore
```
A spider is a small carnivore.

This lizard eats insects—therefore, it is a carnivore.

Write down five examples of carnivores from your local ecosystem (Table 3 in your Field study scaffold).

**Omnivores**

Animals that eat both plants and animals are called *omnivores*. In your local area you may have possums. Possums are mostly herbivorous but will include meat in their diet.

Humans and monkeys are omnivores. They eat both plants and animals. Many insects are omnivorous, for example ants and cockroaches. Look for these in your local ecosystem.
Monkeys are examples of omnivores.

There are not as many omnivores as herbivores and carnivores. List any examples of omnivores from your local ecosystem (Table 3)

**Herbivorous and carnivorous birds**

Birds are one of the easiest animals to see in your local ecosystem. If you know the name of birds that you see, write them down on the lines below. You can look up the names of birds by visiting your local library or asking people who live in the area. From your observations decide whether the bird is a:

- carnivore (eg hawk, eagle, magpie, kookaburra, kingfisher)
- herbivore (eg parrot, lorikeet, cockatoo).

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
A kookaburra is an example of a carnivore.

A lorikeet is a herbivore.

Answer Exercise 2.2

Include the results of your bird study in your field study (Table 3 in your Field study scaffold).
Predator/prey relationship

When we think of a predator, we usually imagine a lion attacking a gazelle or a dingo attacking a kangaroo. A predator is an organism that eats other organisms usually thought of as involving the consumption of animals by animals. A broader definition of a predator is an organism that eats another organism. This is the definition we will use in this module. You can think of carnivores like lions and dingoes but we can also think about herbivores such as kangaroos being predators of grass (their prey). All herbivores, omnivores and carnivores are predators as well.

Transfer the names of carnivores, herbivores and omnivores that you have already written down so that you now have a list of predators for your local ecosystem (Table 4 in your Field study scaffold).

There is a close relationship between a predator and its prey. The populations of the two species follow each other closely. As the prey increase in number so do the number of predators. If predators increase in number, more of the prey will be eaten and their numbers will be reduced. If the prey is wiped out completely by the predator, the predator will also die or have to move to an alternative food supply. This relationship between a predator and its prey results in cycles of increases and decreases in the population of both the predator and its prey.

If there is no predator for an animal such as the rabbit, the number of rabbits will increase to such an extent that the plants that the rabbit are eating would be greatly reduced. This can result in habitat destruction. In the end, the number of rabbits will be decreased, because there is no longer any food for the rabbit to consume. Therefore, the predators keep the number of prey in balance and prevent overpopulation and destruction of habitat. This is what is meant by a balance between predator and prey.

The crown-of-thorns starfish has a cyclic population. Sometimes it occurs in plague proportions. It devastates the coral which is its prey. There are several theories about why this happens. Shell collectors have removed triton shells which are predators of the crown-of-thorns starfish. This has caused the number of starfish to increase. Therefore removing triton shells increases the number of crown-of-thorns, which then decreases the number of corals. Another theory about the crown-of-thorns starfish is that run-off from the land produces an algal bloom. The larvae of the starfish feed on the algae so their survival rate increases greatly. Three years after the algal bloom the adult starfish are in plague proportions.
Most predators have more than one prey species. When the preferred prey becomes scarce, the predator switches to other prey species.

Here is some data collected on a predator, an eagle and its prey, a mouse over a period of two years.

<table>
<thead>
<tr>
<th>Month</th>
<th>Mouse</th>
<th>Eagle</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>111</td>
<td>16</td>
</tr>
<tr>
<td>February</td>
<td>109</td>
<td>18</td>
</tr>
<tr>
<td>March</td>
<td>93</td>
<td>21</td>
</tr>
<tr>
<td>April</td>
<td>91</td>
<td>17</td>
</tr>
<tr>
<td>May</td>
<td>90</td>
<td>16</td>
</tr>
<tr>
<td>June</td>
<td>86</td>
<td>14</td>
</tr>
<tr>
<td>July</td>
<td>94</td>
<td>12</td>
</tr>
<tr>
<td>August</td>
<td>98</td>
<td>9</td>
</tr>
<tr>
<td>September</td>
<td>105</td>
<td>11</td>
</tr>
<tr>
<td>October</td>
<td>121</td>
<td>13</td>
</tr>
<tr>
<td>November</td>
<td>125</td>
<td>15</td>
</tr>
<tr>
<td>December</td>
<td>130</td>
<td>16</td>
</tr>
<tr>
<td>January</td>
<td>124</td>
<td>16</td>
</tr>
<tr>
<td>February</td>
<td>113</td>
<td>19</td>
</tr>
<tr>
<td>March</td>
<td>108</td>
<td>23</td>
</tr>
<tr>
<td>April</td>
<td>99</td>
<td>24</td>
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<tr>
<td>May</td>
<td>95</td>
<td>20</td>
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<tr>
<td>June</td>
<td>97</td>
<td>19</td>
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<tr>
<td>July</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>August</td>
<td>106</td>
<td>14</td>
</tr>
<tr>
<td>September</td>
<td>109</td>
<td>11</td>
</tr>
<tr>
<td>October</td>
<td>113</td>
<td>13</td>
</tr>
<tr>
<td>November</td>
<td>111</td>
<td>14</td>
</tr>
<tr>
<td>December</td>
<td>112</td>
<td>18</td>
</tr>
</tbody>
</table>

A graph is a good visual tool for analysing data. In a table of numbers it is hard to see any trends, whereas a graph can show the relationship that occurs between two sets of numbers.
You have already practised drawing a graph by hand. This time I want you, if possible, to graph the data using a computer.

If you have access to a computer with a spreadsheet (eg Excel), you can use a spreadsheet to graph the data. If you don’t have a computer, the spreadsheet and graph are shown below. More detailed instructions are to be found in the Resource booklet. Check your own software instructions before starting if you haven’t used a spreadsheet before.

Optional.

Print one of the graphs you have created and send it in with your next return of work.
Have a look at the relationship between the predator and the prey and answer Exercise 2.3.

**Decomposers**

In the last section, you saw that energy enters the ecosystem as sunlight, which is trapped by plants for the process of photosynthesis. The energy flows through the system as each organism eats other organisms. At each step there is a loss of energy as heat. If the organisms in an ecosystem do not use the available energy it is lost to the system. This explains why there has to be a continual flow of energy through an ecosystem.

Matter is recycled in an ecosystem—unlike energy, which flows through the ecosystem. An atom of carbon that is produced during
photosynthesis can become part of a kangaroo when the kangaroo eats
the grass. If a dingo eats the kangaroo, that atom can then be passed on
to the dingo. When the dingo dies it is returned to the soil by the action
of decomposers in the soil (bacteria and fungi) and can then become part
of a new plant, thus continuing the cycle.

An ecosystem has a constant supply of energy and the matter is recycled.

Decomposers are usually bacteria or fungi. They break down complex
substances into smaller molecules. Plants can then use these molecules.
This completes the cycle of nutrients by returning minerals to the soil so
they can be used again by plants and so on through the ecosystem.

In forests, leaves fall from grasses, shrubs and trees. The thickness of the
litter remains fairly constant throughout the year. This occurs because
the leaf litter is reduced to humus by the action of decomposers.
What would happen if the decomposers were not so active?

Suggested answer: There would be a build up of dead matter. The nutrients
would be trapped in the dead material and would not be recycled.

Answer Exercise 2.4

Bracket fungus growing on a dead log decomposing the once living tissue.
It is hard to observe decomposers but if you look around your ecosystem you may find mushrooms and bracket fungi. Look around the leaf litter for white threads. These are a part of the life cycle of fungus. List any decomposers you have observed in your local ecosystem (Table 3 in your Field study scaffold).

**Food chains**

Using a simple food chain can show the interactions of organism in an ecosystem. A food chain illustrates what eats what. The arrow means ‘eaten by’. A food chain always begins with a producer.

Why must a food chain always begin with a producer?

Suggested answer: The ultimate source of energy is the sun. Plants capture this energy while animals have to gain their energy by consuming other organisms. Therefore, every food chain has to begin with a producer such as a plant.

Below is a simple food chain showing a producer, a herbivore and a first order carnivore.

The grass is the producer, the kangaroo is the herbivore and the dingo is the carnivore. The matter that was once part of the grass becomes part of the kangaroo and what was once kangaroo becomes part of the dingo. If the dingo dies the matter that was once the dingo is broken down by decomposers and returned to the soil. The cycle of matter can then begin again with the plant taking minerals from the soil. Each step in the food chain is called a *trophic level*.

Answer Exercise 2.5.
Think now about your field study area. In the Result Section of your *Field study scaffold* there is a table (Table 5a) that will help you to create food chains. Turn to that page now.

Fill in as much as you can. Remember to start with a producer. Transfer your food chains to Table 5b in your *Field study scaffold*.
Food webs

Food chains are useful for identifying direct relationships. However, in ecosystems, the relationships may not be so straightforward.

For example, this simple food chain could be expanded to include a carnivore like a shark. The fish could be eaten by a larger fish and then eaten by a human. A further complication is that predators have more than one prey species.

You can get a more detailed picture of the interactions in an ecosystem if the food chains are combined to form a food web. A food web is a series of food chains combined together.
Label the following organisms on the diagram above:

- microscopic algae, seagrass and a mangrove tree
- prawns, oysters and a crayfish
- small fish and a large fish
- pelican, cormorant, oystercatcher.

The food web shown above has three producers __________________
_________________________________________________________
_________________________________________________________

There are three herbivores ________________________________
________________________________________________________

First order carnivores are _______________________________
________________________________________________________

(The large fish is both a first order carnivore and a second order carnivore depending on whether you come through the small fish or the crayfish).

Second order carnivores _______________________________
________________________________________________________

Third order carnivore ________________________________
________________________________________________________

Check your answers.

Use the information from Table 5 and the food chains you have already made to make a food web for your local study area and put this in Table 5b in your Field study scaffold.
Food pyramids

You have looked at food chains and food webs. These show the flow of matter and energy through the ecosystem but they do not show the number of organisms at each trophic level. For this, we use pyramids. The pyramid has a base much greater than its top. This shows the normal ecosystem with more producers than herbivores and more herbivores than carnivores. You will look at two types of pyramids that show:

- biomass
- energy.

![Food pyramid diagram]

Why are there usually more producers than consumers in an ecosystem? It is because there is a loss of energy at every trophic level. At each level only one tenth of the matter consumed is used to make body cells. The rest is used to keep warm, to move, and to power all the living processes (metabolism) in the animal. Some of the material passes through undigested. This means that you need more plants to support a number of herbivores, and more herbivores than carnivores.

Pyramid of biomass

Looking at the animals and plants in the environment we find that there are more plants than animals. The animals that eat plants (herbivores) are more abundant than the next level of consumers. The top consumers are usually the least abundant of any group in the ecosystem. In some circumstances, it is better to weigh the organisms instead of counting them. A gum tree obviously has more affect on the ecosystem than a
tussock of grass. In this case organisms are weighed to calculate the **biomass** (biological mass). To measure biomass the organism is usually dehydrated. This means that water is removed before weighing.

Can you suggest why this is important?

Suggested answer: It is important because some organisms have a higher proportion of water in their bodies than others. In addition, a plant may be wilted. After drying what remains is the dry biomass. This is a more accurate measure of the amount of organic matter in the organism.

<table>
<thead>
<tr>
<th>biomass in grams</th>
<th>2 g</th>
<th>10 g</th>
<th>40 g</th>
<th>820 g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tertiary consumers</td>
<td>secondary consumers</td>
<td>consumers</td>
<td>producers</td>
</tr>
</tbody>
</table>

Pyramid of biomass

From the diagram, it can be seen that it takes 820 g of a producer to support 40 g of first order consumer, 10 g of secondary consumers, which in turn supports 2 g of tertiary consumer. Why does this happen?

If you think of a herbivore eating a plant it does not convert all of the matter contained in the plant into the herbivore. Some of the material is indigestible and passes out of the animal as faeces. A lot of the material is consumed during respiration. This fuels the activities of the herbivore. Only a small amount of the biomass on one level becomes biomass on the next. Much is lost through heat released during respiration. At each level there is a loss of up to 90% of biomass.

Answer Exercise 2.6.
Pyramids of energy

Energy pyramids represent the flow of energy through the ecosystem. At each trophic level there is only 10% efficiency. That means that 90% of the energy is lost at each level. A plant uses 10% of the light energy available. When a herbivore consumes a plant there is only 10% of the energy stored in the plant tissue as sugar that is converted into energy in the herbivore. And so on up the food chain. If humans were the top consumers and ate only plants, there would be less energy loss in the food chain.

Pyramid of energy (kJ/m²/year)

Working out a pyramid of biomass or a pyramid of energy takes a considerable amount of time. For your field study, it is only necessary to describe what you would predict a pyramid of biomass and energy would look like. Use the diagram below. Fill in the names of organisms for your local ecosystem. Transfer this information to your field study (Table 5b in your Field study scaffold).
Competition between species

As you have seen, organisms in an ecosystem interact in various ways. Populations will continue to expand until the numbers are limited by one of the resources that they require.

Examples of resources that organisms need are:

- water
- food
- shelter
- nesting sites
- mates
- light
- soil
- weather.

When there is more than one species contending for the same limited resource, we say that the organisms are ‘competing’. Usually one species has an advantage over the other and may limit the growth of that population. On rock platforms in NSW there are two species of mollusc that feed on algae. One is the limpet Cellana sp. and the other is Melanerita sp. Melanerita moves faster than Cellana. If the algae are in short supply then Melanerita has an advantage over its competitor. It can remove the algae from the rock before Cellana.
Melanerita (periwinkle) and Cellana (limpet) feeding in the same area of a rock platform

Unicellular organisms also compete for resources. If a resource is limited the organism with the adaptive advantage will be more successful with the result that the other species will be reduced in number.

Paramecia (‘paramecium’ is the singular form) are unicellular organisms that live in pondwater, an aquatic environment.

In the experiment below, there are two different species of paramecia, Paramecium caudatum and Paramecium aurelia. The first table shows the growth in population of each paramecium when it is not competing with another species. That is when it is the only paramecium in the environment.

Below are the numbers of paramecia you have if you started with one and let it divide naturally.
<table>
<thead>
<tr>
<th>Days</th>
<th>Number of <em>Paramecia caudatum</em> in 0.5 mL of medium</th>
<th>Number of <em>Paramecia aurelia</em> in 0.5 mL of medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
<td>185</td>
</tr>
<tr>
<td>5</td>
<td>120</td>
<td>255</td>
</tr>
<tr>
<td>6</td>
<td>135</td>
<td>315</td>
</tr>
<tr>
<td>7</td>
<td>155</td>
<td>380</td>
</tr>
<tr>
<td>8</td>
<td>160</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>115</td>
<td>449</td>
</tr>
<tr>
<td>10</td>
<td>140</td>
<td>455</td>
</tr>
<tr>
<td>11</td>
<td>140</td>
<td>430</td>
</tr>
<tr>
<td>12</td>
<td>140</td>
<td>440</td>
</tr>
<tr>
<td>13</td>
<td>140</td>
<td>485</td>
</tr>
<tr>
<td>14</td>
<td>110</td>
<td>470</td>
</tr>
<tr>
<td>15</td>
<td>110</td>
<td>400</td>
</tr>
<tr>
<td>16</td>
<td>110</td>
<td>490</td>
</tr>
<tr>
<td>17</td>
<td>110</td>
<td>490</td>
</tr>
</tbody>
</table>

What can you say about the growth rate of each species?

______________________________________________________________________

Which species do you predict will be more competitive than the other? Explain your choice

______________________________________________________________________

*Answer:* *Paramecium aurelia* is more competitive. It reproduces faster and produces a greater number of individuals.

The next step was to put the two species into a situation where they would have to compete with one another. The results are below.
<table>
<thead>
<tr>
<th>Days</th>
<th>Number of <em>Paramecia caudatum</em> in 0.5 mL of medium</th>
<th>Number of <em>Paramecia aurelia</em> in 0.5 mL of medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>140</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>220</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>160</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>168</td>
</tr>
<tr>
<td>9</td>
<td>35</td>
<td>155</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>175</td>
</tr>
<tr>
<td>11</td>
<td>23</td>
<td>260</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>270</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>285</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>220</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td>225</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>220</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>220</td>
</tr>
</tbody>
</table>

Population growth rates of two *Paramecia* species grown together in the same medium.

On the graph provided, plot the two species of *Paramecia* from the table above. Use a line of best fit.
In the short term these two species could live together. In the long term, especially as resources become limited, *Paramecium aurelia* would out compete *Paramecium caudatum* to the point that only *Paramecium aurelia* remained.

Answer Exercise 3.8
Think about your field study area. Identify two predators and their prey. Consider the abundance of each species. What factors affect the numbers of each? (Table 4 in your *Field study scaffold*)

You have now finished this part of the module. In the next part you will be completing the rest of your field study. Set aside several hours to do this.
Summary

In an ecosystem there is a flow of energy and the matter is recycled. The energy comes from the Sun. Light is trapped by plants through the process of photosynthesis.

Respiration is the process that releases energy from the sugars produced during photosynthesis.

\[
glucose + \text{ oxygen} \xrightarrow{\text{many steps}} \text{ carbon dioxide} + \text{ water} + \text{ energy}
\]

These two reactions are responsible for the flow of energy through the ecosystem.

Organisms use energy to power all of their activities, such as, movement, growth and repair. At each trophic level there is a loss of energy in the form of heat.

Interactions

Organisms can interact through the following relationships.

+ means an organism is benefited

- means an organism is disadvantaged

0 means no effect

• allelopathy (+ -) eg ferns produce allelochemicals that prevent pine seeds from germinating

• parasitism (+ -) eg tapeworm living in the intestine of an animal

• mutualism (+ +) eg lichen is a close relationship between a fungus and an algae where both are benefited.

• commensalism (+ 0) eg an anemonefish living in an anemone
Feeding relationships

Producers. Autotrophic organisms that capture the Sun’s energy by the process of photosynthesis.

Consumers. Heterotrophic organisms that consume other organisms.

Consumers can be divided into:

- **herbivores** plant eaters
- **carnivores** animal eaters
- **omnivores** eat both animals and plants
- **decomposers** break down dead animals and plants

Feeding relationships can be shown using food webs, food chains, and food pyramids. Species compete for the available resources.
Here are suggested answers for many of the questions from throughout this part. Your answers should be similar to these answers. If your answers are very different or if you do not understand an answer, contact your teacher.

**Photosynthesis and respiration**

<table>
<thead>
<tr>
<th>Process</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>photosynthesis</td>
<td>carbon dioxide</td>
<td>oxygen</td>
</tr>
<tr>
<td></td>
<td>water</td>
<td>water</td>
</tr>
<tr>
<td></td>
<td>light</td>
<td>sugars such as glucose</td>
</tr>
<tr>
<td>respiration</td>
<td>oxygen</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td></td>
<td>glucose</td>
<td>water</td>
</tr>
</tbody>
</table>

**Trophic levels**

The Sun is the source of energy for an ecosystem. The energy is captured by plants and used to produce food. Animals eat plants to provide them with energy. Energy is lost to the system at each step.
**Interactions**

**Relationship of organisms**

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Type of relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shark and remora</td>
<td>commensalism</td>
</tr>
<tr>
<td>Strangler fig and eucalypt</td>
<td>parasitism</td>
</tr>
<tr>
<td>Bee and flower</td>
<td>mutualism</td>
</tr>
<tr>
<td>Giardia in the human gut</td>
<td>parasitism</td>
</tr>
<tr>
<td>Insect larvae and scribbly gum</td>
<td>parasitism</td>
</tr>
</tbody>
</table>

**Food webs**

The food web has three producers. Microscopic algae, seagrass, mangrove tree

There are three herbivores: Oysters, prawns, crayfish

First order carnivores are: Small fish, oystercatcher, large fish, pelican

(The large fish is both a first order carnivore and a second order carnivore depending on whether you come through the small fish or the crayfish.)

Second order carnivores: Large fish, cormorant, pelican

Third order carnivore: Pelican
Exercises – Part 2

Exercises 2.1 to 2.7  Name: _________________________________

**Exercise 2.1**

a) What is the role of photosynthesis in an ecosystem?

____________________________________________________________________________________

____________________________________________________________________________________

b) Briefly describe the role of respiration in an ecosystem. How is energy transformed?

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

c) Name the process that the equation below represents. Outline the process that this equation summarises.

\[
\text{oxygen} + \text{glucose} \xrightarrow{\text{enzymes}} \text{carbon diox ide} + \text{water} + \text{energy}
\]

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

d) Name at least three uses of energy in organisms.

____________________________________________________________________________________

____________________________________________________________________________________
**Exercise 2.2**

Select one herbivorous and one carnivorous bird and record your observations in the table below.

<table>
<thead>
<tr>
<th>Name of bird</th>
<th>What do they eat?</th>
<th>Draw the beak</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>eg feeding, singing</td>
</tr>
<tr>
<td>Herbivorous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnivorous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exercise 2.3**

a) What month has the greatest population for the predator and what month has the greatest population for the prey?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

b) Describe the relationship between the predator and the prey.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
c) Outline the factors that affect numbers in predator and prey populations in the area studied.

_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Exercise 2.4
Give two examples of decomposers and explain the role of decomposers in the ecosystem.

_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
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_____________________________________________________
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_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

Part 2: Interactions
Exercise 2.5

a) Add labels to the diagram above using the following terms
   Producer, herbivore, first order carnivore, second order carnivore Then use a different colour pen to add first order consumer, second order consumer and third order consumer.

b) Identify and circle the following animals in the diagram below. A cormorant, a frog, a tadpole, a small fish, a dragonfly, microscopic algae, mosquito larvae and pondweed.

Make up three possible food chains from this picture.
From the pond diagram name the organisms in the following sentences.

A producer is______________________________________________.

The consumers are _________________________________________
________________________________________________________________________
________________________________________________________________________

A herbivore is _____________________________________________

A carnivore is _____________________________________________

A first order consumer is _____________________________________

A second order consumer is ________________________________

A third order consumer is ________________________________

________________________________________________________________________

**Exercise 2.6**

a) Explain the term *biomass*.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

b) How would you draw up a pyramid of biomass for your own ecosystem?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

C) The mass of living things normally gets smaller as you move up levels in a pyramid. Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
d) It is more likely that the producer level will always have more mass than all other levels combined. Why do you think this is so?

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________

______________________________________________________


e) Draw a food chain and then a pyramid of biomass from the following figures.

Pond algae 1000 kg

Tadpoles 100 kg

Small fish 10 kg

Kookaburra 1 kg
f) Look at the food chain below

\[ \text{grass} \rightarrow \text{grashopper} \rightarrow \text{frog} \rightarrow \text{snake} \rightarrow \text{kookaburra} \]

There are 50 kg grass plants, 200 kg grasshoppers, 40 kg frogs, 5 kg snakes and 2 kg kookaburras.

Draw a pyramid of biomass for this food chain.

Is this a balanced pyramid? What will happen to this food chain?

Exercise 2.7

a) In an ecosystem organisms compete for the resources such as food, water, nesting sites. The Indian mynah is an introduced species of bird that uses nest holes in trees. Eastern rosellas also nest in tree hollows. Indian mynahs are more aggressive and takeover the available nesting sites. What are the

i) short-term consequences

ii) long-term consequences of this interaction?

_________________________________________________

_________________________________________________

_________________________________________________

_________________________________________________
A local ecosystem

Part 3: Field study
## Contents

- Introduction .............................................................................. 2
- Field study of an ecosystem ................................................. 4
  - Abiotic factors .................................................................... 7
- Carry out the field study ...................................................... 15
- Write the report ................................................................. 17
- Exercises – Part 3 ............................................................... 19
Throughout the unit, you have been gathering information that will go towards your final report on your local ecosystem. Now you are going to bring the information you have gathered together and complete the investigations that you still need to do. You will carry out the investigations into the abiotic and biotic factors and then write the report using the field study scaffold.

Time management is an important skill to learn. Plan your activities this week so that you can complete all the necessary activities. There will be time allowed in the next part of the module for you to complete the written report.

In this part you will be given opportunities to:

- Choose equipment or resources and undertake a field study of a local terrestrial or aquatic ecosystem to identify data sources and:
  - measure abiotic variables in the ecosystem being studied using appropriate instruments relate this data to the distribution of organisms
  - estimate the size of a plant and animal population in an ecosystem using transects and/or random quadrats
  - collect, analyse and present data to describe the distribution of the plant and animal species whose abundance has been estimated.
  - describe two trophic interactions found between organisms in the area studied
  - identify data sources and gather, present and analyse data by:
    - tabulation of data collected in the study
    - calculation of mean values with ranges.
    - graphing changes with time in the measured abiotic data
    - evaluating variability in measurements made during scientific investigations.
• process and analyse information and present a report of the investigation of an ecosystem in which the purpose is introduced, the methods described and the results shown graphically and use available evidence to discuss their relevance

• gather information from first-hand and secondary sources to construct food chains and food webs to illustrate the relationships between member species in an ecosystem.

During this week you will complete the field study component of this module. When reading the syllabus points that you will be covering this week, the task looks daunting. You have already completed some of these tasks. This week you will complete the compulsory practical activity.

**Virtual field trip**

To make your own investigations easier carry out the virtual field trip on a mangrove ecosystem. This virtual field trip is on the Internet. If you don’t have access to the Internet at home, you may be able to visit your local distance education centre or a local library. In this virtual field trip, all the points that have to be covered by the syllabus are included. Practise carrying out this field study before you start on your own. You may use this as your field study if you cannot physically carry out a field study.

URL  http://www.lmpc.edu.au/science

The report scaffold will help you to structure your information in a scientific way. If you feel confident to write your report without help then you will not need to use the scaffold. Find the *Field study scaffold* now and have a look at what you must do to complete the task.
Planning a field trip

To carry out a field trip there are several steps that you need to follow
• choose your study area
• carry out a risk assessment
• choose and gather your equipment
• plan what data you will collect
• carry out the field study
• write the report

Use the information below to plan your field trip.

Choosing a study area

The study area that you decide on will probably be determined by where
you live. If you have easy access to a natural area then choose that if not
you could study a local reserve. If all else fails there is always your own
backyard. Examples of ecosystems are a balanced aquarium, leaf litter
area, dam, pond, stream, lake, mangrove, sand dune area, woodland,
forest, grassland. Keep in mind the time that you have to complete
your study.

Answer Exercise 3.1

Suggestions of possible study area

Leaf litter

A forest area will have leaf litter. You can study the leaf litter. The
abiotic factors that you can look at are temperature and depth of litter.
When looking at leaf litter wear gloves so that you are protected against
bites. For the biotic factors use a small quadrat. A suitable quadrat
would be 25cm x 25 cm.

Collect the leaf litter using a shovel and place it on newspaper or in a
baking dish. Count the animals present in your quadrat by slowly
removing the larger pieces.
Paddock

You may be able to count the number of ants present in your paddock by using a metre-square quadrat. Plants can be counted for abundance or for percentage cover. A transect across a paddock is a good method to find the distribution of plants. Measure some abiotic factors such as temperature and water content of the soil.

Preparation

Before you start your study, you need to be fully prepared.

Remember to respect the area that you are studying. The community is alive. If you turn over a stone or a log make sure you return it to the way it was. Do not collect specimens unless it is necessary. Disturb the environment as little as possible.

Safety

When working outside make sure you wear sensible footwear and clothing. Wear blockout cream and a hat and carry water. Insect repellent may be necessary. Tell someone where you are going.

Answer Exercise 3.2

Risk assessment

Risk assessment is a process that you go through to analyse the effects of your actions. It is used in industry to predict possible dangers that may occur. Think about the possible dangers that may occur during your field study. Discuss these risks now with your supervisor.

Answer Exercise 3.3
Abiotic factors

Equipment

As a professional biologist, you would have a range of equipment available to carry out your investigation. Unfortunately as a student you will not have this range. What you have to decide at this point is the resources that you do have available. This will determine the abiotic factors that you will measure. Here is a list of resources that you may have. Go through the list and tick the ones that you have. Some are instruments that you may have access to, others are simple pieces of equipment that you will have around the house. Gather the resources together before starting your study. The resources that you have will determine the abiotic features that you are able to measure.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Datalogger</strong></td>
<td></td>
</tr>
<tr>
<td>A datalogger is a machine that records information in the field. The datalogger has different probes that record different factors. For example, you may want to measure</td>
<td></td>
</tr>
<tr>
<td>• temperature</td>
<td></td>
</tr>
<tr>
<td>• humidity</td>
<td></td>
</tr>
<tr>
<td>• the amount of rain</td>
<td></td>
</tr>
<tr>
<td>• dissolved oxygen</td>
<td></td>
</tr>
<tr>
<td>• growth</td>
<td></td>
</tr>
<tr>
<td>• salinity</td>
<td></td>
</tr>
<tr>
<td>• light intensity</td>
<td></td>
</tr>
<tr>
<td><strong>Thermometer</strong></td>
<td></td>
</tr>
<tr>
<td>A thermometer can be used to measure air or water temperature. It is also useful for measuring the temperature of leaf litter.</td>
<td></td>
</tr>
<tr>
<td><strong>A ruler</strong></td>
<td></td>
</tr>
<tr>
<td>You can measure the depth of leaf litter or soil layers. Use the ruler to measure out your quadrat.</td>
<td></td>
</tr>
</tbody>
</table>
**Shovel**  
Use to collect leaf litter or to examine the soil.

**A strip of paper**  
This will help you decide on wind direction. Hold the strip up and see which way the wind is blowing.

**A compass**  
Helpful for wind direction and for aspect.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil testing or pool pH kit or pH paper</strong></td>
<td></td>
</tr>
<tr>
<td>You can use this to work out the pH of soil or water.</td>
<td></td>
</tr>
<tr>
<td><strong>Scales</strong></td>
<td></td>
</tr>
<tr>
<td>Weigh the soil, then evaporate the water and weigh again.</td>
<td></td>
</tr>
<tr>
<td><strong>30 metre tape measure</strong></td>
<td></td>
</tr>
<tr>
<td>Use to measure out transect.</td>
<td></td>
</tr>
<tr>
<td><strong>Clipboard and pencil</strong></td>
<td></td>
</tr>
<tr>
<td>To record your data.</td>
<td></td>
</tr>
<tr>
<td><strong>Light meter</strong></td>
<td></td>
</tr>
<tr>
<td>For measuring the amount of light.</td>
<td></td>
</tr>
<tr>
<td><strong>Secchi disk</strong></td>
<td></td>
</tr>
<tr>
<td>This disk measures turbidity (clearness of water).</td>
<td></td>
</tr>
<tr>
<td><strong>Rain gauge</strong></td>
<td></td>
</tr>
<tr>
<td>To measure rainfall over a long period.</td>
<td></td>
</tr>
<tr>
<td><strong>Universal indicator paper</strong></td>
<td></td>
</tr>
<tr>
<td>To measure the pH. Place 8 drops of water in 5 mL of water and check the colour chart.</td>
<td></td>
</tr>
</tbody>
</table>
A test-tube or glass container
Place soil in the container and add water. Note the level of water.
Let the soil stand and then see how much water has soaked into the soil. This will tell you how much water or how many air spaces are in the soil.

Cobalt chloride paper
This will tell you about the presence of water.

Camera
To record the site.

Answer Exercise 3.4

Plan what data you will collect

Once you know the equipment you have here is a list of the features that you may decide to measure. Remember you only have to measure some abiotic factors in your ecosystem. Look for changes in vegetation as this may be reflected in changes in abiotic factors.

Abiotic factors to measure

These are suggestions of possible abiotic factors to measure.

- Aspect. The direction that the area faces. Whether it is cold and exposed or sheltered.
- Slope. Estimate this. Somewhere between 0-90 degrees. Does it drain or is it swampy?
- Exposure. Estimate how exposed the site is to wind. Design a five-point scale.
- Salinity. Express as a scale from freshwater to saltwater.
- Temperature. If you don’t have a thermometer, estimate the temperature or listen to a weather report for your area. As temperature changes all the time, you should take the temperature at different times.
- Surface. Rock or soil? Is it crumbly or hard?
• Light. Use a light meter or a datalogger. If you don’t have one of these you can estimate the amount of light on a scale of 1 to 5 where 1 is dark and 5 is bright sunlight

• Soil pH. Use a testing kit or datalogger. Small changes in soil pH can dramatically change the vegetation.

• Description of the soil. Soil can have many different features.
  
  Dig a small hole and see how thick the topsoil is. If you can find a cutting or a bank, you can draw the soil layers.
  Describe the soil. Is it
  
  – sandy/clayey
  – rich in humus/not rich in humus
  – deep leaf litter/shallow leaf litter
  – held together tightly by roots/easily eroded?

• Turbidity. This is the clearness of the water. It is important for photosynthesis. Use a secchi disk. You can make one of these with some string, a disk of wood or plastic that you have painted. Or use the template below. The disk is then lowered into the water and brought slowly to the surface. When you can just see the disk, you measure the length of string to the surface. Repeat the experiment and average the results.

![A template for a secchi disk](image)

• Water quality. Is there run-off from industry or houses? Is there a lot of water available or not?

• Local climate. Including rainfall, humidity, wind direction, sunlight hours.
Answer Exercise 3.5

You have to measure at least two different abiotic variables. This will depend on your own ingenuity to decide which ones to measure.

**Suggestions for measuring abiotic factors**

If you have a thermometer you could measure air temperature and soil temperature as two examples of abiotic factors. Choose three sites along your transect and take readings every half an hour and put the results on the first page of the Results section of the *Field study scaffold*.

Record the distribution of vegetation along a transect line and take soil profiles at three sites along your transect.

You will have to present your data in a table and then graph your results against time.

**Hints for constructing tables**

- Every table needs a title.
- Every column should have a heading.
- Units of measurement should be included.
- Figures should be aligned.
- A zero means that the reading was zero and not that the reading was missed.
- Do not use ditto marks for identical readings.

**Graphing changes of abiotic factors against time**

You also need to work out the mean and the range of your measurements. The mean is the average of your readings. For example, if you were measuring air temperature in your study area and you got the following results.

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 am</td>
<td>4</td>
</tr>
<tr>
<td>7:00 am</td>
<td>6</td>
</tr>
<tr>
<td>8:00 am</td>
<td>10</td>
</tr>
<tr>
<td>9:00 am</td>
<td>15</td>
</tr>
<tr>
<td>Time</td>
<td>Temperature</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>10:00 am</td>
<td>17</td>
</tr>
<tr>
<td>11:00 am</td>
<td>19</td>
</tr>
<tr>
<td>Noon</td>
<td>21</td>
</tr>
<tr>
<td>1:00 pm</td>
<td>21</td>
</tr>
<tr>
<td>2:00 pm</td>
<td>21</td>
</tr>
<tr>
<td>3:00 pm</td>
<td>20</td>
</tr>
<tr>
<td>4:00 pm</td>
<td>19</td>
</tr>
<tr>
<td>5:00 pm</td>
<td>19</td>
</tr>
<tr>
<td>6:00 pm</td>
<td>19</td>
</tr>
</tbody>
</table>

The mean temperature for this result would be worked out by adding all the temperatures and dividing by the number of readings.

Mean temperature = \( \frac{134}{9} \) = 14.8 °C

The range of temperatures goes from 4 °C to 21 °C

Answer Exercise 3.6

When you have to graph a result, it is a good idea to use a spreadsheet on a computer. This is what professional scientists use.
When you have measured your abiotic factor, relate this to the distribution of organisms in your study area. Put this on the first page of the Discussion section in your Field study scaffold.

Evaluating variability in measurement

You may find that some of your results do not fit in with the rest of your data. These points are called outliers. They can usually be explained by some error in the measurement. When you are working in the field errors in measurement may occur. Your equipment may not be operating correctly. For this reason, it is important to look at the variability of your results.

Biotic factors

The next step is to record the biotic factors of your study area. Here is a list of equipment you may need.

Equipment list

Read through the list and tick if you have the resource.
# Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>String, pegs and a hammer</td>
<td></td>
</tr>
<tr>
<td>To make a quadrat</td>
<td></td>
</tr>
<tr>
<td>A microscope</td>
<td></td>
</tr>
<tr>
<td>To examine water and soil for micro-organisms.</td>
<td></td>
</tr>
<tr>
<td>Binoculars</td>
<td></td>
</tr>
<tr>
<td>Use for animal observations.</td>
<td></td>
</tr>
<tr>
<td>30 metre tape measure or piece of string</td>
<td></td>
</tr>
<tr>
<td>Use for transects</td>
<td></td>
</tr>
</tbody>
</table>

Answer Exercise 3.7
Carry out the field study

**Observations**

Sit quietly in your area and observe the living things especially the insects. Remember that many Australian animals are nocturnal and sleep during the day.

Fill in the work sheet of animals in the *Field study scaffold* (Table 1).

The plants are the easiest to observe because they are so obvious. Record the names of all the plants you know. The plants that you don’t know can be called Unknown 1, Unknown 2 etc.

Record details of each plant that you see (Table 2).

If you observe any interactions between animals and plants start drawing a food web for your study area. Look for evidence of parasitism, commensalism, mutualism, and predator/prey relationships. Look for scavengers and decomposers. Fill in Table 4.

**Sampling techniques**

You have learnt about sampling techniques in Part 1. These techniques are useful for working out how many of each species is in your area. Now I want you to use your knowledge to estimate the size of one animal and one plant species from your local ecosystem. Write down the name of the animal and the plant that you are going to estimate.

_________________________________________________________

_________________________________________________________

_________________________________________________________

_________________________________________________________

Here is a summary of the techniques to use.
Transects (Sampling 2 - Distribution of a plant Transects sheet)

Use transects to work out the distribution of your chosen organism.

Use a 30-metre length of string or tape measure. You have to decide whether your transect will be continuous, a point or a strip transect.

A good suggestion is to take a point reading every metre along your transect.

Place the string along the ground and note at each half metre the type of plants and animals on one side of the string. Take rough notes and then change your notes into a transect drawing. Draw your transect in the Results section of the field study scaffold.

Quadrat

Use a quadrat to estimate the size of one plant and one animal population.

Adjust the size of your quadrat depending on the size of the area you are studying. Normally a 1-metre quadrat is suggested but if your area contains many trees, you may decide to increase the size of your quadrat. If you are looking at a small area (e.g., a small rock pool or a pond), a smaller quadrat can be used.

The position of the quadrat should be selected randomly. If you chose to use a non-random quadrat you must justify this decision based on the population distribution that you are measuring. To select quadrats randomly throw a stick over your shoulder and use where the stick lands as a corner of your quadrat. Use wooden pegs to mark the four corners of a 1 metre quadrat. Place string around the pegs. Carefully count the number of organisms in your quadrat. Decide what counts as in the quadrat and what counts as out before you start.

Record the numbers of plants in your quadrat. Use the tables in the Results section of the Field study scaffold.

When you have estimated the abundance of a plant and an animal you have to analyse and present data on the distribution of the species. This can be done with transects, profile diagrams and plan sketches.
A written report is required to show that you have completed the field study and should include the following sections:

- *A location map.* Where your ecosystem is located in Australia (in the Introduction of your Field study scaffold).

- *Plan sketch.* Survey the area carefully and record the most noticeable features. A plan sketch is the view that you would get if you were looking down on the area that you are studying. Start at a point you can recognise. Then measure out your study area using steps or a tape measure. If you have a compass use this to walk north, east, south and west. You should end up at your starting point. Now fill in the main features. Include watercourses, rocks, buildings, large trees or bushes. Make sure you include a title, a scale, a legend explaining any symbols and the direction of North. This can be included in your methods section of your report. On the next page is an example of a plan sketch showing the location of a small plant in the study area. You could do the same for gum trees.
Include a scale 1 cm = 1 metre. The plant in this diagram has an uneven distribution.

A profile diagram. A profile diagram is a side view of an imaginary slice. This is a good way of showing how the vegetation pattern changes. It can be used to show changes in distribution of your plant and animal species. If you have a water source in your study area then this will show any changes caused by the presence of water. On a rock platform, a profile diagram is a good way of recording the different types of animals found there.

- A summary of the main plants and animals in the study area.
  Try to identify about 10 plant species. You may have to seek help to do this. Use Table 2 to record this information.
  Animals are harder to locate than plants. Look for droppings, tracks, webs, nests and tree scratchings. Look for animal life in the leaf litter. Birds are often easier to locate than other animals especially in the early morning and the late evening. Record your animal data in Table 1.
- Build up a food web for your study area.
- Observing interactions
  Look for examples of disease in plants. Observe herbivores as they consume their food.
  Describe evidence of observed trophic interactions. For example, look for feeding, seeking shelter. Fill in Table 3.
- Make a plan now of what you need to take and what you are going to measure. Look carefully at the report scaffold now and make it clear in your mind what equipment you need and what you are going to measure before starting your field study.
Exercises – Part 3

Exercises 3.1 to 3.7   Name: _________________________________

Your written work for this part of the module is to complete the field study report and return this to your teacher next week with Part 5 of the module.

**Exercise 3.1**

The study area I have chosen is

_________________________________________________________

_________________________________________________________

**Exercise 3.2**

What are some of the safety issues you must address before going into the field?

_________________________________________________________

_________________________________________________________

_________________________________________________________

_________________________________________________________

_________________________________________________________

_________________________________________________________
**Exercise 3.3**

Write down any risks that you can predict for going into the field. What steps are you taking to prevent these risks?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

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________________________________________________________________________

**Exercise 3.4**

Make a list of the equipment you have available here to measure abiotic factors in your ecosystem.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

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________________________________________________________________________

________________________________________________________________________

**Exercise 3.5**

Write down the abiotic factors that you are going to measure and how you are going to measure them.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Exercise 3.6

Here is some temperature data. Calculate the mean and the range for the data.

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>36</td>
</tr>
<tr>
<td>February</td>
<td>37</td>
</tr>
<tr>
<td>March</td>
<td>29</td>
</tr>
<tr>
<td>April</td>
<td>25</td>
</tr>
<tr>
<td>May</td>
<td>19</td>
</tr>
<tr>
<td>June</td>
<td>18</td>
</tr>
<tr>
<td>July</td>
<td>17</td>
</tr>
<tr>
<td>August</td>
<td>17</td>
</tr>
<tr>
<td>September</td>
<td>19</td>
</tr>
<tr>
<td>October</td>
<td>22</td>
</tr>
<tr>
<td>November</td>
<td>24</td>
</tr>
<tr>
<td>December</td>
<td>29</td>
</tr>
</tbody>
</table>

Exercise 3.7

What are outliers? How may they arise during your investigation?

_________________________________________________________

_________________________________________________________

_________________________________________________________

Exercise 3.8

Write down the equipment you will use for measuring the biotic factors of the ecosystem and what animal and plant you will be estimating.

_________________________________________________________

_________________________________________________________

_________________________________________________________
A local ecosystem

Part 4: Adaptations and human impact
Contents

Introduction ................................................................. 2

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Student evaluation
This week you will be completing the final part of the module. You have looked at the abiotic and biotic factors in an ecosystem and how to measure them, the flow of energy and matter through an ecosystem and the interactions that occur between living organisms. Your main task this week is to complete the written report for your field study. Then, to finish off the unit look at two other factors, the adaptations of organisms to the environment and the impact of human activity on the ecosystem.

In this part you will be given opportunities to learn to:

- define the term adaptation and discuss the problems associated with inferring characteristics of organisms as adaptations for living in a particular habitat
- identify some adaptations of living things to factors in their environment
- identify and describe in detail adaptations of a plant and an animal from a local ecosystem
- identify the impact of humans in the ecosystem studied.

Looking around your local ecosystem you will notice that the species that are present are well suited to where they live and have special features or characteristics that help them to survive in their environment. We say that they are adapted to the environment and the special feature is called an adaptation. An organism that is not suited to its environment may not survive and reproduce.

An adaptation is any feature of an organism that promotes the wellbeing of a member of a species in the environment it usually lives in.

Adaptations are the features that allow an organism to survive in a particular environment. They have often developed over a long period through the process of species evolution. Adaptations can be structural, physiological or behavioural.

A structural adaptation is an anatomical feature that allows a species to survive in the environment where it lives. The pouch of a kangaroo is an example of a structural adaptation. Other examples are the spines on an echidna and the ears of a bilby.

A physiological adaptation is an internal function that increases the chance of survival. An example of a physiological adaptation is the sticky saliva of an echidna, which traps ants.

A behavioural adaptation is something that the organism does in order to increase the chance of survival and therefore reproduction. A kangaroo will cool down by licking its forearms.

Name three organisms that you are familiar with and list three adaptations that each one has.
Examples of adaptations

Desert ecosystem

Many species show remarkable adaptations to the environments they live in. Deserts are areas where the supply of water is limited. The plants and animals that live in the desert have many adaptations to ensure their survival in an arid environment.
Desert plants have adaptations such as:

• their leaves are reduced to spines
• they have extensive root systems
• they store water in swollen stems
• they have sunken stomates (pores) in their leaves.

Animals of the desert also have adaptations that help in survival. Many are nocturnal and obtain water from the food they consume rather than from drinking water.

The kangaroo rat of the North American deserts is well known for its ability to survive without drinking water. It gains its water through the process of respiration.

All of these are adaptations to an environment where water is a limited resource.

Mangrove ecosystem

Adaptation of mangrove trees to saltwater

Estuaries occur where rivers meet the sea. These ecosystems present special conditions that organisms have to cope with if they are to survive and reproduce in that environment.

Mangrove is a general name that is given to trees that can survive regular fresh and salt water flooding. To survive these conditions mangroves have specialised structures and tissues.

Most plants have difficulty growing in water or soils that are high in salt. To cope with salt, mangroves can use three processes

• exclusion
• secretion
• accumulation.

Salt excluders have tissue in their roots and lower stem which allows water to enter but excludes salt. Examples of these are most of the mangroves found in NSW.

Salt secretors, eg the river mangrove, are able to concentrate and exude salt through special glands on the leaves. When it rains the salt is washed off.
Salt crystals on a mangrove leaf.

Salt accumulators deposit salt in older tissue which is then dropped from the plant taking the salt with it.

Mangroves trees can be grown in freshwater. To grow in saltwater the mangrove has adaptations that allow it to survive in the saline environment.

Adaptations develop as a result of natural selection. Organisms with characteristics that make them more likely to survive pass on these characteristics to the next generation, while those that are less favourable die before they can reproduce.

Answer Exercise 4.1

However, looking at organisms you may find there are problems inferring that an adaptation is a result of the environment that the organism now inhabits.
Adaptation—yes or no

Look at the photograph of the straw-necked ibis.

![Straw-necked ibis in a mangrove swamp.](image)

This animal is now regularly found in urban environments. It is often seen walking around parks and places like the zoo. It uses its long curved beak to remove food from drains.

It would appear to be perfectly adapted to live in the urban ecosystem and its beak is perfectly shaped to fit into the grilles in drains.

Does this mean that the ibis has evolved in this environment? After all, ibis have been around longer than urban environments.

The straw-necked ibis is a good example of a species being pre-adapted to an environment. The curved beak has evolved over a long period because it gave ibis an adaptive advantage in a wetland environment. It used the beak to extract worms from their burrows. When the ibis arrived in the urban environment it found a plentiful food source (food scraps) that was not being utilised by any other species. It was able to exploit this food source and therefore survived and reproduced successfully.

The ibis serves as a warning. When you look at adaptations in your local ecosystem it is easy to presume that adaptations found in species have been selected for the environment where it now lives.

During the study of your local environment you have to choose one plant and one animal and describe in detail its adaptations to the ecosystem. If you can think of examples now, then fill in Table 7 in your field study scaffold following the points below.
• Identify the organism as fully as you can. You may need to visit a local library or use the Internet or talk to some local people to identify them fully. Sketch the organism or take a photograph.

• Observe the organism in its natural environment.

• List the adaptations that each of the organisms is showing to its environment.

• Use the table provided to report your information (Table 7).

There are some examples on the next page to get you started.

<table>
<thead>
<tr>
<th>Drawing or photograph</th>
<th>List of adaptations observed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ant (unknown species)</strong></td>
<td>• hard exoskeleton for the prevention of desiccation&lt;br&gt;• sharp pincers for defence&lt;br&gt;• legs lift the ant of the ground to enable rapid movement&lt;br&gt;• compound eyes for all round vision&lt;br&gt;• antennae for sensing surroundings</td>
</tr>
<tr>
<td><strong>Grevillea banksii</strong></td>
<td>• waxy covering to prevent desiccation&lt;br&gt;• bright red flower to attract birds&lt;br&gt;• nectar for rewarding birds&lt;br&gt;• green leaves for photosynthesis&lt;br&gt;• upright branches to gain access to light</td>
</tr>
</tbody>
</table>
The human population has been increasing rapidly particularly over the last century. This has occurred because of the increase in technology especially in regard to medicine and food production. Associated with this increase in population and higher living standards comes the destruction of the environment. The issues that arise include damage to the ozone layer, global warming, deforestation, habitat destruction, extinction, disposal of wastes, air and water pollution. If we are to continue to survive, we must take into account the damage our activities do and reconsider our lifestyles.

Humans are consumers. We take in oxygen, food and water. We use materials from the environment to create our surroundings and we use vast amounts of energy.

Examples of human impact

Below are some examples of how humans impact on ecosystems.

Habitat destruction

Many animals can survive the effects of humans as long as their environment is not destroyed. If the place that an animal lives is destroyed and there is no alternative then habitat destruction can lead to extinction. Pandas are endangered because they have a specialised diet of bamboo. As the areas where bamboo grew have been lost, the distribution of the panda has declined.
Hunting

Koalas have had a changing population because of human impact. When the Aboriginal people arrived in Australia they hunted the koala for food. This would have kept the number of koalas low. After European settlement the koalas were hunted for their furs. In 1924, 2 million pelts were exported. The population was further reduced by disease, fires and habitat destruction. Today the distribution of koalas is greatly reduced. You may be lucky in your area to still see koalas regularly.

Disposal of wastes

The waste that is produced in our homes and industry has to be disposed of and this causes pollution in our environment. Pollution can affect the:

- air
- water
- land.

Air pollution includes substances such as smoke, sulfur dioxide, ozone, CFCs and carbon dioxide. These can lead to breathing difficulties, acid rain, hole in the ozone layer, and the greenhouse effect.

Water pollution can include sewage, fertilisers, oil, and toxic chemicals. This can lead to eutrophication and death in aquatic animals.

Land pollution includes solid waste disposal at tips and mining waste.

Eutrophication

If extra nutrients enter waterways, they provide a rich energy source for bacteria and decomposers. The numbers of these organisms increases rapidly. As these organisms are respiring they use oxygen.

The wastes, which may be sewage or fertiliser run-off, are rich in nitrates and phosphates. This encourages the growth of algae. The algae grow rapidly and a condition called algal bloom occurs. The algae block out the light to the bottom of the water and so the plants that grow there cannot survive and die. Eventually the algal population crashes. The result is that the amount of oxygen in the water falls to a level that will not support fish or invertebrates. This results in a fish kill. The water becomes foul and smells.

This process is called eutrophication. You may have seen a waterway that is polluted in this way.
Global warming

The Earth is warmer than it should be because the atmosphere traps some of the radiation from the sun and prevents it from being radiated into outer space. This operates like a greenhouse (a structure that farmers use to keep plants warm during the colder months). The process of warming is called the greenhouse effect. Our effect on the environment since the start of the Industrial Revolution has been an increase in the concentration of carbon dioxide in the atmosphere. This increase and other greenhouse gases have led to a rise in global average temperatures. The effects of this may be wide-ranging. It could result in the melting of land ice and the expansion of water would result in a rise in sea level. This would lead to the flooding of low-lying ground. Most of the world’s population is found on low-lying land.

Predictions have been made about how quickly the Earth might warm up. It has been suggested that food-producing areas in Australia will be affected. Some areas may become too wet for sheep while others will become too dry for wheat.
Hole in the ozone layer

Ozone is a form of oxygen. It forms a layer around the Earth that reduces the amount of damaging ultra-violet rays that reach the surface. Chemicals known as CFCs release chlorine into the atmosphere. Chlorine speeds up the reaction of ozone (O₃) changing to oxygen (O₂). This has resulted in the thinning of the ozone layer and the creation of a hole in the ozone layer over Antarctica. If the amount of ultra-violet radiation increases so will the level of skin cancer. Australia already has a high rate of skin cancer. Some plants and marine organisms may slow in growth as an effect of the hole in the ozone layer.

Introduced species

When a species is introduced to a different environment it arrives without its natural agents of control. These include predators, disease and abiotic factors. This leads to an uncontrolled population.

One of the most infamous introduced species in Australia is the European rabbit. Rabbits were introduced as a source of food and to make the Australian bushland more like the homeland of the early settlers. Five rabbits came on the First Fleet. The rabbits were so successful that they soon reached plague proportions. The natural predators of rabbits that were found in their original environment were not available to keep the number of rabbits under control. As the rabbit population increased, the vegetation that they consumed was unable to survive. Australia has a very dry climate and with the extra pressure of rabbits, many areas became completely denuded of vegetation. This leads to soil destruction and after a drought the vegetation does not grow back. Native animals therefore had less food and their numbers dropped. Two diseases have been introduced to control rabbit numbers. The first virus was called myxomatosis and the second, more recently released, is the calicivirus.

Other infamous examples of introduced species were bitou bush, cane toads, lantana, prickly pear and water hyacinth. Without their natural predators these species were able to rapidly increase in number and out-compete the native species.

Look for the plants below in your local ecosystem as an example of introduced species.
Certain chemicals can be toxic if they are concentrated enough in living tissue. Plants take up the chemicals when they are dissolved in water. A fish may eat many plants during its lifetime and will accumulate the chemicals that were in the plants. This is then concentrated in the next trophic level because a large fish would eat many small fish during its lifetime.
If a human eats many fish, the concentration may reach a point where it becomes toxic and may kill the higher order consumer. This is called biomagnification. As you move up the food chain the concentration increases.

A case of biomagnification occurred with the chemical DDT. It was used as a pesticide and was washed into waterways. From here, it entered the food chain. The higher order consumers such as birds and humans were affected by the concentrations that occurred.

The pelican laid eggs that had weak shells. Many of these eggs were crushed before they hatched. This greatly reduced the number of pelicans.

**Deforestation**

This is occurring in third world tropical countries where rainforest is being cleared for agricultural purposes and for timber. Once the trees are removed the thin soils may be washed away making the area unsuitable for forest to regrow. Once removed the trees never return.

As part of your field study look for human interaction in your ecosystem study.

You will be completing the field study this week and returning it to your teacher. The following activity forms part of the field study. In the ecosystem that you are studying I want you to analyse the impact of humans. Analyse means to identify components and the relationships among them. Following is a list of possible human impacts that may occur in your area. Add any that have not been mentioned.
Tick off the human impacts that you have observed in your local ecosystem.

<table>
<thead>
<tr>
<th>Human impact</th>
<th>Present</th>
<th>Absent</th>
<th>Human impact</th>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearing</td>
<td></td>
<td></td>
<td>Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
<td>Air pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture improvement</td>
<td></td>
<td></td>
<td>Water pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monoculture</td>
<td></td>
<td></td>
<td>Land pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td>Siltation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduced species</td>
<td></td>
<td></td>
<td>Smog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilisers</td>
<td></td>
<td></td>
<td>Heavy metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pest control</td>
<td></td>
<td></td>
<td>Mining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td></td>
<td></td>
<td>Erosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urbanisation</td>
<td></td>
<td></td>
<td>Weed infestation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td></td>
<td>Die-back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td></td>
<td>Salination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td></td>
<td></td>
<td>Sand-mining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population expansion</td>
<td></td>
<td></td>
<td>Landfill</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This list is repeated in your Field study scaffold in Table 6. List the human impacts that you have ticked off in the table.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Answer Exercise 4.2
If possible present photographic evidence for human interaction in your study area and include them in the field study report.

Drain going into the ocean. Increased run-off from the land.
Also look for any aboriginal occupation of your local area. The aboriginal people were living in your area for at least 40 000 years. There may be middens and rock carvings.

Congratulations!

You have completed the module “A local ecosystem”. Hopefully you have enjoyed exploring your local ecosystem and increased your understanding and awareness of the natural world around us.
An adaptation is any feature of an organism that promotes the wellbeing of a member of a species in the environment it usually lives in.

Living things have adaptations that increase their chances of survival and therefore reproduction. Adaptations can be behavioural, physiological or structural.

Examples of human impact on the ecosystem are:

- habitat destruction
- hunting
- disposal of wastes
- eutrophication
- global warming
- hole in the ozone layer
- introduced species.
Human impact

Exercise 4.1
a) What is an adaptation?

b) Choose an organism and write down three adaptations it has to the environment where it normally lives.

Exercise 4.2
What is pollution? Give an example from your local ecosystem if possible.
Exercise 4.3

How have the activities that you have observed impacted on your local ecosystem?

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Don’t forget to include your field study report with this return.
Verb meanings

In the Biology syllabus the verbs used have specific meanings. The meanings will be used for the examination questions in the HSC. Here are some of those verbs and their meanings.

account state reasons for or causes of, report on, narrate a series of events
analyse identify components and the relationship among them; draw out and relate implications
apply use, utilise, employ to a particular situation
assess make a judgement of value, quality, outcomes, results
calculate determine from given facts, figures or information
clarify make clear or plain
classify arrange or include in classes/categories
compare show how things are similar or different
construct make, build, put together items or arguments
contrast show how things are different or opposite
critically add a degree of level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to
deduce draw conclusions
define state meaning and identify essential qualities
describe provide characteristics and features
discuss identify issues and provide points for and/or against
evaluate make a judgement based on criteria
examine inquire into
explain relate cause and effect, make the relationships between things evident
extract choose relevant and/or appropriate details
extrapolate infer from what is known
identify recognise and name
interpret draw meaning from
investigate plan, inquire into and draw conclusions about
justify support an argument or conclusion
outline sketch in general terms
predict suggest what may happen based on available information
propose put forward (for example a point of view, idea, argument, suggestion) for consideration or action
recall present remembered ideas, facts or experiences
recount retell a series of events
summarise express concisely, the relevant details

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We need your input! Can you please complete this short evaluation to provide us with information about this module. This information will help us to improve the design of these materials for future publications.

1. Did you find the information in the module clear and easy to understand?
   _______________________________________________________

2. What did you most like learning about? Why?
   _______________________________________________________
   _______________________________________________________

3. Which sort of learning activity did you enjoy the most? Why?
   _______________________________________________________
   _______________________________________________________

4. Did you complete the module within 20 hours? (Please indicate the approximate length of time spent on the module.)
   _______________________________________________________
   _______________________________________________________

5. Do you have access to the appropriate resources? eg a computer, the Internet, scientific equipment, chemicals, people that can provide information and help with understanding science
   _______________________________________________________
   _______________________________________________________

Please return this information to your teacher, who will pass it along to the materials developers at OTEN – DE.