A Local Ecosystem

What is this unit all about?

This unit involves the study of:
1) Distribution and Abundance of Organisms
2) Biotic and Abiotic Factors
3) Roles and Relationships
4) The Flow of Energy and Matter
5) Adaptations to Environment
6) Human Impacts

Some important definitions

Ecology – is the study of living things and their environment, and all the inter-relationships between the life-forms and the factors of the environment itself.

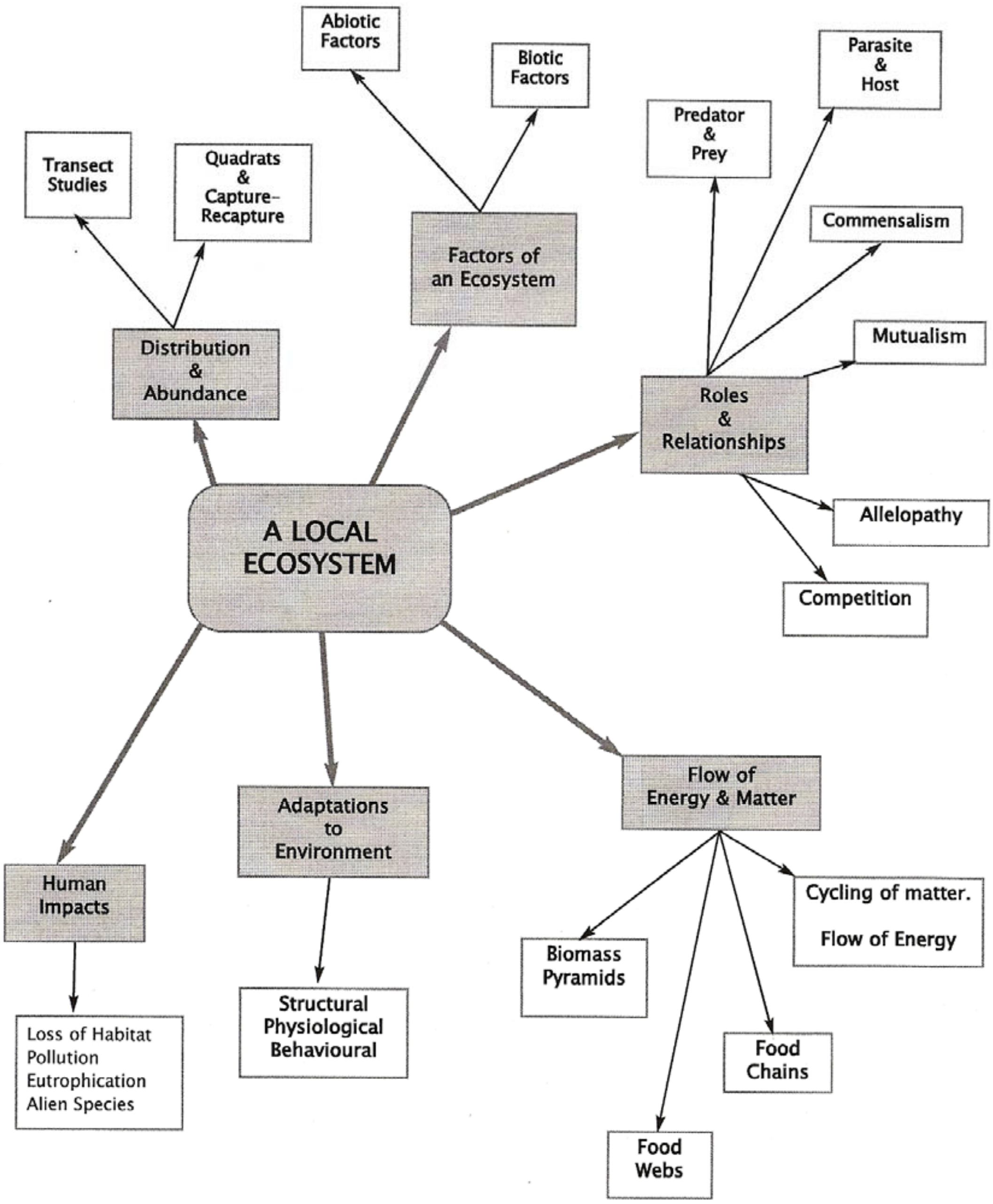
Ecosystem – An ecosystem comprises all the living things and the non-living environment of a particular defined area. The size of an ecosystem can vary enormously.

Community – refers to all the living things within an ecosystem.

Population – refers to all the individuals of a particular species living within an ecosystem.

A Mind Map for this Unit

The mindmap below shows some of the areas we will cover in this topic and how they are related.



Measuring the Distribution & Abundance of Organisms

The first questions you might ask when beginning to study any ecosystem are:

- Which organisms live here?
- Where do they live exactly?
- How many of them are there?

Distribution in ecology refers to <u>where</u> within an ecosystem the individuals of a species are located.

Some species might be more or less evenly distributed throughout the are being studied, but often the population of a species is “clumped” together.

How a species is distributed gives clues about how it is interacting with the environment.

A plant found mainly along the banks of creeks or rivers may have a greater need for water to grow, or might only be able to reproduce by spreading its seeds in water.

An animal that is usually found in tree tops may be there to find food, or it may be escaping from or avoiding predators.

One of the first things to do when studying an ecosystem is to study the distribution of the organisms present.

Transect Study

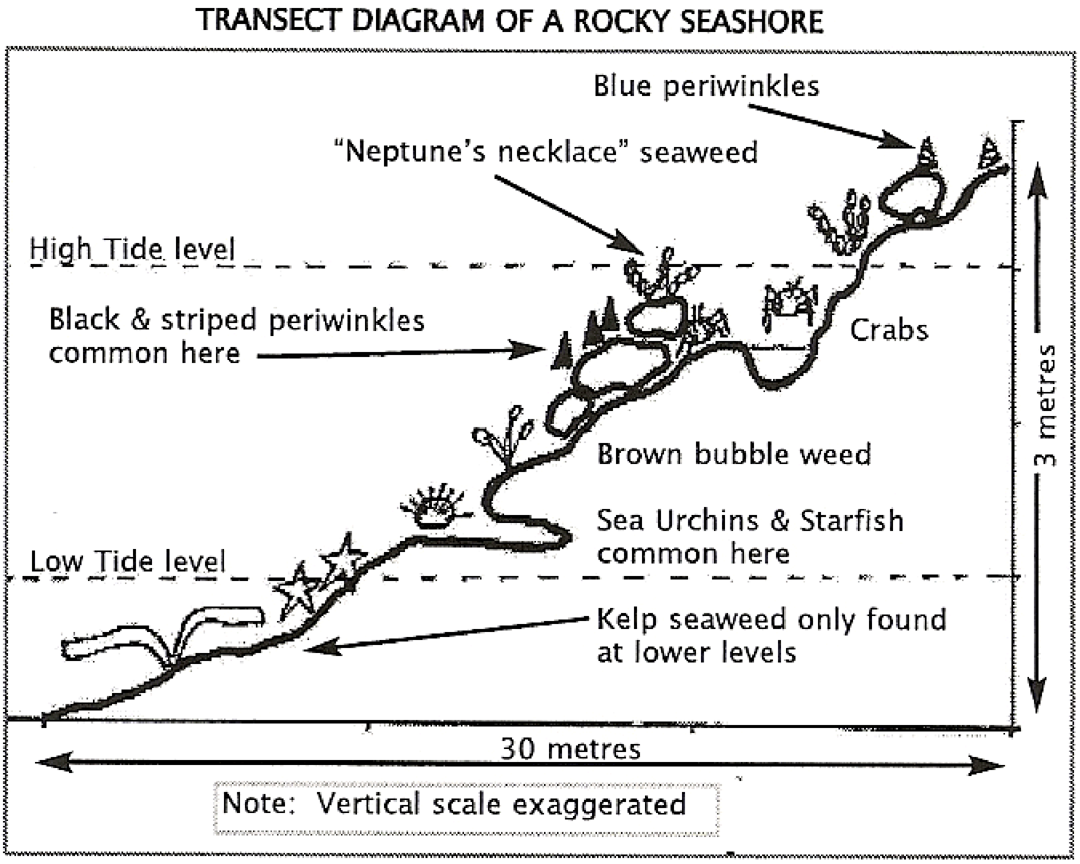
A **transect** is like a cross-section through the ecosystem we are studying.

The idea is to define a line that cuts rights across the area being studied. This could be a string line or a series of marker sticks hammered into the soil.

The study is done by moving along the line and noting and recording which species are located at each point.

Often plants are the main subjects of a transect study, because many animals move around so far and so quickly that they can’t be studied that way.

NB: You may have noticed that this is an obvious disadvantage of transects. They can’t be use to measure mobile organisms.



The **Abundance** refers to how many individuals are in the population of a species in the ecosystem.

In some cases, especially when counting large organisms, it is relatively easy to directly count the individuals that make up the population.

If we are studying small organisms, a large area or animals that are highly mobile (little buggers move around a lot) direct counting is often impossible.

In this case the abundance of a species is measured by **sampling**.

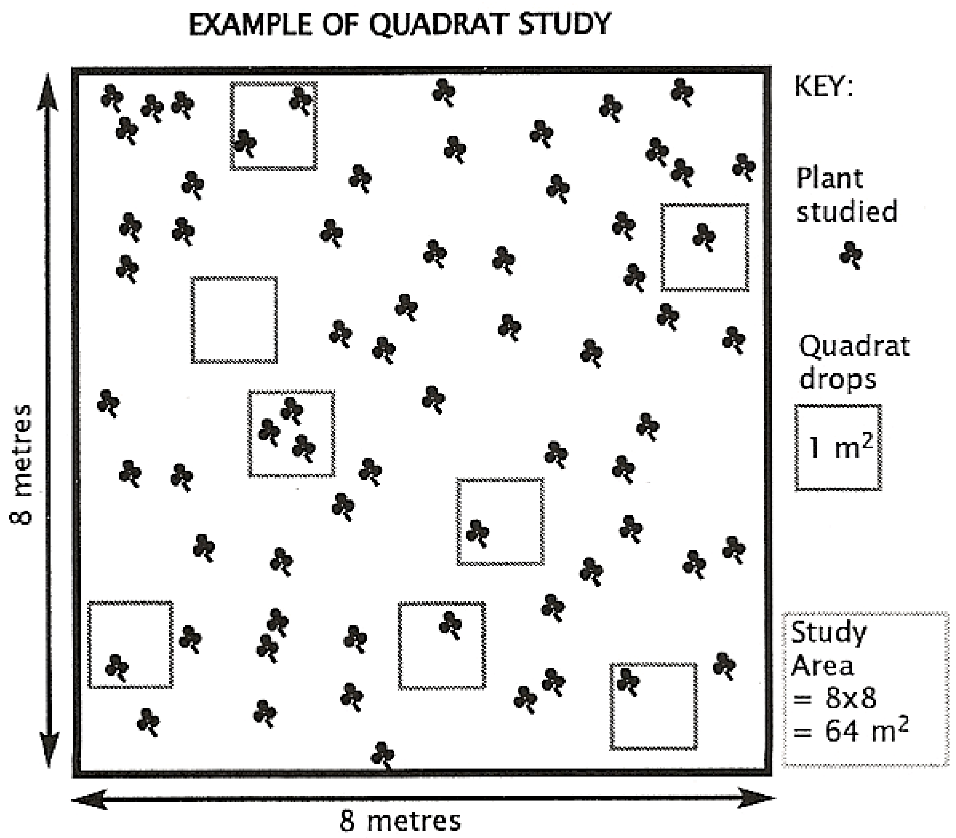
Two commonly used **sampling** techniques are **Quadrat studies** and **Capture-Recapture sampling**.

Quadrat Studies

A quadrat is a simple wire, wooden or plastic frame that is dropped onto the ground at random throughout the study area.

At each quadrat "drop" the number of the species of interest is counted. After a number of "drops" (the more the better) the average number of organisms per quadrat is calculated.

Finally, the estimated population is found by "scaling up" from the area of the quadrat to the total area being studied.



In our example, the quadrat has been dropped eight times within the study area. The number of "target" plants in each quadrat drop were 2,1,0,3,1,1,1,1. This gives an average of (10/8) = 1.25 plants per drop.

Estimated Population = Average count per quadrat x (Study Area / Quadrat Area)

In our example above we would have:

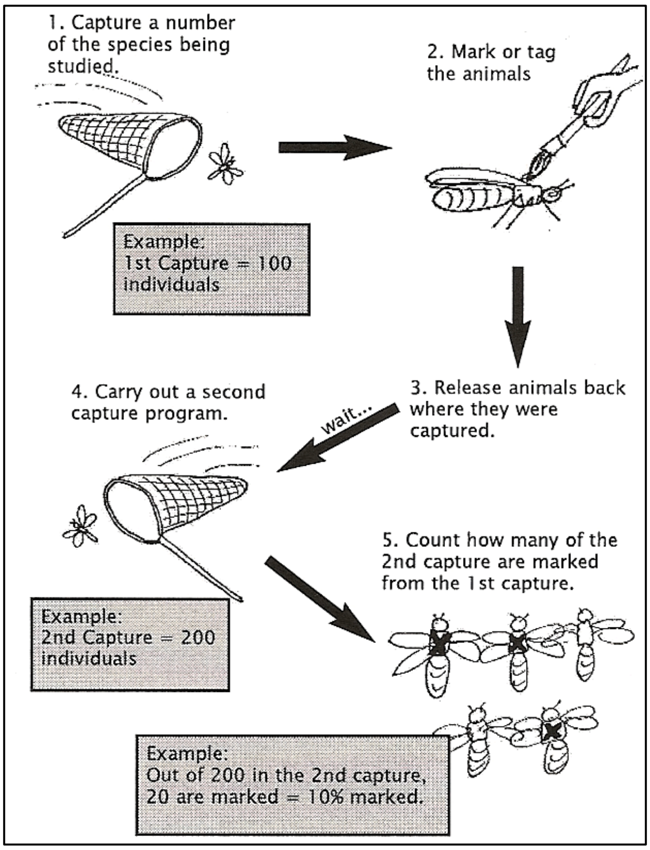
Estimate Population = 1.25 x (64/1) = 80 plants

NB: Remember that the quadrat method is an estimate only. Its accuracy can be improved by increasing the number of quadrat "drops".

Capture-Recapture Sampling

The obvious problem with the Quadrat method is that it does not work with animals that will run/fly/swim away from you.

For mobile organisms, or secretive, hard-to-find types, the "capture-recapture" technique can be useful.



For the example shown to the left, 10% of the 2nd capture are marked.

So statistically, the 1st capture sample of 100 must represent 10% of the total population of the study area.

Therefore our population estimate would be 1,000 individuals.

In Maths:

$$\text{Estimated Pop} = \frac{1^{st}\text{ Capture x }2^{nd}\text{ Capture}}{\text{No. marked in }2^{nd}\text{ Capture}}$$

So, in our example above,

Estimated Pop = 100 x 200 / 20 = 1000

NB: This technique assumes that the marked/tagged individuals mix randomly back into the population and that they are caught again at random. What happens if the species you are studying has learned to avoid your traps or is shunned by its kin because of your marking?

Biotic & Abiotic Factors of an Ecosystem

The distribution and abundance of any species within an ecosystem depends on a number of factors.

Biotic Factors
(living)

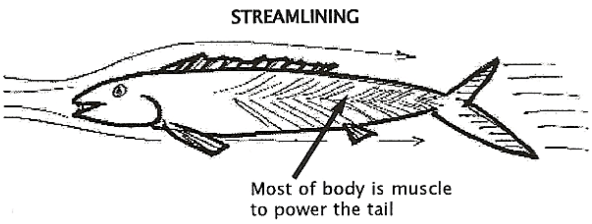
Food organisms
Predators
Diseases
Competitors

Abiotic Factors
(non-living)

Availability of water
Availability of oxygen
Light intensity
Temperature Range
Soil Characterisitics
Salinity
Acidity (pH)
Exposure to wind

Comparison of abiotic Characteristics (terrestrial vs aquatic environments)

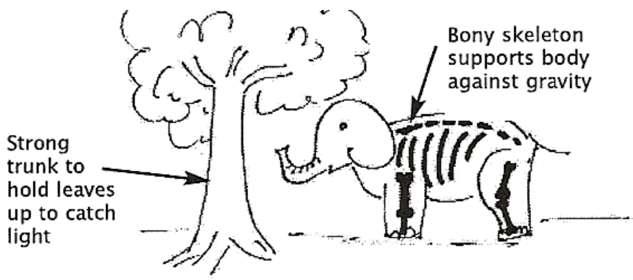
Viscosity is a measure of the “stickiness” of a substance and how easy it is to move through that substance. For example, we say that honey is more viscous or has a greater viscosity than water.



On land, plants and animals are surrounded by air, which has a very low viscosity and is easy to move through.

Water has a much higher viscosity and is more difficult to move through. As a result, aquatic animals are streamlined and equipped with powerful tails for propulsion.

Buoyancy is a measure of “flotation” ability. Water is very buoyant and supports plant and animal bodies against the pull of gravity. Aquatic organisms do not need strong stems or legs to hold themselves up.



Terrestrial plants need strong trunks or stems to grow upwards against gravity. Animals need strong skeletons.

Temperature Variation
On land the temperature can easily vary 20ºC from day to night, and even more from summer to winter. Living things must be able to cope with that while maintaining relatively stable internal body temperatures.

Terrestrial animals need fur or feathers for insulation and have <u>physiological</u> responses such as sweating or shivering, or they alter their <u>behaviour</u> (sunbaking or seeking shade) in response to changes in temperature.

Aquatic organisms typically do not need such special adaptations. Aquatic environments have very stable temperatures and change very little, even between summer and winter.

Availability of Gases (Oxygen and Carbon Dioxide)
Since the air is about 20% oxygen, it is readily available in terrestrial environments. Carbon dioxide (what needs CO_2 and why?) is only about 0.035% of air, so land plants are often limited by this.

These gases do **<u>not</u>** dissolve well in water, so the concentration of gases in aquatic environments is very low and gets lower as the water gets warmer. For this reason, fish gills are highly efficient at extracting oxygen from water and are far better than our lungs for gas exchange.

Availability of Water

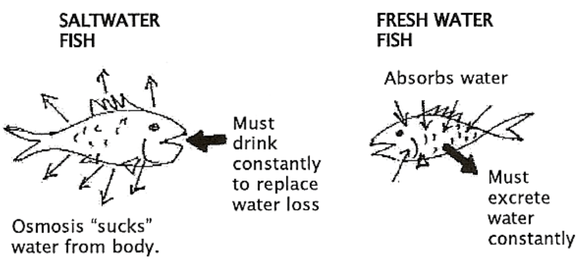
Terrestrial environments are subject to evaporation so plants and animals must have ways to conserve water. This problem becomes extreme in some environments such as deserts.

What are some of the adaptations plants and animals have to conserve water?

In aquatic habitats the organisms are surrounded by water but there can still be problems due to **<u>osmosis</u>**. We will look at osmosis in more depth in the next unit (Patterns in Nature), but if brief:

In salt-water environments animals can lose water by osmosis and must constantly replace it.

In fresh-water, osmosis causes water to flow into the organism's body and must be constantly "pumped out" again.



Availability of Light

Light is essential for plants to carry out photosynthesis. This process makes all the food in ecosystems so the availability of light is a critical factor.

Light penetrates through air very easily, so most terrestrial plants get plenty of light. The floor of a rainforest is an exception because of the abundant growth that leads to the formation of a dense canopy.

Rainforest plants have adapted to this in a number of ways:

- Epiphytes (e.g. staghorn ferns) germinate and grow high up in other plants to avoid the darkness deep below.
- Plants living on the floor have large, broad leaves packed with extra chlorophyll to capture and absorb what little light is available.

In contrast to air, water does **not** allow light through so easily. Light can penetrate the surface layers easily enough, but even just 10 metres down much of the light has been absorbed. By about 100 metres it is totally dark.

Furthermore, water does not absorb different colours (wavelengths) equally. Red and orange light are absorbed rapidly while green and blue penetrate deeper.

Most seaweeds are not green but are brown or red because they contain different pigments to absorb the blue light they receive.

In deep ocean waters there is no light and consequently no plants. Deep ecosystems rely on dead organic matter drifting down from above for their food supply.

Some deep sea vents utilize unique chemosynthetic methods to obtain energy from volcanic vents.

Roles and Relationships between Organisms

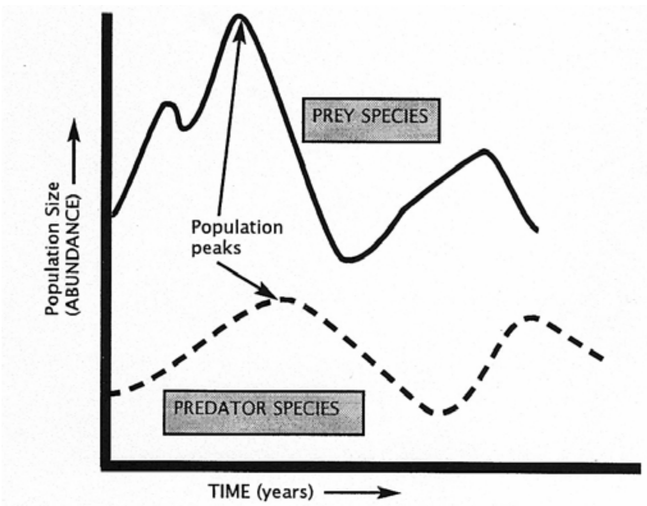
Ecology is about relationships. Not in the touchy, feely sense of the word but in the relationships between different living things. Today we will look at some of the ways organisms in an ecosystem can relate to each other.

Predator – Prey

Although animals eat living plants, this process is not referred to as predation. We only use predation in situations where one animal eats another animal.

for example…	**Predator**		**Prey**
	Dingo	eats	Wallaby
	Lion	eats	Zebra
	Spider	eats	Fly

Both predator and prey have major impacts on each other's distribution and abundance, and can cause the other's population to rise and fall in fairly regular patterns.



Notice on the graph:

- Predator abundance is always lower than prey abundance. Why?
- The "peaks" and "troughs" of the predator's population always occur <u>after</u> those of the prey species.

What happens:

1. The numbers of the prey species increase because of its breeding cycle, or a seasonal increase in available food.
2. This provides more food for predators, who survive in greater numbers and reproduce more successfully.
3. As predator numbers increase, more prey gets eaten and so the prey population decreases.
4. As prey numbers decline, less predators can survive, and breeding is less successful. This causes predator numbers to decline.

NB: Each organism's abundance affects the other's abundance.

Types of Interactions

Commensalism

Commensalism is a relationship in which one organism benefits while the other is neither harmed nor helped.

Examples include:

- Sharks and Remoras – the Remora attaches itself to the shark and hitches a ride. This does not harm the shark. The Remora also feeds off debris and scraps from the shark's meals.
- Birds nesting in a tree – The bird's gain a safe and secure nest site while the tree is unharmed.
- Cattle egret and Cattle – The egret follows cattle and eats disturbed insects. The cattle are not disturbed.

Mutualism

Mutualism arises when both species benefit from the relationship.

Examples include:

- Honey bee and flowering plants – The plant gets pollinated and the bee gets a feed.
- Herbivores and bacteria – Animals with a diet rich in cellulose rely on bacteria in their digestive tract to break it down. Both species obtain food from the relationship.
- Coral and algae – The coral (a microscopic animal) provides the algae with a home and the algae provides the coral with some food.

Parasitism

Parasitism occurs when one organism feeds on another without killing it, or even necessarily harming the host greatly.

Examples include:

- Humans and tapeworms – the tapeworm absorbs food inside the host.
- Leeches or ticks – feed off the blood of the host.
- Viruses, protozoa and fungi – invade the body and feed/reproduce using the body's resources

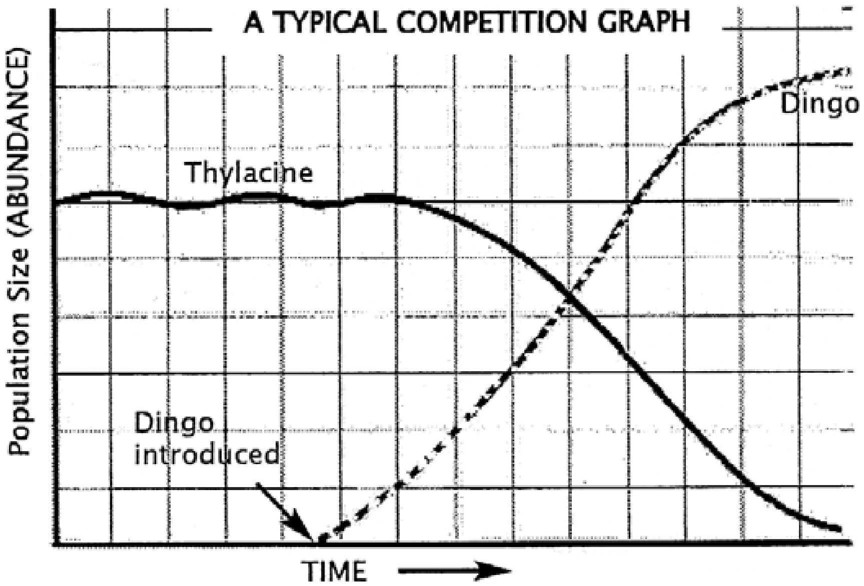
Allelopathy

Allelopathy occurs between plants and fungi. One organism directly inhibits the growth and development of others by releasing toxins. For example, the fungus Penicillium is allelopathic to some bacteria.

Competition

Competition occurs when two different species need to use the same resource in the same way. Competition usually results in a "winner" and a "loser". One species may be slightly more successful than the other, and over a long enough period of time it will "out compete" it's rival

For example, the numbers of Thylacine (Tasmanian Tigers) declined rapidly after the introduction of the Dingo about 10,000 years ago. The Dingo was a more successful predator and out-competed the Thylacine on the mainland.



Human Impacts on Ecosystems

As Human society has grown and expanded beyond its original birthplace to encompass every part of the globe we have had a negative impact on many ecosystems.
Human influence on the world around us ranges from to competition for space and resources through to deliberate, willful and criminal destruction of habitats.
Let's look at some examples of how we affect the world around us:

1. **Loss of habitat**

It is often said that the "Great Australian Dream" is to own a house on a quarter-acre block of land. Unfortunately, all those quarter-acres soon add up and native habitat has to be cleared in order to provide the space for new homes.\

Look at the urban sprawl around the Sydney region.

On top of this, an increasing population requires additional food and water.
Extra land has to be cleared and replaced with agriculture to provide the extra food. This further reduces native habitats.

Furthermore, additional population and agriculture places further pressure on our pressured water resources. Look at the desperate measures some politicians are discussing to address the "water crisis" (e.g. desalination and recycling)

2. **Pollution**

Many human activities produce chemical byproducts that can harm theenvironment.

Acid Rain results when gases such as sulfur dioxide (SO2) are released when fossil fuels are burnt. These gases dissolve in water vapour in the atmosphere to produce acids.

Acid rain has a devastating effect on wetlands, lakes and forests in addition to the cultural damage it can cause to buildings (e.g. sandstone dissolves in acid).

Pesticides and industrial poisons (e.g. heavy metals like mercury) can build up in communities and reach toxic levels thanks to "biological magnification".

3. **Eutrophication**

Eutrophication occurs when rivers and streams are over-fertilised by human sewerage and agricultural run-off.

The result is that algae living in the waterways are stimulated to grow, often to the point where they choke waterways. When these Algae die, they remove oxygen from waterways resulting in widespread "fish kills".

4. Introduction of Alien Species

A number of foreign, alien species have been introduced to Australia that have had a marked impact on local ecosystems and organisms.

For example, cattle, pigs, cats, camels and cane toads.