

A LOCAL ECOSYSTEM

A COMPARISON OF THE ABIOTIC CHARACTERISTICS OF AQUATIC AND TERRESTRIAL ENVIRONMENTS

- 1) Copy and complete the following passage, using the words listed in the box below.

food, disease, non-living, light, wind, living, oxygen, predators

The abiotic components of an ecosystem include _____ chemical and physical factors such as temperature, pH, _____, available water and _____, salinity, _____ and substrate composition. The biotic components of an ecosystem include all the _____ organisms present and the effects they have on each other. Biotic factors that could affect the distribution and abundance of a particular species include _____, competition from other species for _____, and shelter, and the spread of _____ from one organism to another.

- 2) Use the information in the passage below to complete the table that follows.

Light is readily available in terrestrial environments. In aquatic environments light penetration decreases with depth; this has a direct effect on the distribution of aquatic organisms. Water is obviously readily available in aquatic habitats, but its ability to be used by organisms may depend upon osmotic factors. On land, water availability varies, and can be extremely scarce in desert regions. Terrestrial organisms consequently need to be physically adapted to cope with water stress. Oxygen is abundant in terrestrial environments, but its availability in aquatic environments is low, with more being available in dissolved form as temperatures decrease. In general, dissolved oxygen decreases with increasing depth. Water provides more buoyancy (upward lift) to organisms than air does, with the result that terrestrial organisms need to have stronger skeletal structures to support themselves. Water is also more viscous than air, which means that it offers greater resistance to the movement of organisms through it than air does. This helps to explain why many aquatic organisms have a streamlined shape. Mineral nutrients and ions are readily available in a dissolved form in aquatic environments, but their abundance in terrestrial environments varies on land according to the type of substrate present in a particular area. Temperatures in aquatic environments display less variation than on the land, although water temperatures tend to decrease with depth. On land, some desert regions can experience enormous daily fluctuations in temperature, and air temperatures tend to decrease with increasing altitudes.

Abiotic factor	Terrestrial environment	Aquatic environment
light		
water availability		
oxygen availability		
buoyancy		
viscosity		
nutrient availability		
temperature variation		

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ANSWERS

- 1) Copy and complete: non-living, light, oxygen, wind, living, predators, food, disease
- 2)

Abiotic factor	Terrestrial environment	Aquatic environment
light	Readily available	Light penetration decreases with increasing depth.
water availability	Varies	Readily available, but access may depend on osmotic factors.
oxygen availability	Readily available	Limited availability; amount of dissolved oxygen decreases with depth and increases with decreasing temperature.
buoyancy	Air offers little buoyancy, so terrestrial organisms must develop structures to support themselves.	Water provides a high level of buoyancy.
viscosity	Air has low viscosity.	Water is more viscous than air, so it is harder to move through.
nutrient availability	Varies according to the substrate material in a particular location.	Usually readily available in dissolved form.
temperature variation	A large range of temperatures occurs on land.	Usually experience fewer fluctuations than on land.

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MEASURING THE ABIOTIC FACTORS IN AN ECOSYSTEM

Introduction

In this investigation, you will be measuring some physical and chemical properties of an ecosystem in your local area. Choose a location that is reasonably small and easily identifiable as a discrete ecosystem, preferably with a watercourse running through it. Test the following abiotic features at two different locations (A and B) within your ecosystem.

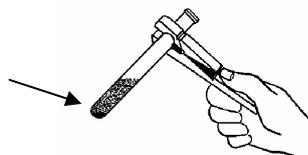
Materials needed

data logger (or light meter), cobalt chloride paper, thermometer, universal indicator paper (or pH meter), metre ruler, anemometer or wind meter

Method

- i) **Moisture** – the moisture content of the air or soil can be tested using either the probe of a data logger, or cobalt chloride paper. This paper must be stored over calcium chloride in an airtight container before use. When exposed to moisture, the paper will change from blue to a pink or white colour. The time taken for the paper to dry out again is a measure of the moisture present.
- ii) **Light intensity** – this can be measured using the relevant probe on a data logger or a light meter.
- iii) **Acidity** – measure the acidity of any water or soil present at each site. Water can be collected in a test tube and tested with the appropriate probe on a data logger, or several drops of universal indicator solution can be added and the resulting colour checked against a pH colour chart. Soil can be mixed with water in a test tube and tested for pH in a similar manner to the above method, or wet universal indicator paper can be held against soil or rocks.

water can be mixed with
universal indicator solution
in a test tube



- iv) **Temperature** – use either a data logger probe or a thermometer to measure air temperature at each site, and allow enough time for the instrument to equilibrate with the environment.
- v) **Wind exposure** – a wind meter or anemometer can be used to determine wind speed at each site, or a relative scale can be used in which + represents minimum wind exposure, and + + + + + represents maximum wind exposure.
- vi) **Height of plants, depth of soil and water** – a metre ruler can be used to determine the average height of plant layers and depth of soil or water at each site.
- vii) **Soil** – a 50cm hole can be dug at each site and used to draw a soil profile. The profile should indicate the relative ratio of leaf litter to soil grains present.

MEASURING THE ABIOTIC FACTORS IN AN ECOSYSTEM – continued

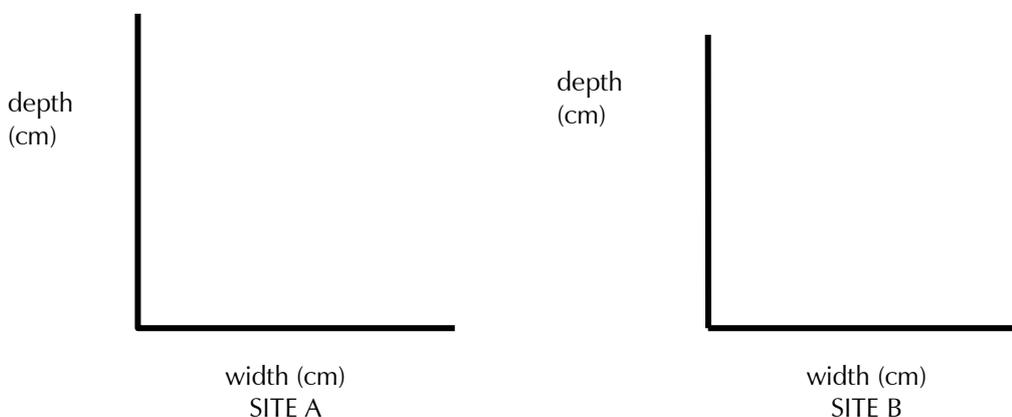
- viii) **Percentage cover** – estimate the percentage covered in each area by water, shrubs, mosses, herbs, trees or leaf litter. This measurement is important, as it can affect aspects of the microclimate such as light intensity, moisture and temperature.
- ix) **Rate of water flow** – the time taken for a stick or other object to float a certain distance can be recorded in any watercourse present at each site.
- x) **Turbidity** – this is a measure of the particle content of any water present, and can be measured by collecting water samples from different locations in stoppered test tubes and rating them from + + + + + (extremely cloudy) to + (clear).

Results

- a) Complete the result table below for each abiotic factor tested.

	Site A	Site B
moisture		
light intensity		
acidity		
temperature		
wind exposure		
height and depth		
percentage cover (record separately for shrubs, mosses, trees, herbs, water, leaf litter)		
rate of water flow		
turbidity		

- b) Draw a soil profile for sites A and B on the axes provided below.



Conclusion

Compare and contrast the abiotic features of sites A and B in approximately one paragraph.

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POPULATION TRENDS IN ECOSYSTEMS

Read the following passage and then answer the questions that follow.

Populations of a particular species are determined by the following factors:

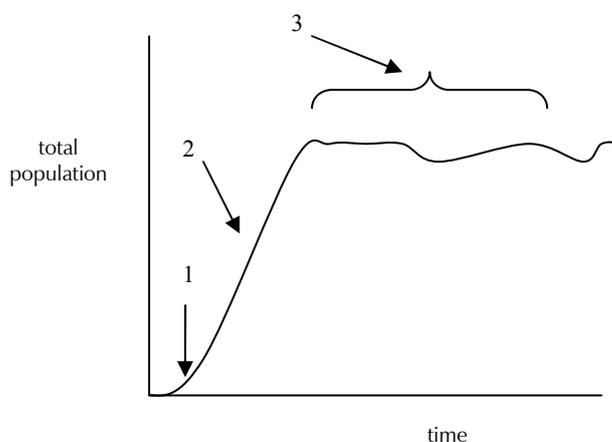
i) **Biotic factors** such as available food, competition from members of the same or different species, shelter, the action of predators, parasites or disease.

ii) **Abiotic factors** such as sunlight, temperature, rainfall, wind and available minerals in the soil.

In animal populations, food supply seems to be the major factor determining the population limit or 'carrying capacity' of a particular ecosystem, whereas for plants the availability of water and light are usually the main factors determining population sizes.

When a species first arrives in an ecosystem, population growth is initially slow, as the species adjusts to the environment and establishes reproductive patterns. Once established, growth of the population then becomes more rapid until environmental factors cause a leveling off in numbers. This equilibrium situation may be represented by a relatively flat curve, usually the result of more individuals competing with each other for the same resources. In cases where cyclic changes (which appear as relatively evenly spaced 'waves' on a growth curve) occur in this part of the growth curve, this may be due to predator-prey relationships or other factors that affect population density, such as birth and mortality rates. Where sharp, uneven population changes occur in this part of the curve, sudden abiotic changes such as increased rainfall may be the explanation.

1) The growth curve below represents changes in an insect population over time.



Use the information in the passage to explain the shape of the curve at positions 1, 2 and 3.

2) A study in Australia found that a locust population followed a similar growth pattern to steps 1 and 2 in the graph above. However, when stage 3 was reached, the curve took on the following shape:



Give one possible explanation for this different curve shape.

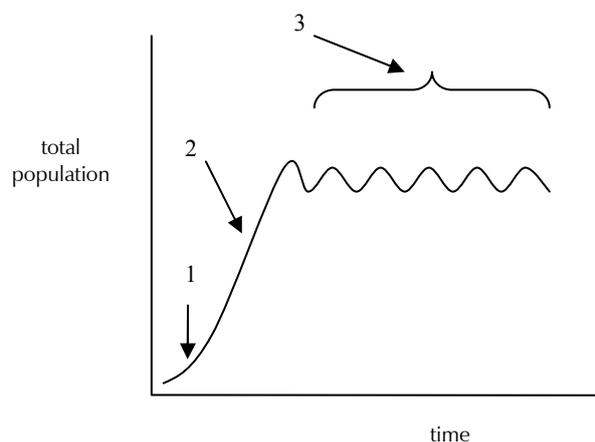
3) A zooplankton population is preyed upon by small fish. As the number of fish increase, zooplankton numbers decrease. This causes the fish population to decrease, so allowing a subsequent increase in the zooplankton population. Draw in the shape of the zooplankton growth curve at stage 3 on the above graph.

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POPULATION TRENDS IN ECOSYSTEMS

ANSWERS

- 1) At position 1, growth is initially slow as the species adjusts to the environment and establishes reproductive patterns. At position 2, the population has become established and growth is more rapid. At position 3, environmental factors such as competition for the same resources cause the curve to level off.
- 2) The population changes at stage 3 are sharp and uneven here, suggesting a sudden abiotic environmental change, such as increased rainfall, causing swarming and perhaps subsequent migration from the area.
- 3) This situation can be represented by a cyclical growth curve, as shown below:



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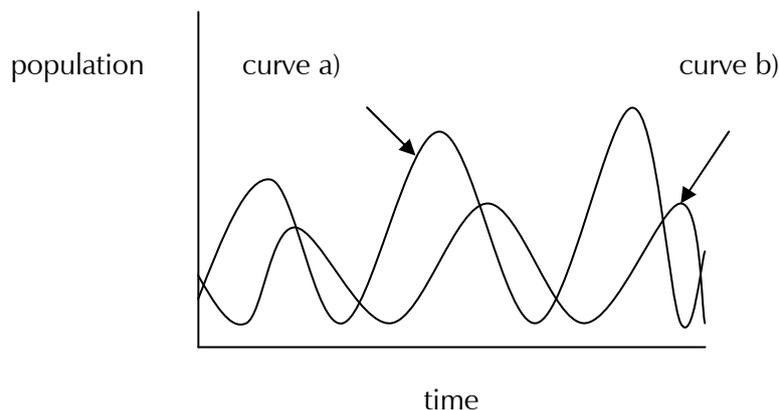
PREDATOR-PREY POPULATIONS IN ECOSYSTEMS

- 1) Copy and complete the following passage, using the words listed in the box below:

increases, escape, decrease, predator, prey, decrease, larger, increase, die

The size of a population of predators is determined by the number of _____ available to them. In a simple relationship in which a predator feeds on only one type of prey, an _____ in the prey population means that more food is available, and the predator population therefore also _____. This causes the prey population to _____, in turn resulting in a _____ in the predator population. If members of the remaining prey population cannot escape, they may all be eaten, and so _____ off. This will also result in the demise of the _____ species. In situations where at least some prey can _____, however, equilibrium between the two species is reached. In cases where a predator population feeds on more than one type of prey, the predator may consume a _____ proportion of a certain species if numbers of the other prey species have decreased.

- 2) Cicadas can have a life cycle of up to seventeen years. In what way is this a protection mechanism against predators?
- 3) In Canada, the snowshoe hare is preyed upon by lynxes. Both of these species show sudden changes in their population densities every 10 years, as shown in the graph below.



On the above graph, label each curve as either the hare population or the lynx population. Explain your answer.

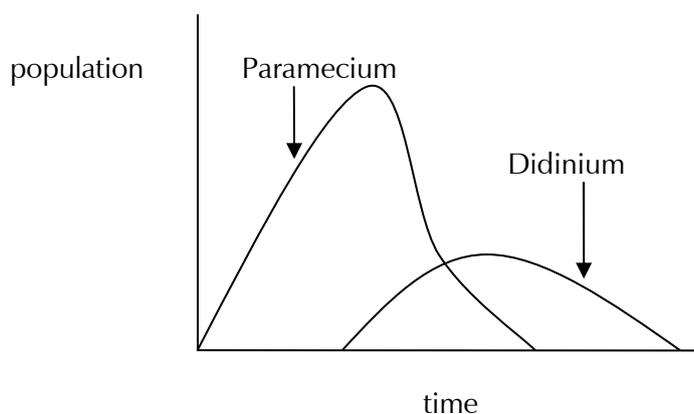
- 4) Use resource material to outline the way in which the prickly pear cactus in Australia has been controlled by an imported predator.
- 5) A population of the protozoan, Didinium, is introduced into a closed petri dish containing another protozoan, Paramecium. Assuming Didinium preys upon Paramecium, draw a population/time curve to represent the changes in the number of each species over time.

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PREDATOR-PREY POPULATIONS IN ECOSYSTEMS

ANSWERS

- 1) Copy and complete: prey, increase, increases, decrease, decrease, die, predator, escape, larger.
- 2) This is because by the time they are mature, they are virtually an unknown species to other organisms and therefore have no natural predators.
- 3) Curve a) is the hare population
Curve b) is the lynx population.
This is because the lynxes, being predators, increase in number only after an increase in the hare population; their population curve therefore seems to 'lag' behind the hare curve.
- 4) The prickly pear, being a native of South America, had no natural predators in Australia when it was introduced. As a result, it became a weed, spreading at the rate of 400,000 hectares per year. One of its natural predators from South America, the cactoblastis moth, was finally introduced. The female moths produce thousands of eggs, which hatch into caterpillars. These caterpillars devour all parts of the plant, and have been highly successful in controlling its spread.
- 5) In a small, closed system, the prey will eventually be consumed. This will in turn result in the elimination of the Didinium population, as their food supply will have become exhausted.



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RELATIONSHIPS BETWEEN ORGANISMS IN AN ECOSYSTEM

- 1) Relationships between organisms in an ecosystem may be either beneficial or detrimental to their chances of survival. Rewrite the table below so that the type of relationship listed in column A matches its description in column B.

A	B
predation	A detrimental relationship in which one plant reduces the growth of another one in its vicinity by secreting inhibitory chemicals.
alleopathy	A necessary beneficial relationship between two organisms; both need each other for survival.
parasitism	A detrimental relationship in which one organism kills and eats another one.
mutualism	A relationship between two organisms in which one or both benefit; neither are harmed.
commensalism	A relationship in which one organism uses another organism (the host) as its food source. The host is adversely affected, but does not usually die.

- 2) Identify each of the relationships described below as predation, alleopathy, parasitism, mutualism or commensalism.
- A lichen, which is in fact composed of an alga and a fungi living together. The alga provides food for itself and the fungus by photosynthesising, and the fungus stores necessary water for both organisms.
 - A remora fish, which attaches itself to a shark as a means of transport. It also eats any food remains dropped by the shark.
 - Epiphytic ferns, which attach themselves to the trunks of large rainforest trees as a means of support.
 - A tapeworm feeding on digested food in the human intestine.
 - The rhizobium bacteria, which lives in the root nodules of legume plants. Rhizobium obtains food from the plant, while at the same time converting nitrogen from the air into nitrates that can be used by the plant.
 - Many eucalypt species produce toxic chemicals that inhibit the growth of seedlings of other species underneath their canopies.
 - Wildebeest calves in Africa are killed and eaten by hyenas.
- 3) Some ants have a relationship with aphids in which the ants feed off the sugary liquid exuded from the aphids. In return, the ants often keep the aphids in their colony, feeding them and protecting them. Both species, however, are capable of living independently of each other. Is this an example of mutualism, parasitism or commensalism? Explain.



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RELATIONSHIPS BETWEEN ORGANISMS IN AN ECOSYSTEM

ANSWERS

1)

A	B
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- 2) a) mutualism
b) commensalism
c) commensalism
d) parasitism
e) mutualism
f) alleopathy
g) predation

3) Commensalism, because each species is capable of existing independently of the other.