

A LOCAL ECOSYSTEM



Characteristics of ecosystems are determined by biotic and abiotic factors

The distribution, diversity and numbers of plants and animals found in ecosystems are determined by biotic and abiotic factors

1.1



Matching terms and definitions exercise

Ecology

Ecology is the study of the **distribution** and **abundance** of living organisms and how these properties are affected by interactions between the organisms and their environment.

There are a few important terms that need to be defined prior to

understanding the study of ecology (see Table 1.1). These terms will be regularly used throughout this chapter so it is essential to know them well before proceeding.

Term	Definition
Abiotic	Non-living features—physical and chemical factors (e.g. temperature, rainfall, salinity)
Aquatic environment	An environment existing mainly in water: freshwater, saltwater or both
Biome	Large regional system characterised by major vegetation type (e.g. desert); region of earth with similar ecosystems grouped together
Biosphere	The part of the earth and atmosphere in which living organisms are found
Biotic	Living features—all living things (e.g. numbers, distribution, interactions)
Community	Groups of different populations in an area or habitat
Ecology	Study of the relationships living organisms have with each other and their environment
Ecosystem	A community together with its environment: any environment containing organisms interacting with each other and the non-living parts of the environment (e.g. rainforest, freshwater pond)
Environment	Both living (biotic) and non-living (abiotic) surroundings of an organism
Habitat	Place where an organism lives
Niche	Place of a species within a community involving relationships with other species
Organism	Living thing (e.g. plant, animal)
Population	Group of organisms of the same species living in the same area at a particular time
Species	Groups of similar individuals that can reproduce fertile offspring (e.g. kookaburra, snow gum)
Terrestrial environment	An environment existing mainly on land

Table 1.1 Key terms used in ecology and their meanings

Ecology is studied at different levels as illustrated in Figure 1.1.

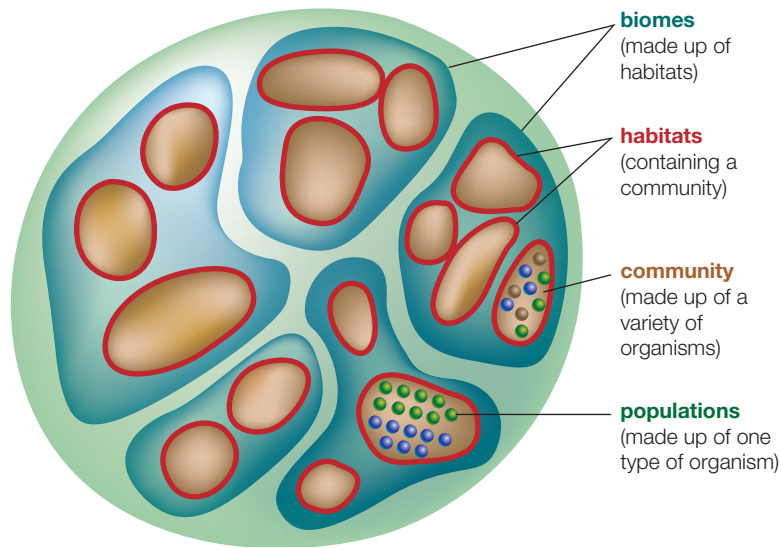


Figure 1.1 Schematic diagram representing the biosphere

Components of ecosystems

An ecosystem is the combination of all organisms (biotic factors) living in a community and all the non-living features (abiotic factors) with which they interact. There is a fine balance between the biotic and abiotic factors in ecosystems. The distribution of the different Australian ecosystems is due to the variation in biotic and abiotic factors found within each particular area (see Fig. 1.2).

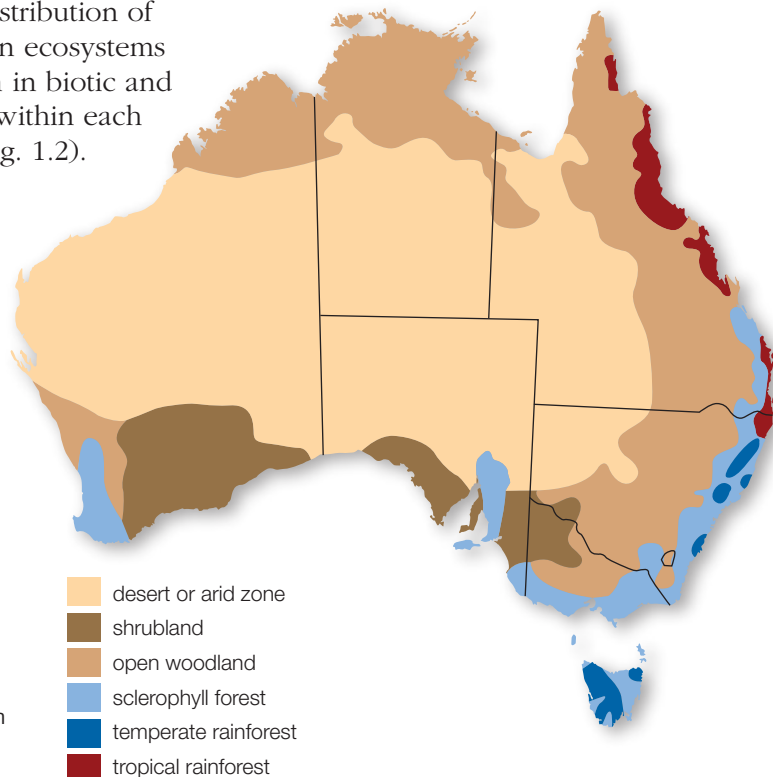


Figure 1.2 The distribution of Australian terrestrial ecosystems

1.2

Terrestrial and aquatic environments

Terrestrial environments are those found on land, for example desert or rainforest ecosystems (see Table 1.2). There are two main types of aquatic (water) environments: saltwater or **marine environments** (e.g. coral reefs) and freshwater environments (e.g. lakes) (see Fig. 1.3).

However, some aquatic environments are exposed to both freshwater and saltwater, such as an **estuarine environment** affected by tidal changes. The major types of organisms found in aquatic environments are influenced by the level of water **salinity**.

Figure 1.3 Examples of aquatic environments






Table 1.2 Examples of common terrestrial ecosystems found in Australia (ordered from lowest to highest rainfall)




Examples of Australian terrestrial and aquatic environments

There are many diverse ecosystems found in Australia. Examples of aquatic ecosystems include wetlands and mangrove swamps; rock platforms—bare rock and littoral zones;

estuaries, rivers and lakes; oceans and coral reefs. Common terrestrial ecosystems found in Australia are described in Table 1.2.

Terrestrial ecosystem	Appearance	Description
Desert		<ul style="list-style-type: none"> ■ Annual rainfall is low, <250 mm ■ High temperatures through the day (approx. 40°C) and cold temperatures through the night (approx. 0°C) ■ Often sandy soil, sometimes rocky ■ Typical organisms include sparse grasses and saltbushes; the spinifex hopping mouse; insects, lizards and snakes
Grassland		<ul style="list-style-type: none"> ■ Annual rainfall 250–750 mm ■ Temperature can be hot or mild ■ Typical organisms include grasses (e.g. spinifex), kangaroos, rabbits and snakes
Shrubland		<ul style="list-style-type: none"> ■ Annual rainfall 200–400 mm ■ Temperatures are hot ■ Typical organisms include mallee trees, mulga; kangaroos, rabbits and snakes

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Terrestrial ecosystem	Appearance	Description
Woodland		<ul style="list-style-type: none"> ■ Annual rainfall 400–750 mm ■ Temperature can be mild, and sometimes hot ■ Canopy cover 10–30% ■ Typical organisms include grasses, shrubs, eucalypt trees, mice, birds, insects, spiders and wallabies
Temperate forest		<ul style="list-style-type: none"> ■ Annual rainfall >750 mm ■ Temperature is mild ■ Canopy cover 30–70% ■ Typical organisms include eucalypt trees of various types
Rainforest		<ul style="list-style-type: none"> ■ Annual rainfall >1500 mm ■ Air is humid and temperature can be hot or mild ■ Canopy cover is dense (70–100%) and layers (strata) develop (i.e. canopy, understorey, forest floor) ■ Typical organisms include a diverse number of habitats and species (e.g. birds nest ferns, palms, lianas, bracken ferns, leaf litter organisms)

Abiotic factors in aquatic and terrestrial environments

Biotic and abiotic factors differ significantly between aquatic and terrestrial environments. Abiotic factors create various conditions which suit different types of organisms and hence affect biotic factors. First, we must look

at the underlying abiotic factors of an environment in order to determine the possible effect that they may have on the living (biotic) component of that environment.

■ *compare the abiotic characteristics of aquatic and terrestrial environments*

Abiotic factors in aquatic and terrestrial environments are described comprehensively in Table 1.3. It must be noted that the abiotic factors of water environments differ depending on whether the water is saltwater or freshwater. For easy reference, variations in some of the abiotic characteristics described in Table 1.3 for a marine (saltwater) environment are illustrated in Figure 1.4. However,

in order to approach this dot point, you must first understand the meaning of the verb used (refer to page viii for verb definitions). The verb ‘compare’ requires a discussion of *both* the similarities and differences in the abiotic characteristics of the two environments. Refer to the information provided above for a description of aquatic and terrestrial environments (or refer to Table 1.1 for definitions).

Table 1.3 Abiotic characteristics of aquatic and terrestrial environments

Abiotic characteristic	Aquatic environment	Terrestrial environment
Temperature	<ul style="list-style-type: none"> ■ Only small temperature changes occur in aquatic environments ■ Temperature changes in water are more gradual ■ Large bodies of water such as the sea are more or less constant in temperature, whereas smaller bodies of water such as lakes are more variable ■ It is much easier for water organisms to adapt to a constant temperature environment than the varying temperatures on land. However, organisms in the water tend to lose heat more rapidly because water conducts heat better than air ■ Water organisms having body temperatures higher than the water must have adaptations to prevent heat loss by conduction 	<ul style="list-style-type: none"> ■ Large variations in temperature can occur in terrestrial environments over short periods of time. Daily temperatures may vary up to 20°C in one typical day ■ A desert environment may vary 40°C in one day (0°C at night and 40°C during the day) ■ Seasonal variations between summer and winter are quite significant ■ Different altitudes also demonstrate temperature variation. For every 1000 m above sea level, the average temperature drops by 1°C ■ Land organisms must therefore have adaptations to cope with such large temperature changes
Pressure	<ul style="list-style-type: none"> ■ As the depth of water increases, pressure increases ■ Deep-sea organisms must be adapted to the crushing effects from the pressure of the water above them 	<ul style="list-style-type: none"> ■ Only small variations occur in pressure on land. Organisms in environments at sea level are under more pressure than those in environments on high mountains above sea level (high altitude) ■ Small daily fluctuations in pressure may occur due to weather changes
Light availability	<ul style="list-style-type: none"> ■ Water surfaces reflect up to 55% of light reaching depths of 1 m or more. Only 1% of light reaches depths of 100 m or more ■ When the sun is high in the sky more light can be absorbed, whereas at sunset the light strikes the water surface at a more acute angle and less light is absorbed. The angle of the sun during times of the day will vary depending on the time of the year ■ Different coloured wavelengths of sunlight penetrate to different depths of water. Red wavelengths are absorbed first by water and do not penetrate as far as blue or violet wavelengths ■ Cloud cover will affect the intensity and the length of time the light strikes the water. Seasons will affect light availability as does latitude. Extreme latitudes receive 6 months of light and 6 months of darkness, whereas the equator receives roughly 12 hours of sunlight and darkness each day ■ The cloudiness (turbidity) of the water affects the light availability. This depends on the disturbance or movement in the body of water that may disturb the soil, organic material or other small particles or objects in the water ■ Aquatic organisms therefore must have adaptations to the amount of light available to them 	<ul style="list-style-type: none"> ■ Light availability is abundant on land ■ Cloud cover may only reduce a small proportion of light availability
Landscape position (slope/aspect)	<ul style="list-style-type: none"> ■ The slope and aspect of the surrounding landscape may affect light availability and the temperature of aquatic environments ■ It may also affect exposure to currents, tides and waves 	<ul style="list-style-type: none"> ■ Slope (angle of the slope of the land) and aspect (direction facing, e.g. north) may affect temperature, water and light availability as well as impact on soil quality ■ Runoff and erosion can cause dramatic effects to an environment. However, drainage may be essential in some environments

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Abiotic characteristic

Aquatic environment

Terrestrial environment

Gases (O₂ and CO₂)

- Where air and water are in close contact, gases from the air, like oxygen and carbon dioxide, readily dissolve in the water. The more movement in the water, the more gases dissolve. For example, the rapids of a river would contain more oxygen and carbon dioxide gas than would a still pond
- Temperature also affects the amount of gases in water. As temperature increases, dissolved gases decrease
- Aquatic organisms must have adaptations to the variations in gas availability in the water

- Oxygen and carbon dioxide are found in abundant quantities for terrestrial organisms



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Rainfall and water availability

- Water is abundant in aquatic environments but may not be readily available
- In freshwater environments, water tends to move into organisms freely and this must be removed effectively
- In marine (saltwater) environments, the opposite happens where water readily moves out of the organism and must therefore be replaced regularly by the organism (for more information see osmosis in 'Patterns in Nature')
- Aquatic organisms must have adaptations to the type of water environment they exist in, in order to maintain water balance

- Water is not freely abundant in land environments. It must be sourced from the soil or consumed
- Organisms must have adaptations to the amount of water available in their environment and the process by which it needs to be sourced

Salinity and ion availability (dissolved salts)

- In marine environments, most ions are available in abundance (e.g. Na⁺)
- Ions from decomposing organisms are distributed by currents throughout the different water depths and therefore available to many organisms

- Dissolved ions are available in soil water and the amount of ions in the soil is called the soil salinity
- Different soils contain different salinity levels and plants must have adaptations to cope with the different levels

pH (acidity/alkalinity)

- The pH may vary between different aquatic environments depending on things such as the organic material and dissolved gases available
- Carbon dioxide can lower the pH of the water, making it more acidic

- Soil pH can vary significantly between different terrestrial environments
- Dissolved salts play a large role in determining the pH of the soil
- Plants must have adaptations to the soil pH of their environment

Buoyancy (the amount of support provided by a medium)

- Water provides much more buoyancy and support than air. Water may not only hold an organism up but may also maintain its shape (e.g. jellyfish)

- Air provides a very small amount of buoyancy and support. Land organisms therefore need more supporting skeletal and muscular structures to assist with support

Viscosity (the amount of resistance provided by a medium)

- Water is more viscous than air
- Water provides more resistance and it is therefore more difficult for an organism to move through it than air
- Organisms with more streamlined shapes (i.e. fish) find it easier to move through water than organisms of other shapes

- Air is less viscous than water
- Air provides less resistance and it is therefore easier for an organism to move through it than water
- A human finds it easier to walk through air than to walk through water because the high viscosity of water provides greater resistance against any movement

Exposure to natural forces (wind, tide, waves)

- Different aquatic environments are exposed to different natural forces
- Marine environments may have to cope with varying strengths of tides, currents and waves which vary depending on the weather or season
- Freshwater environments may have to cope with the varying strength of running water (e.g. rivers/waterfalls as opposed to still ponds with no water movement at all)

- Different terrestrial environments are exposed to different strengths of wind and rain which vary depending upon weather patterns and seasonal changes
- Exposure can range from the extremes of monsoons and cyclones, through to floods and drought

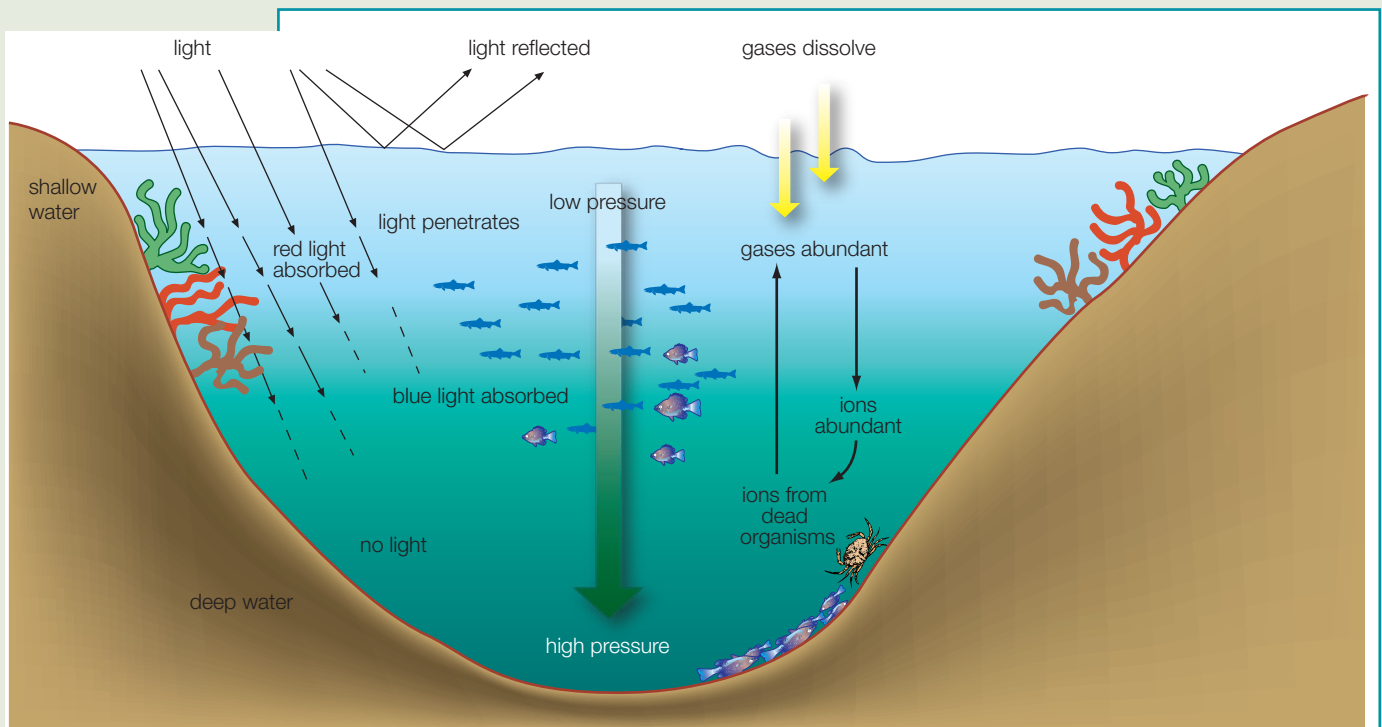


Figure 1.4 Comparing abiotic characteristics at different depths of an aquatic marine environment

Table 1.4 Comparison of abiotic characteristics in aquatic and terrestrial environments

Now that you know what the dot point requires, construct a table using Table 1.4 as a guide. Use the background information provided in Table 1.3 and Figure 1.4, and any other

sources of information, to complete your table by listing the differences and similarities that exist between aquatic and terrestrial environments.

Abiotic characteristic	Differences		Similarities
	Aquatic environments (e.g. freshwater or marine/saltwater)	Terrestrial environments (e.g. rainforest or woodland)	
Temperature	Only small changes occur. Usually more gradual changes	Large variations can occur	Temperature is not stable and does change or vary
Pressure			
Light availability			
Landscape position (altitude/slope/aspect)			
Gases (O ₂ and CO ₂)			
Rainfall and water availability			
Salinity and ion availability (dissolved salts)			

continued . . .

Abiotic characteristic	Differences		Similarities
	Aquatic environments (e.g. freshwater or marine/saltwater)	Terrestrial environments (e.g. rainforest or woodland)	
pH (acidity/alkalinity)			
Buoyancy			
Viscosity			
Space and shelter			
Exposure to natural forces (wind, tide, waves)			



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First-hand investigation—abiotic factors

The distribution and abundance of a species

■ *identify the factors determining the distribution and abundance of a species in each environment*

When an ecosystem is barren and unoccupied, new organisms colonising the environment rely on favourable environmental conditions in the area to allow them to successfully live and reproduce. These environmental conditions are abiotic factors. When a variety of species is present in the ecosystem, the actions of these species can affect the lives of other species in the area; these factors are biotic factors.

The distribution of a species describes where it is found and the abundance of a species determines how many members of that species live throughout the ecosystem. Abiotic and biotic factors affect the distribution and abundance of organisms in an ecosystem by causing fluctuations or changes in populations. Populations may occupy certain areas and not others due to the resources that are available.

Abiotic and biotic factors can affect the abundance and distribution of a species

Abiotic and biotic factors play a very important part in affecting how many species live in a particular area (abundance) and where they may be distributed. In terrestrial environments, abiotic factors such as temperature range, light and water availability most commonly affect a species' abundance and distribution. In aquatic environments, the importance of each abiotic factor differs between the two main types of environments: freshwater and saltwater (see Table 1.5). Of course, an estuarine environment (one exposed to both freshwater and saltwater) must deal with constant changes in the environment.

1.3

Table 1.5 The importance of abiotic factors differs between freshwater and marine environments in affecting the distribution and abundance of species

Freshwater environment	Marine (saltwater) environment
1. Temperature variation	1. Salinity
2. Dissolved gases (O ₂ and CO ₂)	2. Dissolved gases (O ₂ and CO ₂)
3. pH (acidity) of water	3. Tidal movements and wave action
4. Light availability	
5. Clarity of water	

Just as important as the abiotic factors are the biotic factors that may influence an organism's existence in an ecosystem. Even though there is a much greater variation in biotic factors between ecosystems (e.g. availability of worms as a food source for kookaburras in one ecosystem may be much higher than for kookaburras in another), a few key factors will affect organisms within an ecosystem. Examples of biotic factors that may determine the distribution and abundance of a species:

- availability and abundance of foods
- number of competitors
- number of mates
- number of predators
- number and variety of disease-causing organisms.

Generally, in Australia, rainfall, temperature and landform patterns significantly affect the abundance and distribution of vegetation and ecosystems. As can be seen in Figure 1.2, most of the rainforest ecosystems are distributed along the east coast of Australia, particularly in the northern regions. Abiotic factors such as high temperatures and high rainfall create a suitable **tropical** environment for this type of ecosystem. Desert ecosystems, however, are distributed among the central areas of Australia. Abiotic factors such as a high temperature range and low rainfall (**arid** conditions) create an environment suitable for desert ecosystems. Of course, the distribution

and abundance of organisms within these ecosystems may also vary due to biotic factors such as the availability of food, competition within and between species, the availability of mates for reproduction, exposure to predators, and exposure to disease.

Population ecologists, in order to understand and record environmental changes in plant and animal populations over time, must collect information on the distribution and abundance of organisms in each ecosystem. Ecologists usually wish to determine the size of a population (total number of organisms present); however, it is also useful to know the density of organisms (total number of organisms per unit area) as it is often a reflection of how many organisms a particular environment can support. Ecologists also need to determine the distribution of organisms in order to look at any patterns that are formed and the possible reasons for this. This information enables us to determine whether a population is increasing or decreasing in size and what particular aspects of the habitat are favoured over others. It comes down to two main questions:

- Why is a species only present in particular places?
- What determines the number of individuals (size) of a population in one particular place?

In other words, what determines the distribution and abundance of populations?

1.4

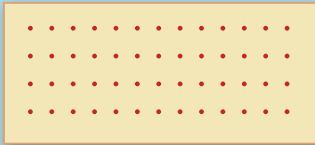
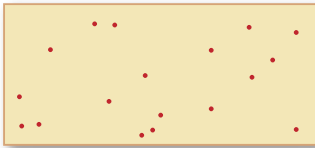

Measuring the distribution of a species in an ecosystem

Types of distribution

Where an organism can be found is the distribution of that organism. Distribution may differ from species to species. Some may randomly distribute themselves around an ecosystem or they may be found distributed in patterns, determined by the resources

around them. Some organisms can be found in clumped patterns, others in uniform patterns (see Table 1.6). For example, barnacles clump together for shelter from the waves and to prevent water loss during low tides (see Fig. 1.5).

Table 1.6 Types of distribution of individuals or species in a community

Type of distribution	Example	Possible explanations of distribution
Regular distribution—very rare in nature		Territorial species
Random distribution (no clear pattern exists)		Random distribution of resources
Clumped distribution—possibly the most common pattern reflecting the fact that species need resources that are not distributed uniformly		Patchy distribution of resources

Transects

There are different techniques that may be used to measure the distribution of a species in an ecosystem. In large areas **transects** are commonly used to give an idea of the variation that may occur. A transect is a narrow strip that crosses the entire area being studied, from one side to the other. Transects provide an accurate and easy method of representing an area simply. Two examples of transects are a **plan sketch** and a **profile sketch**.

A plan sketch is an aerial or surface view of a representative area within an ecosystem. It shows to scale the distribution of organisms in a measured and plotted view (see Fig. 1.6). A profile sketch is a side-on view of an area showing to scale the distribution of organisms along a line (see Fig. 1.7).



Figure 1.5 Clumping distribution pattern made by barnacles to maximise their resources of shelter and water

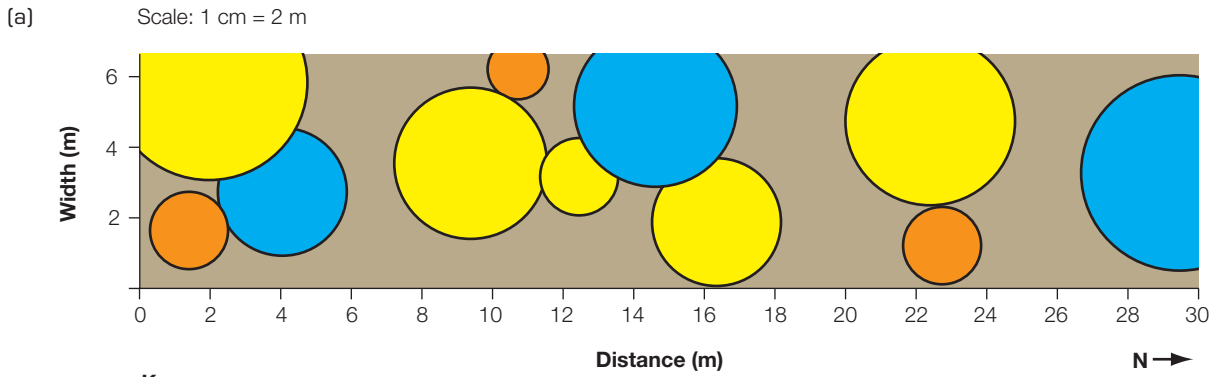


Figure 1.6 Plan sketch (surface view) of (a) woodland ecosystem and (b) marine rock pool

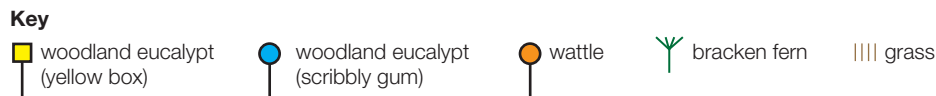
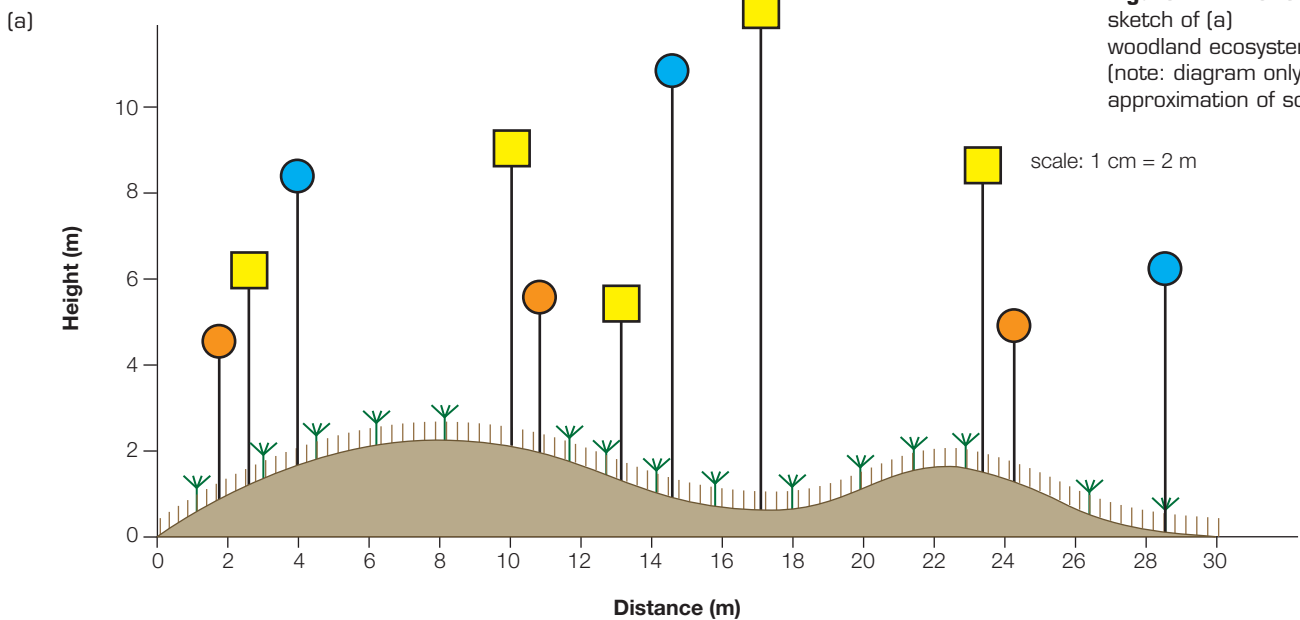
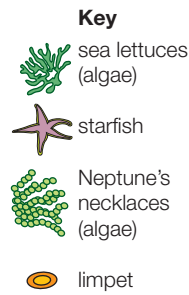
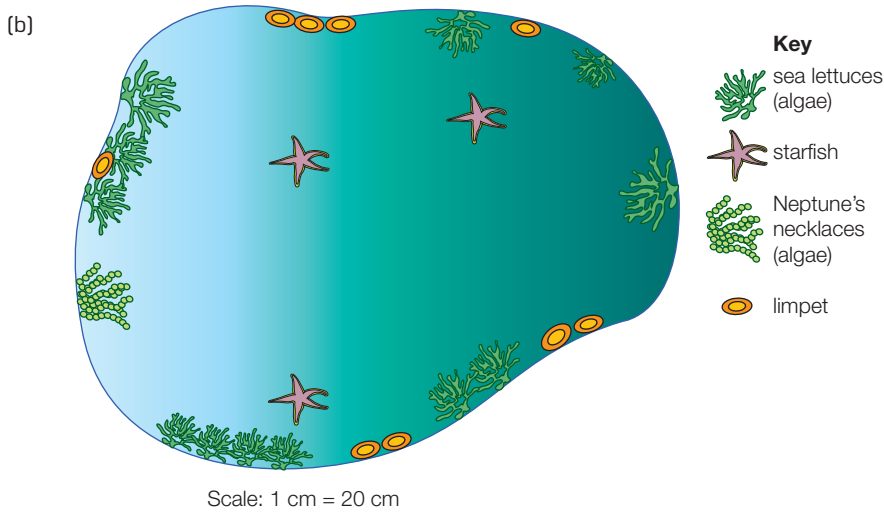


Figure 1.7 Profile sketch of (a) woodland ecosystem (note: diagram only approximation of scale)

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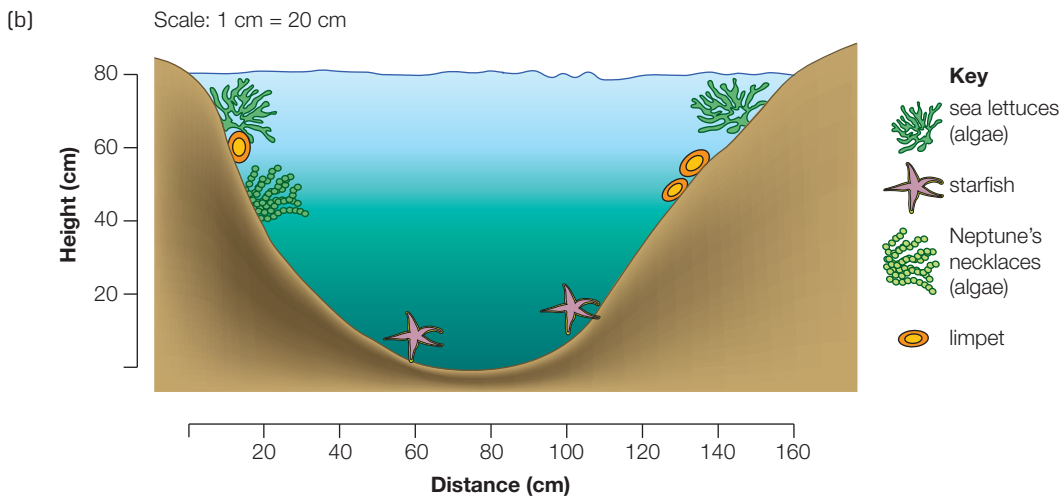


Figure 1.7 Profile sketch of (b) marine rock pool

It is more difficult to assess the distribution of animals due to their daily and seasonal movements. When assessing the animals in an ecosystem we can only observe evidence of their existence in the area. For example, personal sightings, hearing their call,

observing their tracks or burrows and traces such as scats (animal faeces) or footprints. Transects can only be used to determine animal distribution for those that hardly move such as barnacles or snails.

Measuring abundance of a species in an ecosystem

One of the most important features of any population is its size. Population size has a direct bearing on the ability of a given population to survive. The number of individuals of a species found in an area is the abundance of that species.

Plants

It is much easier to calculate the abundance of plant species because they stay in the one place. However, calculating the number of an entire plant species in many cases would be an endless task, so ecologists commonly use sampling techniques to estimate plant species abundance. Usually one or more samples are taken randomly from a population and assumed to be representative of the total population.

There are a few different techniques used to estimate abundance in plants.

The one that is simple and easy to use in the field is the percentage cover method. This method uses **quadrats** (1 m × 1 m squares) to cover randomly-selected representative areas for estimating the percentage cover of an area (see Fig. 1.8). This method is beneficial when plant species are too high in number to count individually.



Figure 1.8 Quadrats are commonly used in the field for estimating percentage cover for plant species (or slow-moving animal species): a rock platform in the Sydney area

1.5

Percentage cover calculations require randomly plotting a number of quadrats (e.g. ten), estimating the percentage cover for each one and then finding an average percentage cover. If the area of the ecosystem is known or estimated, then the percentage cover can then be converted to area (see example below).

Estimating the abundance of grass

If the school gardener, Mr G, needs to purchase new turf for the football ground, he needs to know how much grass cover the football oval has. To find this out he uses the percentage cover method to estimate the grass cover. Ten 1 m × 1 m quadrats were

randomly placed on the oval and the grass cover was drawn to scale and plotted for each one.

A sample of three of the quadrats is shown in Figure 1.9. Back in the office, estimates of percentage cover were made for each of the ten quadrat drawings (see results in Table 1.7), then the percentages were added up and averaged.

Total of the ten quadrats = 540

An average of the percentage of grass cover for the entire oval is calculated.

$$\begin{aligned} \text{Average \%} &= \frac{\text{total\%}}{\text{no. of quadrats}} \\ &= \frac{540}{10} \\ &= 54\% \end{aligned}$$

Therefore the oval is estimated as having 54% of grass cover.

If the area of the oval is measured at 250 m² then the estimated area of grass cover is 54% × 250 m² = 135 m². Mr G can now safely assume he needs to purchase 115 m² (250 m²–135 m²) of turf to fill the bare areas. He can then repeat the same process the following year to determine if the turf replacement has successfully changed the percentage grass cover of the football oval.

Animals

Obviously, it is a little more difficult to calculate the abundance of animals than plants, and attempting to count every animal species in an area is sometimes very difficult. For those that are slow moving counts can be made; however, for those that move around much more quickly estimates may need to be

Figure 1.9 Calculation of the percentage of grass coverage—sample of three quadrats from the ten recorded

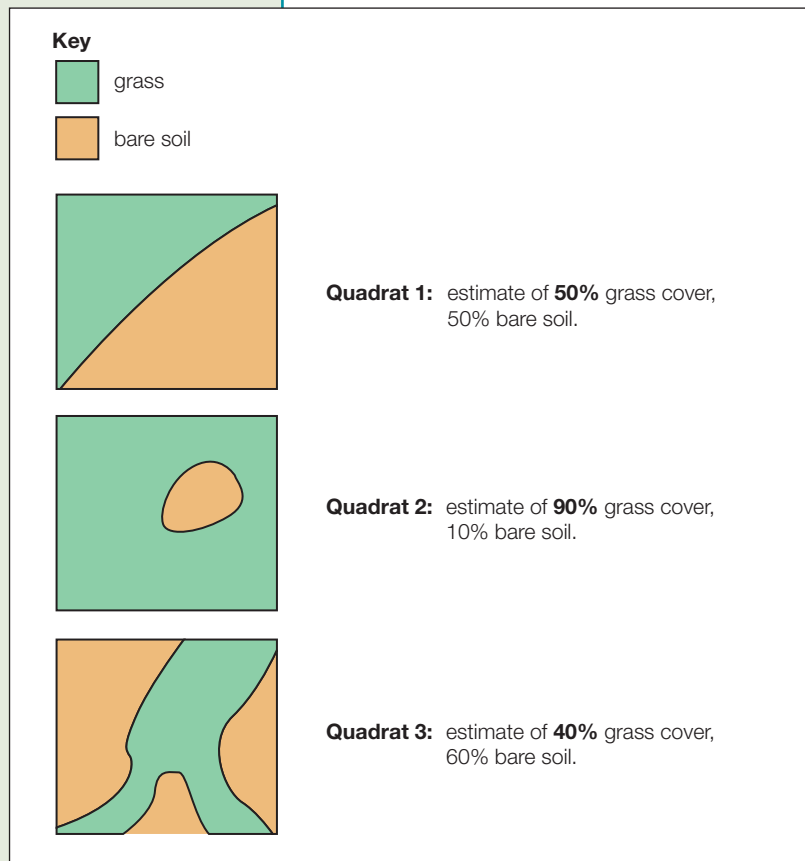


Table 1.7 Results of quadrat percentage cover

Quadrat	1	2	3	4	5	6	7	8	9	10	
Estimated percentage cover	50	90	40	60	20	70	90	80	10	30	Total percentage cover 540

taken. Hence, estimating abundance is a much easier way of finding out roughly how many animal species exist in an area. This is a little more difficult than the method used for plants as animals may constantly move around or hide. That is why ecologists use a **sampling technique** called the *mark–release–recapture technique*. Animals are captured, the sample animals are tagged then released, these animals are given time to mix again, recaptured and the number tagged in the sample are counted.

Estimating the abundance of an animal sample

The formula for calculating the estimated abundance of animals using the mark–release–recapture method is as follows:

$$\text{Abundance} = \frac{\text{number captured} \times \text{number recaptured}}{\text{number marked in recapture}}$$

Example of the mark–release–recapture technique:

1. *Capture*—a random sample of animals from the population is selected
 - Twenty small birds (Superb Blue Wren) were captured, using bird nets
2. *Mark and release*—marked animals from the first capture are released back into the natural population and left for a period of time to mix with unmarked individuals
 - The 20 birds are tagged with leg bands and released back into their area and left for three weeks to mix with the population
3. *Recapture*—a sample is captured again to look at the proportion of animals marked from the previous sample
 - After three weeks a second sample of ten birds is captured to find four marked birds from the first capture

4. We now insert the following values into the formula:

number captured = 20

number recaptured = 10

number marked in recapture = 4

$$\text{Abundance} = \frac{\text{number captured} \times \text{number recaptured}}{\text{number marked in recapture}}$$

$$\begin{aligned} \text{Abundance} &= \frac{20 \times 10}{4} \\ &= 50 \end{aligned}$$

Therefore, we have estimated the total Superb Blue Wren population size in that area as being 50.

The mark–release–recapture technique is based on a number of assumptions for accurate estimates of the total population to be calculated:

1. There is no population change through migration, births or deaths between the sampling periods
2. All animals are equally able to be caught (individuals are not ‘trap happy’ or ‘trap shy’)
3. Marked animals are not hampered in their ability to move and mix freely with the rest of the population.

Capturing animals requires various trapping techniques, all designed so that animals are unhurt (e.g. traps, nets and small pits) (see Fig. 1.10). Some techniques avoid the need for recapturing the animals such as radio-tracking and the use of electronic detection devices. Conservationist Steve ‘The Crocodile Hunter’ Irwin, in his last television project *Ocean’s Deadliest*, demonstrates the use of satellite-tracking devices for crocodiles. He is seen having to subdue a giant crocodile in order to attach the device; however, the crocodile remains unharmed.

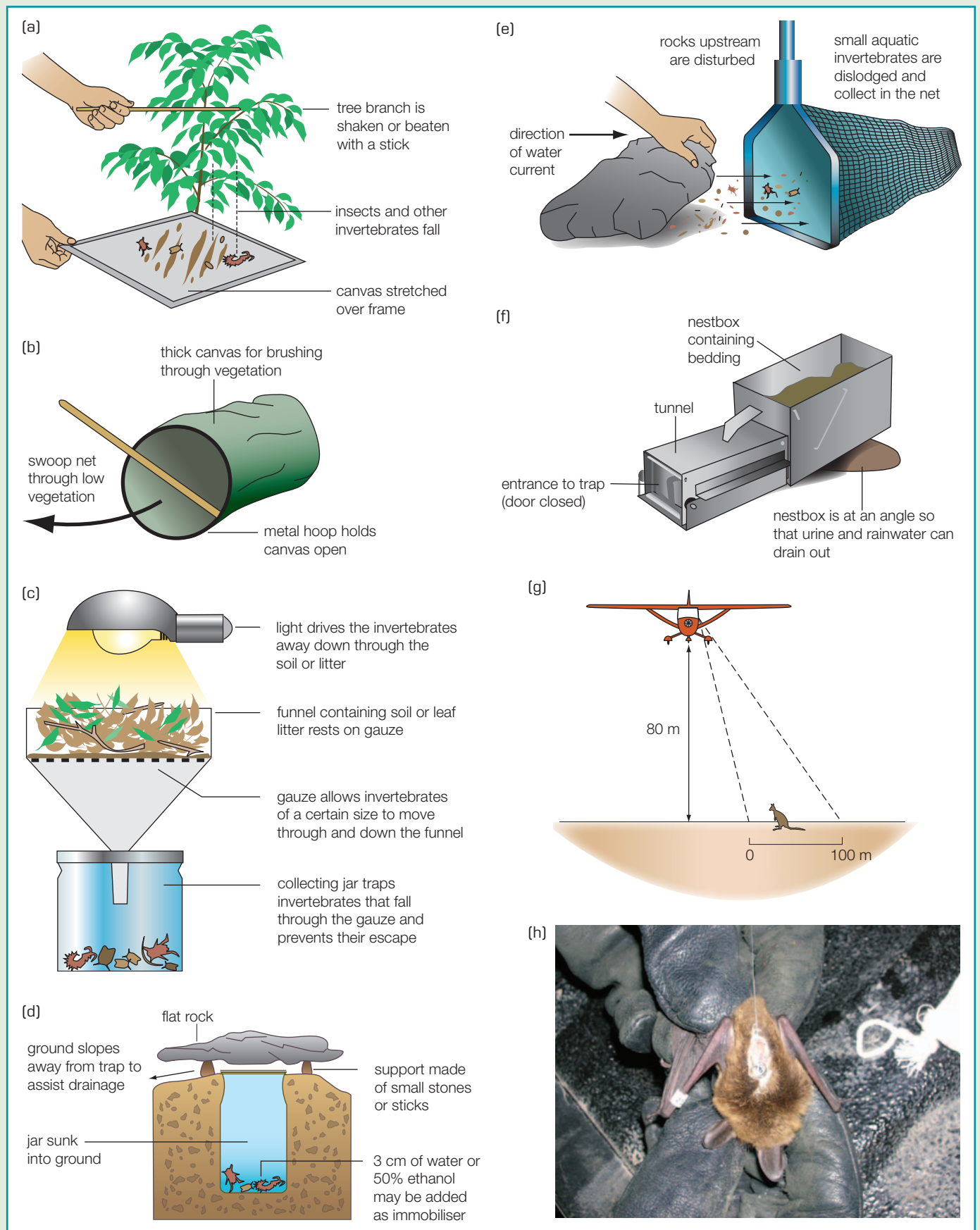


Figure 1.10 Examples of animal sampling techniques (a) beating tray; (b) sweep net; (c) Tullgren funnel; (d) pitfall trap; (e) kick sampling; (f) Longworth small mammal trap; (g) counting from a plane (h) *Myotis septentrionalis* with a Holohil LB-2 transmitter attached using skin-bond glue

The discussed sampling techniques, their uses, and their advantages and disadvantages can be best summarised in Table 1.8.

Table 1.8 Sampling techniques

Sampling technique	Equipment and method	Advantages	Disadvantages
Transects: plan sketches and profile sketches	<ul style="list-style-type: none"> ■ Rope or measuring tape marks the line that is drawn to scale ■ The area is selected at random across the ecosystem ■ Species are plotted along the line, in surface view for a plan sketch or in side-on view for a profile sketch 	<ul style="list-style-type: none"> ■ Provides a quick, easy and inexpensive method for measuring species occurrence ■ Minimal disturbance to the environment 	<ul style="list-style-type: none"> ■ Only suitable for plants or slow-moving animals. ■ Species occurring in low numbers may be missed
Quadrat sampling	<ul style="list-style-type: none"> ■ Measuring tape, metre rulers or quadrats are used to randomly place the 1 m × 1 m square areas ■ The occurrence of organisms in the quadrat is recorded and repeated a number of times ■ Individual species can be counted if in small numbers or percentage cover can be calculated for larger numbers by estimating the percentage cover for each quadrat and then finding an average of the quadrats taken 	<ul style="list-style-type: none"> ■ Easy and inexpensive method for measuring abundance in large populations ■ Minimal disturbance to the environment ■ Quadrats can also be used for determining the distribution of species along a transect 	<ul style="list-style-type: none"> ■ Only suited for plants and slow-moving animals
Mark–release–recapture	<ul style="list-style-type: none"> ■ Animals are captured (e.g. traps, nets, pits), tagged or marked (e.g. limb bands) and then released ■ After a suitable time to mix with others, a sample is recaptured ■ The number of tagged or marked animals recaptured is counted ■ Numbers are then entered into the formula: Abundance = $\frac{\text{number captured} \times \text{number recaptured}}{\text{number marked in recapture}}$ <p><i>Note:</i> Technology is sometimes used in marking very mobile animals using tracking bands and tracing their movements by GPS systems and satellites</p>	<ul style="list-style-type: none"> ■ A simple method that provides an estimate of abundance for animals in large populations that are difficult to count 	<ul style="list-style-type: none"> ■ Only suitable for mobile animals ■ Can be time consuming depending on the type of species captured, method of tagging, and time suitable for waiting while tagged group mix with others ■ Can be disturbing to the environment

Sampling techniques for determining distribution are coloured red and techniques for determining abundance are coloured green.

Justification of different sampling techniques

- ***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***

Background information

When ecologists attempt to analyse the distribution and abundance of a species in an ecosystem there are particular reasons why population estimates must be made when total counts cannot be performed. When observing very large populations of plant or animal species it is too difficult to count species

individually. Mobile animal species are also very difficult to count individually. This is why population estimates are used instead. It is less time consuming, less expensive and less disturbing for the environment. Techniques such as quadrat sampling (percentage cover) for plants and mark–release–recapture methods for animals are commonly used.

SECONDARY SOURCE INVESTIGATION

BIOLOGY SKILLS

P14



Aim

1. To process and analyse information from a variety of sampling studies.
2. To justify the use of different sampling techniques to make population estimates when total counts cannot be performed.

Method A: Processing information obtained from a variety of sampling studies

Using the following information on the grey-headed flying-fox (see Fig. 1.11), and information from other sources, research sampling techniques used for estimating population size for three organisms that are either too high in number to count or are too mobile and quick to count (e.g. flying-foxes, crocodiles and sharks).

Information sources may include scientific journals, CD-ROMs, Internet sites, textbooks,

library reference books, newspaper articles, microfiche and experts in the field. Using a variety of different sources increases the reliability of your information. Using recent sources, such as scientific journals, improves the accuracy and validity of your information.

The search for information usually begins with keywords. These are used when looking up the index of a textbook or using an Internet search engine such as google.com.au to find relevant websites. Once you have found a source of information you then need to analyse and sort through it to select what is important and relevant to your task. This information then needs to be collated for its specific use.

Carefully read the background information in this section and on pages 13–17 before beginning this task. Use this information to help you identify some keywords that you might use in your search for information from a variety of sampling studies.



Website for radio-tracking study of bats



Population estimates of the grey-headed flying-fox

Radio-tracking study of grey-headed flying-foxes (*Pteropus poliocephalus*) in Gordon, Sydney (Augee & Ford, 1999)

This study looked at the release and integration of hand-reared grey-headed flying-foxes in the northern suburbs of Sydney.

Radio-collared hand-reared bats (belonging to the Ku-ring-gai Bat Conservation Society) were found after release to move between Gordon and the Royal Botanical Gardens at Sydney and at Cabramatta Creek south of Sydney. Individual bats moved along the coast as far as 310 km north and 279 km south of Gordon.

When radio-tracking bats there is virtually no chance of recapturing the bat in order to remove the expired transmitter. Therefore, transmitters were designed in 1995 to be glued onto the back of the bat (see Fig. 1.10h) so it would fall off over a short period of time. The transmitters weighed 7 g and had 26 cm-long antennae that were detectable from up to 5 km; however, most transmitters fell off within 20 days (or were possibly removed by grooming). New transmitters weighing 16 g with shorter antennae were used in 1996. They were attached to collars made out of surgical tubing. Sunlight destroyed the rubber surgical tubing after approximately three to four months when the collars fell off. These collars were previously tested on captive flying-foxes and were tolerated very well by the bats. The position of individual flying-foxes was determined using directional antennae and magnetic compasses plotting bearings on a map. The bearings were taken from transmitters in a number of different locations in the area.



Figure 1.11 Grey-headed flying-fox



For the complete study, access www.sydneybats.org.au/cms/index.php?references and download 'Radio tracking study.pdf'

Method B: Analysing information obtained from a variety of sampling studies to justify the use for making population estimates when total counts cannot be performed

Using the information you have processed and collated from Method A, analyse and search for information that justifies the use of such techniques. This information must support your argument or conclusion as to why these

different sampling techniques are used to make population estimates when total counts cannot be performed. Use Table 1.9 as a guide for completing this task.

Example	Sampling technique	Method	Reasons why useful when total counts cannot be performed
Flying-foxes	Radio-tracking		
Crocodiles	Satellite-tracking		
Sharks	Tagging		

Analysis questions

- Explain** the reasons why ecologists may opt for population estimates rather than individual organism counts.
- Name** three examples of sampling techniques used for population estimates and briefly **describe** the methods involved.
- Justify** the use of the examples described in Question 2 for making population estimates when total counts cannot be performed.



For recommended websites

Table 1.9 Different sampling techniques to make population estimates when total counts cannot be performed



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Energy use in ecosystems

■ identify uses of energy by organisms

Energy enters the ecosystem firstly from the sun. Sunlight is absorbed by producers (plants) and used in the process of **photosynthesis** to make glucose. Glucose is an energy source and a small amount of it is used by the plant for the production of organic molecules (e.g. proteins, carbohydrates); growth, repair and maintenance; fluid movement and transport; and for specialised cell functions.

Most of the glucose is used for plant growth or reproduction, which in turn may be consumed by animals. These consumers then receive the energy contained by the plant and use a small amount of this energy for cellular function, but lose most of it as heat. All organisms release energy as heat during the process of **respiration**. Most of the energy is used in respiration to fuel the many chemical reactions of cells in the body.

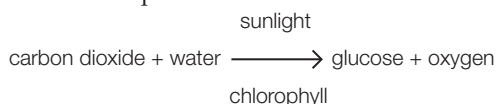
1.6

■ describe the roles of photosynthesis and respiration in ecosystems

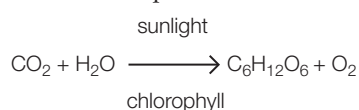
Role of photosynthesis in ecosystems

Photosynthesis is the process in which plants use the energy from sunlight (absorbed by the green pigment **chlorophyll**) to convert carbon dioxide and water to glucose (a type of sugar) and oxygen (released back into the air). Plants take in carbon dioxide from the air through their leaves and absorb water in through their roots. A small amount of glucose is used by the plant for energy but most of it is used for plant growth or reproduction. Photosynthesis is carried out by green plants and even by photosynthetic bacteria (blue-green algae). The process of photosynthesis can be summarised by a word equation, expressed as an equation using chemical symbols or as a balanced chemical equation:

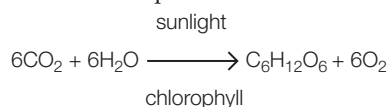
■ word equation:



■ chemical equation:



■ balanced equation:



■ identify the general equation for aerobic cellular respiration and outline this as a summary of a chain of biochemical reactions

Aerobic respiration

Cellular respiration is the process in which glucose is converted into energy, usable for life processes. It allows organisms to use (release) the energy stored in glucose. The following general equation for aerobic cellular

Plants that manufacture their own food through the process of photosynthesis are sometimes referred to as **producers** as they produce or make their own food rather than eat or consume other organisms (plants or animals), which are referred to as **consumers**. Plants are responsible for harnessing the energy from sunlight for use in ecosystems. Their role as producers starts the food chain with high amounts of energy, ready for passing on to consumers. This involves the removal of carbon dioxide from the air, the return of oxygen to the air and the manufacture of food.

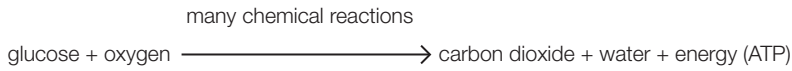
Role of respiration in ecosystems

Aerobic respiration (or mitochondrial respiration) takes place in the **mitochondria** of all living cells and results in the release of energy for organisms to use. Glucose is broken down in the presence of oxygen to produce carbon dioxide and water and in doing so energy is released. Energy in the form of ATP (adenosine triphosphate) is released as heat from this process and is used for cell functions such as growth, repair and maintenance. The role of respiration is to remove oxygen from the air, return carbon dioxide to the air and provide energy.

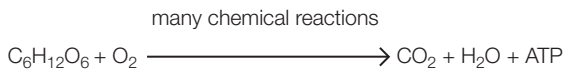
respiration is a summary of a chain of many biochemical reactions which occur in the cells of the organism and is generally used in order to understand the main changes through the respiration process.

General equation for aerobic cellular respiration expressed as a:

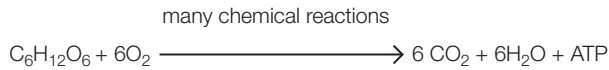
■ word equation:



■ chemical equation:



■ balanced equation:



The reaction appears to be the reverse of photosynthesis, but it is not. Respiration is a series of chemical reactions which have no similarity to the processes occurring during photosynthesis. In fact, the processes of respiration and photosynthesis actually work together as a cycle essential to plant life (see Fig. 1.12).

Anaerobic respiration

Cellular respiration may sometimes occur as **anaerobic respiration**, meaning without adequate oxygen. Anaerobic respiration does not produce the high quantity of ATP energy that aerobic respiration does. This is due to the lack of oxygen that can assist in releasing ATP when converted to carbon dioxide and water. Figure 1.13 illustrates the two reaction pathways that respiration can take depending upon the availability of oxygen. Aerobic respiration releases 36 ATP in total, while anaerobic respiration releases only 2 ATP in total. There is a large difference in the amount of energy released from each reaction.

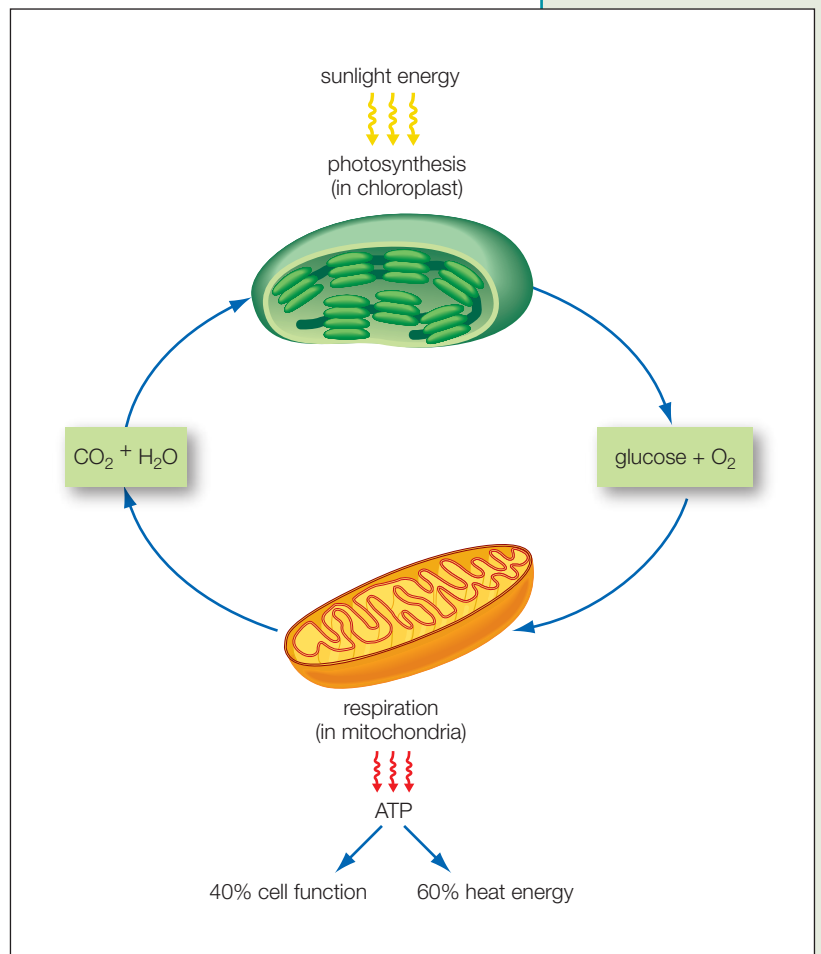
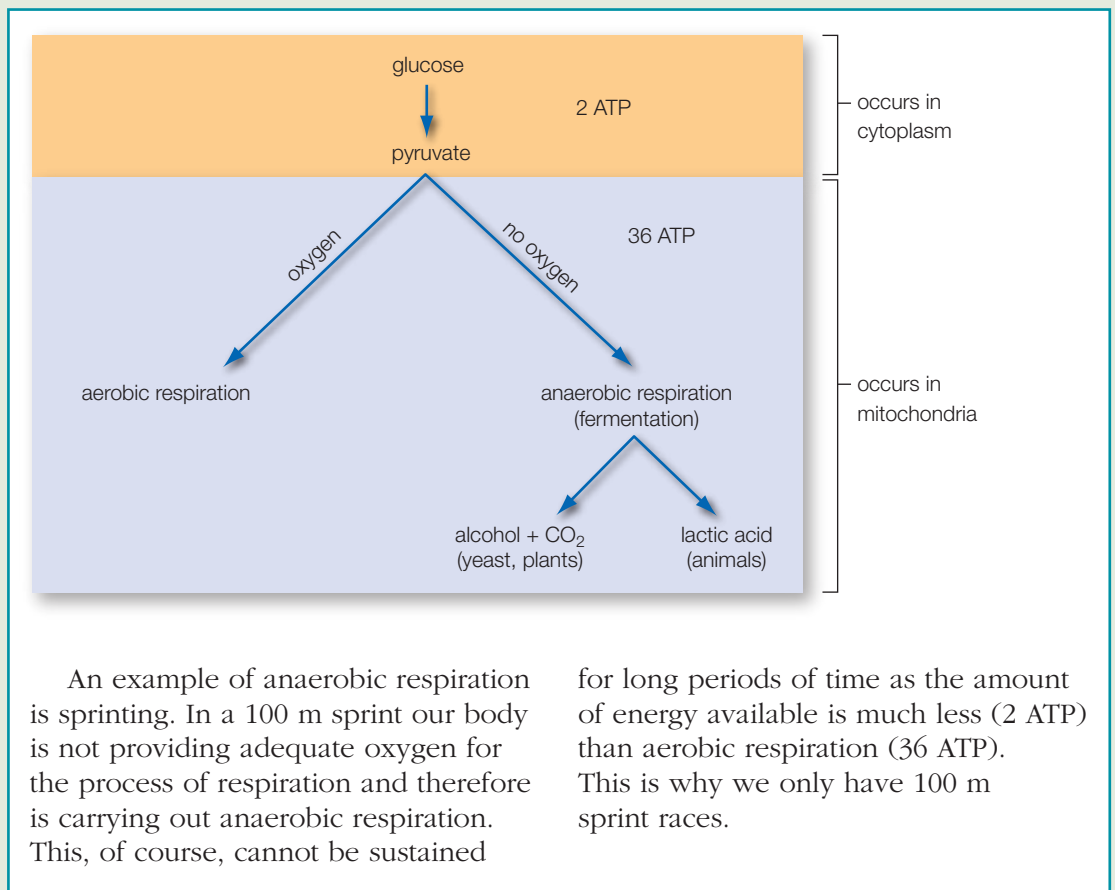


Figure 1.12 The processes of photosynthesis and respiration in cell function as a cycle essential to plant life

Figure 1.13 Aerobic and anaerobic respiration pathways occurring in a cell



For recommended websites

An example of anaerobic respiration is sprinting. In a 100 m sprint our body is not providing adequate oxygen for the process of respiration and therefore is carrying out anaerobic respiration. This, of course, cannot be sustained

for long periods of time as the amount of energy available is much less (2 ATP) than aerobic respiration (36 ATP). This is why we only have 100 m sprint races.

REVISION QUESTIONS



1. **List** three abiotic characteristics and briefly **describe** the main differences between aquatic and terrestrial environments.
2. Briefly **describe** how an ecologist would go about recording the distribution of plants in a rainforest ecosystem.
3. **Describe** an investigation you conducted using the quadrat method. List one advantage and one disadvantage of this method.
4. **Describe** a method you would use to estimate population numbers of kookaburras in an area.
5. **Identify** two factors that might determine the distribution and abundance of mangroves in their estuarine environment.
6. **Describe** the roles of photosynthesis and respiration in ecosystems.
7. **Identify** two uses of energy by organisms.
8. **Identify** the general word equation for aerobic cellular respiration.
9. **Justify** the use of two different sampling techniques to make population estimates when total counts cannot be performed.



Answers for revision questions