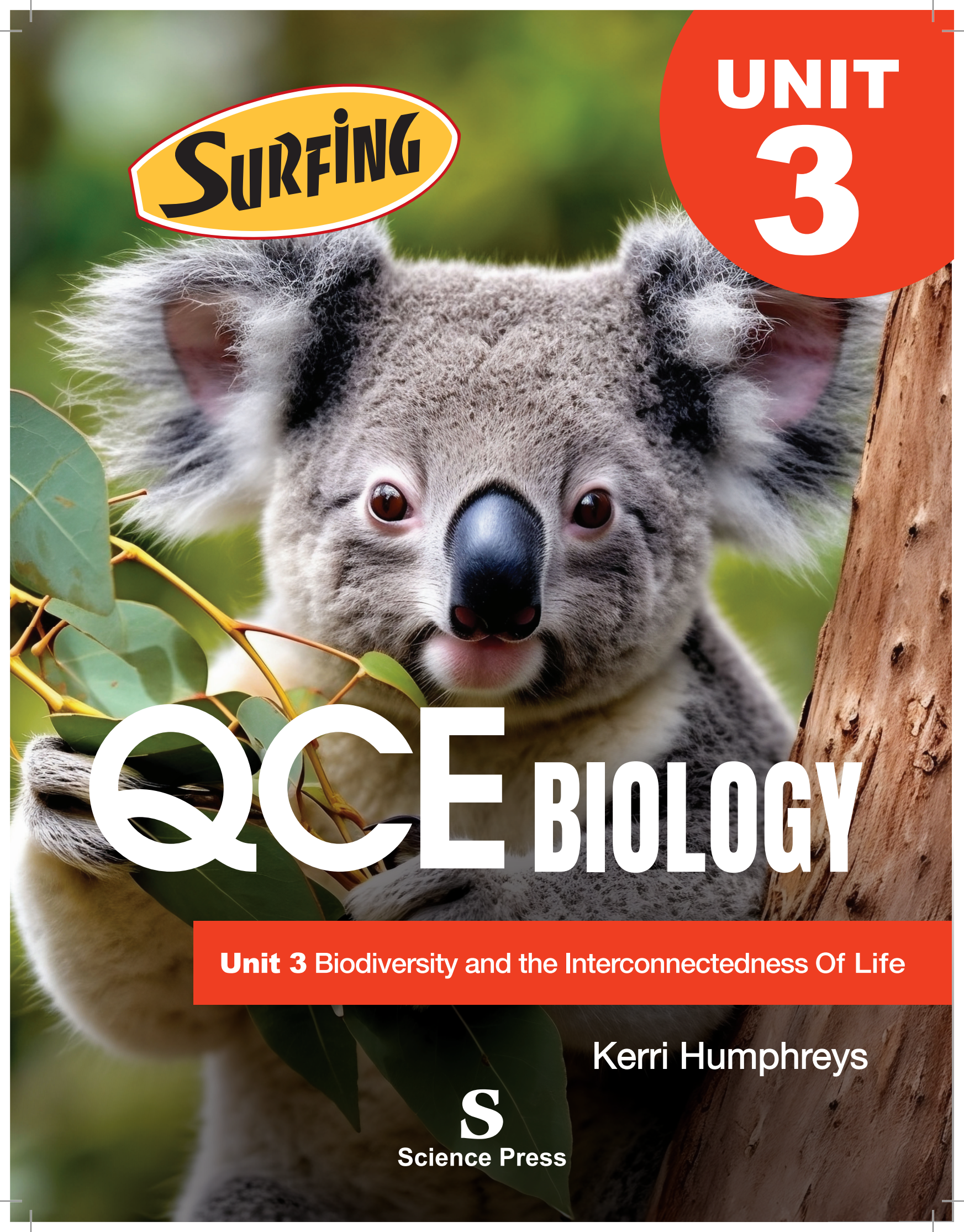




SURFING

**UNIT
3**

QCE BIOLOGY

Unit 3 Biodiversity and the Interconnectedness Of Life

Kerri Humphreys

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Science Press

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UNIT 3

Biodiversity and the Interconnectedness Of Life

In this unit you will:

- Explore the ways biology is used to describe and explain the biodiversity within ecosystems, a range of biotic and abiotic components, species interactions, adaptations of organisms to their environment and principles of population dynamics.
- Understand how classification systems are used to identify organisms and aid scientific communication.
- Understand the structure of ecosystems, the processes involved in the movement of energy and matter in ecosystems and how environmental factors limit populations.
- Measure abiotic factors, population numbers and species diversity.
- Interpret interactions between species making spatial and temporal comparisons between ecosystems.
- Carry out field work to understand the interconnectedness of organisms, the physical environment and the impact of human activity.
- Apply scientific knowledge and understanding to offer valid explanations and reliable predictions.
- Analyse data and develop ecological models to describe and explain the diversity and interconnectedness of life on Earth.

TOPIC 3.1

Describing Biodiversity and Populations

In this topic you will:

- Describe and explain types of biodiversity.
- Recognise there are multiple definitions of species with each having limitations.
- Classify ecosystems.
- Investigate how species diversity is determined for a group of organisms based on a given index.
- Describe different classification systems.
- Investigate the use of stratified sampling to collect and analyse primary biotic and abiotic data in classifying ecosystems.
- Use dichotomous keys to identify and classify organisms.



1 Assumed Knowledge Topic 3.1

QUESTIONS

1. Distinguish between biotic and abiotic factors.
2. What is meant by the 'physical conditions' of the environment?
3. Many species compete for resources. What is meant by 'resources'?
4. The diagram shows the photic zone in a body of water.

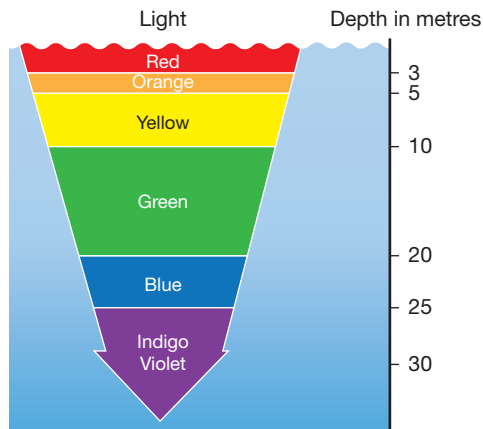


Figure 1.1 Photic zone in water.

- (a) What is meant by the photic zone?
 - (b) Outline the importance of the photic zone.
5. Discuss how abiotic factors can lead to desertification.
 6. Define an adaptation.
 7. Use an example to show how a named adaptation assists in a specific environment.
 8. What is meant by the habitat of an organism?
 9. The diagram shows the red kangaroo, *Macropus rufus*.

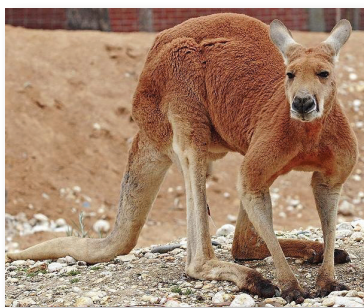


Figure 1.2 Red kangaroo, *Macropus rufus*.

- (a) How does the binomial system help identify this kangaroo?
 - (b) Describe one adaptation of the red kangaroo to its environment.
10. What is meant by topographic factors?
 11. What conditions occur in Australia with El Nino?
 12. Define speciation.
 13. What is biodiversity?
 14. Define an ecosystem.

15. Define symbiosis.
16. Distinguish between abundance and distribution of a population.
17. The diagram shows a cane toad. Outline why there is concern in Queensland and the Northern Territory about the spread of cane toads across the land.
18. Define producer, consumer and decomposer.
19. Define an ecological community.
20. What is stratified sampling?
21. Distinguish between qualitative data and quantitative data.
22. Distinguish between primary data and secondary data.
23. Figure 1.4 shows how habitats vary from the pole to the equator as well as from sea level to the top of tall mountains.



Figure 1.3 Cane toad.

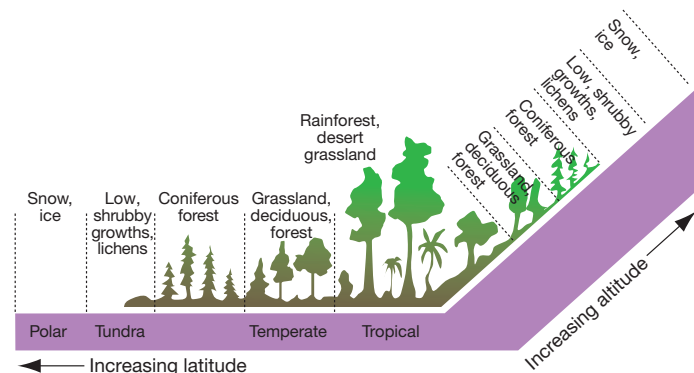


Figure 1.4 Changes in habitat with altitude and latitude.

- (a) Use this diagram to list the changes in habitat from the pole to the equator.
 - (b) Compare the change in habitat as you move from the equator to the poles with the change in habitat as you move from sea level to the top of a high mountain.
24. What is meant by binomial nomenclature?
 25. The diagram shows two types of ecosystems.

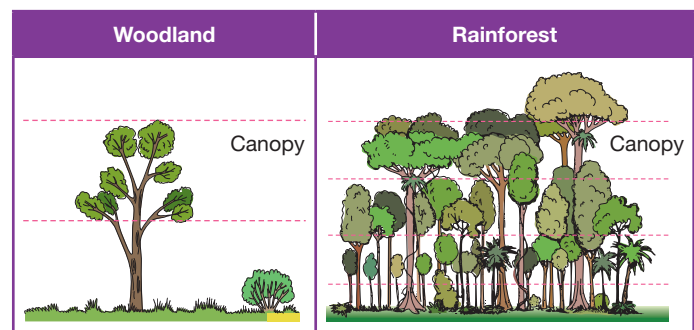


Figure 1.5 Two types of ecosystems.

Use the diagrams to suggest factors that are used to classify ecosystems.

3 From Biosphere To Microhabitat

The **biosphere** can be divided into several major biomes and the biomes can be divided into ecosystems.

An **ecosystem** is a self-sustaining unit consisting of all interactions of all living things with their physical surroundings and with each other. Within the ecosystem there are **communities** of organisms. The physical factors of an ecosystem tend to be physically similar and linked to nutrient cycles, e.g. water cycle, carbon cycle, nitrogen cycle.

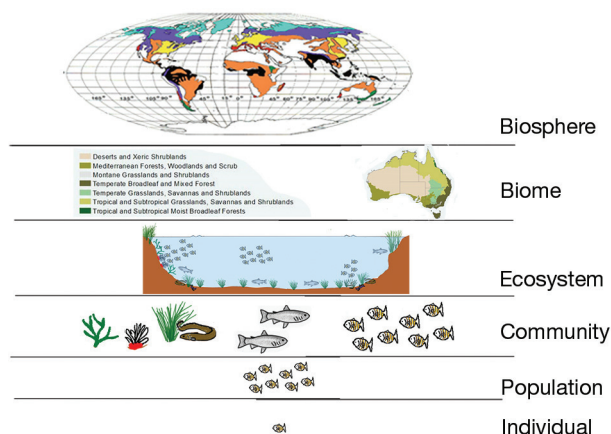


Figure 3.1 Levels from the biosphere to an individual.

Ecosystems contain a range of habitats from very large to very small. Each **habitat** has a range of abiotic and biotic factors that supports the survival and reproduction of a particular species.

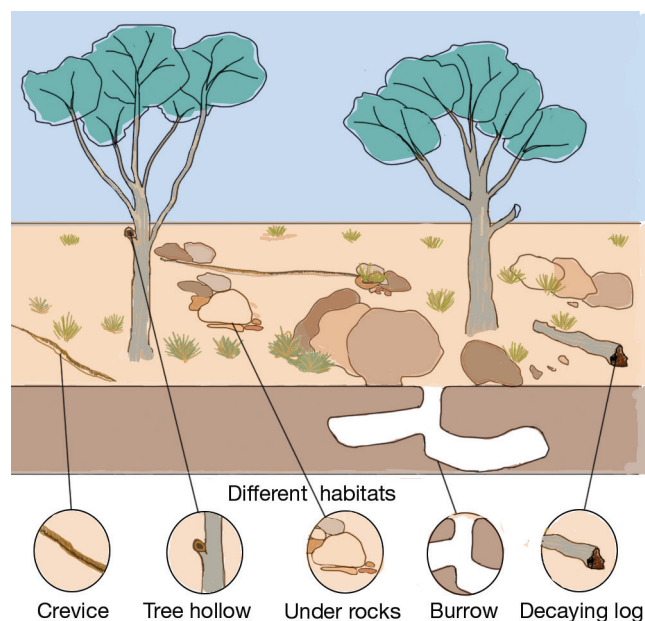


Figure 3.2 Different habitats in an ecosystem.

Microhabitats within an ecosystem have different ranges of abiotic (non-living) conditions and can support a different range of species.

QUESTIONS

1. Define ecosystem.
2. Distinguish between a community and a population.
3. The diagram shows a food web for a leaf litter found in a wet sclerophyll forest beneath a rose gum, *Eucalyptus grandis*.

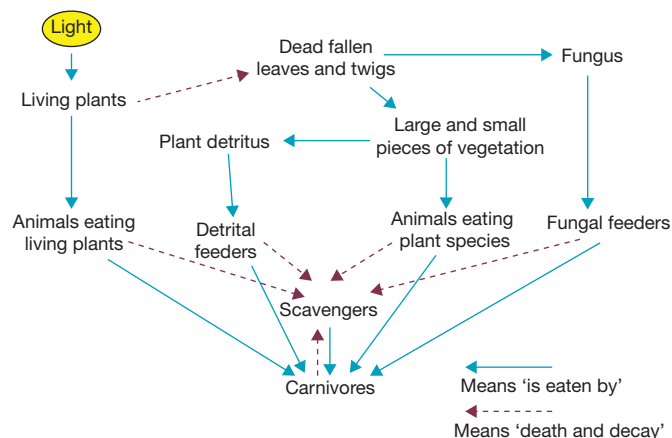


Figure 3.3 Leaf litter food web.

- (a) Explain why this leaf litter could be classified as a habitat for a fungal feeder within the forest.
 - (b) Identify an abiotic factor named in this food web.
 - (c) Explain why dead fallen leaves and twigs are not abiotic factors in this food web.
4. Which of the following best describes an ecosystem?
 - (A) All organisms together with their physical environment.
 - (B) All plants and animals in a particular area at a particular time.
 - (C) The interactions between plants and animals in a particular area at a particular time.
 - (D) Interacting organisms and their physical environment in a particular area.
 5. Which of the following lists biological levels from the smallest to the largest grouping?
 - (A) Individual, community, biome, population.
 - (B) Individual, population, community, ecosystem.
 - (C) Ecosystem, community, population, individual.
 - (D) Population, ecosystem, biome, biosphere.
 6. Which of the following would be an example of a microhabitat?
 - (A) Fallen branch.
 - (B) Grassland paddock.
 - (C) Beach.
 - (D) Desert.

6 Biodiversity – Ecosystem Diversity

Ecosystem diversity refers to the variety of ecosystems on Earth. Ecosystem diversity also considers the range of communities in each area, the range of habitats and the ecological processes that occur within each ecosystem.

Since the continent of Australia covers a large area, there is a large range of terrestrial ecosystems from tropical rainforest to cool temperate forest to arid desert to subalpine grasslands. The distribution of most vegetation types and ecosystems is determined by rainfall.

Australia can be divided into eight major ecoregions based on the climate or main type of vegetation. The classification system was developed by the WWF (World Wildlife Fund). Each ecoregion can contain several biomes. The biomes are made of many interacting ecosystems. An **ecosystem** is the interaction of living things with their environment and with other living things in an area functioning together to make an ecological unit. Ecosystems tend to be smaller than biomes. A **community** is all the populations of organisms living in a particular area at a particular time.

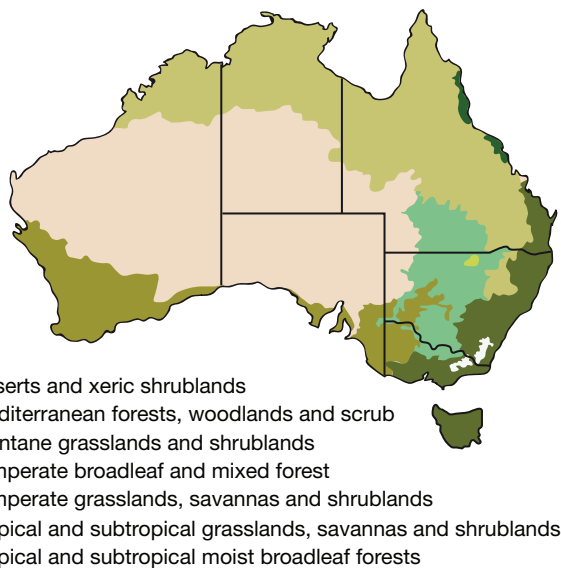


Figure 6.1 Australian ecoregions.

Ecosystems are composed of different habitats and can be described in terms of the species present and the abiotic factors that make up the environment. A **habitat** is the environmental place where an organism, population or species lives. A **microhabitat** describes a small, very localised environment.

The boundaries of many communities are often fluid as species move to find food, shelter, a mate or escape a predator. This means that ecosystem diversity is harder to define than either species diversity or genetic diversity.

Table 6.1 Climate of Australian ecoregions.

Ecoregion	Temperature	Rainfall
Desert and xeric shrubland	From 50°C in summer to –7°C in winter.	Less than 250 mm/year.
Mediterranean forests, woodlands and scrub	Hot dry summers, cool moist winters.	650 to 1500 mm/year with a short dry season (3 to 4 months).
Montane grasslands and shrublands	Low average temperatures with snow and harsh winters.	Australian Alps receive approximately 25% of the country's precipitation – 3800 mm/year.
Temperate broadleaf and mixed forest	Wide variation with a warm and cold season.	800 to 1000 mm/year in southern NSW; 400 to 600 mm/year on inland boundary of ecoregion.
Temperate grasslands and shrublands	Hot summers and cold winters.	Low and inconsistent rainfall.
Tropical and subtropical grassland, savannas and shrubland	Summer maximum about 38°C in inland areas; winters warm in north and cold in the south with occasional snow above 600 metres.	900 to 1500 mm/year. Can be highly seasonal with a long dry season (winter) and very wet season (summer).
Tropical and subtropical moist broadleaf forest	Low variability 23°C to 32°C for tropical forests.	High rainfall, over 2000 mm/year.
Tundra (subantarctic) islands, e.g. Heard Island, Macquarie Island, McDonald Island)	Low seasonal and daily temperature ranges 3.7 to 5.2°C in summer and –0.8 to 0.3°C in winter.	Most precipitation is in the form of snow during winter.

QUESTIONS

1. Define ecosystem diversity.
2. What is considered when studying ecosystem diversity?
3. Why is there a wide range of ecosystems in Australia?
4. What determines the distribution of most ecosystems?
5. Define an ecosystem.
6. Define a community.
7. Compare a biome and an ecosystem.
8. Define habitat.
9. Explain why it is harder to define ecosystem diversity than either species diversity or genetic diversity.
10. What is a microhabitat?

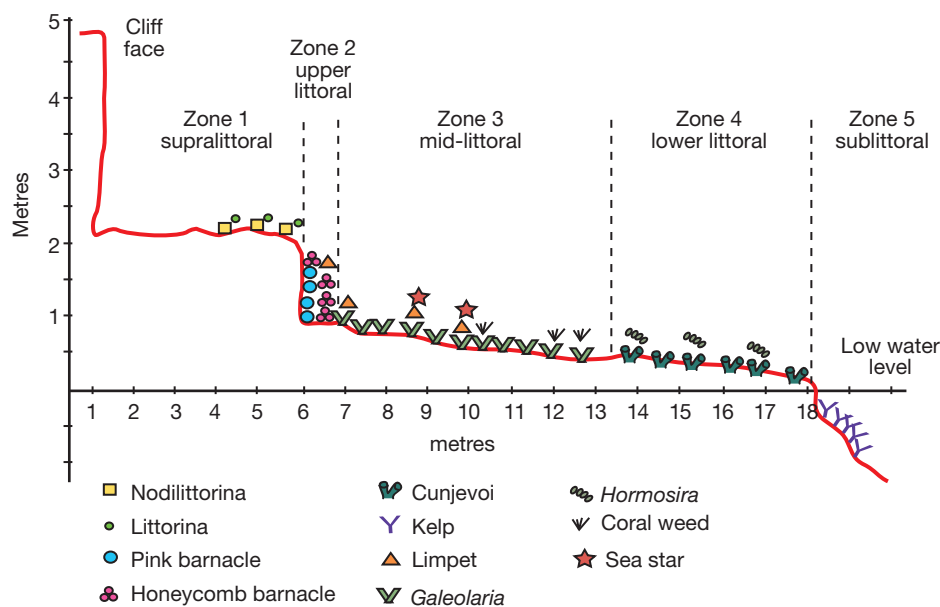


Figure 21.4 Transect results.

QUESTIONS

- What is a transect?
- Name the organisms that were used as the marker species for each zone on the rock platform.
- Relate the distribution of organisms on the rock platform to the abiotic variables of the ecosystem.
- Using the profile drawn by the students, describe how the topography of the rock platform changes going from the cliff face to the sea.
- Using the students' drawing of their transect, describe where you would expect to find limpets.
- Identify some hazards that need to be part of the risk assessment for this field study and outline the risk management strategies you would take.
- How can reliability of data be increased?
- The following diagram shows a transect across a rock platform.
- On a rock platform, what was the indicator species for the sublittoral zone?
(A) *Galeolaria* (B) Kelp
(C) Blue periwinkle (D) Barnacle
- A student drew the following diagram as her transect of the rock platform.

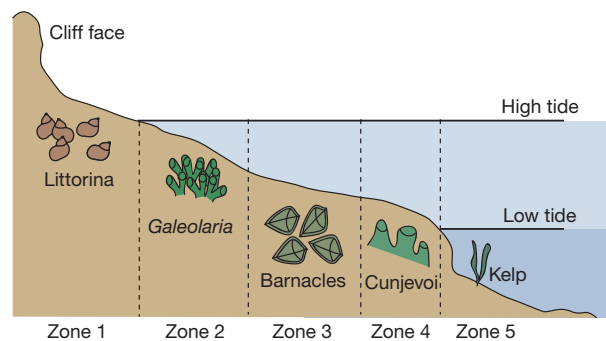


Figure 21.6 Student transect of the rock platform.

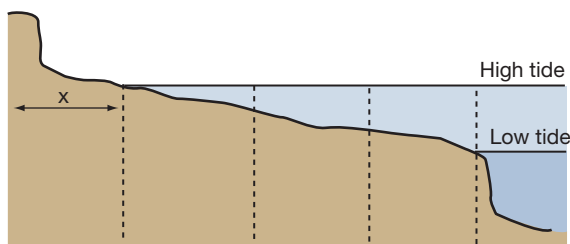


Figure 21.5 Transect across a rock platform.

What zone is the area marked 'X'?

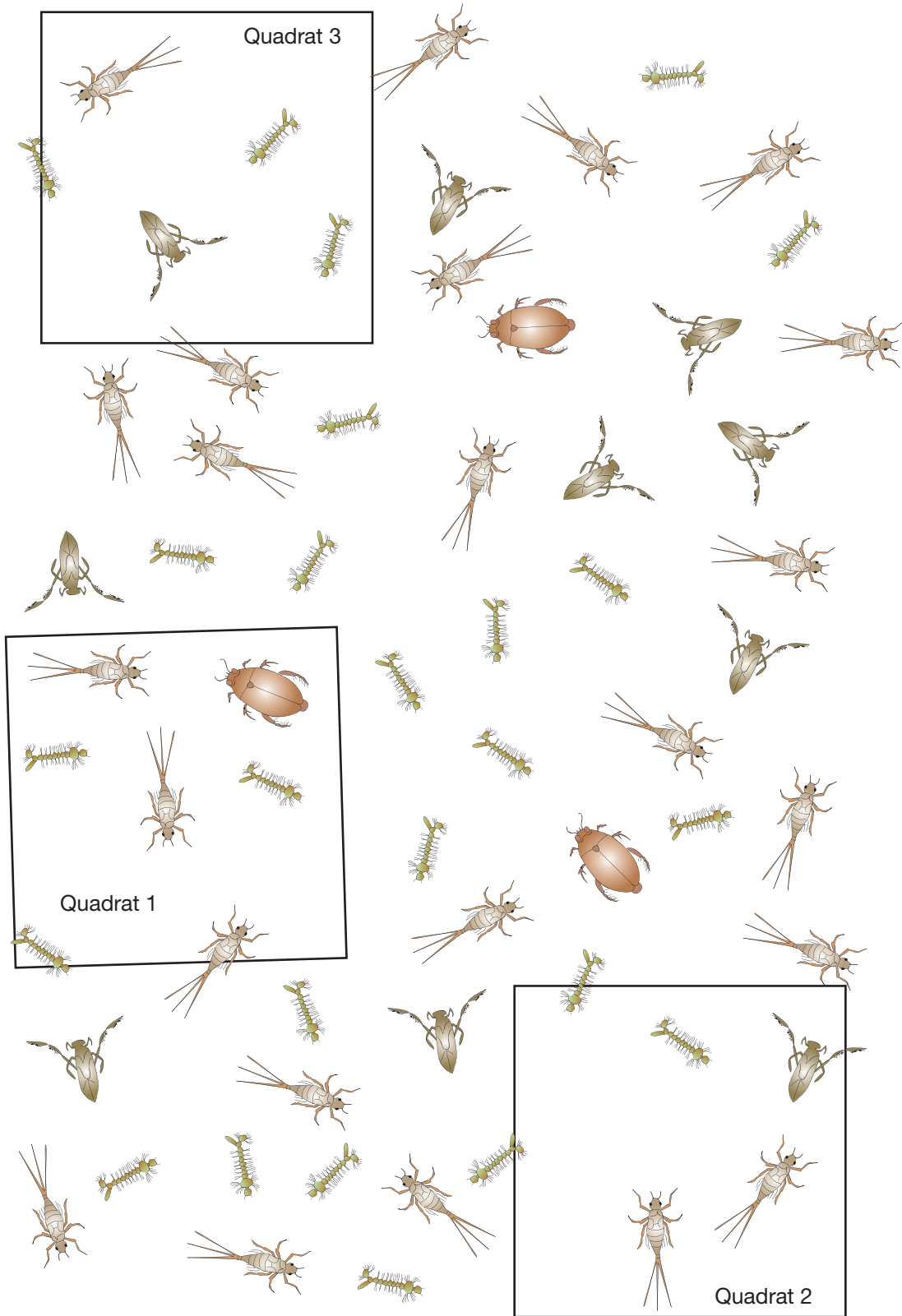
- Supralittoral
- Sublittoral
- Mid-littoral
- Infralittoral

Why would the teacher have criticised this diagram?

- Littorina is usually found in zone 4.
 - Cunjevoi is usually found in zone 1.
 - Galeolaria* is usually found in zone 3.
 - Barnacles are usually found in zone 4.
- Which of the following organisms is able to withstand the greatest amount of exposure to sunlight and desiccation?
(A) Cunjevoi (B) Barnacles
(C) *Galeolaria* (D) Littorina
 - Which size quadrat is most suited to studying barnacle distribution along the transect?
(A) 10 cm × 10 cm
(B) 10 mm × 10 mm
(C) 10 m × 10 m
(D) 10 km × 10 km

Map of one moment in a freshwater pond

Quadrat study



24 Field Study – Abundance Using Random Quadrats

On their field trip to the rock platform, the biology students used the quadrat method to estimate the abundance of the **blue periwinkle**, *Nodilittorina unifasciata*, in two different zones on the rock platform.

The family Littorinidae are the true periwinkles and are nearly able to live out of water. Different species of littorinids are found in their own distinct zones. *Nodilittorina unifasciata* is a very small periwinkle (about 15 mm long), able to survive for long periods of time out of the water in dry conditions. It is a grazer, eating lichen and algae from rocks. It is named after the blue-grey colour of its shell.

The students found that the blue periwinkle is found in clusters on the rocks, especially in crevices and indentations in the rocks. Gathering in clusters helps prevent moisture loss. The periwinkle does not have any special adaptation for strongly clinging to the rocks and can be easily picked off the rocks.

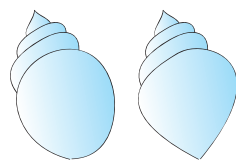


Figure 24.1 Blue periwinkle, *Nodilittorina unifasciata*.

The students used quadrats 10 cm × 10 cm and counted the number of blue periwinkles present in six random quadrats in the barnacle zone and six random quadrats in the supralittoral zone. Due to the clumped distribution pattern, the students tried to ensure that their ‘random’ quadrats were representative of the whole area.

The students collated their data to calculate the arithmetic mean and standard deviation for the size of the whole population of blue periwinkles. Collating the data increases the sample size for the calculations.

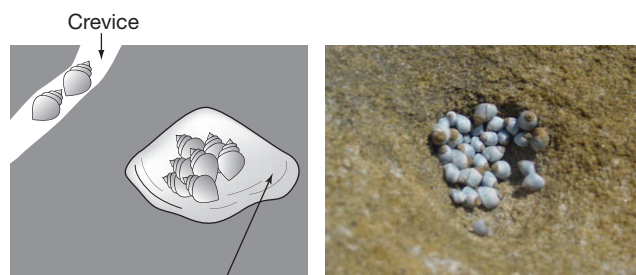


Figure 24.2 Clumped distribution of blue periwinkle.

The students recorded their results in the following table.

Table 24.1 Student results.

Quadrat	Number of blue periwinkles present	
	In barnacle zone	In supralittoral zone
1	0	7
2	0	0
3	0	6
4	1	0
5	0	9
6	0	4

QUESTIONS

- Describe the blue periwinkle.
- Use the student results to calculate the average number of blue periwinkles per quadrat in each zone.
- If each quadrat was 10 cm × 10 cm, calculate the density of the blue periwinkles per square metre.
- The students measured the dimensions of each zone. The supralittoral zone measured 128.6 metres × 4.2 metres and the barnacle zone measured 128.6 metres × 3.8 metres. Estimate how many blue periwinkles would be in each zone.
- Which zone has the greatest abundance of the blue periwinkle?
 - Briefly discuss the reasons for this abundance, with reference to the physical factors in the environment.
- Suggest one possible source of inaccuracy that could have occurred in this investigation.
 - Suggest how the investigation could be improved to rectify this source of inaccuracy.
- Explain why the students collated their data and worked out the arithmetic mean and standard deviation for the blue periwinkle population.
- Another group of students estimated that there are 35 littorina in an area 50 cm × 50 cm. What is the density of littorina per square metre?
 - 9 littorina/m²
 - 70 littorina/m²
 - 140 littorina/m²
 - 280 littorina/m²
- When studying the distribution of littorina, where would you expect to find individuals?
 - Only in the supralittoral.
 - Most in the supralittoral but some in the upper littoral.
 - Equal amounts in the supralittoral and upper littoral.
 - Random distribution across the five zones.

28 Abiotic Features Of Aquatic Environments

A **biome** is one of the world's major ecosystems usually named after the dominant vegetation of the area. Most of the world is covered by aquatic biomes which are divided into freshwater biomes and marine biomes. The salt concentration in marine biomes averages around 3% while the salt concentration in freshwater biomes is less than 1%.

Around 75% of the Earth's surface is covered by ocean biomes. The abiotic features of the ocean biomes, e.g. temperature, amount of evaporation and wind patterns influence the world climate and all other biomes. Photosynthesis carried out by phytoplankton and marine algae is highly important in recycling atmospheric carbon dioxide.

The abiotic features, and thus the biotic features of aquatic biomes, change with depth. Light falling on water can be absorbed, reflected or scattered. Most visible light is absorbed in the top 10 metres. The **photic zone** is the region where there is sufficient light for photosynthesis. The **aphotic zone** is where there is no light.

When light enters water the long wavelengths are preferentially absorbed. This means that the long wavelengths of light (red, orange and yellow) can only penetrate short distances while the shorter wavelengths (blue and violet) can penetrate further. Oceans appear blue because blue light is not strongly absorbed by water.

The amount of 'green' in the colour of oceanic water indicates the amount of chlorophyll (phytoplankton) present. The availability of light strongly affects the distribution of aquatic organisms.

Thermal energy in sunlight warms surface water. This means that water temperature decreases with depth in aquatic biomes. Temperature also varies with latitude from freezing near the poles to 30°C at the equator.

Pressure in water increases with depth, e.g. at 10 metres the pressure is twice the surface air pressure. Aquatic organisms require specific adaptations to enable them to change depth or to live at great depths.

QUESTIONS

1. Define biome.
2. Name the two types of aquatic biomes and state how they are classified.
3. Distinguish between the photic zone and the aphotic zone.
4. Identify which wavelengths of light penetrate least and furthest into water.
5. Explain why oceans appear blue.
6. Explain why the colour of ocean water around some islands often appears green.
7. Outline how temperature can vary in ocean biomes.
8. How does pressure affect aquatic organisms?

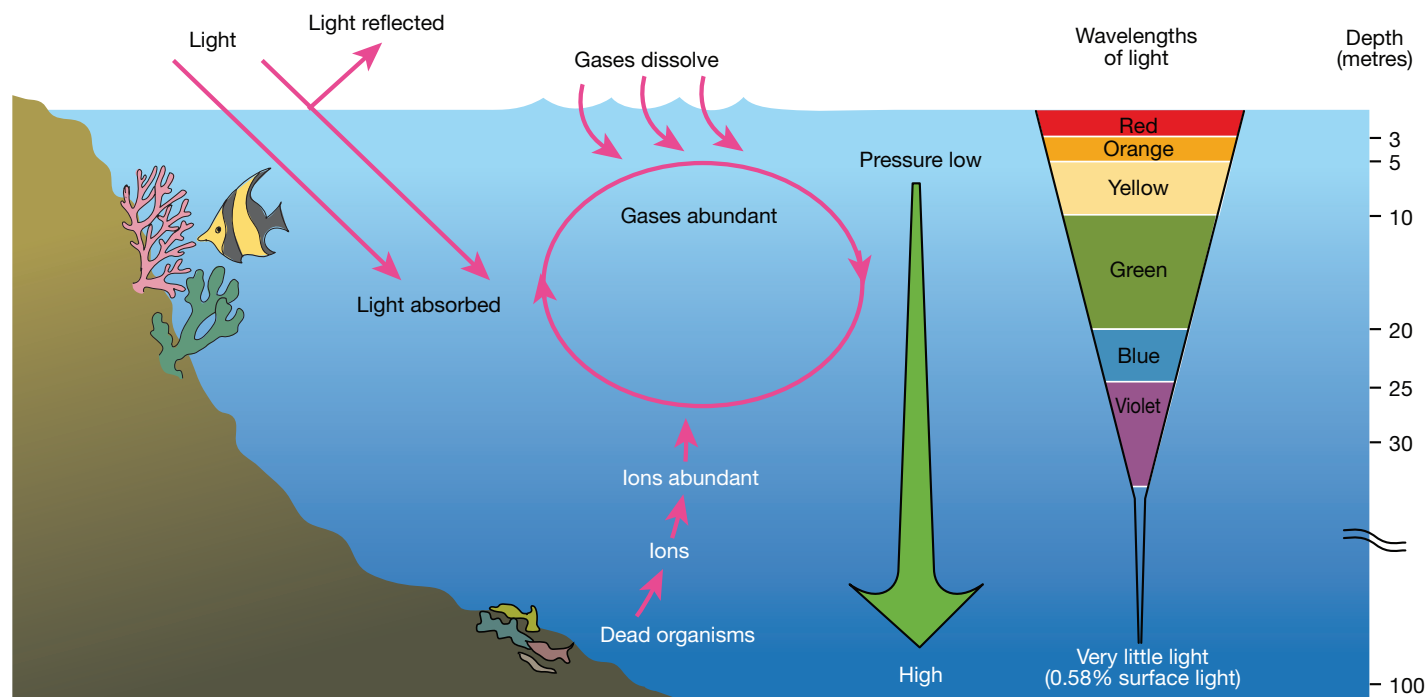


Figure 28.1 Ocean characteristics.

30 Species Diversity and Abiotic Factors

Species diversity is affected by abiotic factors.

Abiotic factors are non-living factors including those that relate to climate, e.g. temperature, rainfall, wind, light intensity, day length and humidity.

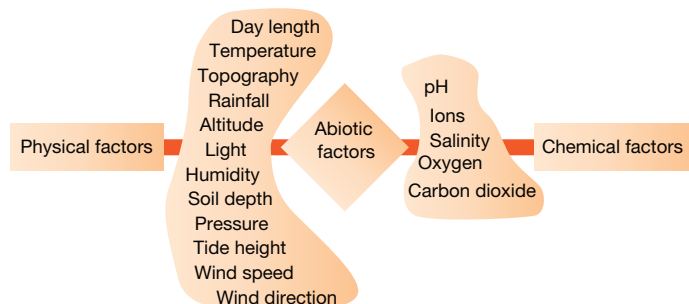


Figure 30.1 Abiotic conditions.

Changes in physical conditions

The distribution and abundance of a species is determined by the physical and chemical nature of the environment. Each ecosystem can be described by its temperature and rainfall requirements, e.g. deserts have low erratic rainfall and high temperatures.

A change in the physical conditions, e.g. temperature or rainfall, will act as a selection pressure for evolution. For example, in the past 25 million years the physical conditions in Australia have changed, with increased aridity causing a decrease in rainforests and an increase in open woodlands and grasslands with poor quality grasses. These changes have altered the selecting pressure on the kangaroo so that the ancient kangaroo, which was much smaller with generalised molars, has evolved into the modern day red kangaroo, which is much larger in size and eats grasses using its high crested molar teeth. In the red kangaroos there has been a reduction in the number of toes, the disappearance of a 'big' toe and an increase in toe length, which all assist in increasing the speed of the red kangaroo and changing to a hopping gait.



Figure 30.2 Red kangaroo and musky rat kangaroo.

The musky rat kangaroo, found only in rainforest in north Queensland, has several primitive features and is believed to resemble the early kangaroo. For example, it still has five toes on its hind foot, doesn't hop but gallops like a horse when moving fast, it has no specialised teeth and its stomach is a simple sac.

Changes in chemical conditions

A change in the chemical conditions in the environment can have a marked effect on plant life. Many plants prefer a specific soil type and the introduction of mining has led to the evolution of plant varieties especially tolerant to mineral wastes, e.g. plants near copper mines.

The use by humans of insecticides and antibiotics has led to the evolution of resistant varieties, e.g. strains of staphylococcus bacteria that are resistant to penicillin. In Australia, the change in the physical conditions, with increasing temperatures and lower rainfall as Australia drifts north, has also led to a change in the chemical composition of the soil. Increased erosion and leeching have helped to alter the soil type and have influenced the evolutionary path of Australian flora, e.g. eucalypts.

Soil salinity is the salt content of the soil. **Salination** can be caused by several processes, e.g. mineral weathering and extensive irrigation. As ground water rises it brings the salt to the surface and evaporation can leave dry salt ponds. Many native Australian plants are salt tolerant with deep roots and a high demand for water. The replacement of native woodland trees for farming crops which require less water meant rainwater seeped down to the water table which slowly began to rise bringing salt to the surface. The change in the chemical composition of the topsoil has dramatically decreased the viability of the area as farmland.

QUESTIONS

1. What is meant by abiotic factors?
2. Construct a table to distinguish between physical abiotic factors and chemical abiotic factors.
3. Outline the relationship between ecosystem and physical factors.
4. Use an Australian case study to show how changes in the physical or chemical conditions have led to changes in a species.
5. Explain how mining can influence the evolution of the plants in the area.
6. Use an Australian example to show how changes in physical and chemical conditions and increased competition for resources have led to changes in a species.

Rain gauges

The size of a rain gauge as well as the height of the orifice above the ground depends upon the country. The students used daily weather reports from the website of the Bureau of Meteorology to find the rainfall on the day of their field trip.

pH meters

The pH of an aqueous solution shows the acidity or basicity. A pH meter has electrodes enclosed in glass to measure pH. Universal litmus paper reads to 1 on the pH scale. The students decided to use data loggers with a pH probe to measure the pH of the small rock pool, the large rock pool and the ocean water. The pH data logger measures pH to 0.1 on the pH scale.

Dissolved oxygen content

Data loggers have probes that can measure the dissolved oxygen content in the small rock pool, the large rock pool and the ocean water. Some students used the 'Dissolved oxygen test kit' and comparisons were made between the two methods of collecting first-hand data about the oxygen content in the water. The degree of accuracy of the recorded data depends on the instruments being used to collect the data. Each type of equipment has its own level of accuracy.

Wave action

Dynamic factors such as water movement, tidal rhythm and wind can influence the abundance and distribution of organisms on a rock platform. The students measured wave action by counting the time for ten waves to break against the rock platform. They repeated this four times and then calculated an average.

QUESTIONS

1. Suggest why the students used the website of the Bureau of Meteorology to collect data about some abiotic variables.
2. Define meteorology.
3. Draw up a table to show abiotic factors and name an instrument that can be used to make quantitative measurements of each factor.
4. The students found that the air pressure on the day of their field trip was 1030.3 hPa at 9 am, 1026.3 hPa at 3 pm and 1027.4 hPa at 7 pm. Would these air pressure values be associated with a low air pressure system or a high air pressure system? Explain your answer.
5. How does the accuracy of measurement depend on the type of instrument being used? Give an example.

6. Why is the dissolved oxygen content of water an important factor?
 - (A) It determines the amount of photosynthesis that can occur.
 - (B) It determines the amount of respiration that can occur.
 - (C) It is needed for anaerobic bacteria to survive.
 - (D) It is needed for transpiration.
7. The level of the gas carbon dioxide in the atmosphere is an abiotic factor that influences plant and algae growth. During the last century the rising carbon dioxide concentration in the atmosphere was mainly attributed to the increased burning of fossil fuels and greater agricultural activities. Which of the following strategies would help reduce the carbon dioxide levels?
 - (A) Extensive clearing of forests.
 - (B) Planting extensive pastures.
 - (C) Allowing overgrazed pastures to remain unrestored.
 - (D) Extensive use of fertilisers.
8. Which of the following includes only physical factors?
 - (A) Light, substrate, temperature, rainfall.
 - (B) Light, salinity, pH, grazing, pressure.
 - (C) Substrate, water movement, predation, pH.
 - (D) Air pressure, wind, salinity, competition.
9. An anemometer is an instrument that measures wind speed. What is the structure of anemometers found at most weather stations?
 - (A) A plate hung perpendicular to a wind vane.
 - (B) A standing column of water in a tube.
 - (C) Semiconical cups rotating on a pivot.
 - (D) A hot wire attached to an electric current.
10. The picture shows a photochemical smog over Sydney on a warm autumn day. Smog influences the abiotic factors of an ecosystem.



Figure 31.5 Photochemical smog.

Which of the following strategies would not decrease the amount of photochemical smog?

- (A) Reduce pollutants from car exhausts.
- (B) Decrease the need for individuals to take their own car for transport.
- (C) Reduce the amount of pesticides used to kill insects.
- (D) Increase fines for industry releasing nitrogen oxides into the atmosphere.

The data collected by remote sensing radar imagery and satellite tracking and entered into supercomputers is also used to determine ways to aid the protection of endangered species. Key locations along migration routes can be identified and international agreements and regulations can be introduced to ensure survival of these species.

QUESTIONS

1. Define supercomputer.
2. How are many supercomputers created?
3. How are supercomputers aiding the study of ecological systems?
4. Discuss why supercomputers are important in ecological classification.
5. List some areas of abiotic data that needs to be entered into supercomputers so that complex models of ecosystems and future changes can be simulated.
6. List some areas of biotic data that needs to be entered into supercomputers so that complex models of ecosystems and future changes can be simulated.
7. Discuss the role of supercomputers in predicting the impact of climate change on different ecosystems.
8. (a) What is remote sensing radar imagery?
(b) Give an example of the use of remote sensing radar imagery.
9. What is satellite tracking?
10. Study the following diagram.

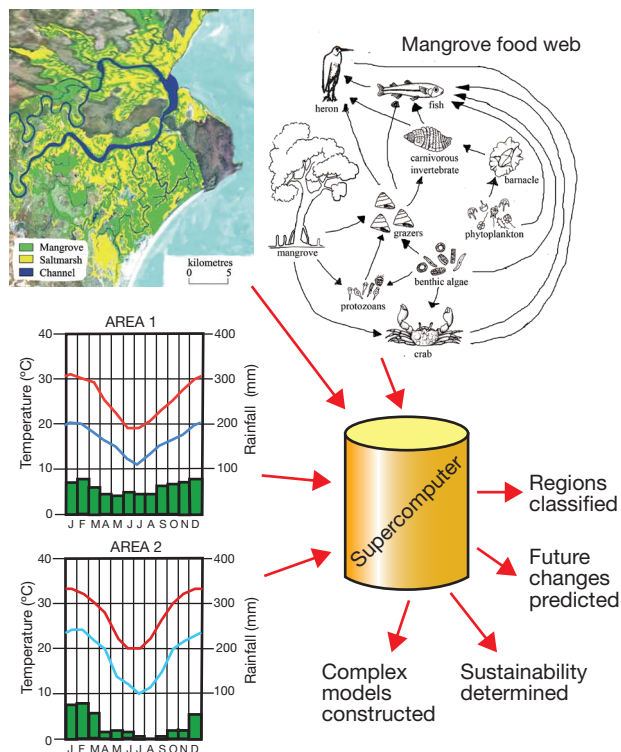


Figure 37.3 Supercomputers use abiotic and biotic data to develop complex models.

Discuss how this diagram shows the use of supercomputers in biology.

11. Discuss why supercomputers are used to determine the evolutionary past.
12. Study the following flow chart.

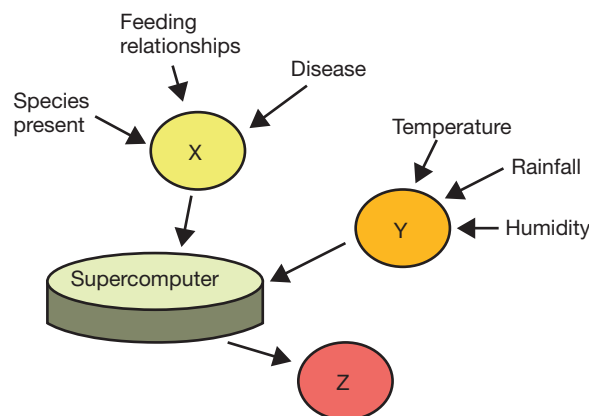


Figure 37.4 Using a supercomputer.

Identify X, Y and Z.

	X	Y	Z
(A)	Biotic data	Abiotic data	Complex model
(B)	Abiotic data	Biotic data	Complex model
(C)	Complex model	Abiotic data	Biotic data
(D)	Abiotic data	Complex model	Biotic data

13. Which of the following groups would *not* be monitored using satellite tracking?
(A) Sea turtles, whales, Adelie penguins.
(B) Great white sharks, whales, cockatoos.
(C) Fur seals, sea turtles, honey bees.
(D) Estuarine crocodiles, fur seals, wild dogs.
14. The diagram shows Australia's current climate zones and some predicted effects of climate change.

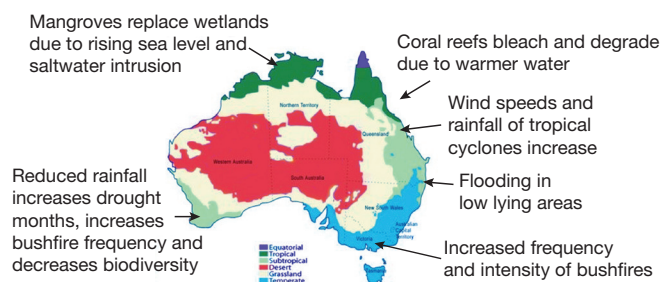


Figure 37.5 Predicted effects of global warming.

According to this diagram which area(s) are likely to have a higher frequency of bushfires?

- (A) South-eastern Victoria only.
- (B) Northern Northern Territory.
- (C) South-eastern Queensland and northern NSW.
- (D) South-eastern Victoria and south-western Western Australia.

EUNIS habitat classification system

The EUNIS (European Nature Information System) habitat classification was developed between 1996 and 2001 to describe all types of habitats – terrestrial, aquatic, natural and artificial across Europe. It has since been reviewed with online databases holding the collected information, habitat descriptions and maps. The EUNIS habitat classification system is highly important in determining policies for nature conservation and in ecosystem modelling.

QUESTIONS

1. When was the Holdridge life zones scheme proposed?
2. What features are used in the Holdridge life zone scheme?
3. How many classes of ecosystems are in the Holdridge life zone scheme and give some examples.
4. The diagram shows a triangle that represents the Holdridge life zone scheme.

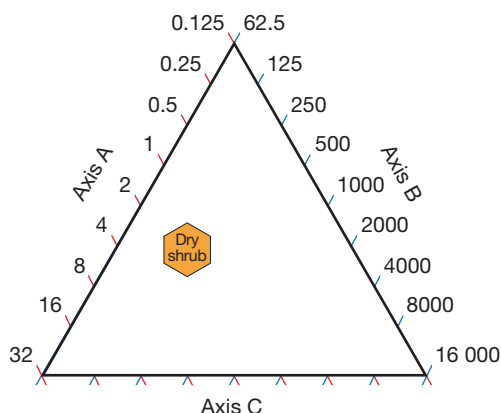


Figure 38.2 Triangle for Holdridge life zone scheme.

- (a) Identify the axes on the diagram – axis A, axis B and axis C for the Holdridge life zones.
 - (b) The hexagon on the diagram shows the conditions identified for dry scrub according to the Holdridge life zone scheme. Copy the triangle and identify the annual precipitation (mm) and potential evapotranspiration ratio for dry scrub.
 - (c) On your triangle of the Holdridge life zones mark in the latitudinal regions and the altitudinal belts.
 - (d) Explain why the dry scrub is referred to as boreal dry scrub.
5. When did RL Specht produce his classification system for Australian vegetation?
 6. What did Specht use as a basis for his classification system and give an example.
 7. (a) Discuss one advantage of using Specht's classification system.
(b) Discuss one disadvantage of using Specht's classification system.

8. Discuss how Specht's classification scheme is used in Australia.
9. What is one way of distinguishing a tree from a shrub?
10. The diagram shows the profile of an ecosystem.



Figure 38.3 Plant profile of an area.

How would this ecosystem be classified using Specht's classification system?

11. What is the ANAE classification framework?
12. Outline one advantage of the construction of the ANAE classification system.
13. In Queensland the Chillagoe caves, west of the Atherton Tableland have an underground wetlands that is part of the riverine system. The limestone caves contain fluctuating groundwater levels and are one of the few nesting sites of the white rumped swiflet *Aerodramus terraereginae*. The area also has the endangered Gouldian finch *Erythrura gouldiae*, the spotted python *Antaresia maculosa* and a variety of insects and spiders. Discuss the importance of conservation of underground wetlands.
14. What is the EUNIS habitat classification system?
15. Discuss the importance of the EUNIS habitat classification system.
16. A large portion of Queensland is covered by woodland. According to Specht's classification, what would be the most likely tallest stratum and its foliage cover for woodlands?
 - (A) Trees over 30 metres with 30% to 70% cover.
 - (B) Trees less than 30 metres with less than 30% cover.
 - (C) Trees less than 2 metres with 30% to 70% cover.
 - (D) Shrubs less than 10 metres with 10% to 30% cover.
17. According to Holdridge life zones what annual rainfall occurs in rainforests?
 - (A) 250 to 500 mm
 - (B) 500 to 1000 mm
 - (C) Over 1000 mm
 - (D) Variable each year from 125 to 16 000 mm

75 Case Study – The Great Barrier Reef

The Great Barrier Reef is megadiverse with a vast range of marine organisms and marine habitats and forms the largest living structure on Earth. It is on the continental shelf off eastern Australia, off Queensland. In 1975 the Great Barrier Reef Marine Park was created extending from the Murray Islands in the Torres Strait to just north of Bundaberg covering an area of 344 400 km². It is the responsibility of the Australian government mainly through the Great Barrier Reef Marine Park Authority. In 1981 it was the first Australian property inscribed on the World Heritage list under all four criteria for natural sites. The Great Barrier Reef World Heritage Area is larger than the Great Barrier Reef Marine Park.



Figure 75.1 Location of Great Barrier Reef.

Reef structure

Formation of the reef began around 18 mya in the Miocene and since then changing sea levels due to glacial/interglacial periods have caused new coral to grow when sea levels rose in the interglacial periods and exposed coral to die when sea level dropped in glacial periods. There are three main types of reefs – fringing reefs, barrier reefs and atolls. A barrier reef is an extensive linear reef that is parallel to the shore and can contain ribbon reefs within their structure. An atoll is a ring shaped reef.

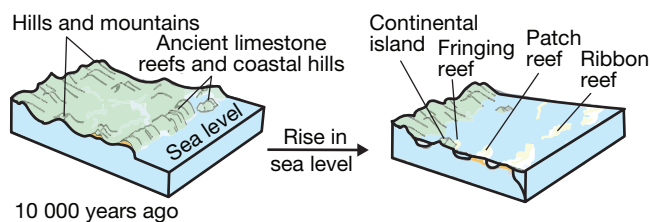


Figure 75.2 Formation of different types of reefs.

In the life cycle of corals the **polyp stage** is sessile and is a cylindrical tube attached to a substrate with tentacles at the oral end.

Hard coral polyps, e.g. brain coral and staghorn coral have limestone (calcium carbonate) skeletons that form the main structure of the reef while **soft coral polyps** do not have solid skeletons and are flexible supported by spicules which are limestone spike-like structures. Most of the base coral reef is dead skeletal remains of old polyps.

Many corals have photosynthetic **zooxanthellae** in their tissues living in mutualistic relationships where the algae produce oxygen and help remove wastes and the coral provides protection, carbon dioxide for photosynthesis and nutrients for growth. When the coral is stressed the polyps expel the zooxanthellae causing coral bleaching. Recovery from bleaching can take decades.

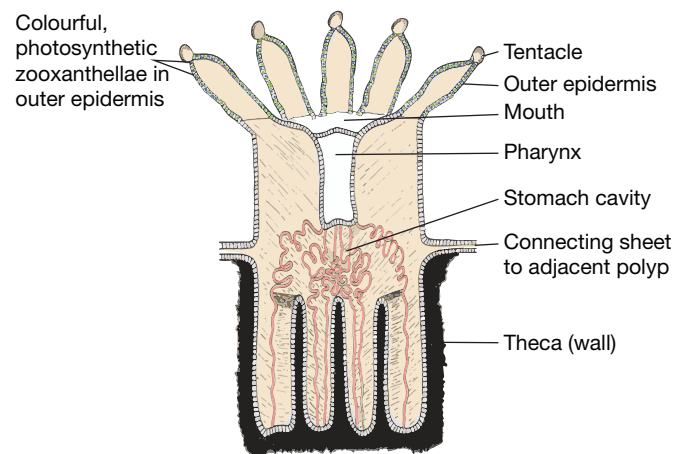


Figure 75.3 Coral polyp.

Threats to the Great Barrier Reef

- The structure and megadiversity of the Great Barrier Reef is threatened by the following.
- **Climate change** – several threats are related to shifts in climate and climate zones, e.g. the frequency and severity of storms, cyclones, hurricanes etc, ocean acidification, rising sea temperatures and rising sea levels.
- **Land based run-off** – poor water quality is the most severe threat to the maintenance of the inner reef and is due to increased sediments and nutrients entering the water from rivers and other outlets. The water quality is affected by run-off, e.g. from agriculture, coastal developments, stormwater drains, pesticides, detergents.
- **Coastal development** – can be due to mining, agriculture, urban development, industrial and port development, aquaculture and tourism and resort development.
- **Illegal fishing** – for example, net, trawl, line or pot fishing can deplete specific species in specific areas interrupting the food chains and endangering the survival of other species.

81 Eutrophication

Eutrophication is a process where nutrients especially nitrogen and phosphorus accumulate in a body of water causing the increased growth of organisms such as algae. The process can be natural, e.g. in tropical and monsoonal flood plain areas when the first seasonal rains wash decaying vegetation and animal manure into the river systems, or accelerated by human activities, e.g. when agricultural run-off joins natural nutrient run-off or mainly caused by humans, e.g. pollution from septic systems and sewers. **Cultural eutrophication** occurs when the nutrients primarily originate from human activities, e.g. release of sewage or agricultural drainage. Cultural eutrophication is a form of water pollution.

Phytoplankton respond to high nitrogen and phosphorus levels with high growth rates. An **algal bloom** is a rapid increase in the population of one or a few species of phytoplankton or macroalgae in a body of water, either freshwater or saltwater. The water becomes discoloured, e.g. cloudy with distinctive shades of red, green, yellow or brown due to the density of the population. Cyanobacteria cause bright green blooms, while dinoflagellates of the genus *Alexandrium* cause a 'red tide'.

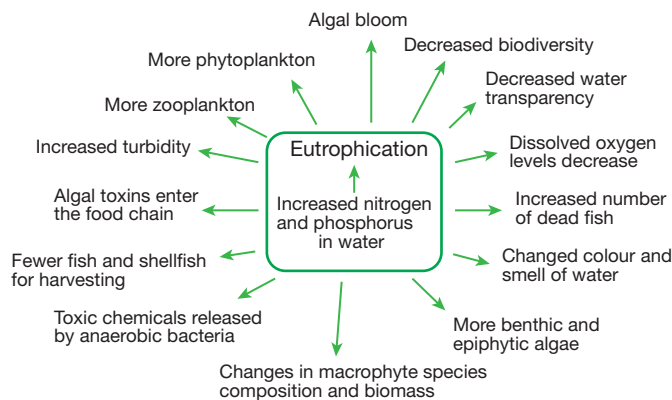


Figure 81.1 Effect of eutrophication.

During the day the producers use carbon dioxide in photosynthesis. Carbon dioxide is more soluble than oxygen in water. The producers release oxygen which either dissolves in the water or bubbles to the surface. At night, all organisms use the oxygen for respiration. If the algal bloom covers the surface organisms can die.

When the excessive numbers of algae die, they sink to the bottom where decomposing bacteria break down and recycle the nutrients. There is an increased number of micro-organisms decomposing the additional organic matter. This process can deplete the water of oxygen putting stress on other aquatic organisms, e.g. shellfish and fish. Thus algal blooms affect other populations potentially harming the abundance and distribution of other species, decreasing biodiversity and changing species composition and dominance.

Biochemical oxygen demand

Biochemical oxygen demand (BOD) is an analytical procedure to measure the amount of dissolved oxygen needed by aerobic organisms to break down organic materials in a water sample at a certain temperature over a specific period of time. It is important when looking at aquatic food webs.

The BOD test is usually carried out at 20°C over 5 days and gives an indication of organic pollution in the water or is used to show the effectiveness of wastewater treatment plants. The presence of some chemicals, e.g. industrial waste, antibiotics or medical wastes, disinfectants, chlorinated water or sanitisers from food processing can inhibit microbes in the water and lower the BOD test result. This limits reproducibility of individual BOD tests and decreases its precision as a quantitative test.

QUESTIONS

1. Define eutrophication.
2. Describe how eutrophication can occur in a natural ecosystem.
3. Explain why cultural eutrophication is a form of water pollution.
4. Define an algal bloom.
5. List some ways eutrophication affects the aquatic ecosystem.
6. Define biochemical oxygen demand.
7. Describe the biochemical oxygen demand test.
8. Identify some factors that can reduce the precision of the biochemical oxygen demand test.
9. A rise of phosphorus levels in lakes is believed to be the main cause for eutrophication in these areas. Explain why many people prefer to buy 'NP' (no phosphorus) washing powders rather than 'P' (has phosphorus) washing powders.
10. The following two statements have been made about mangroves.
'Estuaries and mangrove ecosystems are susceptible to eutrophication.'
'Nitrogen is often a limiting factor in mangrove ecosystems.'
From these statements explain why nitrogen is a significant cause for eutrophication of estuaries.

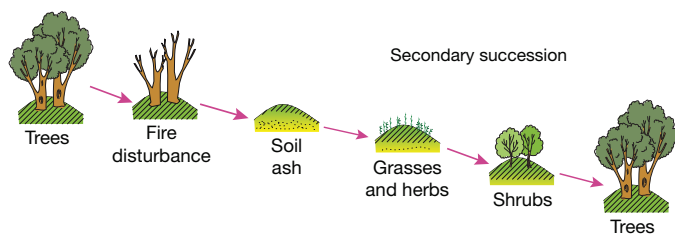


Figure 84.4 Secondary succession.

Secondary succession

Secondary succession occurs when all life in an area has been destroyed, e.g. due to a bushfire, hurricane, tsunami or cleared for farming and then abandoned. There are already seeds in the soil and some organic matter. Herbaceous plants, e.g. grasses are likely to be the first plants in the area. The seeds can be already present, blown in by the wind or carried by animals into the area. The roots of some plants may have survived the destruction. Revegetation is faster than in a primary succession as the soil is already present and in some cases, e.g. bushfire, there is added ash which returns nutrients to the soil making it more fertile. The succession continues with shrubs and trees leading to a stable community. If the area is prone to frequent destruction, e.g. frequent bushfires, the composition of the community may change with fire resistant species becoming more common and becoming the dominant plant species in the area.

The new community that becomes established in a secondary succession is not necessarily the exact community that existed before the destructive event.

Coastal sand dune succession

Many areas on the east coast of Australia show sand dune succession. Spinifex grasses can live in dry, salty conditions and are the first to colonise the sand. Their long stems grow across the sand and their roots bind the sand grains reducing erosion. The succulents form a mat covering that helps bind and stabilise the sand.

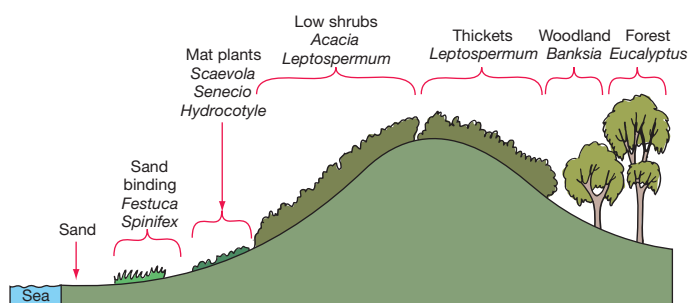


Figure 84.5 Coastal sand dune succession.

The mat plants improve the soil making it possible for small shrubs such as *Acacia* (wattles), *Leptospermum* (tea trees) and for vines to grow. These shrubs are still on the windward side of the dune and usually have nitrogen fixing bacteria in root nodules which provide the nitrates needed for growth. The leeward side of the dune, out of the wind, has taller thickets with richer soil forming a woodland with plants such as banksias. As the plants become established they provide increased shade, reduced sand temperature, reduced wind movement and a catchment for wind blown seeds. As plant diversity increases the leaf litter and humus increase allowing more water to be retained in the sand which is now becoming soil.

The final zone depends on the drainage in the area. It can develop into a stable forest community or if there is poor soil drainage or the area is unprotected from sea wind it can become a heathland. If the area is part of an estuary it can change to mangroves or coastal marsh.

QUESTIONS

1. Define ecological succession.
2. What is primary succession?
3. What are lichens?
4. What photosynthetic organisms are found in lichens?
5. How do lichens obtain their nutrients?
6. Which organisms replace the lichen community?
7. Draw a flow chart to show the order of organisms in a primary succession.
8. Which stages of succession show great species diversity?
9. Explain how organisms change their environment.
10. Explain why primary succession leads to reduced erosion.
11. What is secondary succession?
12. Explain why revegetation is faster in secondary succession than in primary succession.
13. Construct a table to compare primary succession and secondary succession.
14. Will a secondary succession establish a community exactly identical to the one that was destroyed? Explain your answer.
15. Draw a flow chart to show the stages in a coastal sand dune succession that leads to a stable forest community.
16. What is the final zone of a sand dune succession?
17. Which plants would be the first to colonise a sand dune?
 - (A) *Spinifex*
 - (B) *Eucalyptus*
 - (C) *Leptospermum*
 - (D) *Acacia*



Figure 90.3 Uluru.

Uluru is an **inselberg**, an isolated steep sided hill/mountain rising 340 to 350 metres above a plain and is 877 metres above sea level. It consists of coarse sandstone of Cambrian age formed from big feldspar crystals dumped at the bottom of a mountain range in an alluvial apron. The large crystals show limited chemical or mechanical erosion which indicates a small river system. The area then became an inland sea with limestone, sand and mud deposited above the sand that would become Uluru. Compression and some folding during the Devonian (420 to 360 mya) turned the sediments into rock making the bedding layers vertical, very hard, homogenous and resistant. During the Mesozoic era erosion of the softer surrounding rocks left Uluru standing alone. Oxidation (rusting) of the iron bearing minerals causes the red colour of exposed areas.

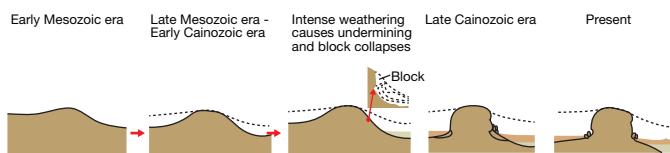


Figure 90.4 Suggested history of Uluru.

Wind blown sand forms dunes that have a distinctive shape with the ridge direction showing wind direction. Crescent shaped dunes have the tails pointing in the same direction as the wind direction. There are longitudinal palaeodunes dating from the Late Pleistocene stretching from the Eyre Peninsula across to the Yorke Peninsula, SA showing the area was once much drier than the present climate in the area.

QUESTIONS

1. Distinguish between palaeontological and geological evidence.
2. Why are stratigraphic columns studied?
3. Discuss some new technologies that have greatly increased the ways in which researchers can record and analyse evidence.
4. List some sites of Aboriginal rock paintings and/or rock engravings.
5. Outline how Aboriginal rock paintings can provide evidence for past changes in ecosystems.
6. Discuss why drawings and the cultural stories of the Rainbow Serpent have been linked with the change in sea level around 6000 years ago.
7. In 2003 Professor Paul Taçon discovered hundreds of rock paintings at Eagle's Reach in Wollemi National Park, NSW dated 2000 to 4000 years old. The art included anthropomorphised eagles that had not been recorded anywhere else. Discuss why it is important to record and preserve such finds.
8. Riversleigh, Qld is known for its large fossil deposits. At Riversleigh there are marine limestone layers dated 530 million years old and freshwater limestones dated 25 million years old. What does this tell us about past ecosystems in the area?
9. The diagram shows landform features found on a coastline.

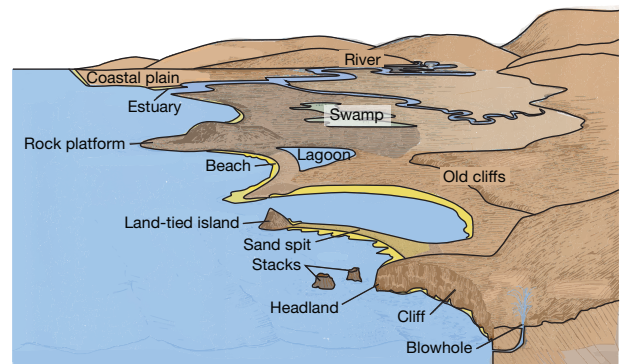


Figure 90.5 Coastal landforms.

Discuss how the mapping of estuarine deposits and beach and dune deposits provides evidence for past changes in ecosystems.

10. (a) Why is Uluru called an inselberg?
(b) What does Uluru tell us about past changes in this area?
11. Use an example to discuss the information about an area that is obtained from palaeodunes.
12. The diagram shows the major structural areas of Australia.

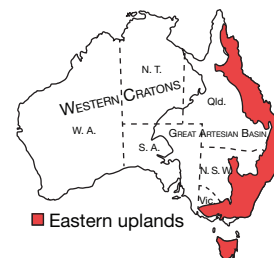


Figure 90.6 Major structural areas of Australia.

The Eastern Uplands consists of a complex series of fold belts of Proterozoic and Palaeozoic rocks with many basins of Palaeozoic and Mesozoic rocks and some Cainozoic volcanism. Suggest why it is difficult to make a general statement about the history of the area.

91 Ice Core Drilling

An **ice core** is a long vertical section of ice removed from a glacier or ice sheet. **Ice core drilling** involves using thermal or mechanical drills to remove ice cores from glaciers and ice sheets that cover areas in the Arctic and Antarctic regions. Antarctica and Greenland have permanent ice sheets and glaciers as temperatures remain low enough to prevent annual melting though the energy from the summer sun which shines all day and all night can cause sublimation of surface ice. Sublimation makes the top layer less dense and once buried the lighter layer indicates summertime compared to the more dense winter snow layer. Some areas in Antarctica have had continuous ice for over 800 000 years.

Drilling methods

Mechanical drills often consist of a rotating barrel with cutters at the digging end (head). Electrothermal drills have a heating element at the head that heats the ice around the core being drilled. The heating process is a disadvantage when drilling very cold ice, e.g. less than -15°C as the core is affected by thermal shock.

Some ice core drills have penetrated thousands of metres into an ice sheet. These drills are usually self-contained drills that are suspended at the surface by a cable. Small sections, e.g. 2 to 6 metres long and 10 to 13 cm in diameter are removed at a time and the drill sent down again to remove the next section. Since only small sections are removed at a time digging to great depths can be a multi-year operation.

Other drills can be hand held, e.g. a **hand auger** is about one metre long and can dig to around 20 to 30 metres to remove ice cores from shallow ice sheets.

Analysis of ice cores

Chemical analysis of ice cores provides information about the following.

- **Bubbles** – air bubbles of atmospheric gases are trapped in bubbles as fallen snow is compacted into ice on the ground. Bubbles act as time capsules providing evidence for past climate changes.
- **Impurities in the snow** – solid and dissolved impurities in the water.
- **Isotopes of hydrogen and oxygen** – the ratio of isotopes of the hydrogen atoms and isotopes of oxygen that make up the water molecules (H_2O) in the ice. Water containing heavy isotopes are sensitive to wind speed and temperature so that the ratio of heavy isotopes changes as water evaporates and moves to polar regions to become snow.

This data shows changes in temperature over time, rainfall, ocean volume, atmospheric circulation and particles that were in the atmosphere, e.g. dust, volcanic ash, pollen, forest fire smoke, solar variability.

Layers in the ice cores can show seasonal snow fall with the thickness of the layer giving precipitation rate.

QUESTIONS

1. What is an ice core?
2. What is involved in ice core drilling?
3. Distinguish between mechanical drilling and electrothermal drilling.
4. Outline a disadvantage of using electrothermal drilling.
5. Explain why digging to great depths to remove old ice core sections can be a multi-year operation.
6. When is a hand auger used?
7. The graph shows the parts per million (ppm) of carbon dioxide found from an ice core.

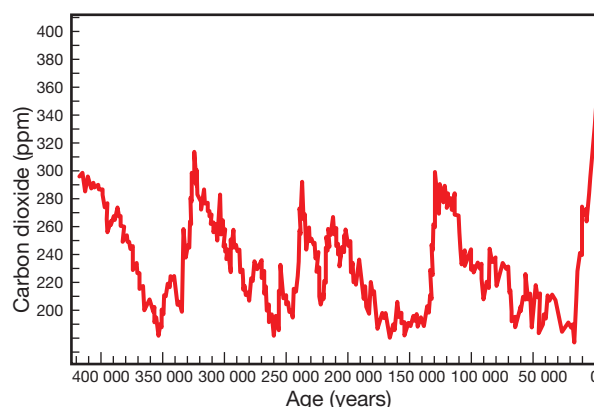
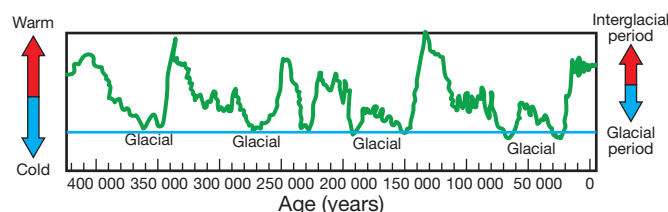


Figure 91.1 Atmospheric carbon dioxide levels determined from ice core analysis.

- (a) Outline the trend shown in this graph.
- (b) The diagram shows times of glacial periods and interglacial periods in geological times.



Compare carbon dioxide levels and glacial and interglacial periods in geological times.

- (c) Suggest a relationship between glacial and interglacial periods and carbon dioxide levels.
8. Outline how ice cores can provide information about climate.
 9. Suggest why there is interest about ice core drilling in Antarctica and Greenland.

92 Indigenous Knowledge Of Ecosystems

Indigenous Ecological Knowledge (IEK) refers to the rich heritage of information about the land, the plants and the animals held by the first people to settle Australia. Australia has a wide range of landforms, climate and ecosystems and to live in these different areas Aboriginal peoples learnt the unique characteristics of each area and adjusted their lifestyles according to the available resources.

Changing conditions since first occupation

During Aboriginal occupation the climate and landscape have changed and Aboriginal peoples learnt to adapt to these changing conditions. The landscape changed with volcanic eruptions and changing sea levels and the climate has changed with increasing aridity.

Current estimations date the arrival of humans in Australia between 50 000 and 60 000 years ago. Since then there have been volcanic eruptions on the east coast of Australia, e.g. at Lake Barrine, Queensland 12 000 years ago, at Mount Eccles, Victoria 8000 years ago and at Mount Elephant, Victoria 5000 to 20 000 years ago.

At the end of the last ice age around 20 000 years ago the climate became warmer and sea levels rose. Many coastal areas and river valleys around Australia were submerged removing Aboriginal hunting grounds, e.g. Homebush Bay, Sydney. By 13 000 years ago the Torres Strait connection to Australia and the Victoria-Tasmania connection across Bass Strait were being covered by rising sea levels and the removal of these land bridges affected migration patterns and cultural exchange.



Figure 92.1 Dingo and thylacine.

Introduction of the dingo

Around 4000 years ago dingoes first appeared in Australia. Aboriginal peoples domesticated the dingo using them as watchdogs and pets and it is believed the dingo was also used to help hunt reptiles and other animals.

The dingo was not introduced into Tasmania. Tasmania had the thylacine (commonly called the Tasmanian tiger or Tasmanian wolf) which was a large carnivorous marsupial.

The thylacine was once found across Australia with Aboriginal rock art in northern Australia and in the Kimberley region of Western Australia showing pictures of thylacines. The thylacines became extinct on the Australian mainland around 2000 years ago and its extinction could be due to competition with the dingo which was both a competitor for food and a predator. The thylacines survived in Tasmania until European settlement when they were hunted and the last captive thylacine died in Tasmania in 1936. The International Union for Conservation of Nature declared the thylacine extinct in 1982 and the Tasmanian government officially announced the extinction of the species in 1986.

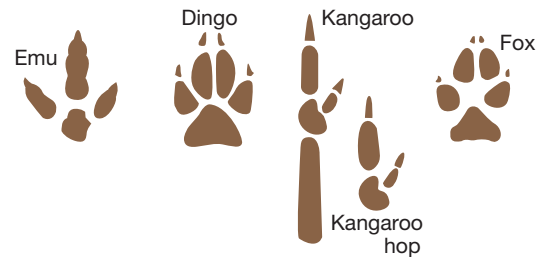


Figure 92.2 Animal footprints.

Food supplies, tracking and hunting

Relying on the land for all food and water resources requires an intimate knowledge of the edible plants found in different habitats, the behaviours of different animals, the life cycles of organisms, the seasonal changes in the environment and the location of freshwater supplies throughout the year. Many areas of Australia are desert or semi-arid and survival in these areas requires a deep understanding of the natural rhythms of nature.

Living off the land and using native plants as a major food source requires botanical knowledge of growing seasons as well as knowledge of how much to harvest, how much can be carried to the next location and how much needs to be left to form future food supplies for a return to that location. Aboriginal land practices were passed from generation to generation to ensure survival for their people. Aboriginal culture and spirituality relate to the land, the plants and the animals and show how the land has been managed since first occupation.

For various reasons some of this information is under threat and could be lost forever.

Fire management practices

Aboriginal peoples have used fire management practices for thousands of years. Fire is used for signalling, for creating and maintaining tracks through the countryside and as a hunting method.

In the north, burning in the early dry season removes the grasses and undergrowth that can become the fuel of high intensity late dry season fires.

High intensity fires cause large amounts of damage with many plants and animals unable to quickly recover. After the managed burning of an area the region is left for two or three years for animals to regain numbers and for plants to flourish and regain size.

Fires can be beneficial as the ash aids in fertilising the soil returning nutrients which can be utilised by plants for regrowth. When areas begin to regrow after a fire the new shoots can attract herbivores to the area. Indigenous practices are often used to complement current conservation strategies and land management decisions.

Many Australian plants have adaptations for fire resistance. The leaves of eucalypts are highly flammable due to the oils in the leaves so that fires can quickly spread across tree crowns and dense leaf litter can ignite as a fire sweeps across the ground. Eucalypts survive fires as they have epicormic buds in their bark which sprout after a fire and they have lignotubers in the ground which send up new shoots after the fire. Many eucalypts store their seeds which are only released after a fire. Grass trees flower after fires and then seeds are released.

Some areas cannot be managed by controlled burning, e.g. rainforests, river areas and the land around springs. Deciduous beech trees and native conifers are highly susceptible to fire and these areas can take centuries to regenerate after a fire.

Water resources and river control

In some areas of Australia, e.g. northern New South Wales, Aboriginal peoples have affected the water flow in rivers by building fish traps out of stones. In western Victoria to maintain supplies of fish and birds, Aboriginals constructed canals, trenches, dykes and traps.

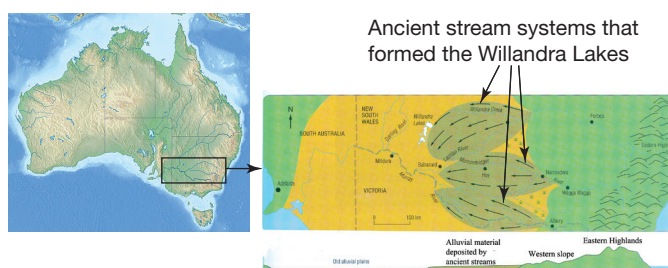


Figure 92.3 Lake Mungo and the Willandra Lakes.

The Western Plains of New South Wales are flat with large areas of shallow riverine sediment. When the Eastern Highlands were uplifted the inland area sank with the Murray, Lachlan and Murrumbidgee Rivers depositing soil and water into the lower areas. A series of freshwater lakes including Lake Mungo formed along the Willandra Creek. The climate became drier and as the water receded the westerly wind shaped the lakes and formed distinct layers of sediment. The area is important in showing indigenous habitation and land management practices.

The Willandra Lakes region is listed with World Heritage with significant natural and cultural features. Mungo Man is one of the oldest human remains found in Australia and Mungo Lady is the oldest human remains that were cremated. The artefacts from the archaeological sites show how people lived 40 000 years ago in this area. Food such as Murray cod, perch, emus, kangaroos, wombats, reptiles and wallabies were cooked in earth ovens.

QUESTIONS

1. What is Indigenous Ecological Knowledge?
2. When did Aboriginal peoples arrive in Australia?
3. Identify some volcanic eruptions that have occurred since Aboriginal occupation.
4. What climate change occurred around 20 000 years ago?
5. How does the end of an ice age affect sea level?
6. When did mainland Australia become separated from Tasmania and the Torres Strait Islands?
7. (a) When were dingoes introduced into Australia?
(b) How did Aboriginal peoples use dingoes?
8. Suggest why the dingo was not introduced into Tasmania.
9. Outline what happened to the thylacine.
10. Outline some areas of knowledge needed to enable a person to live off the land.
11. How is fire used by Aboriginal people?
12. The diagram shows a eucalypt before and after a bushfire.

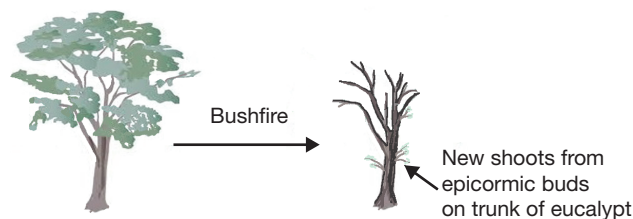


Figure 92.4 Eucalypts survive bushfires.

Use the diagram to explain how Aboriginal land management practices influence the evolution of Australian plants such as the eucalypts.

13. Explain why Aboriginal peoples in the north burn areas early in the dry season.
14. Which areas should not be managed with regular burning with fire?
15. Explain why Lake Mungo and the Willandra Lakes region are listed with World Heritage.
16. Which of the following is *not* a traditional indigenous strategy used in land management?
(A) Fire stick burning.
(B) Stone fish traps.
(C) Sustainable plant harvesting.
(D) Fencing.

Topic 3.2 Test

Topic 3.2 Functioning Ecosystems and Succession

Section A – Multiple Choice (20 marks)

- Phytoplankton are microscopic photosynthetic organisms found in aquatic environments. Why are they found in the top few metres of water?
 - Light does not penetrate far into water.
 - They drift with ocean currents.
 - They feed on zooplankton which are found in that layer.
 - The top layer is the warmest layer.
- The diagram shows part of a food web in an ecosystem.

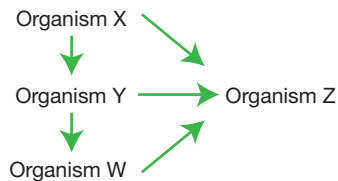


Figure TT3.2.1 Food web.

- What could you deduce from this food web?
- Organisms X, Y, W and Z must all be producers.
 - Organism Y is the most adapted to its environment.
 - Organism X provides chemical energy to the other organisms.
 - The biomass of organism Z is greater than biomass of any of the other organisms.
- Which of the following would cause the most damage to the ecosystem?
 - Using river water for human consumption.
 - Building a house on an open area of grassland.
 - Introducing a foreign plant species into a suburban garden.
 - Introducing a foreign species with no known predator into the bush.
 - The following food chain shows the relationship between four organisms.
 Grass → grasshopper → wolf spider → magpie
 If the grass has 100 units of energy, how much of this energy reaches the magpie?
 - 50%
 - 10%
 - 1%
 - 0.1%
 - Poisons, such as DDT and dieldrin, accumulate in the body tissues. Which of the following organisms is most likely to concentrate the highest levels of poisons in their body tissues?
 - Producers.
 - Herbivores.
 - Carnivores.
 - Decomposers.

- Which process is responsible for the increase in carbon dioxide in the atmosphere?
 - Photosynthesis.
 - Respiration in plants.
 - Respiration in animals.
 - Combustion of fossil deposits.
- The diagram shows a process that occurs in nature.

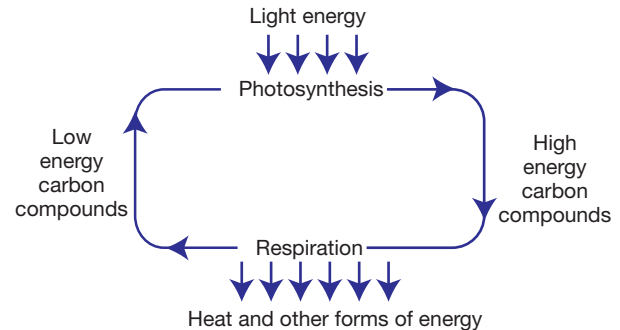


Figure TT3.2.2 Process.

What is shown by this diagram?

- The cyclic flow of matter and energy through an ecosystem.
 - The non-cyclic flow of matter and energy through an ecosystem
 - The cyclic flow of matter and non-cyclic flow of energy through an ecosystem.
 - The non-cyclic flow of matter and cyclic flow of energy through an ecosystem.
- If a city had a population of 18 317 and during the year 464 babies were born, 82 people died, 133 people moved into the city and 96 left the city, what was the population growth rate for that year?
 - 1.0%
 - 1.3%
 - 2.3%
 - 3.2%
 - The diagram shows a Tasmanian devil.



Figure TT3.2.3 Tasmanian devil.

Devils play an important and unique role in their ecosystem as they eat dead and sick animals. What role has been given to the devils?

- Top predator.
- Decomposer.
- Warship species.
- Keystone species.

10. In 1984 an engraved incisor tooth of *Diprotodon optatum* was found at Spring Creek, Victoria. The tooth has 28 tiny grooves etched by stone into the tooth when it was still fresh.

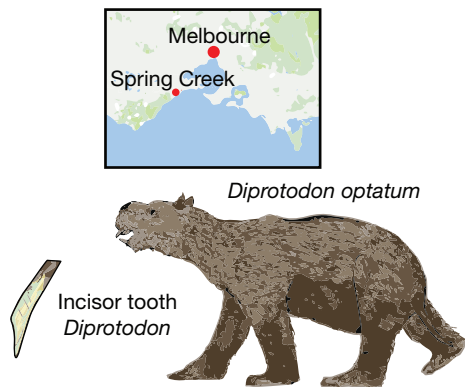
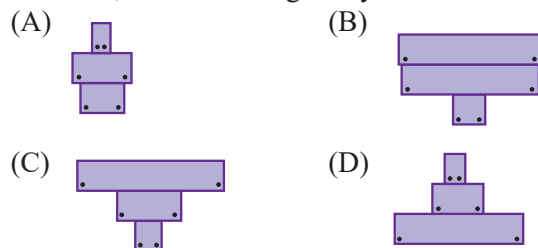


Figure TT3.2.4 *Diprotodon optatum* and incisor tooth.

What does this show about the past ecosystem?

- (A) The area was once at the equator.
 (B) Aborigines coexisted with extinct dinosaurs.
 (C) Aborigines coexisted with extinct megafauna.
 (D) The area was a coal-forming swamp 25 000 years ago.
11. Which of the following energy pyramids shows a balanced, self-sustaining ecosystem?



12. The following diagram shows temporal changes in an area.

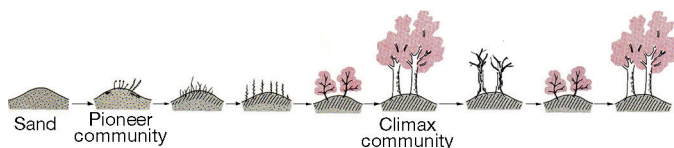


Figure TT3.2.5 Temporal changes in an area.

What is shown in this diagram?

- (A) Primary succession.
 (B) Secondary succession.
 (C) Primary succession, a destructive event, then secondary succession.
 (D) Secondary succession, a destructive event, then secondary succession.

13. On Sunday 26 August 1883 the volcano on the island of Krakatoa erupted destroying over 70% of the island and surrounding areas. The graph shows the changes after the volcanic eruption.

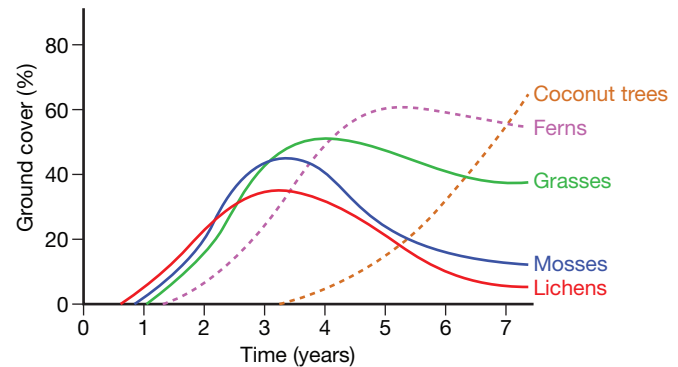


Figure TT3.2.6 Changes in abundance after the volcanic eruption on Krakatoa, August 1883.

What had the highest ground cover percentage after two years?

- (A) Lichen.
 (B) Mosses.
 (C) Grasses.
 (D) Ferns.
14. The grey headed flying fox has been identified as an Australian keystone species on the east coast. What is the major reason for the identification of the flying fox as a keystone species?

Grey headed flying fox



Figure TT3.2.7 Grey headed flying fox.

- (A) Faeces from flying foxes is essential to maintain soil fertility in east coast ecosystems.
 (B) Flying foxes are the dominant predator that keep the populations of herbivores in check.
 (C) Flying foxes are important in the pollination and distribution of seeds for many native hardwoods, palms and rainforest plants.
 (D) Flying foxes determine the growth rate of many types of plants by eating and removing new shoots, buds, fruit and flowers.
15. Which of the following is likely to cause a systematic error when taking field study measurements?
- (A) Instruments not calibrated.
 (B) Same student collecting all data.
 (C) Different day temperatures when collecting data.
 (D) Using different size quadrats for different species.

16. A recent report noted that the 2016 coral bleaching event made some reef fish too weak to fight for food. Aggression between butterfly fishes was estimated to have decreased around two thirds with no significant change in fish abundance or community composition.



Figure TT3.2.8 Butterfly fish.

What is the main reason for the usual aggressive behaviour of butterfly fish?

- (A) Predation on other species.
 (B) Predation on own species.
 (C) Learned behaviour from parents.
 (D) Mated pairs defending their territory.
17. *Paramecium* is a genus of unicellular ciliates that live in water – fresh water, brackish water and marine environments. They are eukaryotic heterotrophs that use their cilia to sweep prey organisms into an oral groove. The following graphs show changes in population size when two *Paramecium* species (*P. aurelia* and *P. caudatum*) are grown separately and when grown together in culture.

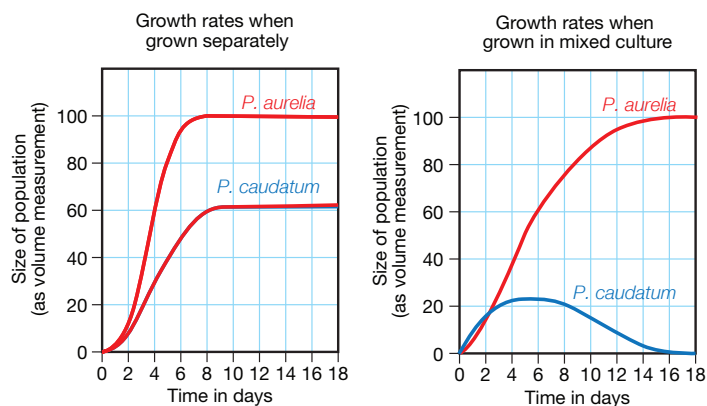


Figure TT3.2.9 Graphs of *Paramecium* abundance.

What principle is shown by this experiment?

- (A) Lincoln index can be used to measure mobile species.
 (B) Competitive exclusion principle.
 (C) Precautionary principle.
 (D) Realised niche principle.

18. Which of the following shows the most likely succession on a bare rock.
 (A) Lichen → fern → moss → shrub → tree.
 (B) Tree → shrub → moss → fern → lichen.
 (C) Lichen → moss → fern → shrub → tree.
 (D) Lichen → moss → shrub → tree → fern.
19. In an experiment to determine the size of a population of crimson finches in a small woodland area in northern Queensland 20 birds were captured and banded with leg tags. Six months later 25 birds were captured of which two had leg tags. What is the estimated size of the population of crimson finches in this area?
 (A) 50
 (B) 250
 (C) 500
 (D) 1000
20. It has been estimated that 70% of the natural habitat in the eastern and south-eastern parts of Queensland have been lost because of clearing. The diagram shows spatial planning with environmental areas and corridors.

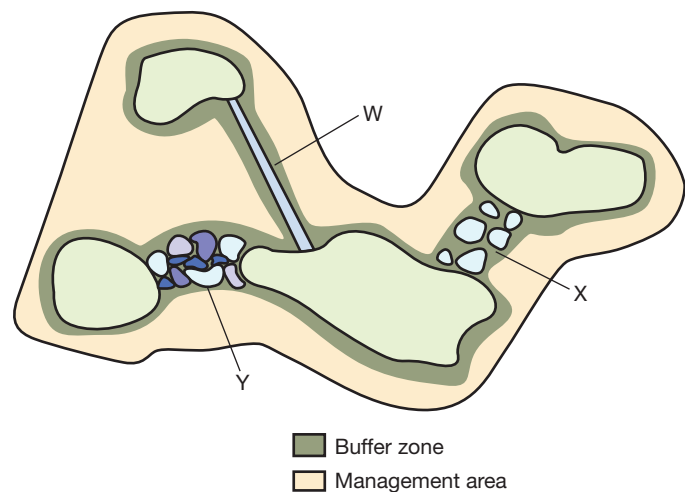


Figure TT3.2.10 Environmental areas and corridors.

Which of the following correctly describes the planning action.

- (A) W is a landscaped corridor to provide additional habitats for native species.
 (B) X is a linear corridor to allow migration from one protected area to another.
 (C) W is a stepping stone corridor to increase natural resilience in the landscape.
 (D) Y is a landscaped corridor connecting patches to reduce fragmentation.

Section B – Written Response (30 marks)

21. (a) Define carrying capacity. (1 mark)
 (b) Describe three biotic factors with examples that can limit population growth. (6 marks)
22. Complete the table to compare pioneer species and climax species. (6 marks)

Feature	Pioneer species	Climax species
Growth rate		
Growth pattern		
Mature plant size		
Maximum life span		
Seed viability		
Species diversity		

23. The following graphs show the change in weight of small fish under different conditions. In one series of experiments, small fish of uniform size were placed in an overcrowded fish tank and given unlimited food supplies. In the second series of experiments, small fish and large fish were mixed together in the fish tank also with an unlimited supply of food. In both cases only the growth of the small fish was measured. The results are plotted on the same graph so growth rates can be compared.

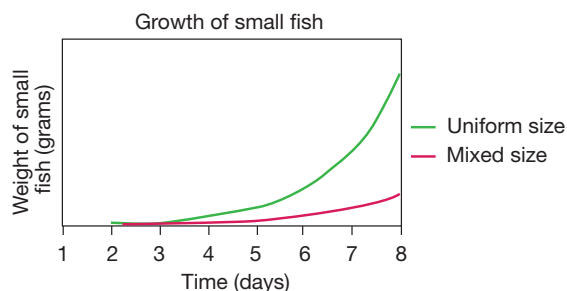


Figure TT3.2.11 Graphs of growth of small fish.

What could be concluded from this experiment? (1 mark)

24. The diagram shows a generalised coast profile from the sea to the hind dune and lagoon.

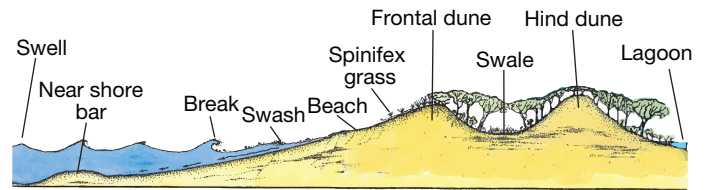


Figure TT3.2.12 Profile of beach and dunes.

Suggest why an understanding of the ecosystems involved in a sand dune succession aid reconstruction of past ecosystems in an area. (3 marks)

25. The diagram shows the formation of different sand dune profiles, e.g. as found in arid, desert zones.

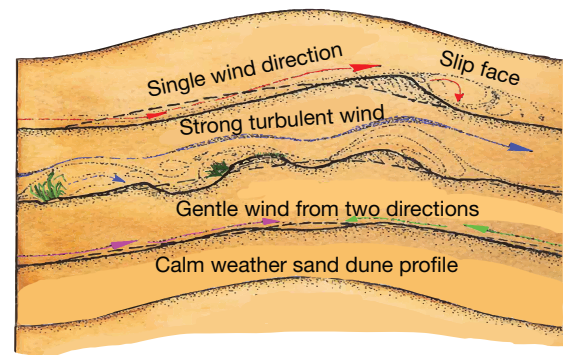


Figure TT3.2.13 Different sand dune profile shapes.

Use this diagram to explain how geological evidence can provide information about past changes in ecosystems. (2 marks)

26. Explain how human activity has influenced the greenhouse effect and impacted on biodiversity. (5 marks)
27. Construct a table to compare *r*-selected and *K*-selected species for six features. (6 marks)

	Group 1		Group 2		Group 3		Group 4	
Species	n	N(N-1)	n	N(N-1)	n	N(N-1)	n	N(N-1)
1	2	870	3	870	1	870	0	870
2	6		6		7		7	
3	8		6		5		4	
4	10		7		8		7	
5	4		8		9		12	
N	30		30		30		30	

SDI group 1	SDI group 2	SDI group 3	SDI group 4
SDI = $1 - \frac{190}{870}$ = $1 - 0.218$ = 0.78	SDI = $1 - \frac{229}{870}$ = $1 - 0.263$ = 0.74	SDI = $1 - \frac{190}{870}$ = $1 - 0.218$ = 0.78	SDI = $1 - \frac{229}{870}$ = $1 - 0.263$ = 0.74

- (b) Groups 1 and 3 had identical SDI values and groups 2 and 4 had identical SDI values.
- All communities did not have the same species richness as group 4 did not have any species 1 (no aces) and thus only had 4 species present while the other groups had 5 species present.
 - The experiment gives a high level of biodiversity (SDI = 7.4 or 7.8). This is due to the presence of 5 possible species in a total of 30 individuals which is high species richness.
 - (a) The calculations for SDI are:

$$SDI = 1 - \frac{\sum n(n-1)}{N(N-1)}$$
 And the student reported

$$SDI = 1 - \frac{156}{870}$$

$$= 0.218$$

$$= 0.22$$
 The correct answer is $1 - 0.218$ which is SDI = 0.78.
 (b) The result for group 5 is consistent with the results from the other groups and identical to the results for Groups 1 and 3.
 - B

18 Species Diversity In Mangrove Ecosystems

- The term mangrove is used to describe both an individual plant species and the type of swampy forest where these trees grow.
- The greatest species diversity in mangroves is in the far north and north-eastern coasts of Australia.
- In Australia, mangroves are found along sheltered tropical and subtropical coastlines and as far south as Victoria.
- Mangroves are not found in Tasmania or southern Western Australia.
- Temperature is the most important factor in mangrove distribution – they are mainly tropical and subtropical with few species able to survive temperate conditions.
- Wind speed and direction can affect coastal water drift and wave action which can then undermine the roots of mangroves and move sediments.
- The character and composition of the community refers to the types of species present, the number of different species and the number of each species present. It also looks at how these organisms interact with each other.
- The composition and character of a mangrove community is determined by temperature, shelter, the tides, the salinity, the height of the water table, rainfall and rainfall patterns, evaporation, the soil type, soil aeration, the slope of the land and the shape, orientation and channel pattern of the coastal area.
- Pneumatophores are ‘breathing roots’ that grow up out of the mud and are exposed to the air at low tide.
- Lenticels are small raised areas in the bark of stems or roots that allow gas exchange between living cells and outside air.
- Pneumatophores assist survival in waterlogged soils as they grow out of the mud and at low tide are exposed to the air. During this time oxygen can enter the root through the lenticels supplying oxygen for respiration and for the rest of the plant.

- Mangroves can survive in a high salt environment by using salt glands to secrete excess salt and/or storing salt in older leaves which remove the salt from the plant when they fall off the tree.
- Algae is found on the mud surfaces and on the pneumatophores of the mangrove trees. Algae is important as a food resource for other organisms and for a number of biological processes within the soil and water.
- Invertebrates include snails, marine annelid worms, isopods, tubeworms, bivalves, (e.g. oysters, mussels), crayfish, lobsters, prawns, a wide variety of insects and spiders.
- Mud crabs burrow into the mud where salt concentrations are more uniform.
- At low tide mussels will close their valves and keep shut to maintain a more constant internal salt concentration and prevent desiccation.
- (a) The salty taste on the leaf is due to salt glands in the leaf which excrete excess salt from the plant.
 (b) To prove that the leaves excrete salt, the students could wash the leaves of several different species in the area, including *Avicennia marina*, with deionised water, preferably in the morning so that no salt is present on any of the leaves. The leaves should be covered by a plastic bag to prevent salt deposition from the salty air. In the afternoon the students should once again wash the leaves with deionised water and this time collect the washings. The salt content of the washings can then be estimated by either electrical conductivity or by evaporation. If there is salt in the washings in the afternoon from the leaves of *Avicennia marina* then salt must be excreted. A comparison with the other species being tested will show the extent of this adaptation.

19 Stratified Sampling

- Stratified sampling involves dividing a population into strata – non-overlapping groups that will make up different layers of the population.
- Random sampling involves taking a selection of samples with each sample having an equal and independent probability of being chosen.
- Stratified sampling is used in computational statistics to determine population statistics for a defined population, e.g. to estimate population, density, distribution, environmental gradients and profiles, zonation and stratification.
- Benefits of stratified sampling include – 1. Can reduce error of estimation, especially if measurements are homogenous within with stratum. 2. Can reduce the overall sample size for same level of precision or increase precision for the same sample size. 3. Can reduce cost of sampling, e.g. in time and effort to survey areas. 4. Can reduce time to identify subgroups within the population.
- Disadvantages of stratified sampling include – 1. The population or area cannot be effectively divided into different strata. 2. Accurate estimations of the proportion of each stratum cannot be made. 3. If subgroups are joined to ensure there are adequate numbers for manipulation then trends in different subgroups can change, disappear or reverse.
- Site selection for stratified sampling needs to be free from bias and the different strata should be homogenous for the particular characteristic for the layer and different layers vary with this characteristic of interest. With site selection the more homogeneous the layer the higher the precision of estimates for each stratum.
- In an ecological study geographical features, e.g. elevation, aspect, soil type often cause zonation and different layers in an area.
- A transect is a line, strip or profile for counting and mapping the number of individuals at different distances along the line.
- A quadrat is a defined area used in an ecological study to measure the distribution, number in a population (abundance) or density (number per given area or volume).
- The number of quadrats used influences the validity and reliability of the results – the higher the number of quadrats the higher the validity and reliability of the results.
- Sampling bias occurs when information is collected in such a way that results do not reflect the actual situation.