PEARSON

Science

STUDENT BOOK | WESTERN AUSTRALIA

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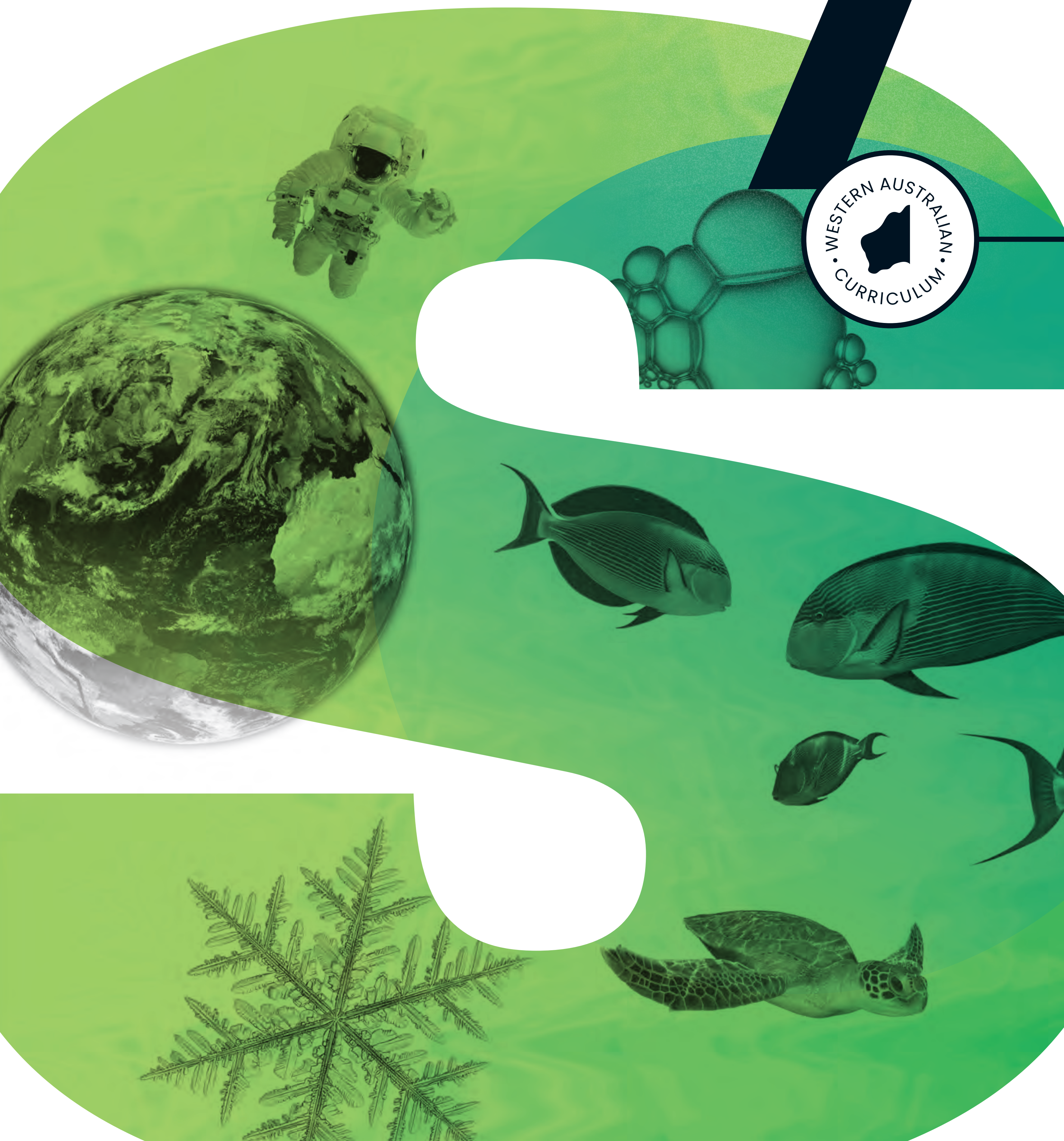


TOPIC 6

Matter and energy in ecosystems

A habitat is more than just a location where organisms live. It provides all the necessary resources for survival, including sufficient space, shelter, water, nutrients, and suitable conditions for reproduction. The interactions between living organisms in an environment are examined and represented in diagrams known as food chains and food webs. These diagrams illustrate feeding relationships between species and can be used to predict the effects of changes within a habitat.

Understanding these relationships and the impact of introduced species on an ecosystem helps in managing and protecting the natural environment. Ecosystem management is a shared responsibility, incorporating both the traditional knowledge and sustainability practices of First Nations Peoples alongside modern scientific approaches. This combination ensures the long-term health and stability of natural systems.

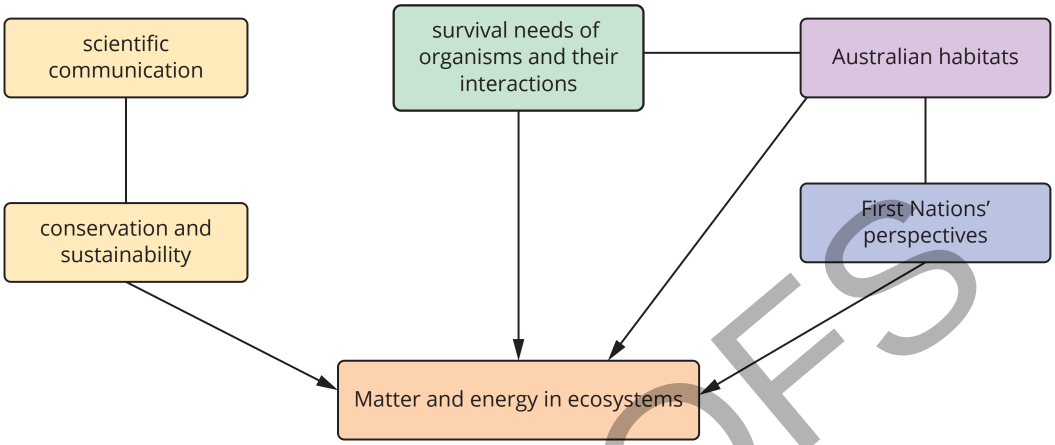
This topic explores the flow of energy through ecosystems and the survival needs of organisms. It also involves representing these processes in diagrams, interpreting their meaning, and predicting how various changes may affect the species within them.

Learning intentions

- [ ] To understand the requirements of organisms and populations for survival
- [ ] To be able to describe factors that threaten Australian ecosystems
- [ ] To be able to explore how scientists communicate their research to support conservation practices and policies
- [ ] To be able to conduct a safe, ethical survey of organisms in a local environment
- [ ] To understand how food chains can demonstrate feeding relationships and energy flow within ecosystems
- [ ] To understand how biomass pyramids can be used to describe and compare different ecosystems
- [ ] To understand and predict interactions and energy flow in an ecosystem using a food webs
- [ ] To be able to apply the concept of trophic levels to a food web in a local ecosystem
- [ ] To understand how human use of the environment can cause habitat damage or destruction
- [ ] To be able to develop hypotheses to test relationships
- [ ] To understand how desalination plants impact local marine ecosystems
- [ ] To understand how First Nations Australians used deep ecological understanding to develop sustainable practices

6 Matter and energy in ecosystems

The key concepts that you will use in this topic:



The following prior knowledge questions will help to support your learning in the topic and can be attempted before the first lesson.

Survival needs of organisms and their interactions

1 What are the basic requirements that mammals need to survive?

A Food and water

B Shelter and suitable conditions

C Mating partners

D All the above

2 Explain the factors that make an environment biodiverse.

3 Describe the flow of energy in a food chain.

4 Draw a food chain that demonstrates the following description:

A rabbit eats the grass. The rabbit is then eaten by a snake and the snake is preyed upon by a kookaburra.

Australian habitats and First Nations' perspectives

5 List three Australian habitats.

6 Outline two ways humans can have an impact on Australian native plants and animals.

7 Describe how First Nations peoples use traditional knowledge to protect the environment.

6.1 Survival needs

Lesson overview

There is a huge variety of life on Earth. This life comes in all different shapes and sizes, with different needs and requirements. All living things must have their needs met for their survival, and life can only exist when these needs are met. Imagine an environment with lots of life or imagine an environment where there is very little life. What is present in both areas that could support life?

In this lesson you will learn about the six basic needs that all living things require, where these needs can be met and how these requirements allow each organism to survive in their environment.

SC 1	I can describe the basic survival needs of plants and animals in Australia

Basic survival needs

In biology the term **biotic factor** is used to describe living things in the **environment**. Earth contains a wide variety of **organisms**, and each organism has different requirements for survival; however, all organisms require the same six basic things:

- nutrition (food sources)
- a water source, to aid vital functions
- a place to live and shelter
- the ability to reproduce
- gases including oxygen, carbon dioxide and nitrogen
- suitable living conditions, such as a suitable temperature and salinity.

Organisms will only live in places where these needs are met by the **resources** available in the environment.

Adaptations

Adaptations are features of an organism that allow it to survive in its environment. Plants and animals must adapt to compete for resources and live successfully in their environment.

Adaptations can help organisms survive better in their environment because they are able to hide, control their body temperature and not get eaten.

A good example of a well-adapted animal is the western quoll (Figure 6.1.1). It has white spots for camoflage, sharp claws to climb trees and they hunt and feed at night to avoid being seen in the bush.

Learning intention

To understand the requirements for survival of organisms and populations

Success criteria

SC 1: I can describe the basic survival needs of plants and animals in Australia.

SC 2: I can describe a range of habitats in the Australian environment.

SC 3: I can explain the requirements for the maintenance of populations within an ecosystem.

KEY TERMS

biotic factor a living factor in the environment
environment all the factors in an organism's surroundings that affect its survival
organism a living thing
resource something that meets a particular need or fulfils a particular purpose
adaptation a structure, behaviour or internal bodily function of an organism that helps them survive

FIGURE 6.1.1 This western quoll (*Dasyurus geoffroii*) is blending in with the bush behind it.

Scifile

Nutrient necessity

Just like humans need vitamins and minerals to stay healthy, all organisms need specific chemical nutrients to survive. For example, plants need nitrogen, phosphorus, and potassium to grow strong and healthy.

Biotic and abiotic factors

Ecosystems are made up of two parts: biotic factors and **abiotic factors**.

- Biotic factors are the living parts of an environment, including prey (an animal that is eaten by another animal), predators (an animal that eats another animal), mating partners and competition with another organism for these resources.
- Abiotic factors are the nonliving parts of an environment, including water, light, wind, salinity and temperature.

The number of organisms living in a particular space is determined by these factors. A rainforest has lots of food (Figure 6.1.2), water and mating partners, which allows many organisms to live in that space.

However, in the desert, these factors are limited; therefore, fewer organisms live there.

KEY TERMS

abiotic factor a nonliving factor in the environment

habitat the place where an organism lives

FIGURE 6.1.2 Australia has diverse environments – some are rich in wildlife, such as the rainforest, while others have fewer organisms, such as deserts.

SC 1 CHECK YOUR UNDERSTANDING

Identify the six basic requirements that organisms require for survival.

SC 2 I can describe a range of habitats in the Australian environment

A place where an organism lives is called a **habitat**. The habitat provides all the environmental requirements an organism needs for survival. Because of its size and varying climate, the Australian environment has a range of habitats. These habitats include wetlands, deserts, coastal waterways and bushland. Read about each of the Australian habitat types in the information in Table 6.1.1 on page 309.

Scifile

Water is essential

On average, water makes up about 60% of the human body. Without it, humans can only survive for about three days. Water is crucial for all living organisms as it helps with digestion, temperature regulation, and transporting nutrients.

TABLE 6.1.1 Habitat types in Western Australia.

Habitat type	Habitat image	Habitat description
Forest	 Karri trees in Boranup National Park, Western Australia	A forest habitat is dominated by trees and woody vegetation. There is often a thick canopy of leaves formed at the top of the trees. There are three main types of forest habitat in Australia: dry sclerophyll forest, wet sclerophyll forest and rainforest.
Woodland	 Woodlands in Norseman, Western Australia	A woodland habitat is characterised by trees that are spaced apart with grassland in between. Habitats in woodlands include rocky outcrops, decaying trees and grasslands.
Freshwater	 Marlgu Billabong on the edge of the Ord River floodplain, Western Australia	Freshwater habitats have a lot of plant life and water with little dissolved salt. These habitats include ponds, rivers, lakes and billabongs.
Coastal	 Coastal cliffs at Pot Alley, Kalbarri National Park, Western Australia	Coasts are places where land meets the sea. This includes a diverse range of habitats including beaches, rockpools, estuaries, mangroves, salt marshes and coral reefs.
Arid	 Arid landscape at Balgo, Western Australia	Australia is the driest inhabited continent on Earth, with large areas of central desert. Despite the lack of water in deserts, they include several habitats that support life, including gorges, grasslands and open plain sandy areas.

SCIENCE IN SOCIETY

Coral reefs

Coral reefs are one of the most biodiverse ecosystems on the planet. Coral reefs need clean, warm water, plenty of sunlight, and a stable environment in order to be healthy. They are home to thousands of species of fish and other marine organisms, all of which have specific requirements for survival.

In Australia, the Ningaloo Reef, Coral Bay is one of the most well-known coral reefs. It not only supports a diverse range of marine life (Figure 6.1.8) but, also contributes significantly to the Australian economy through tourism and fishing. Understanding the needs of the organisms that live in coral reefs helps scientists develop conservation strategies to protect these vital ecosystems.

FIGURE 6.1.8 Ningaloo Reef, Exmouth, Western Australia.

Habitat and environment

All ecosystems include a wide range of habitats (where an organism lives). These also include a variety of environments which contain all the interactions between living (biotic) and non-living (abiotic) parts of the ecosystem.

For example, rainforest environments have various factors that affect the organisms that live within it. The canopy of the rainforest contains both living and non-living factors that are different from those found on the forest floor (Figure 6.1.9).

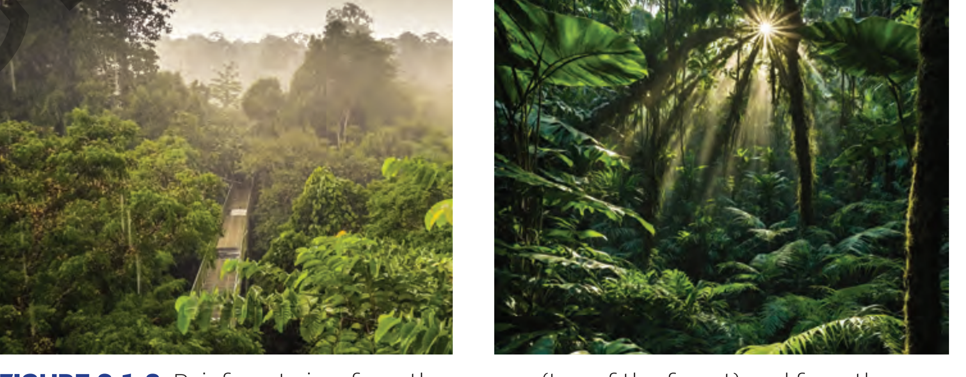


FIGURE 6.1.9 Rainforest view from the canopy (top of the forest) and from the forest floor (bottom of the forest)

SC 2 CHECK YOUR UNDERSTANDING

Explain why plants and animals need water to survive.

SC 3 I can explain the requirements for the maintenance of populations within an ecosystem

An **ecosystem** involves interactions between the living (biotic) and nonliving (abiotic) factors in an environment. This dynamic **community** includes animals, plants and microorganisms as well as the soil type, climate and water availability. These interactions (Figure 6.1.10) determine how many organisms can live in a particular space at any time.

Communities contain different types of living things called **species**, which fill specific roles in the ecosystem. Organisms of the same species that are living together in the same area are called a **population**.

KEY TERMS

ecosystem a system formed by organisms interacting with each other and their nonliving surroundings

community groups of organisms that interact within an ecosystem

species different types of living things

population a group of organisms of the same species, which live in the same area

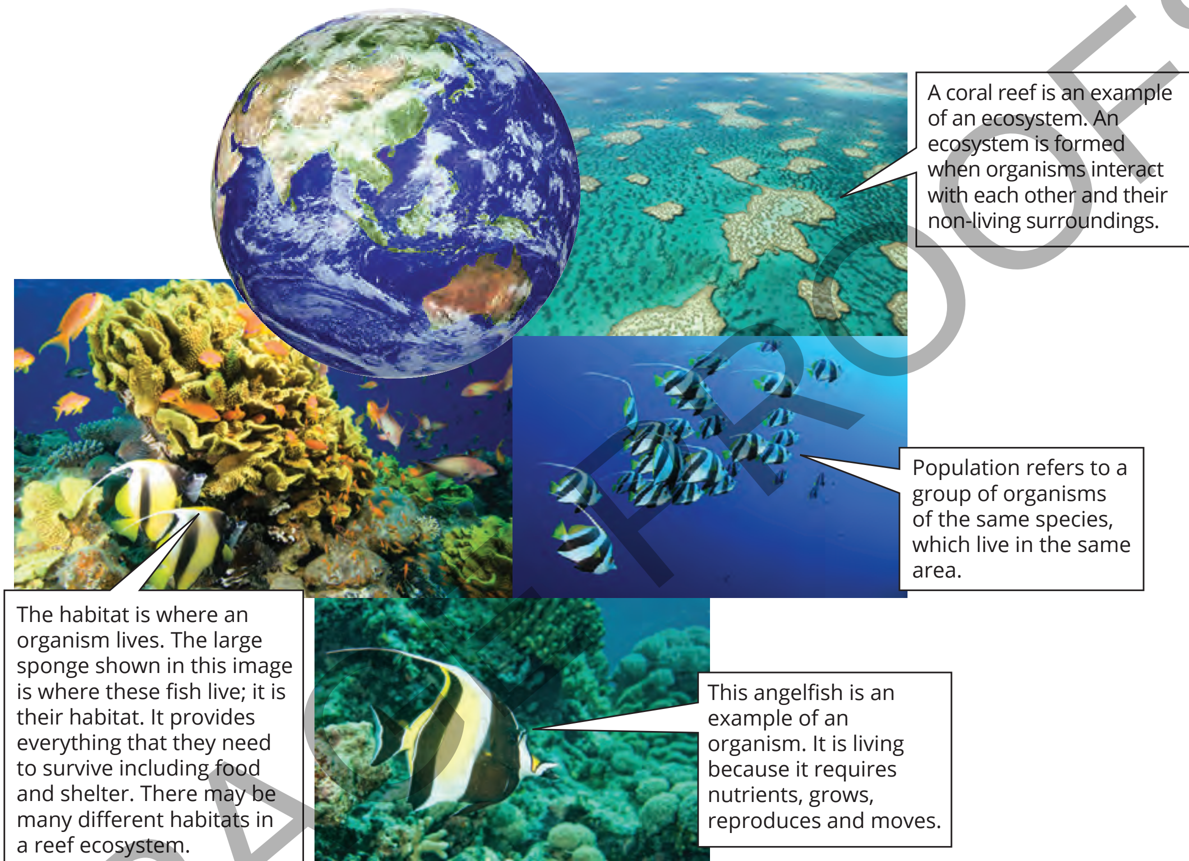


FIGURE 6.1.10 The relationship between ecosystems, habitat and the organisms that live there

Changes in a population are related to the availability of resources in an ecosystem. Changes in resource availability can include:

- a lack of food sources
- competition for shelter
- significant changes in temperature
- introduction of disease-causing organisms
- soil erosion.

KEY TERMS

biodiversity the number and range of species that exist in an ecosystem, biome or biosphere

tolerance the ability of an organism to survive under particular conditions

genetic relating to heritable characteristics or features passed on from parent to offspring

A healthy ecosystem is home to many different species. The more species an ecosystem has, the higher its **biodiversity**. All species differ from one another in their resource use, **tolerance** to changes in the environment (such as temperature or rainfall) and in their interactions with other species.

The importance of biodiversity

Ecosystems thrive when there is variation. Biodiversity has three important and intertwined parts:

- species diversity
- ecosystem diversity
- **genetic** diversity.

When any of these parts are missing, it reduces the ability of an ecosystem to adapt to environmental changes. In some environments, taking away just one important factor can weaken the entire ecosystem causing damage that cannot be repaired.

FIGURE 6.1.11 Managed ecosystems might include cleared land for crops or grazing as well as built features such as roads, fences or wind turbines.

Ecosystem management

Ecosystems are either wild or managed.

Wild ecosystems have little to no human influence, such as savannas or deserts. These natural ecosystems preserve biodiversity. For example, maintaining predator-prey relationships in an ecosystem helps manage population numbers so that prey species do not become too numerous. This balances the ecosystem because other species can also use available resources, and biodiversity continues.

Managed ecosystems are areas that have been heavily affected by humans, such as farms. These usually reduce biodiversity to a limited number of species.

SC 3 CHECK YOUR UNDERSTANDING

List three factors that can affect population numbers in an ecosystem.

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1. Define 'biotic factor'.
2. List three abiotic factors that can be found in an arid environment.
3. How do rainforest habitats differ from those of a desert habitat in Australia?
4. Explain how the survival needs of a kangaroo would be different from those of a eucalyptus tree in Australia.
5. Explain why it is important to maintain balanced predator-prey relationships in an ecosystem.
6. Seawater temperature is one of the most important factors affecting the population size and diversity of life in coastal seas. Explain how one abiotic factor, like seawater temperature, could alter the biodiversity of the Ningaloo Reef.

6.2 The Australian environment today

Introduction

To remain healthy and sustainable, an ecosystem needs a variety of organisms in its environment. Areas with a wide range of organisms are said to have high biodiversity. In this inquiry activity you will investigate why there are so many endangered species in Australia and the causes of population decline threatening Australian species.

Learning intention

To be able to describe factors that threaten Australian ecosystems

Success criteria

SC 1: I can describe specific threats to Australian ecosystems.

SC 2: I can explain the dangers of loss of biodiversity in Australia.

SC 3: I can describe how abiotic and biotic factors are affecting a local ecosystem.

Background

Ecosystems that are diverse and can provide for the needs of the organisms that live there are **sustainable** ecosystems. However, many factors can affect the long-term health of an ecosystem. These factors include habitat loss (Figure 6.2.1) and natural disasters such as fire (Figure 6.2.2), drought, flood or introduced threats such as invasive species and disease. The maintenance of a sustainable ecosystem is a delicate balance, and as human activity causes change in an ecosystem this may lead to a loss of biodiversity.

Australia is a known biodiversity hotspot, so why are there so many **endangered species** in Australia, and what is the cause of their population decline?

In this inquiry activity you will look at some of the reasons a population is in decline and consider the dangers if the population continues to decline.

KEY TERM

endangered species an animal or plant that is at serious risk of disappearing forever

FIGURE 6.2.1 Raptors such as this hawk are at risk of population decline because of habitat alteration or destruction.

FIGURE 6.2.2 Bush fires are a natural process in the Australian environment. However, uncontrolled wildfires can have devasting effects on ecosystems.

Endangered Australian species

The Australian organisms in Table 6.2.1 are all endangered species.

TABLE 6.2.1 Endangered Australian species

Lord Howe Island stick insect	Leadbeater's possum	Helmeted honeyeater
The Lord Howe Island stick insect is a critically endangered Australian insect species. There are only about 20–30 individuals left in the one remaining population in the wild.	The Leadbeater's possum is one of Australia's most endangered species. It is estimated that there are about 2000 adults remaining in the wild.	The helmeted honeyeater is an endangered bird species in Australia. Conservation efforts have increased the numbers of these birds from 70 to about 200.
		

Aim

To create a pamphlet or poster through print or digital media that will educate your community about an Australian endangered species

Plan

GO TO
Toolkit section 4.3, Selecting and using secondary data
Toolkit section 5.1, Scientific writing

1. Select an Australian plant or animal species that is endangered.
2. Think about what information the community will need to know about your species to protect it from extinction and what information should go on your poster or pamphlet.
   This information should include the answers to the following guiding questions.
   - What is the species habitat? Include the biotic and abiotic factors.
   - How many of the species are left in the wild?
   - When is its breeding season, and how often does it breed?
   - How many young does it have in each breeding season?
   - What is its diet?
   - What threats are in the ecosystem leading to this species being endangered?
   - What **conservation** strategies are already in place?
   - What are the risks to the ecosystem if the population of the species continues to decline?

KEY TERM
conservation taking care of natural resources making sure they stay healthy and are around for a long time

Design

Plan what your poster or pamphlet will look like; it should be informative and eye catching and should have a balance between information and visual appeal.

Remember to include and think about:

- your audience
- headings
- key information
- images
- materials you will use to create your poster or pamphlet.

Complete your research to get all the information required on your chosen species. Remember to think about the guiding questions listed in the Plan section and to use scientific sources to gather your research.

Conduct

Prepare your poster or pamphlet using available craft materials (such as cardboard, markers, pencils), or create your poster digitally.

Improve

Have a look around the class to see what other students have done. Consider how each poster or pamphlet communicates the information about the species. Look back at your own poster and identify two strengths of your poster and two areas for improvement.

Evaluate

1. List three biotic and three abiotic factors that affect the species you investigated in its ecosystem.
2. Predict what would occur if the species you investigated became extinct. Explain how this would affect the other organisms in the ecosystem.
3. Describe three threats that could lead to an organism in an environment becoming endangered.

6.3 Scientific communication

Learning intention

To be able to explore how scientists communicate their research to support conservation practices and policies

Success criteria

SC 1: I can explain the importance of communicating scientific research.

SC 2: I can describe how Dame Jane Goodall influenced conservation policies.

SC 3: I can describe how Dame Jane Goodall's communication of her research changed individual viewpoints.

FIGURE 6.3.1 Dame Jane Goodall communicating her life-long research on primates.

Introduction

Scientists communicate their research through a variety of methods to support their findings. For example, they may publish papers in peer-reviewed scientific journals, present their findings at conferences and workshops and communicate with policy makers and members of the public through popular media and educational outreach programs. Ecologists or scientists working in conservation share their findings with organisations to help them make informed decisions about conservation practices and policies.

In this inquiry activity you will explore how scientists communicate their research to support conservation practices and policies. In particular, you will explore how Dame Jane Goodall (Figure 6.3.1) communicated her research.

Background

The effective communication of scientific research is important because it:

- allows other scientists to verify and build upon the current work, leading to further advancements in knowledge and understanding
- ensures that policy makers, decision-makers and the public have access to accurate and up-to-date information, which is essential for informed decision-making and for addressing important issues
- can increase public understanding of scientific issues, which can lead to greater public interest and support efforts in these areas
- can bridge the gap between scientists and the public, fostering trust and collaboration between these groups and ultimately lead to more effective efforts
- can help to avoid misconceptions and misinformation, which can have harmful consequences.

Dame Jane Goodall is a renowned primatologist and conservationist who has had a significant influence on conservation policies through her research and advocacy. Conservation policies are rules and guidelines that are put in place to protect the natural environment, including animals, plants and their habitats. They achieve this by regulating human activities that may harm ecosystems. Conservation policies are designed to promote sustainability and preserve natural resources for future generations. This inquiry activity will develop your understanding of how scientists like Dame Jane Goodall communicate their research and how doing so can support conservation practices and policies.

Aim

To explore how scientists such as Dame Jane Goodall communicate their research to support conservation practices and policies

Plan

1. Explore how scientists communicate their research to support conservation practices and policies.
2. Explore and explain how Dame Jane Goodall communicates finding from her research, providing examples.
3. Investigate how Dame Jane Goodall influenced conservation policies.

GO TO
Toolkit section 4.3, Selecting and using secondary data
Toolkit section 4.2, Referencing secondary data
Toolkit section 5.1, Scientific writing

Design

1. Choose a conservation topic that is currently in the spotlight in Australia.
2. Using your research into effective scientific communication, consider how you could communicate key scientific learnings. What platform would you use to present this information? What key headings would you use to structure your work?

Conduct

1. Research your topic of interest. Note your key findings.
2. Create a presentation sharing your findings about this topic and its influence on conservation in Australia.

Improve

1. How could you improve your communication strategy for sharing scientific information?
2. Would you change any key headings or the platform you used to communicate? How and why?
3. To what extent do you feel you communicated your conservation topic effectively?

Evaluate

1. What aspects of conservation did you investigate in this inquiry activity?
2. In this activity, you planned and conducted an inquiry into effective communication strategies to support conservation practices and policies. What skills did you use during this activity?

6.4 Organisms and habitats in the school grounds

Learning intention

To be able to conduct a safe, ethical survey of organisms in a local environment

Success criteria

SC 1: I can carry out a sampling technique.

SC 2: I can consider ways to reduce risk and damage to the environment when conducting fieldwork.

SC 3: I can use evidence from primary data to predict observations.

FIGURE 6.4.1 When you explore a habitat and conduct field work, you collect samples and data to learn more about the ecosystem and make predictions.

SAFETY NOTES

- Wear protective gloves when handling any organisms, and wash hands after activity.
- Use dissecting tweezers to pick up any leaves, avoid handling directly.
- If there are any animals still caught in the net, avoid touching them directly.

Introduction

The study of ecosystems often involves sampling areas for the presence of organisms living in habitats. Populations of organisms can be recorded and monitored using a range of sampling techniques.

In this practical investigation you will use the school grounds to investigate a range of habitats and learn about sampling and data collection techniques (Figure 6.4.1).

Background

Living organisms can survive in a range of habitats. There are very few places in the world that have no living organisms.

The organisms living on school grounds will vary depending on the location of the school, but there will be habitats available for this practical.

Aim

To investigate the organisms that are living in various habitats on the school grounds

Materials

- 1 small paintbrush
- 1 dissecting tweezers
- protective gloves
- magnifying glass
- sweep net
- 4 m of string
- 4 weights or stones
- field guide for identification of organisms
- large resealable plastic bags or specimen jars
- map of the school grounds

Assessment of risk

Ensure you are aware of the risks of this practical investigation and have considered how safety can be improved before carrying out this activity.

Method

1 Using the map of the school grounds, choose the location for your experiment. If possible, each group should choose a location with a different type of ground cover.

2 Draw a sketch of your location, noting the date and time, types of plants present and the ground conditions. Take photographs if you can.

3 At your location, measure and construct a 1 m × 1 m square area. Mark the area using the string and weights. This is the area you will sweep and investigate.

4 You will now sweep your 1 m^2 area. To do this, you will brush your net back and forth over the surface of your site in a figure-of-eight pattern. You should keep the open side of the net facing away from you. The aim is to capture any organisms at your site in the net.

Alternatively, you can collect plant samples in your location to identify the variety of plant organisms in your chosen area.

5 Immediately after sweeping hold the bag of the net halfway up to make sure that the organisms in the net do not escape. Another student should prepare the resealable bag.

Alternatively, place any leaves collected in the resealable bags or specimen jars.

6 While another student holds the resealable bag, place the net over it, loosen your hold on the net and turn it inside out into the bag. Carefully shake the net and remove it from the bag. Immediately seal the resealable bag or jar so that the organisms do not escape.

7 Observe the organisms through the resealable bag or specimen jar and try to identify them using your field guide. Count and record the numbers of each type of organism in a suitable table.

8 When your observations are complete, release the organisms. If possible, release them where you found them.

GO TO

Toolkit section 2.2, Ethical behaviour and safety in science

Toolkit section 3.3, Designing a results table

KEY TERM

sampling technique method that scientists use to collect information about plants, animals, and other living things in a certain area

SkillBuilder

Recording results using sampling

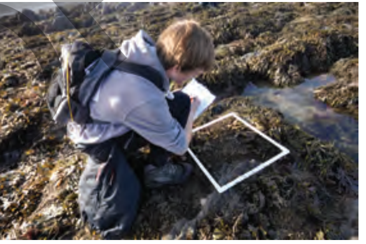
Using sampling to gather data

When studying ecosystems, it is impossible to observe the whole ecosystem. Instead, **sampling techniques** are used to measure aspects of the ecosystem (such as the organisms in the ecosystem).

When using sampling, a part of the ecosystem is selected for observation. It is important to select a part that is a fair representation of the wider ecosystem. If the sample is representative of the wider ecosystem, the data gathered about that location can be used to draw conclusions about the wider ecosystem.

Sampling techniques

Quadrat sampling: A square (or quadrat) is placed on the ground. All the stationary organisms or other features of interest within the quadrat are identified and counted.



Transect sampling: A length of string or measuring tape is used to mark a line through the area to be studied. All the organisms or other features of interest that touch the line are identified and counted.

Time sampling: If recording events, such as animals feeding or sightings of birds returning to nests, it is possible to record results by measuring for only some of the time. When choosing the length of time or when to sample, it is important to keep the sampling fair. For example, some events may only happen at certain times of the day.

Using digital devices: Sampling techniques can be improved with the use of digital technology, such as taking photos, using drones or web cam footage. Smart phones can also use apps to measure several things that will affect an ecosystem such as sound levels, light intensity and air pressure.

Example

Amin wanted to know how many earthworms were in the bushland on his school grounds. Amin used a $1\,m \times 1\,m$ ($1\,m^2$) quadrat to survey an area of bushland and he found 4 earthworms. The total area of bushland was $40\,m^2$, so he estimated a total population of 160 earthworms in the bushland (4 earthworms per metre $\times$40 metres).

SkillBuilder

Ethical collection of data

Ethics are moral principles that govern a person's behaviour. In science, ethics ensure that scientific research is conducted safely and fairly and that the rights of people, animals and the environment are protected.

Ethics in science

Ethical behaviour in science includes:

- being honest with data
- avoiding bias when interpreting results
- sharing data and methods with other scientists
- crediting sources of information correctly
- protecting the rights of humans
- protecting animals and the environment.

The rights of humans

Protecting the rights of humans includes:

- making sure that nobody is physically, mentally or emotionally harmed in science experiments
- recognising First Nations Australians' heritage sites and avoiding disturbing these sites
- obtaining informed consent from all participants in research that involves people.

Protecting the living environment

Protecting the living environment includes:

- planning experiments to minimise disturbance and eliminate any potential for harm to animals
- ensuring all animals that have been trapped are released safely back into their original habitat
- using observation techniques that minimise any damage to the environment
- replacing the use of animals with other techniques where possible, such as simulations.

Example

Marcella was conducting an environmental survey in their local bushland. They:

- checked who owned the land to get permission to complete the survey
- conducted the survey with just one other person to avoid too much damage to the ecosystem
- used a quadrat to sample small sections of bushland
- ensured that they had appropriate clothing to protect their arms and legs from Sun exposure, insects and scratches from small branches when walking through the bush
- used their mobile phone to take photos rather than remove samples
- shared the results of the survey with the owner of the land.

Results

GO TO
Toolkit section 3.3, Designing a results table

1 Record your results as described in the method including the time and date of your data collection and a description of the sample area. Construct a table showing the appearance and number of each type of organism at your site. Record your results in the table.

2 Predict if the results from the other members of the class will show the same trend across the school grounds or if some areas will be more densely populated than others.

3 Record the results of other members of your class on your map of the school grounds.

Conclusion

Write your conclusion by answering the following questions:

1 Compare the numbers and different types of organisms caught at the various sites. For example, which site had the largest number of organisms observed? Which site had the largest variety of organisms observed?

2 Discuss the differences between the sites that could cause these variations.

3 a Discuss whether you would expect the same organisms in your sweep if you conducted this experiment at different times of the day and different times of the year. If you think you would observe different results, propose reasons for this variation.

b Describe a way of testing your predictions.

Evaluation

GO TO
Toolkit section 2.2, Ethical behaviour and safety in science

Evaluate your practical investigation. Include how you considered ethics, including ways to reduce risk and damage to the environment when conducting fieldwork.

6.5 Food chains

Lesson overview

Energy is captured from the Sun by producers to make food. Most producers are green plants and without them there would be no life, because animals cannot make their own food (Figure 6.5.1). All organisms must have a source of food to make energy to survive. Food chains show feeding relationships and energy flow within ecosystems in a single path. In this lesson you will learn about the relationships organisms have with each other and how energy flows through ecosystems.

SC 1 I can construct a food chain based on an Australian ecosystem

All organisms need energy to survive. Plants are called **producers** because they make their energy from sunlight. All other organisms are called **consumers**, because they get their energy from the plants and other animals they eat. The flow of energy from one organism to another can be represented as a **food chain**. The arrows in a food chain show the direction of energy flow from one organism to another (Figure 6.5.2).

FIGURE 6.5.2 The Sun fuels the wheat, which fuels the harvest mouse, which fuels the kookaburra.

If the kookaburra dies, then **decomposers** such as bacteria or fungi break down the remains and return the nutrients to the soil.

SC 1 CHECK YOUR UNDERSTANDING

What is the correct definition of a producer?

A Needs to eat other organisms to survive.
B Needs to breakdown other organisms to survive.
C Needs to produce sunlight to gain their energy.
D Needs to capture sunlight to manufacture its own energy.

Learning intention

To understand how food chains can demonstrate feeding relationships and energy flow within ecosystems

Success criteria

SC 1: I can construct a food chain based on an Australian ecosystem.

SC 2: I can identify producers and primary, secondary and tertiary consumers in a food chain.

SC 3: I can describe specific feeding relationships, including predator-prey, in Australian terrestrial and aquatic ecosystems.

FIGURE 6.5.1 A koala snacks on eucalyptus leaves.

KEY TERMS

producer organism able to manufacture its own food; plants are producers
consumer organism that must eat other organisms to get the energy and nutrients it needs
food chain the flow of energy from organism to organism in a series of feeding relationships
decomposer organism that gets the energy it needs by breaking down dead matter and waste products

KEY TERMS

primary consumer a consumer that only eats plants, algae and other producers; also known as first-order consumer

secondary consumer a consumer that eats a primary consumer; also known as second-order consumer

tertiary consumer a consumer that eats a secondary consumer; also known as third-order consumer

apex predator predator that has no natural predators except humans

SC 2 I can identify producers and primary, secondary and tertiary consumers in a food chain

The flow of energy from organism to organism in an ecosystem can be shown in a food chain. The direction in which the arrow is pointing shows the direction of energy flow. The grass is the producer as it obtains its energy from the Sun. Each organism in the food chain increases in consumer level. Figure 6.5.4 is an example of a grassland food chain.

The grasshopper is a **primary consumer** (also known as a first-order consumer) as it consumes the producer.

The bird is the **secondary consumer**.

The fox is the **tertiary consumer**.

Food chains always end with the top predator or **apex predator** which is not preyed upon by any other organism but will be decomposed after its death. In this food chain, the fox has no natural predators, so it is apex predator.

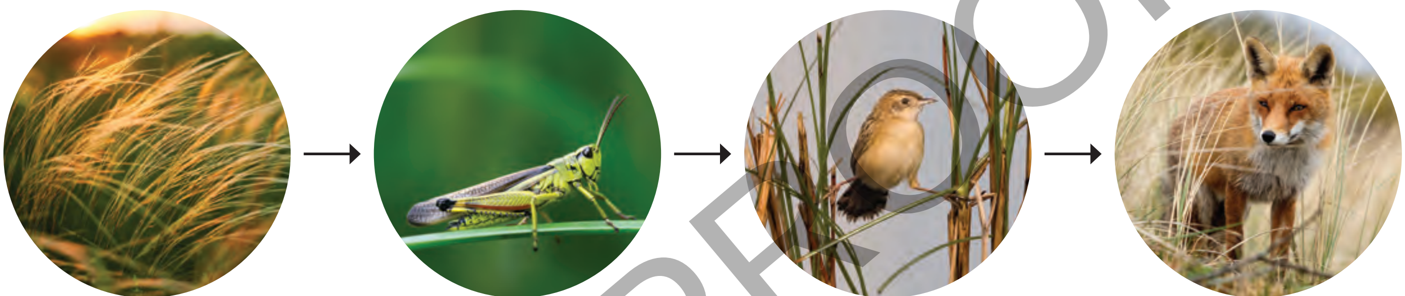


FIGURE 6.5.4 A grassland food chain showing the direction of energy flow.

Food chains are not usually bigger than four steps, this is because there will be too much energy lost between each step and the energy available for the next organism will be lost.

Energy can be lost in a few ways; through heat and in removal of waste such as faeces (digestive waste).

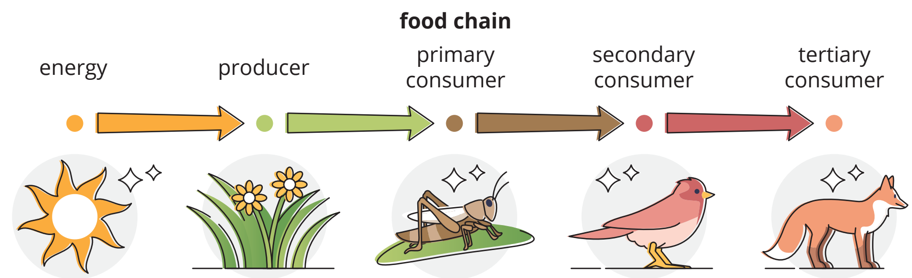
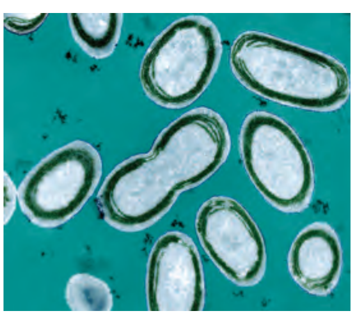


FIGURE 6.5.5 A food chain showing different producers and consumers.

Scifile

Primary tiny producers

In a food chain, primary producers like plants and algae create energy through photosynthesis. Scientists estimate that about half of the oxygen production on Earth is produced by oceanic plankton, drifting plants, algae, and some bacteria that can photosynthesise.



When you join all of the food chains in an ecosystem you create a **food web** (Figure 6.5.6). Food webs are a representation of the relationships between lots of organisms.

FIGURE 6.5.6 An example of an interconnected food web.

KEY TERM

food web a diagram representing two or more connected food chains

Scifile

Apex predators

Apex predators, like sharks, bears, wolves and eagles are at the top of the food chain. They have no natural predators and play a crucial role in maintaining the balance of ecosystems.

Great white shark (*Carcharodon carcharias*), hunting and eating a seal.

SC 2 CHECK YOUR UNDERSTANDING

Look carefully at the photo and consider the food chain it represents.

a Which is the producer?
b Which is the primary consumer?
c Which is the secondary consumer?
d Although it is not pictured, what might be an apex predator in this food chain?

The smallest sea creatures, plankton, attract bait balls of sardines which then attract sea lions.

SC 3 I can describe specific feeding relationships, including predator-prey, in Australian terrestrial and aquatic ecosystems

In an ecosystem, a variety of organisms live together and rely on each other in many ways. Living organisms affect each other when they compete for resources such as food, shelter, mates and a suitable environment. Some of these relationships are helpful and some are harmful.

Competition

Competition can occur between members of the same species or different species. For example, when a tree in the rainforest drops its seeds, if they fall in the same place, the seedlings will compete for sunlight availability, space, as well as nutrients and water from the soil (Figure 6.5.7).

FIGURE 6.5.7 Seeds competing for the same resources in a rainforest.

KEY TERMS

competition relationship between organisms that are trying to use the same limited resource
predator an animal that kills and eats other animals
prey an animal that is eaten by a predator

FIGURE 6.5.8 The pitcher plant consumes a moth.

FIGURE 6.5.9 Numbats are carnivores.

Predator-prey relationship

Predation is a relationship where one organism kills and eats another. In this feeding relationship the attacker is the **predator** and the one being eaten is the **prey**. In the photograph (Figure 6.5.8), a moth is being consumed by a pitcher plant. The predator is the pitcher plant, and the prey is the moth.

Types of consumers

The following terms are used to describe different types of consumers.

Herbivore: A herbivore is an organism that feeds only on plants such as grass, leaves, roots and vegetables. Examples of herbivores include wombats, kangaroos, sugar gliders and caterpillars.

Carnivore: A carnivore is an animal that feeds only on other animals. Examples include quolls, sharks, eagles, numbats (Figure 6.5.9) and the Tasmanian devil.

Omnivore: An omnivore is an organism that feeds on both plants and animals. The Australian bandicoot is an example of an omnivore. It eats roots, insects, worms, berries and fungi. Other examples of omnivores include the emu, bilby and bobtail lizard.

Examples of feeding relationships and their position on the food chain

Table 6.5.1 shows some examples of feeding relationships and the organism's position on the food chain.

TABLE 6.5.1 Feeding relationships and the organism's position on the food chain

Bobtail lizard	Gum moth caterpillars	Rose gum eucalyptus trees
consumer - omnivore	consumer - herbivore	producer
Consume: a variety of plants and insects including flowers and beetles	Consume: eucalyptus leaves	Consume: use sunlight, water and carbon dioxide to produce their own food
		

SCIENCE IN SOCIETY

Urban food chains

Food chains are not just found in natural ecosystems; they also exist in urban environments (for example, Figure 6.5.10). In a city, a simple food chain might start with plants growing in a park or garden. These plants are eaten by insects, which are then eaten by birds. The birds might then be preyed upon by larger animals such as cats or hawks.

Understanding urban food chains can help scientists and city planners develop strategies to support urban biodiversity. This might include planting native plants to provide food for insects and birds, or creating green spaces that support a variety of species.

FIGURE 6.5.10 An example of an urban environment: Kings Park, Perth, Western Australia.

SC 3 CHECK YOUR UNDERSTANDING

Would a herbivore or a carnivore be closer to the start of a food chain? Explain your answer.

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1. Explain why producers are essential in a food chain.
2. Explain how primary consumers differ from secondary consumers in a food chain.
3. Identify the producer, primary consumer, secondary consumer and tertiary consumer in the following food chain:

   eucalyptus tree → koala → dingo → eagle
4. Define a predator-prey relationship.
5. An organism eats leaves, roots, insects and it sometimes eats small mammals. Identify its position on the food chain and its feeding relationship. Give reasons for your answer.
6. Describe a predator-prey relationship in an Australian aquatic ecosystem.
7. Describe how you would construct a food chain for a coastal Australian ecosystem.

6.6 Biomass pyramids

Learning intention

To understand how biomass pyramids can be used to describe and compare different ecosystems

Success criteria

SC 1: I can explain how ecological pyramids can be used to represent the flow of energy between populations in a food chain.

SC 2: I can describe the flow of energy through a biomass pyramid.

SC 3: I can measure and compare the flow of energy within biomass pyramids using provided data.

KEY TERMS

biomass pyramid visual representation to show how mass and energy are distributed in an ecosystem
mass the amount of matter in a substance or object; measured in grams (g), kilograms (kg) or tonnes (t)
trophic level feeding level in a food chain such as a producer or consumer
ecology the study of how organisms interact with each other and with their non-living surroundings
ecologist scientists who study the interactions between living things and their environment
terrestrial on land

Lesson overview

Imagine a bustling forest filled with tall trees, colourful flowers, and a variety of animals. Every living thing in this ecosystem plays a role in the balance of its environment. But, have you ever wondered how energy moves through these different levels of the ecosystem?

In this lesson you will learn about the concept of biomass and biomass pyramids which is tell us about the mass of all the organisms at each level of a food chain.

SC 1	I can explain how ecological pyramids can be used to represent the flow of energy between populations in a food chain

A **biomass pyramid** can be used to visualise the total **mass** of all the organisms in a food chain at the different feeding levels. These diagrams describe the quantity or mass of the of the organisms at each of the **trophic levels** that you can see in a food chain or food web.

To understand the **ecology** and health of an area **ecologists** will survey the number of each organism in a food chain and draw a diagram to represent the mass of organisms at each stage (Figure 6.6.1).

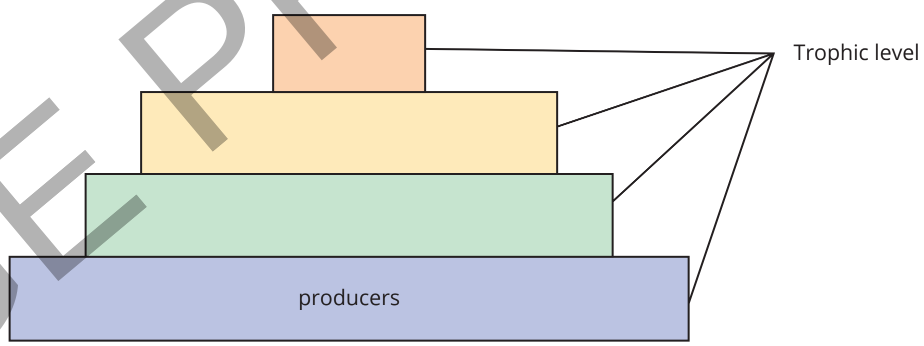


FIGURE 6.6.1 A generalised terrestrial biomass pyramid showing each trophic level from largest (bottom level – producers) to smallest mass (top level – apex predators).

Terrestrial biomass pyramids

Energy in a **terrestrial** biomass pyramid is passed up from the bottom of the pyramid to the top. The energy is being transferred up the pyramid because the organisms are being consumed by the organisms above them.

In a biomass pyramid, the producers are at the bottom (first feeding level), followed by herbivores (primary consumers) and then carnivores (second and third order consumers).

Figure 6.6.2 shows a similar pyramid for a community made up of grasses and blackberries, rabbits, corn snakes and eagles. The rabbits eat the grasses and blackberries, then pass their energy on to the corn snake, which is then killed and eaten by the eagle. It is important to recognise that without the producers (grasses and the blackberries) the eagle could not survive.

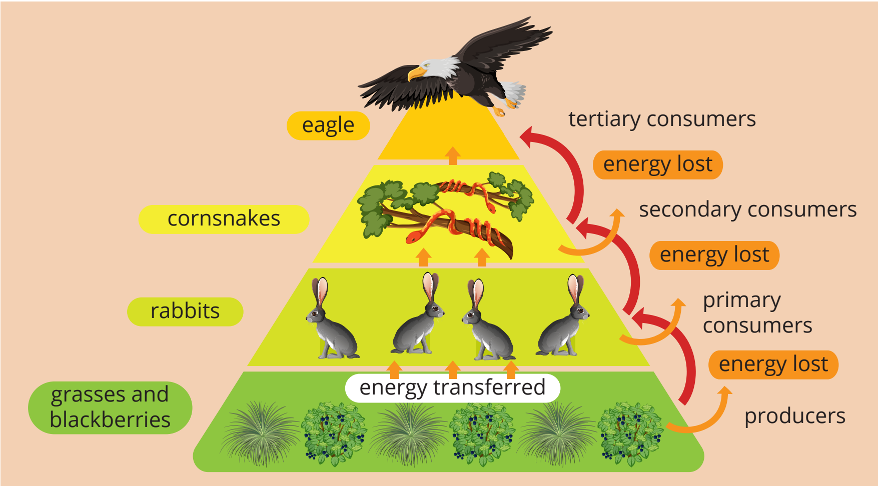


FIGURE 6.6.2 The biomass pyramid shows how energy flows through a terrestrial ecosystem.

SCIENCE IN SOCIETY

Australian rainforests

In an Australian rainforest, the base of the biomass pyramid is made up of the large number of plants that produce energy through photosynthesis. These plants support a smaller number of herbivores, which in turn support an even smaller number of predators. By comparing the biomass pyramids of different ecosystems, scientists can gain insights into the structure and function of those ecosystems. This information is crucial for developing conservation strategies and managing natural resources.

FIGURE 6.6.3 The green tree python (*Morelia viridis*) is a predator in the Daintree rainforest, Queensland.

Aquatic biomass pyramids

Aquatic biomass pyramids are often drawn upside down. They are also a visual representation of the food chains in water except that the producers are on the top and the apex predators are on the bottom.

The pyramid is inverted because the total mass of aquatic producers, such as plankton and seaweed, can be much smaller than the mass of large organisms that live in the ecosystem, such as whales. Figure 6.6.4 shows a biomass pyramid for a community consisting of seaweed, parrotfish, sharks, and killer whales. In this food chain, parrotfish consume the seaweed, transferring energy to the sharks that eat them. The sharks are then hunted and eaten by the killer whale.

KEY TERM

aquatic in water, water environments such as ponds, lakes, oceans and seas

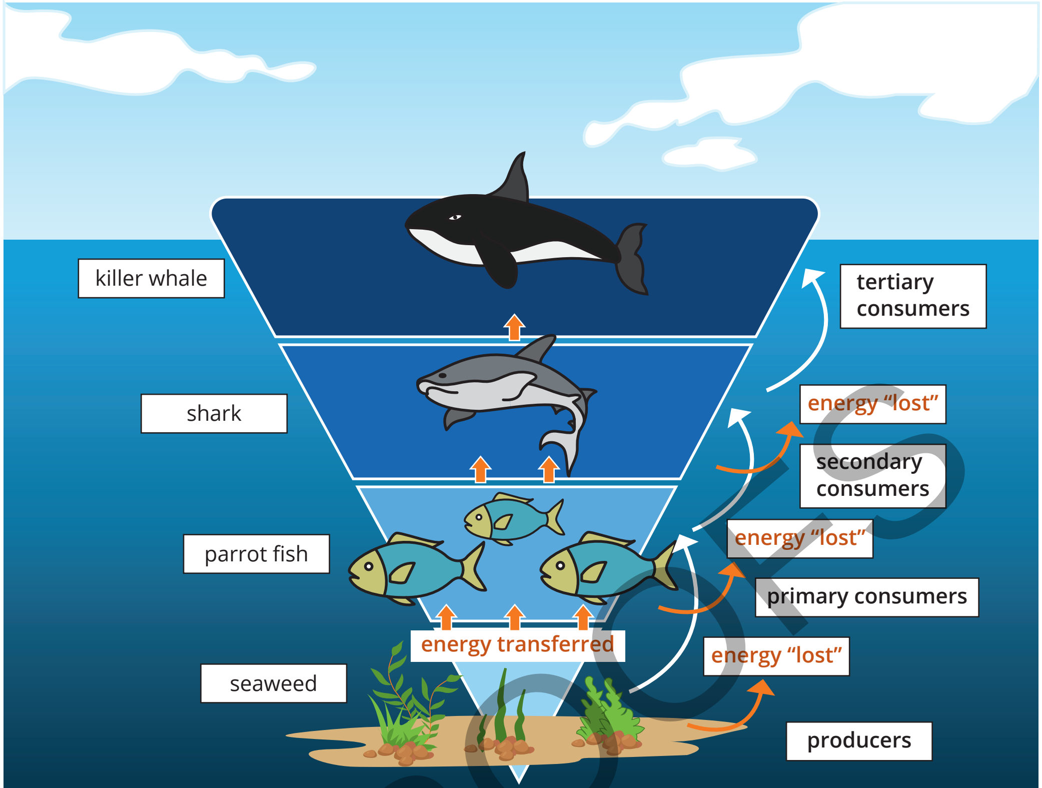


FIGURE 6.6.4 The biomass pyramid shows how energy flows through an aquatic ecosystem.

Pyramids of numbers

A **pyramid of numbers** is like a biomass pyramid, but instead of being based on the total mass of organisms, a pyramid of numbers is based on the individual number of organisms at each level.

Pyramids of numbers can have a variety of shapes, especially when there are many small consumers feeding off a large producer. The number pyramid might not look like a pyramid at all.

For example, when 20 caterpillars, with an average mass of 3 g, feed on two lettuces, with an average mass of 60 g, the pyramid of numbers might look quite different as shown in Table 6.6.1.

TABLE 6.6.1 Pyramid of numbers vs pyramid of biomass

Organism	Average mass of one organism (g)	Pyramid of numbers (includes the total number of organisms in each feeding level)	Pyramid of biomass (includes the total mass of all organisms in each feeding level)
sparrow	12	1	12
caterpillar	3	20	60
lettuce	60	2	120

SC 1 CHECK YOUR UNDERSTANDING

Outline the difference between a biomass pyramid and a pyramid of numbers.

SC 2 I can describe the flow of energy through a biomass pyramid

All living things need energy to survive. Energy enters an ecosystem as sunlight and is converted by plants into chemical energy through the process of photosynthesis. This energy is then used by plants for growth and other plant functions.

Energy is also used up by animals in everyday functions. An example of this is a chicken losing heat energy while running. This energy is now 'lost' from the food chain, so less energy is available to the next consumer.

Usually only 10% of energy is passed on from one consumer to the next; this means that 90% of energy is used up from the level below. The example in Figure 6.6.5 shows 90% of energy being lost from the chicken (first-order consumer) and only 10% going directly to the farmer (second-order consumer).

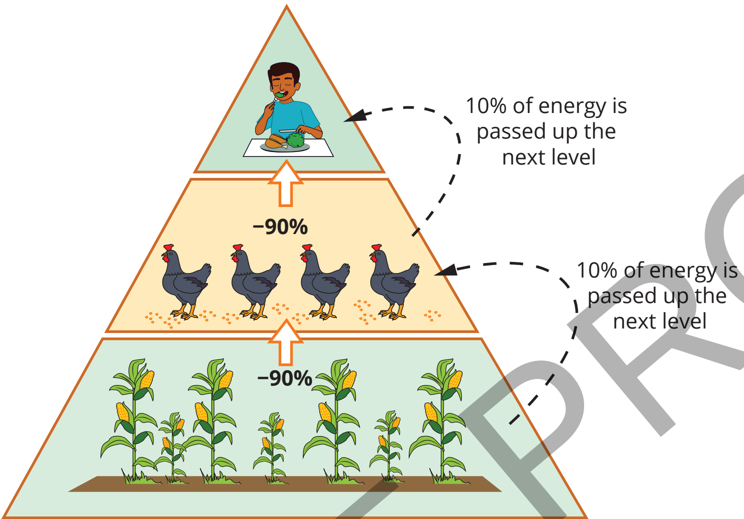


FIGURE 6.6.5 The amount of energy available reduces the further you go up the biomass pyramid.

SC 2 CHECK YOUR UNDERSTANDING

In a biomass pyramid, identify the total amount of energy:

a transferred between levels

b lost between levels.

SC 3 I can measure and compare the flow of energy within biomass pyramids using provided data

Energy transfer in food chains

A healthy ecosystem has lots of producers, many herbivores and relatively few carnivores and omnivores. In this way the ecosystem can maintain and recycle its **biomass** quickly without running out of resources. In an ecosystem, biomass shrinks at each level of the food chain or at each trophic level because about 90% of an organism's energy is lost as heat or waste. A predator only consumes the remaining biomass.

KEY TERM

biomass all plant and animal matter found on Earth

Efficiency of biomass transfer in food chains

The efficiency biomass transfer is used to calculate the amount of biomass that is transferred from a lower feeding level to a higher one.

The efficiency of biomass transfer can be calculated using a simple equation:

$$\text{efficiency of biomass transfer} = \frac{\text{amount of biomass transferred to the next level}}{\text{biomass that was available at the previous level}} \times 100\%$$

Calculating energy flows

If there were 100 kg of grasshoppers and they were eaten by 10 kg of birds, the efficiency of energy transfer would be calculated as follows.

$$\frac{10 \text{ kg birds}}{100 \text{ kg grasshoppers}} \times 100\% = 10\% \text{ transfer}$$

This means that only 10% of the energy consumed by the grasshoppers is passed on to the birds. The remaining 90% will have been used by the grasshoppers.

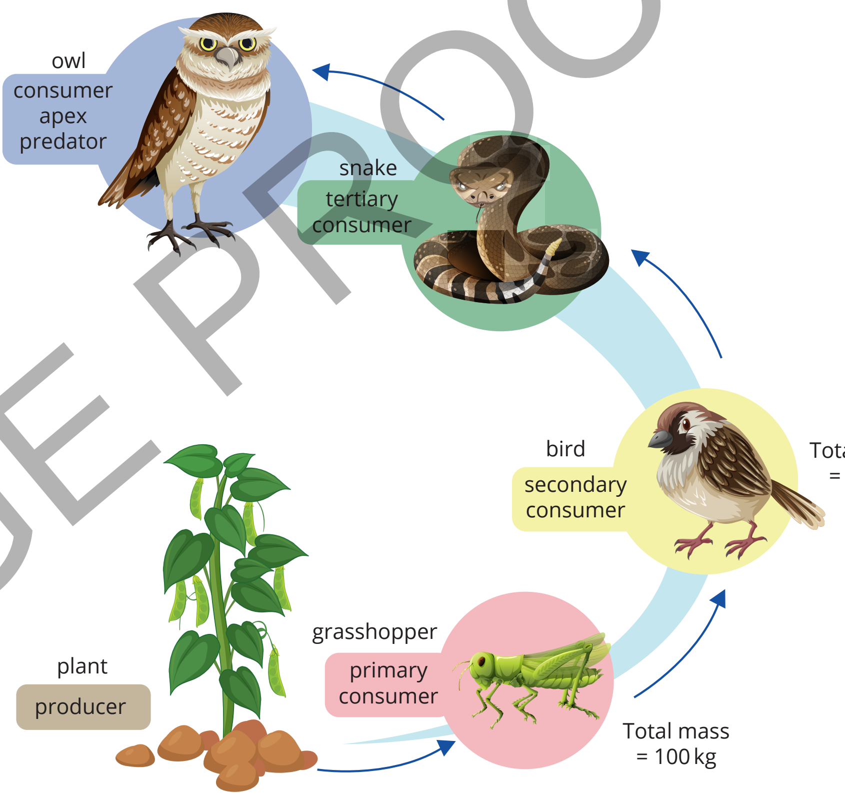
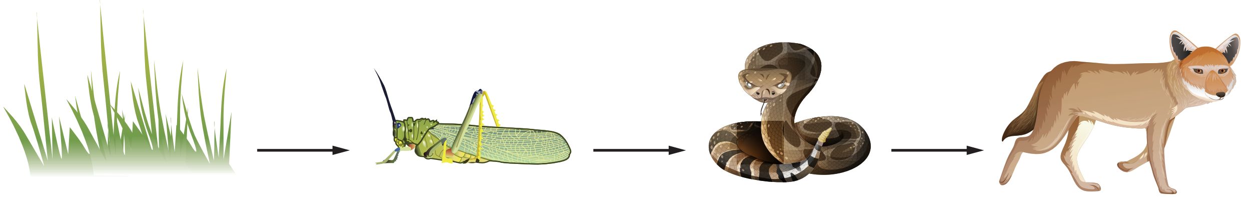


FIGURE 6.6.6 Energy flow among the organisms in a food chain through biomass transfer.

Using calculations such as these, the energy flow in different biomass pyramids can be compared.

SC 3 CHECK YOUR UNDERSTANDING

Calculate the efficiency of biomass in this food chain.



Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1. Define a biomass pyramid.
2. Identify the primary source of energy for most biomass pyramids.
3. Compare the biomass pyramids of a rainforest and a desert ecosystem in Australia.
4. Calculate the efficiency of transfer if 60 kg of eastern brown snakes were eaten by 2 kg of kookaburras.

6.7 Food webs

Learning intention

To understand and predict interactions and energy flow in an ecosystem using a food web

Success criteria

SC 1: I can create a food web from information about feeding relationships in an ecosystem.

SC 2: I can explain the energy pathways in a food web, including identifying producers, different levels of consumers and apex predators.

SC 3: I can use relationships from a food web, and the concept of competition, to predict the effect of population changes within an ecosystem.

Lesson overview

The flow of energy from one organism to another in an ecosystem can be shown in a food chain. However, animals rarely eat just one type of food. Most animals have a varied diet which depends on what they can catch or what is available during different seasons. These relationships can be shown using interconnected food chains, which are called food webs. Much like a spider web, food webs have many points of connection.

In this lesson you will learn about how food chains interconnect to become food webs to be able to predict changes in populations in an ecosystem.

SC 1 I can create a food web from information about feeding relationships in an ecosystem

Creating food webs

A food web is made up of every food chain in an ecosystem. One type of organism can be part of many food chains. Like food chains, food webs start with producers and show the path that energy may take as it moves through the ecosystem. The producers are at the bottom of the food web, and the carnivores are at the top of the food web.

The food web in Figure 6.7.1 contains several food chains, including:

1 carrot → rabbit → fox

2 grass → grasshopper → owl

3 grass → grasshopper → bird → fox

4 grain → mouse → owl

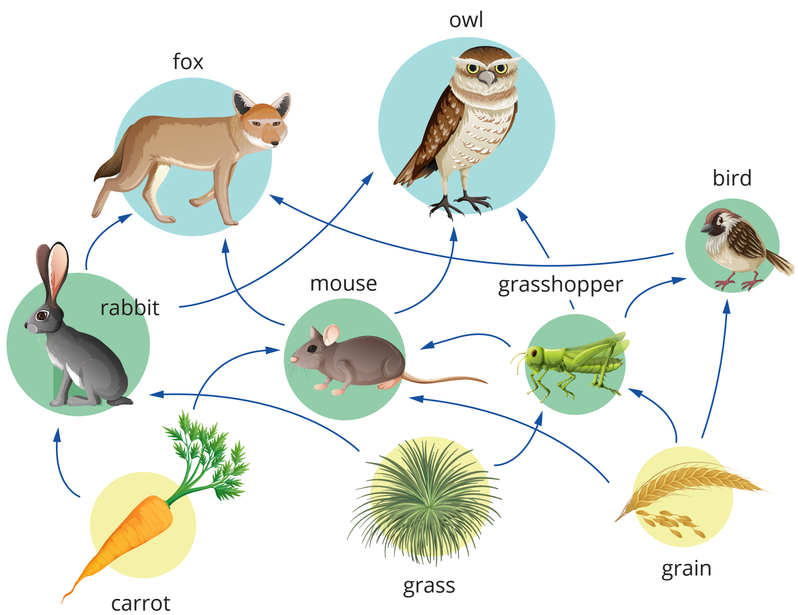


FIGURE 6.7.1 Food webs show the many places that energy can flow.

HINT

When constructing a food web, draw all the producers at the same level on the diagram. Make sure that the primary consumers and secondary consumers are aligned. This is not always possible, especially with complex food webs, but it makes the food web easier to follow.

GO TO Toolkit section 5.4, Graphic organisers

Food webs use arrows to show the flow of energy between organisms. The arrows point from the organism being eaten to the organism doing the eating. The arrows also show the direction the energy is transferred to.

Several organisms can have the same food source, and there can be multiple producers as well as many primary, secondary and tertiary consumers in any given food web.

SC 1 CHECK YOUR UNDERSTANDING

Use Figure 6.7.1 to identify one example of each of the following trophic levels.

a producer
b primary consumer
c secondary consumer
d tertiary consumer

SC 2 I can explain the energy pathways in a food web, including identifying producers, different levels of consumers and apex predators

Purpose of food webs

Food webs show the flow of energy between organisms and visually represent who eats who in a habitat. Several organisms can have the same food source. An organism can even hold several feeding positions of primary and secondary consumer (or secondary and tertiary consumer), depending on which food chains they are a part of.

It is rare for an organism to rely on only one food source – if it did, then it may not survive if that food source disappeared due to disease, seasonal changes, or a natural disaster.

For example, in Figure 6.7.2, the snake can eat mice, frogs or lizards. If, for example, frogs were to run out, the snake could still eat mice and lizards to survive.

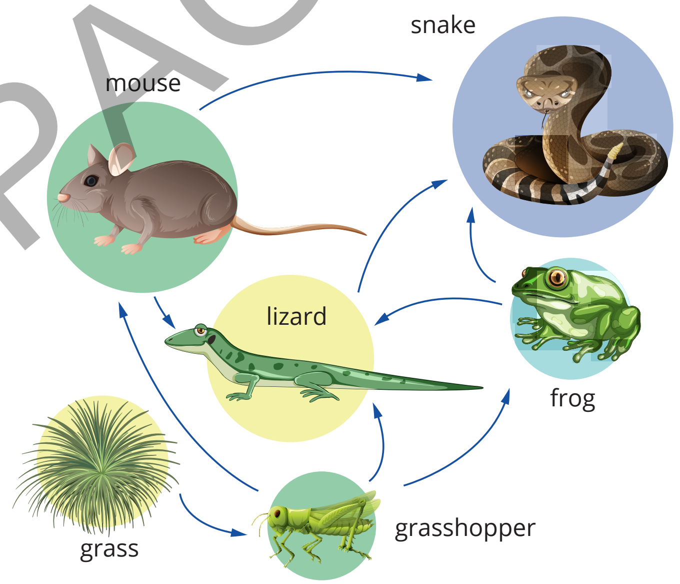
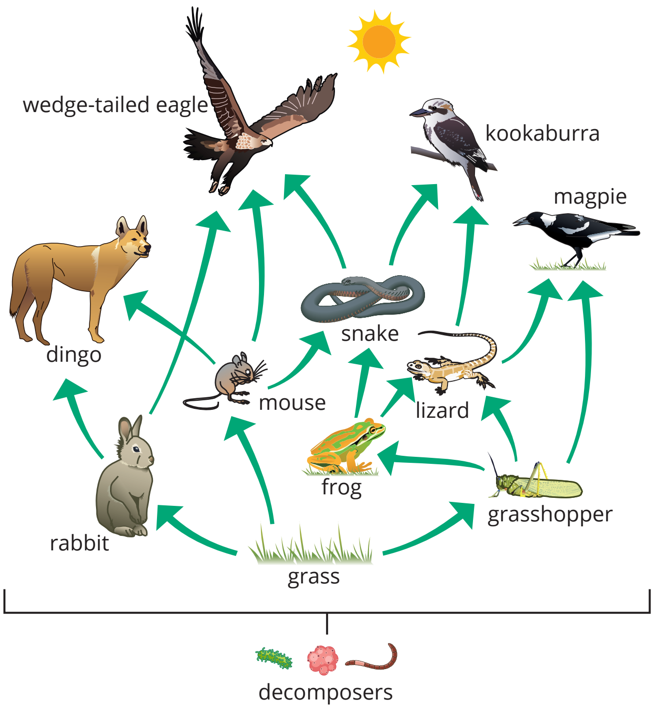


FIGURE 6.7.2 Many simple food chains can interconnect to create a more complex food web.

Scifile

Energy flow

Energy flows through a food web from primary producers to various consumers. Understanding this flow helps scientists predict how changes in one species can affect the entire ecosystem.



The primary energy source in a food web is the Sun. The Sun provides the energy that help plants, the producers, make their own food.

Apex predators are at the top of the food web. They have no natural predators, except humans.

- Tertiary consumers eat the secondary consumers.
- Secondary consumers eat primary consumers.
- Primary consumers gain their energy from eating producers.
- Producers are at the base of a food web and provide energy for the primary consumers.

When organisms die or produce waste, decomposers break down this material and return the nutrients to the soil. These nutrients are then reused by the producers.

FIGURE 6.7.3 This food web shows the flow of energy in a eucalypt woodland.

Apex predators

Apex predators are at the top of the food web. They have no natural predators, except humans.

Energy pathways in food webs

Food chains typically involve around four to five steps because too much energy would be lost if there were too many feeding levels.

Food chains and food webs

Two of the food chains within the food web shown in Figure 6.7.2 are:

grass → grasshopper → frog → snake → wedge-tailed eagle

grass → mouse → snake → wedge-tailed eagle

The snake sits within both food chains. In the first, the snake is a tertiary consumer. In the second, it is a secondary consumer.

Can you see any other examples of organisms occupying more than one **trophic level** in the food web?

KEY TERM

trophic level the position of an organism in a food chain

SC 2 CHECK YOUR UNDERSTANDING

Identify the primary energy source in a food web.

SC 3 I can use relationships from a food web, and the concept of competition, to predict the effect of population changes within an ecosystem

Predicting the effect of population changes using food webs

Population changes occur in ecosystems for a variety of reasons including:

- seasonal changes
- the introduction of a species that is not native to the area
- predator-prey relationships (Figure 6.7.4)
- **climate change**
- disease
- natural habitat change (such as a fallen tree)
- human-caused changes (such as adding fertilisers to lawns near waterways).

These changes in the ecosystem may cause population increases, decreases or the disappearance of an organism from the ecosystem altogether.

It is for this reason that there are a variety of organisms in an ecosystem; in other words, a biodiverse ecosystem is a healthy ecosystem. For example, in an ecosystem that has greater biodiversity, if one food source is in short supply, another food source can be found and used by the organism that needs it.

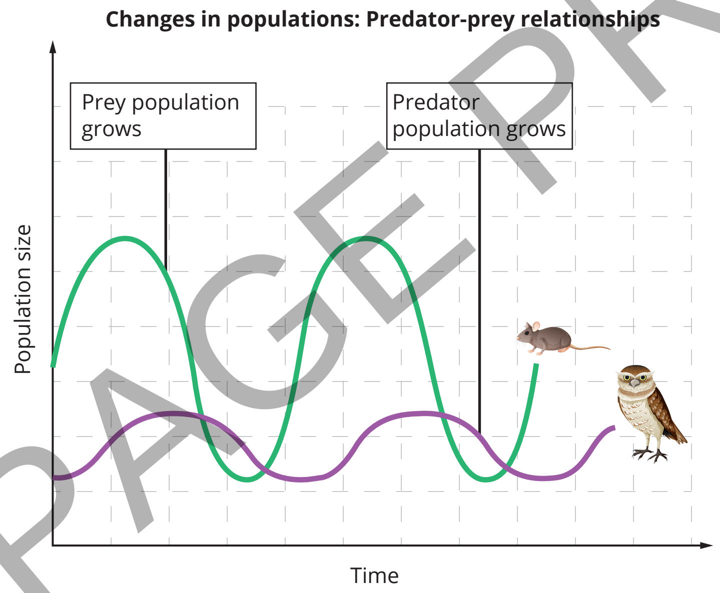


FIGURE 6.7.4 The graph shows that there is almost always more prey than predators: when predators are greater in number, prey decreases; when predators are lower in number, prey increases.

KEY TERM

climate change long-term changes in climate, including temperature change and weather patterns

Scifile

Omnivorous bears

In Alaska, climate change is causing berries to ripen earlier in the season, causing bears to switch their diet from salmon to berries. This shift affects the salmon population as well as scavengers who normally rely on the carcasses of the fish left behind by the bears.

GO TO Toolkit section 3.5, Patterns and trends in data

Competing for food

Food webs have many organisms that eat the same type of food or prey. In Figure 6.7.5, foxes compete with owls for mice. What would happen to the fox if there were fewer mice available? It could be assumed that the fox would eat more rabbits, and this would reduce the rabbit population. This might result in an increase in the amount of grass available as there would be fewer rabbits eating the grass.

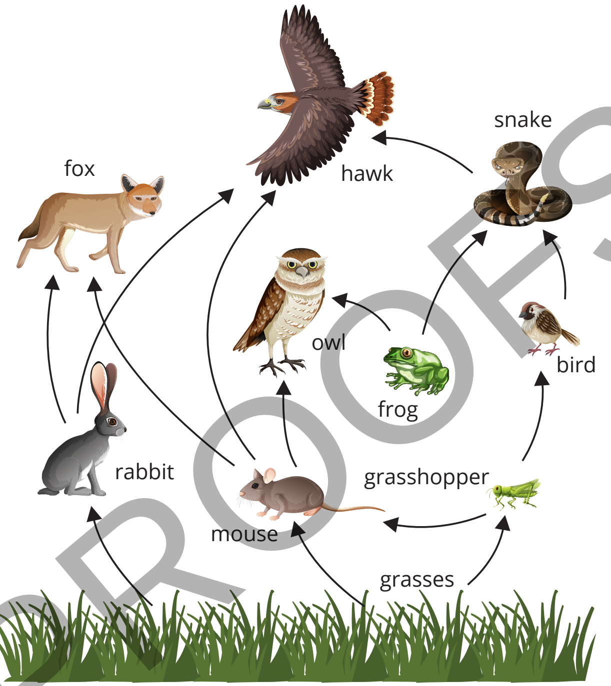


FIGURE 6.7.5 Food webs are complex and can affect many organisms in an ecosystem.

SC 3 CHECK YOUR UNDERSTANDING

Using Figure 6.7.4 and Figure 6.7.5, explain what would happen to the mouse population if the number of owls increased.

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1 Explain what is shown in a food web.
2 Explain why food webs in a rainforest are more complex than food webs in a desert ecosystem.
3 Describe competition in an ecosystem.
4 Creating food webs helps understand the interactions and energy flow in an ecosystem.
   a Describe the steps needed to create a food web.
   b Identify the key producers and consumers in a costal ecosystem.
   c Draw the food web based on the identified feeding relationships in part b.
   d Explain the importance of each trophic level in maintaining the ecosystem's balance.
5 Predict how an increase in the population of a primary consumer may affect the food web in a grassland ecosystem.

6.8 Food web in an Australian ecosystem

Introduction

Understanding feeding relationships and interactions between organisms is important for the management and conservation of ecosystems and species. By understanding the complex interactions between organisms, scientists can predict the impact of disturbances to ecosystems (figure 6.8.1). Food webs are useful tools for understanding these interactions and the trophic levels within them. In this practical investigation you will observe the feeding relationships in your local environment.

FIGURE 6.8.1 Marine scientists observe the feeding relationships in the ocean.

Learning intention

To be able to apply the concept of trophic levels to a food web in a local ecosystem

Success criteria

SC 1: I can collaboratively plan to survey an ecosystem including selecting appropriate equipment.

SC 2: I can propose at least one possible food web based on the organisms observed in the ecosystem.

SC 3: I can predict, with reasoning, the effect of a change on populations within the ecosystem.

Background

There is a complex network of organisms living all around you—even in your backyard. You may not have thought about the connections before, but producers, such as plants, use energy from the Sun to make their own food through photosynthesis. This energy is then passed on when herbivores eat plants and continues to transfer through food webs as predators eat their prey. From small plant-eaters to top predators, all organisms in an ecosystem depend on the energy that starts with the producers.

HINT

Remember that, in part, science is carried out through observation. You do not need a lot of specialist equipment to observe your local environment. You will, however, need to document your results. What equipment will you need? What if you cannot see an organism clearly or do not know what it is? What equipment can you use to help you?

Aim

To conduct a survey of a local ecosystem and construct a food web to represent the feeding relationships between the organisms that live there

Materials

Write a materials list for your investigation.

SAFETY NOTE

- Write safety notes for your investigation. Think of three to four different aspects of your investigation that might need some more careful consideration.

GO TO

Toolkit section 2.1, Writing a method for an experiment
Toolkit section 5.4, Graphic organisers

Assessment of risk

Ensure you are aware of the risks of this practical investigation and have considered how safety can be improved before carrying out this activity.

Method

Working in a small group of approximately 3–4 students, write a method for your investigation.

Remember you will need to collect information that will help you to create a food web when you are back in the classroom. Your method will vary depending on your location and time available but consider including:

- exactly where the survey will take place
- what actions are required from each team member
- what kind of data sheet you will use for recording the ecosystem survey data
- how you will identify and record all the organisms you observe, and what they are eating.

Results

1 Using your survey data, classify each organism that you observed as a:
   - producer
   - herbivore (primary consumer)
   - carnivore (secondary consumer)
   - carnivore (tertiary consumer)
   - omnivore, or
   - decomposer.

   If you are not sure which trophic level an organism belongs to, research its diet and then classify it. Consider how you could present this information.

2 Construct a food web to show the relationships between the organisms that you have observed.

Conclusion

1 How does the food web you created assist you in understanding the interactions between organisms in this ecosystem?

2 How could a food web be used to predict the impact of human activities on an ecosystem? Describe one example to support your answer.

Evaluation

1 Identify all the organisms in your food web that compete for the same food.

2 Modify your food web to include an invasive species that could be introduced into the ecosystem.

3 Identify at least one problem with the procedure you used to conduct your practical investigation. Suggest an improvement you could make to overcome this problem.

6.9 Habitat destruction and pollution

Lesson overview

Throughout history, humans have lived within ecosystems, often unaware of how their actions disrupt the balance of abiotic and biotic factors. Today, a deeper understanding of the natural world allows for more informed choices and efforts to correct past mistakes, helping to preserve the environment for future generations.

As societies have developed, people have become less connected to nature and more dependent on exploiting natural resources. Many Australians have opportunities to work with scientists, governments, and First Nations Australians to share knowledge and influence environmental outcomes.

In this lesson, you will explore the shared responsibility of protecting the planet for future generations. It also examines how First Nations Australians provide valuable knowledge for rebuilding a sustainable and respectful relationship with nature.

Learning intention

To understand how human use of the environment can cause habitat damage or destruction

Success criteria

SC 1: I can explain how farming practices can affect ecosystems.

SC 2: I can explain how First Nations Australians' traditional knowledge can inform sustainable harvesting practices.

SC 3: I can describe examples of chemical pollution caused by agriculture, industry and urbanisation.

SC 1 I can explain how farming practices can affect ecosystems

Farming, which began over 12 000 years ago, has evolved into a global practice. Today, food supplies rely heavily on intensive farming methods. These are designed to boost efficiency in production within a very limited land area to reduce costs for farmers. Farming practices include the use of advanced technology, mechanisation, increased chemical application, specialisation and government policies.

For example, modern tractors (Figure 6.9.1) can prepare fields at a much faster rate than manual labour. This results in significant time and labour cost reductions. However, these intensive practices can have adverse effects on soil structure, water supplies and the integrity of the environment. To counteract these consequences, additional measures, such as the application of chemicals and fertilisers, are often employed.

FIGURE 6.9.1 A tractor working on a field.

Scifile

Food waste

In Australia, about 35% of food production every year goes to waste. While boosting food production is vital for enhancing food security, it should also be coupled with sustainable and quality-focused practices to reduce food waste and guarantee the nutritional value, safety and overall quality of the food supply.

Alternatives to intensive farming practices

Many individuals are now prioritising food that is grown without harmful chemicals and without a significant negative impact on the environment. As a result, there have been an increasing number of farmers that have turned to more sustainable food production practices.

KEY TERM

agricultural relating to the practice of growing plants and animals to make food

Permaculture

Permaculture principles focus on designing **agricultural** systems that align with nature and promote biodiversity. This adaptable approach can be applied across various Australian environments, from arid zones to temperate regions (see Figure 6.9.2).

FIGURE 6.9.2 An organic permaculture garden with a variety of different species.

Organic farming

Organic farming practices avoid synthetic pesticides and fertilisers. By doing this organic farming safeguards the natural environment promoting healthier soils and reducing chemical contamination (Figure 6.9.3).

FIGURE 6.9.3 Changes to the chemicals used in pesticides and fertilisers used in large scale crops can assist in ensuring the health of the environment.

SC 1 CHECK YOUR UNDERSTANDING

Intensive farming is commonly used in society.

a Describe intensive farming.

b List some practices that are commonly used in intensive farming.

SC 2 I can explain how First Nations Australians' traditional knowledge can inform sustainable harvesting practices

When the First Fleet arrived in Australia in January 1788, European settlers encountered a vastly different climate and landscape from their homeland. Their existing tools, farming methods, crops, and livestock were not suited to the challenging and comparatively barren conditions of the Australian environment. However, First Nations Australians have expertly managed the land and environment through sustainable practices for millennia (tens of thousands of years). These practices include crop cultivation, fish-trapping and cultural burning (also known as cool burning or firestick farming Figure 6.9.4).

FIGURE 6.9.4 (a) A Bindarray, Walbunja Fire Practitioner, demonstrates how to spark up a patch of native forbs and grasses; (b) A traditional firestick using pieces of stringy bark to light a mosaic of cultural burning fires.

The farming techniques of the First Nations Australians aimed to encourage new growth in native plants, facilitate hunting and enhanced the food supply for their communities. First Nations Australians have adapted their practices over millennia to harmonise with the land, while the newcomers struggled to apply their familiar methods to the harsh Australian terrain.

The regular use of cultural burns, for example, transforms scrublands into grasslands, changing the composition of local plant and animal species, while also fostering edible ground-level plants like bush potatoes and populations of grass-eating species, including kangaroos to regenerate or repopulate the ecosystem.

Incorporating First Nations' knowledge into modern practices can provide more sustainable alternatives while harnessing the potential of seemingly inhospitable regions for agriculture. The following examples explore First Nations knowledge in more depth.

Flour production

First Nations peoples of Australia once managed and cultivated vast grain belts covering most of the continent. These regions provided fertile ground for grain harvests, used in turning wild seeds into flour over 30 000 years ago (Figure 6.9.5). By incorporating First Nations knowledge into modern agricultural practices, farmers can gain the potential knowledge to manage different types of land in order to produce sustainable harvest.

FIGURE 6.9.5 Grinding stones like this were found at Cuddie Springs archaeological site in Western NSW; these were used to create grind seeds into a flour-like substance.

Traditional Australian bush foods

While there are over 6500 native food varieties in Australia, only 13 have received certification from Food Standards Australia New Zealand (FSANZ) for development in local and international markets. Recently, however, there has been a surge in the commercial cultivation of traditional Australian bush foods, known for their resilience in the arid Australian climate. Some examples include lemon myrtle, Kakadu plums, quandongs and wattle seed (Table 6.9.1).

TABLE 6.9.1 Images of native Australian busk tucker

lemon myrtle	Kakadu plums	quandongs
		

This trend represents a growing interest in embracing First Nations agricultural practices, as well as an appreciation of First Nations traditions and flavours in promoting a sustainable food future.

SC 2 CHECK YOUR UNDERSTANDING

State two examples of First Nations' farming practices.

Scifile

Modern bush tucker

Incorporating bush tucker into traditional recipes, like baked cheesecake containing wattle seeds is one example of how First Nations food knowledge may be leveraged.

SC 3 I can describe examples of chemical pollution caused by agriculture, industry and urbanisation

Examples of chemical pollution

For thousands of years, human activities have disrupted ecosystems through habitat destruction, pollution, and invasive species. Unlike other species, humans reshape the environment to meet their needs through urbanisation, mining, agriculture, and industrial development. The long-term consequences of these actions, including biodiversity loss, are only now being fully recognised.

Industrial activity, urbanisation and agriculture have played a major role in shaping the environment. As understanding grows, many governments and businesses are shifting toward sustainable practices to reduce long-term environmental impact.

FIGURE 6.9.6 Dead northern gannet with plastic fishing net wrapped around its beak; animals affected by plastic in the marine ecosystem include birds, seals, fish and turtles.

Industry

One striking example of chemical pollution caused by industry is the amount of microplastics in the environment. Microplastics are tiny plastic particles formed by industrial processes and the breakdown of larger plastic items like water bottles, textiles and cosmetics. Taking hundreds of thousands of years to decompose, microplastics pose a severe threat to ecosystems and animal health as they enter the food chain. Plastic waste produced by industry can have severe and long-term effects on the environment even before it breaks down as large plastic pollution can choke and entangle animals (Figure 6.9.6).

FIGURE 6.9.7 An owl poisoned after consuming a rodent that had ingested bait.

Urbanisation

Increasing urbanisation has led to an increase in pest species such as rats and mice in residential areas. To control these rodents, poison baits called rodenticides are commonly used. However, these toxins build up within individual animals in a process known as **bioaccumulation**. Additionally, when predators consume poisoned rodents, the toxins pass along the food chain and become more concentrated at higher levels, a process known as **biomagnification**. These chemicals can persist in the environment, affecting many species over time.

This results in harm to unintended targets higher up the food chain, including owls (Figure 6.9.7), hawks, eagles, and even pet cats and dogs.

KEY TERMS

bioaccumulation when harmful chemicals or pollutants build up inside the bodies of organisms over time

biomagnification when a harmful chemical builds up in organisms as it travels up the food chain

Agriculture

The use of chemicals in agriculture, such as certain herbicides, has raised concerns regarding their environmental and health implications. Some herbicides, sprayed on genetically modified crops like corn, canola and soybeans, has been linked to soil degradation and water contamination (Figure 6.9.8). Furthermore, the health risks associated with exposure to certain herbicides have fuelled ongoing debates, with some studies suggesting there could be a connection to certain cancers and disruptions in the body.

This results in algal blooms (Figure 6.9.9) which starves aquatic organisms from the oxygen they need to breath and survive.

FIGURE 6.9.8 A herbicide is sprayed over a field of barley before harvesting.

There are many other examples of chemical pollution damaging ecosystems and problems with commercial waste products are still being discovered. Chemical pollution affects many aquatic environments. Chemical pollutants like nitrogen, phosphorous or sulphur can cause water ways to become more toxic or acidic, which leads to species decline. Another effect of chemical pollution is eutrophication, which is when a body of fresh water ends up with too many nutrients, usually from fertilisers or waste.

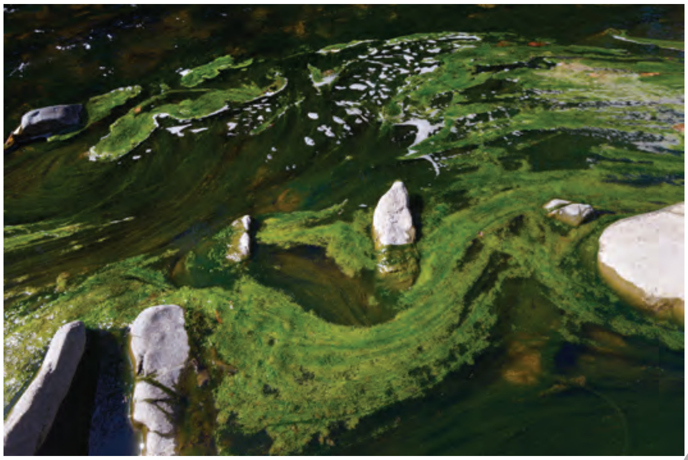


FIGURE 6.9.9 Algal bloom in freshwater river ecosystem, a response to increased nutrient levels.

It is important that people consider the potential impact of their choices, and make careful, well-informed decisions about what to support through purchasing behaviour. Balancing industry and sustainability is essential for preserving the natural world and maintaining biodiversity.

SC 3 CHECK YOUR UNDERSTANDING

Describe some effects of chemicals on the ecosystem.

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1 Outline one intensive farming practice that can damage ecosystems.

2 Intensive farming practices can have significant effects on ecosystems.

  a Describe the main features of intensive farming practices.

  b Explain how these practices can lead to habitat damage.

  c Discuss the impact of intensive farming on local wildlife populations.

3 Identify one example of chemical pollution from agriculture.

4 Draw a table to compare the sources and effects of chemical pollution from agriculture and urbanisation on aquatic ecosystems.

6.10 Detergents in waterways

Learning intention

To be able to develop hypotheses to test relationships

Success criteria

SC 1: I can write a hypothesis and a prediction for an investigation that tests the relationship between the abiotic and biotic factors in an ecosystem.

SC 2: I can plan and conduct a reliable and valid investigation to determine the effects of detergents on aquatic plants.

SC 3: I can identify relationships between biotic and abiotic factors in an ecosystem from experimental data and evaluate the quality of a conclusion.

FIGURE 6.10.1 Everyday products impact local plant life and ecosystems.

GO TO
Toolkit section 1.3, Hypotheses and predictions

Introduction

Detergents are found in cleaning products that are widely used in households and industry. Products like laundry and dishwasher powders and liquids have chemicals that are toxic to aquatic life. These products can enter waterways through storm water and sewage systems, devastating aquatic ecosystems. Phosphates in detergents can cause algal blooms in freshwater environments, and surfactants (substances in detergents that increase their spreading and wetting properties) can damage the cell membranes of plants and animals.

In this practical investigation you will design an experiment to test the effect of detergents on aquatic plants.

Detergents in waterways

Aquatic plants are plants that live in, under or float on top of the water. In this investigation you will collect data to determine if the soap you wash your hands with several times a day, the detergent your clothes are washed in, or the soap you use in the shower is causing damage to these plants (Figure 6.10.1).

Aim

To design and conduct an experiment to investigate the effect of detergents on aquatic plants

Hypothesis

Write a hypothesis for your investigation.

Remember that a hypothesis is a statement about the relationship between two variables, which can be tested experimentally. It should also include the independent variable (what is being changed in the experiment) and the dependent variable (what is being measured).

Before writing your hypothesis think about how detergents entering waterways might affect the plants in those environments. Refer to the introduction to this lesson for some ideas.

Method

1 Working in a small group, discuss ways to investigate the effects of detergents on aquatic plants in a laboratory.

2 Choose the idea that is likely to result in the most valid and reliable data with the time and resources you have available.

3 Design a method to determine the effect of detergents on aquatic plants. Write out your procedure as a list of steps that each begin with a verb. Ensure you include the necessary equipment and safety considerations.

4 Check your procedure and safety measures with your teacher before continuing.

Materials

Write a materials list for your investigation based on your chosen method. Include all equipment and substances—and the quantities—required.

Assessment of risk

Ensure you are aware of the risks of this practical investigation and have considered how safety can be improved before carrying out this activity.

Results

Record your results.

- When drawing a table of results, it should include:
- A descriptive title which includes the independent and dependent variables.
- A heading for the independent variable including units if appropriate.
- A heading for the dependent variable including units if appropriate.

Example table of results:

Title:____

Detergent (%)	Mass of the plant (g)			
	Day 1	Day 3	Day 5	Day 7
0				
2				
4				
6				

Conclusion

1 Write a conclusion for your investigation.

2 Was your hypothesis supported or not supported?

Remember to add data to your conclusion.

Evaluation

Discuss the strengths of the procedure used and propose ideas for improvement. Make note of three strengths and three areas for improvement for the procedure used.

HINTS

A valid experiment tests only one independent variable and has controlled or constant variables so that it measures what the aim intends.

A reliable experiment is one that can be repeated to produce consistent results each time.

HINT

Remember to include one set up without any detergent as a control so that you can compare the other plants to this. Make clear how you will measure the effect of the detergent on the aquatic plants.

SAFETY NOTE

- Write safety notes for your investigation. Note that some detergents can be irritating to skin and eyes.

6.11 Desalination

Learning intention

To understand how desalination plants impact local marine ecosystems

Success criteria

SC 1: I can describe the process of desalination and how waste is produced.

SC 2: I can describe the effects desalination plants have on local marine ecosystems.

Lesson overview

Desalination plants are facilities that remove salt and other minerals from seawater, making it safe to drink and use for irrigation, industry and agriculture. These factories are usually found in places where freshwater is not readily available. While desalination plants can help reduce the pressure on other freshwater resources, they can also have negative impacts on the local marine and aquatic ecosystems.

In this lesson you will learn about the impacts that desalination plants have on local marine ecosystems.

SC 1 I can describe the process of desalination and how waste is produced

Desalination plants are becoming more popular, in fact, there are about 15 000 plants around the world and around 270 in Australia (Figure 6.11.1). In Western Australia just two desalination plants located in Kwinana and Binningup provide approximately half of Perth's drinking water. A third desalination plant in Alkimos is currently under construction and due to be completed in 2028.

They are used in areas where freshwater resources are scarce like arid regions or coastal regions and islands because they can provide a more reliable source of freshwater that is not dependent on rainfall alone.

Desalination is the process of removing minerals, mostly salt, from seawater through physical and chemical processes to make it safe to drink and use for **irrigation** and other purposes. There are several methods of desalination, but the most common method and the one that uses less energy than the rest is by a process called reverse osmosis. Reverse osmosis is a process that pushes water through a super fine filter allowing some substances to get through and others not.

KEY TERMS

desalination removing dissolved salts such as sodium chloride from water

irrigation used in agriculture to provide water to crops

FIGURE 6.11.1 The Victorian Desalination plant, Wonthaggi, Victoria.

In Australia, the process of desalination involves a variety of steps in order to make the water removed from the ocean both drinkable and ready for use (Figure 6.11.2).

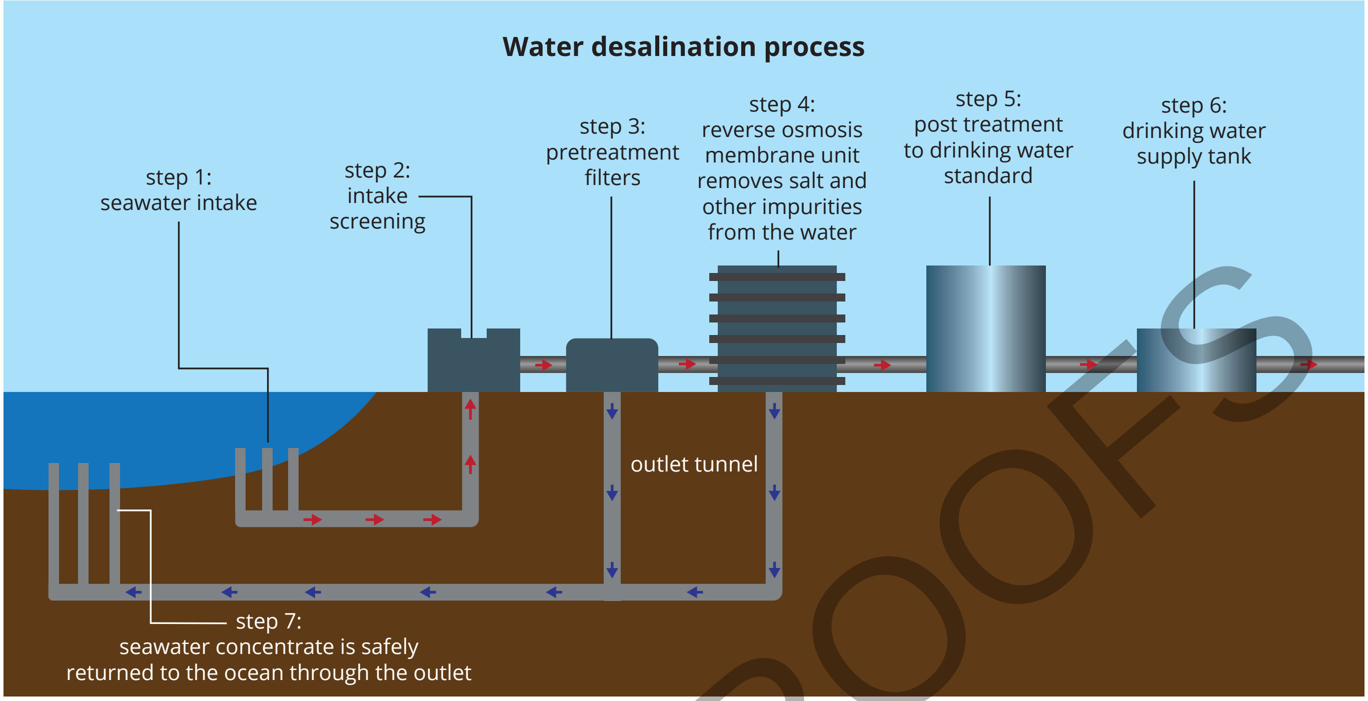


FIGURE 6.11.2 There are six steps to the reverse osmosis desalination process.

Screening and pre-treatment

Seawater is passed through large concrete tunnels at a very slow rate. Drum screens or filters to remove large solid items, such as man-made pollution, seaweed and shells. The water is then passed through layers of filter coal and sand.

High-pressure pumping

The seawater is then pressurised and pumped through a filter that allows certain substances to pass through while blocking others based on their size, charge or other properties.

Desalination

The salt and other minerals in the seawater are unable to pass through the membrane, while the freshwater can. This process leaves the seawater on one side of the membrane, while the freshwater is collected on the other side. The water that is left behind is much saltier than the initial seawater.

Post-treatment

The freshwater may be further treated to remove any remaining impurities. At this stage other factors like adjusting its pH or the addition of other chemicals necessary for drinking are also included. The water is then stored in large water tanks.

Desalination waste

The main waste generated by desalination plants is called brine, a salty seawater concentrate. The seawater concentrate is sent out to sea through outlet tunnels. In most cases, the saltier water is sent out through nozzles that help it mix quickly in the natural seawater to make sure that it does not affect the local marine environment.

However, the discharge location, timing and volume of seawater concentrate needs to be carefully monitored to prevent negative impacts on the marine environment and coastal ecosystems (Figure 6.11.3).

FIGURE 6.11.3 Desalination must consider the surrounding marine life when disposing of the leftover brine.

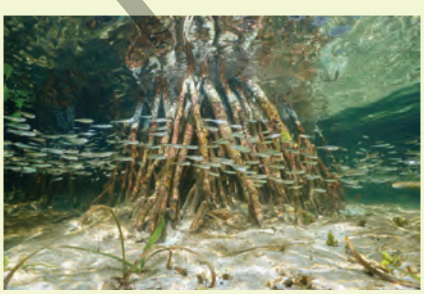
SC 1 CHECK YOUR UNDERSTANDING

List the key steps involved in the desalination process.

SC 2 I can describe the effects desalination plants have on local marine ecosystems

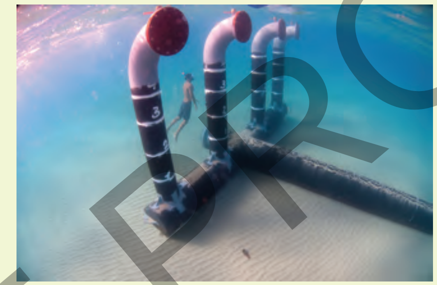
Desalination plants can have negative effects on local marine ecosystems (see Table 6.11.1). The waste product of the desalination process, seawater concentrate (or brine), has a higher salt concentration than the original seawater. When this brine is discharged back into the ocean, it can have negative impacts on the marine environment. The high salinity and higher temperature of the brine in comparison to seawater can be toxic to certain marine species, reducing local populations and biodiversity.

TABLE 6.11.1 Marine ecosystems at risk from the effects of desalination plants

Mangrove forests	Coral reefs	Seagrass beds
Mangrove forests play an essential role in coastal ecosystems. They also help to protect coastal areas from erosion and storms. Desalination plants can change the flow of water, temperature, the levels of dissolved oxygen and other chemicals in the water.	Coral reefs are delicate and complex ecosystems. They are also important for protecting coastlines from erosion and storms. The discharge of brine can be harmful to coral reefs, as the high salt concentration can change the chemistry and temperature of the water.	Seagrass beds are underwater meadows of marine flowering plants. They play a vital role in coastal ecosystems as they provide food and habitats for many marine species. They also help to improve water quality. Desalination plants can affect the growth of seagrasses.
		

Other potential aspects of using desalination plants for drinking water include the disruption of marine animal behaviour, discharge of seawater concentrate increasing the temperature and decreasing quality of sea water as well as impacting the structure of the seabed (see Table 6.11.2).

TABLE 6.11.2 Negative impacts of desalination plants

Taking water from the ocean	**Underwater noise**	**Energy demand**
Large amounts of seawater that are constantly being pumped from the ocean can reduce the water level of the ocean around the plant. This affects the surrounding habitat and can alter the **migration patterns** of aquatic species in the area.	The underwater noise and vibrations generated by desalination plants can have harmful impacts on marine life. For example, the noise pollution created by desalination plants can disrupt the communication, feeding and mating behaviours of marine mammals such as dolphins and whales.	The energy demands of desalination plants have a range of broader environmental impacts as many plants require large amounts of energy to operate. This can increase their impact on **greenhouse gas** emissions and air pollution. There is a push to use more sustainable energy sources in powering desalination plants.
		

SC 2 CHECK YOUR UNDERSTANDING

Outline two ways that desalination plants affect marine ecosystems.

KEY TERMS

migration pattern regular route that animals travel from one place to another, often because of seasonal changes

greenhouse gas gases that trap heat close to Earth's surface

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1 Define desalination.

2 Describe how waste brine produced by desalination plants can affect local marine ecosystems.

3 Explain why desalination plants are becoming more popular.

4 Identify ways that water from the desalination process can be used.

5 Construct a method you could use to investigate the impact of a desalination plant on local fish populations.

6.12 Cultural understandings and sustainable practices

Learning intention

To understand how First Nations Australians use deep ecological understanding to develop sustainable practices

Success criteria

SC 1: I can explain how First Nations Australians' deep ecological understanding can inform sustainable practices.

SC 2: I can name various sustainable practices used by First Nations Australians.

SC 3: I can explain how First Nations Australians' practices have influenced scientific knowledge about ecosystems.

KEY TERMS

ecological relating to ecosystems or interactions between living things and their environment

Creation story story that explains the origins of the universe, the rules for living and the relationship of people to each other and the environment; also known by many as a Dreaming story

Traditional Lore all the old stories, beliefs, and customs that people pass down through generations. It includes things like myths, legends, fairy tales, and ways of doing things that have been around for a long time

Lesson overview

First Nations Australians have a deep spiritual and cultural connection to the land that emphasises the interdependence of all living things in the environment. Everything in the environment is considered equally important. This means that a bird or an ant in a food chain is appreciated for the unique and important role it plays, without prioritising one organism over another. This respect is founded on the knowledge that everything in nature is connected; humans are part of one vast system and its wellbeing depends on the health of all its individual parts.

First Nations Australians have a particularly strong connection to their ancestral lands or Country, which is central to both their identity and belonging. Their deep ecological understanding is a result of many thousands of years of observation and interaction with their environment.

In this lesson, you will explore how First Nations Australians apply their deep ecological insights to develop sustainable practices.

SC 1 I can explain how First Nations Australians' deep ecological understanding can inform sustainable practices

First Nations Australians have developed a deep **ecological** wisdom through their enduring connection to the land. First Nations peoples used their traditional knowledge to grow crops, make traps for fishing and utilised practices passed down over many generations (Figure 6.12.1). This is embodied in **Creation stories** and **Traditional Lore**, which provide a holistic and sustainable approach to environmental management and resource use. Many First Nations people moved around their lands seasonally sometimes for trade and cultural reasons (such as ceremonies). People in harsher climates tended to move around their lands more, whereas those whose lands contained rich resources developed more permanent settlements.

First Nations communities can offer invaluable insights in shaping modern sustainability practices for ecological management.

FIGURE 6.12.1 Siblings fishing at Mukkamukka, a billabong in Arnhem Land.

The Creation

First Nations Australians have a deep understanding of Australian ecosystems. All elements of the natural world are intricately interconnected and hold **spiritual** significance in the Creation stories of First Nations Australians.

Creation is not confined to a distant past; it includes the past, present and future. Deeply rooted in the Earth, it continues to be a guide for many First Nations people today. Specifically, Creation is a spiritual and cultural framework that guides practices like resource use and land management, that helps to create innovative and regenerative solutions to environmental issues through art and story (Figure 6.12.2).

KEY TERMS

spiritual relates to the soul or spirit or religious beliefs

Creation the concept that encompasses the belief systems that bring together spiritual and physical knowledges for First Nations Australians; also known by many as the Dreaming

sacred to have great cultural or spiritual significance

FIGURE 6.12.2 Serpent painting from Central Australia.

First Nations people use storytelling to show closely held beliefs about Country and the natural environment. Creation stories place a strong emphasis on respect for all species and the need to understand the consequences of human actions on the natural world. These teachings may be seen in practices like controlled burns for land management and resource conservation, the use of natural materials, and a commitment to living in harmony with the environment.

Traditional Lore

Traditional Lore refers to the beliefs, stories, customs and spirituality of First Nations Australians that has been passed down through generations since the Creation (also known as the Dreaming). It affects the relationships people have with each other the environment and their totems.

Traditional Lore recognises that humans play a significant role in impacting the environment, both positively and negatively. Therefore, lore guides behaviour around everyday life and cultural obligations, including family and marriage, ceremonies, land management, the division of labour, conflict resolution and the sharing of knowledge. Any problems are resolved by Elders. For the environment, traditional Lore provides practical guidance, including sustainability principles, to maintain a balanced relationship between human activities and the natural world.

Connection to Country and Traditional Lore

The strong connection to Country, includes all living beings and the **sacred** land, rocks and waters. The lore serves as a guiding principle for the spiritual wellbeing of First Nations communities. This deep respect fosters sustainable practices, reinforcing the belief that human actions must safeguard the environment's harmony and equilibrium (balance).

FIGURE 6.12.3 The freshly harvested edible tubers of the yam daisy or murnong an Australian native bush food.

Traditional Lore provides the guidelines for the critical practice of ongoing environmental assessment to ensure that the ecosystem remains in balance. The guidelines prevent the over-harvesting of resources, extinction of organisms, and is especially important during times of change. For example, First Nations people replanted the crown of bush yams to ensure they had crops for the next harvest (Figure 6.12.3).

Intergenerational responsibility

Traditional Lore also highlights intergenerational responsibility, which means learning from ancestors, respecting Elders and understanding how actions today may affect the well-being of future generations. This understanding informs sustainable practices that help protect the environment for future generations.

FIGURE 6.12.4 A swamp mahogany fishing canoe made by Gubbi Gubbi (Kabi Kabi) elder Lyndon Davis to demonstrate traditional construction techniques.

The traditional practice of using bark from trees to construct canoes is an example of intergenerational responsibility (Figure 6.12.4). Bark is removed in a way that allows the tree to keep growing, ensuring that the tree and anything it produces is available for future generations.

SC 1 CHECK YOUR UNDERSTANDING

Discuss how the deep ecological understanding of First Nations Australians is valuable for modern sustainability efforts.

SC 2 I can name various sustainable practices used by First Nations Australians.

Over more than 65 000 years, First Nations Australians have used their comprehensive knowledge to shape the land in response to changes in society and the environment. Some of these practices include seasonal harvesting that align with natural cycles of the land, cultural burning, sustainable fishing, construction using sustainable materials, waste management, water and land conservation (Figure 6.12.5).

FIGURE 6.12.5 Luritja women working with local, renewable resources for food preparation.

Table 6.12.1 summarises various sustainable practices used by First Nations Australians.

TABLE 6.12.1 Sustainable practices used by First Nations Australians

Resource conservation and land management	Resource use is based upon seasonal and location-specific knowledge, ensuring that fishing, hunting and plant gathering align with natural cycles. This included use of controlled burning, natural materials, responsible use and careful harvesting of crops to promote regeneration of plants.	
Fishing	Fish traps were carefully constructed to allow large fish to enter but not exit, serving to catch the fish and encourage their breeding. This reduces the impact on wild fish populations.	
Agriculture	Using intercropping (cultivating multiple crops in the same area) and crop rotation (alternating the crops grown in a particular field over time) to maintain soil fertility and enhance agricultural productivity as well as employing eco-friendly pest and weed control methods to manage crop pests.	
Building	Using natural materials to build shelters with materials like timber, stone, and clay, which were readily available and well-suited for construction purposes. Using sustainable building materials, the need for artificial heating, cooling, or lighting is minimised.	
Food production and harvesting	Harvesting of crops is done when resources are abundant and plentiful. Ensuring that both breeding and growth seasons of native plants and animals are followed for the ecosystem to have sufficient time to regenerate. This practice supports regrowth while safeguarding biodiversity.	
Water management	Rainwater harvesting, wetlands management, and restoration of damaged waterways ensured the health of aquatic ecosystems.	
Waste management	This includes composting, recycling, and waste reduction. For example, using traditional techniques, like using natural materials for construction and crafting, to minimise waste generation.	

SC 2 CHECK YOUR UNDERSTANDING

State why traditional agricultural practices of First Nations Australians are considered sustainable.

SC 3 I can explain how First Nations Australians' practices have influenced scientific knowledge about ecosystems

KEY TERM

empirical observation
something you notice or learn by looking at the world around you, using your senses (like seeing, hearing, or touching), and collecting real, concrete information

First Nations Australians have made significant contributions to scientific developments, particularly in understanding Australian ecosystems. First Nations peoples followed scientific practices – continually hypothesising and experimenting on different aspects of plants and animals, making **empirical observations** and gathering evidence about patterns in the natural world.

First Nations peoples inferred and predicted environmental patterns to develop knowledge that helped them navigate Australia's harsh landscape. In the past, this knowledge was often ignored, exploited, or not recognised. Recognising and valuing it leads to a more inclusive and holistic approach to environmental research and conservation.

Table 6.12.2 provides examples of First Nations Australian practices and their impact on ecological management.

TABLE 6.12.2 First Nations Australian ecological management practice examples

Traditional Practice	Description	Image
Land management	Knowledge of different Australian plants and their reliance on fire or smoke has informed modern conservation strategies and fire management.	
Biodiversity conservation	Conservation strategies that consider the cultural and spiritual significance of different species support the re-introduction and increase in populations in areas of concern as well as aiding in the reduction of introduced species.	
Climate change	First Nations peoples have lived through climate change before. Understanding the relationships between the environment, weather patterns, and the health of ecosystems can influence scientific thinking about climate change.	
Traditional medicine	Using of plants and other natural remedies for healing has influenced scientific thinking about the medicinal properties of plants and has contributed to the development of new treatments and medicines. Many plants used by First Nations Australians have anti-bacterial and anti-inflammatory properties.	

SC 3 CHECK YOUR UNDERSTANDING

Outline one way that First Nations peoples' actions or knowledge have influenced modern science.

Lesson review

Use these questions to check whether you have met the learning intention for this lesson.

1 List three sustainable practices developed by First Nations Australians.

2 Describe how one practice listed in question 1 is used by First Nations Australians.

3 Explain how an understanding of Creation informs sustainable practices.

4 Outline how Traditional Lore has influenced modern sustainable practices in Australia.

5 Compare one method of traditional First Nations practices with a non-traditional practice.

6 Matter and energy in ecosystems

Topic summary

The key concepts included in this topic are:

- All organisms require six basic needs to survive.
- Changes in populations are affected by biotic and abiotic factors.
- Australia has a range of aquatic and terrestrial habitats.
- Ecologists study the environment using research, observations and a variety of sampling techniques.
- Food chains and food webs represent the feeding relationships in an environment.
- Habitat destruction and pollution have a significant effect on the environment.
- First Nations knowledge is invaluable in ensuring the environment is not harmed.
- Desalination removes salt and minerals from seawater for human use but may have an impact on marine ecosystems.

Review questions

The following questions will assess your success in achieving the learning intentions for this topic.

Remember

1 Identify the basic survival needs of plants in Australia.

2 List three different types of habitats found in Australia.

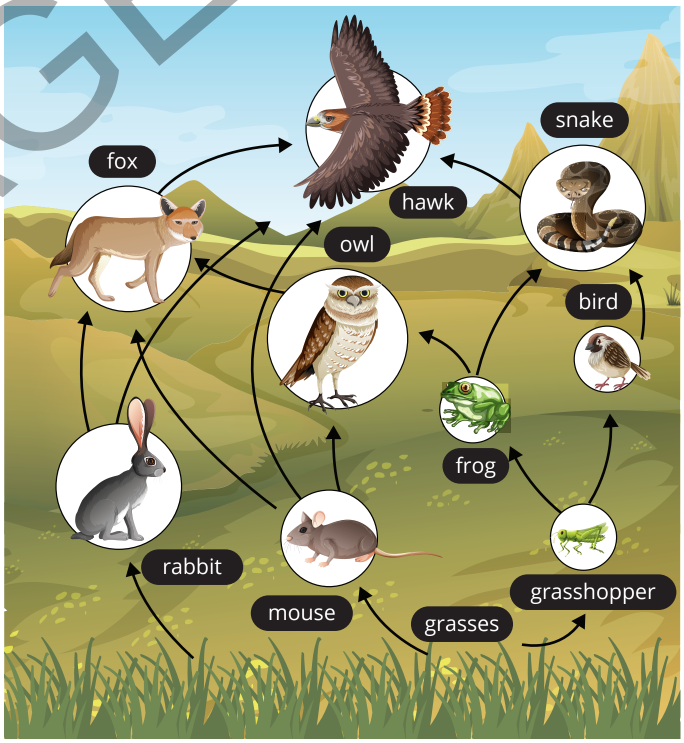
3 Name three specific threats to Australian ecosystems.

4 Define the term biodiversity.

5 Explain what a food chain represents and how it shows the flow of energy between organisms.

Understand

6 Using the grassland food web below, construct one food chain.



7 Using the grassland image above, identify:

a an abiotic factor and explain how that factor can affect the survival of the mouse in its grassland environment

b a biotic factor and explain how that factor can affect the survival of the mouse in its grassland environment.

8 List three factors that contribute to species decline.

9 Explain one way Dame Jane Goodall's research has influenced conservation policies.

10 Describe how transects are used to observe the environment.

Apply

11 Using the grassland image, identify the producer, primary consumers, secondary consumers, and tertiary consumers in the food web.

12 Construct an African savannah biomass pyramid that has the following organisms and masses.

- Lions are the tertiary consumer with a mass of 100 kg.
- African wild dogs are the secondary consumers with a mass of 200 kg.
- Springboks are the primary consumers and have a mass of 700 kg.
- Grasses are the producers and have a mass of 1200 kg.

Analyse

13 Discuss the impacts of farming practices on ecosystems.

14 A student was investigating the effects of two types of laundry detergent on five aquatic insects that were found in the local creek. They found that one insect population decreased from 10 organisms to three organisms, and another decreased from 20 organisms to 16 organisms in their sample.

a Identify the independent variable in this investigation.

b Identify the dependent variable in this investigation.

15 Australian organisms have specific needs and depend on several factors to survive.

a Identify the basic survival needs of a native Australian animal of your choice.

b Compare how increased drought conditions caused by climate change may affect your chosen organism in their environment.

Extension: Research and create

16 You will use the internet and other sources to research and compare traditional First Nations medicines to those found in common supermarkets or pharmacies. Then create a poster to advertise this medicine.

- Name one bush medicine and the health issues or problems it treats.
- Describe how First Nations people create the medicine and the process involved.
- Compare your chosen bush medicines to a similar medication found in supermarkets or pharmacies.
- Describe the benefits of your chosen bush medicine.

Topic reflection

The learning intentions for this topic are given in each lesson and at the beginning of the topic. Consider how well you have achieved them. Note down any particular areas that you are confident in, and others where you are not so sure.

3 Glossary

abiotic factor a nonliving factor in the environment

adaptation a structure, behaviour or internal bodily feature of an organism that helps them survive

agricultural relating to the practice of growing plants and animals to make food

anti-bacterial a substance that kills bacteria

anti-inflammatory a substance that reduces swelling

antiseptic a substance that kills microbes

apex predator predator that has no natural predators except humans

aquatic in water, water environments such as ponds, lakes, oceans and seas

bioaccumulation when harmful chemicals or pollutants build up inside the bodies of organisms over time

biodiversity the number and range of species that exist in an ecosystem, biome or biosphere

biomagnification when a harmful chemical builds up in organisms as it travels up the food chain

biomass all plant and animal matter found on Earth

biomass pyramid a visual representation of the biomass at different levels of a food chain

biotic factor a living factor of the environment

carnivore consumer that eats only other animals

climate change long-term changes in climate, including temperature change and weather patterns

community groups of organisms that interact within an ecosystem

competition relationship between organisms that are trying to use the same limited resource

concentration the amount of dissolved substance in a defined space

conservation the protection of resources, such as land and biodiversity

consumer organism that must eat other organisms to get the energy and nutrients it needs

Country the land that First Nations peoples have a cultural connection to through their ancestry

Creation the concept that encompasses the belief systems that bring together spiritual and physical knowledges for First Nations Australians; also known by many as the Dreaming

Creation story story that explains the origins of the universe, the rules for living and the relationship of people to each other and the environment; also known by many as a Dreaming story

decomposer organism that gets the energy it needs by breaking down dead matter and waste products

desalination removing dissolved salts such as sodium chloride from water

ecological relating to ecosystems or interactions between living things and their environment

ecologist scientists who study the interactions between living things and their environment

ecology the study of how organisms interact with each other and with their non-living surroundings

ecosystem a system formed by organisms interacting with each other and their nonliving surroundings

empirical observation something you notice or learn by looking at the world around you, using your senses (like seeing, hearing, or touching), and collecting real, concrete information

endangered species an animal or plant that is at serious risk of disappearing forever

environment all the factors in an organism's surroundings that affect its survival

food chain the flow of energy from organism to organism in a series of feeding relationships

food web interconnected food chains representing the varied sources of energy for organisms

genetic relating to heritable characteristics or features passed on from parent to offspring

greenhouse gas gases that trap heat close to Earth's surface

habitat the place where an organism lives

herbivore an animal that eats only plants

irrigation used in agriculture to provide water to crops

mass the amount of matter in a substance or object; measured in grams (g), kilograms (kg) or tonnes (t)

migration pattern regular route that animals travel from one place to another, often because of seasonal changes

omnivore an animal that eats both plants and animals

organism a living thing

population a group of organisms of the same species, which live in the same area

predator an animal that kills and eats other animals

prey an animal that is eaten by a predator

primary consumer a consumer that only eats plants, algae and other producers; also known as first-order consumer

producer organism able to manufacture its own food; plants are producers

pyramid of numbers a diagram representing the number of organisms in an ecosystem

resource something that meets a particular need or fulfils a particular purpose

sacred to have great cultural or spiritual significance

sampling technique method that scientists use to collect information about plants, animals, and other living things in a certain area

secondary consumer a consumer that eats a primary consumer; also known as second-order consumer

species different types of living things

spiritual relates to the soul or spirit or religious beliefs

sustainable using resources in a way that keeps the Earth healthy for a long time

terrestrial on land

tertiary consumer a consumer that eats a secondary consumer; also known as third-order consumer

tolerance the ability of an organism to survive under particular conditions

totem an object, like an animal or symbol, that represents a group of people, often a family, tribe, or clan

Traditional Lore are all the old stories, beliefs, and customs that people pass down through generations; it includes things like myths, legends, fairy tales, and ways of doing things that have been around for a long time

trophic level the position of an organism in a food chain

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