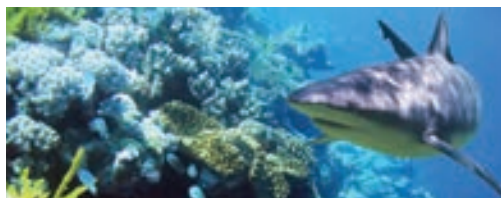
TEACHER RESOURCE

BIODIVERSITY



Introduction to the guide

This Student Learning Resource is designed to assist high school teachers engage students in Years 7 to 10 in the study of biodiversity and related issues. It is supported by the use of the CSIRO text *Biodiversity: Science and Solutions for Australia* and links to the Australian Curriculum: Science, with a flexible matrix of activities based on the Five Es model.

The resource explores elements of Years 7 to 10 science and geography curriculums, covering the cross-curriculum priorities of Sustainability and Aboriginal and Torres Strait Islander Histories and Cultures. For science, it more specifically covers the areas of: science understanding; science as a human endeavour and science enquiry skills. For geography, it covers the area of geographical knowledge and understanding, and geographical inquiry and skills.

How to use the guide

The notes in this study guide offer both variety and flexibility of use for the differentiated classroom. You and your students can choose to use all or any of the five sections – although it is recommended to use them in sequence, along with all or a few of the activities within each section.

The ‘Five Es’ model

This resource employs the ‘Five Es’ instructional model designed by Biological Sciences Curriculum Study, an educational research group in Colorado. It has been found to be extremely effective in engaging students in learning science and technology. It follows a constructivist or inquiry-based approach to learning, in which students build new ideas on top of the information they have acquired through previous experience.

ABOUT

Its components are:

Engage

Students are asked to make connections between past and present learning experiences and become fully engaged in the topic to be learned.

Explore

Students actively explore the concept or topic being taught. It is an informal process where the students should have fun manipulating ideas or equipment and discovering things about the topic.

Explain

This is a more formal phase where the theory behind the concept is taught. Terms are defined and explanations are given about the models and theories.

Elaborate

Students have the opportunity to develop a deeper understanding of sections of the topic.

Evaluate

Both the teacher and the students evaluate what they have learned in each section.

WARNING: Aboriginal and Torres Strait Islander people are warned that this document may contain images of deceased persons.

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INTRODUCTION

This resource is based on content from the CSIRO book *Biodiversity: Science and Solutions for Australia*. The main concepts it covers include:

- Australia's biodiversity (major features)
- Current status and trends
- Managing biodiversity
- The value of biodiversity
- Indigenous perspectives

See Chapter 1: What is biodiversity, and why is it important? for background information.

To help you prepare your lessons, the table below shows which pages from the CSIRO book *Biodiversity: Science and Solutions for Australia* have been used as reference material for student activities.

Section and Activity	Pages
Explore	
What don't we know?	41
Benefits of biodiversity	5–7
Gone. Forever.	45
Next in line?	42 + 44
Farming and biodiversity	117
The domino effect	4
Explain	
Article 2 – Australia's biodiversity	19 + 25
Article 3 – Managing biodiversity	44 + 52
Elaborate	
Ethical thinking (Developing)	84–85
Creative and critical thinking (Developing)	56–62
Creative and critical thinking (Extending)	79 + 114
ICT (Developing)	42–43
ICT (Extending)	70–77
Time travel (Developing)	45

Lifesaving algorithms

Dr Iadine Chadès uses artificial intelligence to solve the most complex conservation problems.

Growing up on the south-pacific tropical island of New Caledonia, Dr Iadine Chadès (pictured below) was exposed to nature's rich diversity from a young age. It wasn't, however, her appreciation of the natural world but her mathematical skills that led her down a career path in biodiversity conservation.

"I think that making the best decisions is what we try to do every day as humans – for ourselves, for our families," says Dr Chadès, who is leader of the Conservation Decisions team at CSIRO, Land and Water. "That's what my team tries to do, but for biodiversity."

Photo: Iadine Chadès, CSIRO.

After completing an MSc in Computer Science in France, she became interested in artificial intelligence (AI), so pursued a PhD that looked at how to make robots smarter. “It’s not that robots aren’t smart, it’s just they do what they’re told, so you have to write algorithms so they make the right decisions,” Dr Chadès explains.

Recruited by French research institution INRA just after her PhD, Dr Chadès came to Australia for a sabbatical. Here, she worked in an ecology lab where she made a connection that has since formed the basis for her entire career. “I discovered that exactly the same mathematics that I was using to teach robots how to make optimal decisions could be used to make the best decisions to protect species,” she says. This crucial insight led her to her current role, where she is developing and applying AI methods in the fight to solve pressing global conservation problems.

One example is her team’s study of the five million shorebirds that migrate between the Arctic and Australia/New Zealand every year along a bird superhighway known as the East Asian–Australasian flyway. These birds are threatened *en route* by habitat destruction, pollution, hunting and rising sea levels, all of which point to a very uncertain future.

Making the entire flyway a protected area would be impossible, so Dr Chadès and her team applied one of their AI-derived algorithms to identify which areas to protect and when. The algorithm works by taking the best decisions based on the information (about issues such as rising sea levels or new buildings destroying habitats) available now and then reassessing as new information comes in. In this way, a conservation strategy is constantly adapting to new circumstances. Using this technique could save an extra 25,000 birds.

Having applied her AI methods to the conservation of Sumatran tigers, sea snails and various important plants, Dr Chadès is now pushing the limits of AI-inspired conservation. “My work is about trying to find the method that offers the best decision when you don’t have a lot of data,” she says. “Because endangered species are low in numbers and very difficult to detect, we can’t wait to gather more data and do nothing, we have to do something now.”

Biodiversity blitz

Exploring the biodiversity of your school grounds

One of the best ways to experience biodiversity is to get outside and look around you! It's not until you stop and think about it that you realise just how much is out there – from the smallest bug to the largest tree, we are surrounded by an incredible diversity of life.

What to do:

1. Get into groups of two or three.
2. Your teacher will give you a set amount of time (e.g. 10 minutes) to head outside and find as many different species as you can.
3. Before you go, make a guess at how many different species you think you might find.
4. When you are given the go-ahead, head outside and try to find as many species from as many different groups as possible (e.g. birds, insects, spiders, plants, fungi).
5. If you find a plant, carefully take one leaf from it (watch out for bees!).
6. If you find anything other than a plant, take a photo of it – the closest, clearest photo you can. This includes any living animal, as well as anything from an animal (e.g. a feather).
7. DO NOT TOUCH any insect or spider – your job is to take a photo of it, not catch it.
8. When time is up, go back inside.
9. In your group, go over all your photos and leaves, and calculate:
10. a) how many types of plants you found
    b) how many types of animals you found (or evidence of animals e.g. feathers).
    c) how many species you found all together
11. As a class, add up the totals of each group to work out the grand total of species found.
12. Fill in your totals in the table provided.

	Plant species found	Animal species found	Total species found
By your group:			
By all groups:			

For class discussion:

1. How many different species did the class find?
2. Was this more or less species than you expected to find?
3. Are there other areas nearby (apart from where you looked) where you think you may have been able to find more species? Why?
4. Why do you think some species can survive in one place (habitat), but not in another?
5. What sorts of things make an animal or plant suited to the environment it lives in?
6. What might happen to that plant or animal if the environment it lives in changes?
7. What could cause the environment to change in this way?

Teacher information

The aim of the Explore section is for students to begin investigating some concepts within the broad topic of biodiversity. Some or all of the workstations can be set up, depending on the size and interests of the class. It is intended that students work independently as they move around the different workstations.The table below lists the equipment and preparation required for each of the workstations.

Station	Equipment
1. What lives here? Use the Atlas of Living Australia to discover the biodiversity of your local area.	Computer to access the Atlas of Living Australia website www.ala.org.au/species-by-location/
2. Biodiversity lucky dip Have some fun using blindfolds and identifying leaves collected from your school.	One per pair of students: - beaker or other container for leaves - blindfold
3. Making connections Play the game 'Pond Life' to explore different types of relationships in an ecosystem.	Computer to access The Royal Institution website www.rigb.org/education/games
4. What don't we know? Find out how much life out there is just waiting to be discovered...	See p41 of the CSIRO book *Biodiversity: Science and Solutions for Australia*; Calculators (one per group of students)
5. Benefits of biodiversity Have a think about just how important biodiversity is to your life.	See pp5–7 of the CSIRO book *Biodiversity: Science and Solutions for Australia*; Computer to access the American Museum of Natural History website www.amnh.org/ology/features/biobenefits/ and to watch video at www.csiro.au/en/Research/Environment/Biodiversity/Biodiversity-book/Chapter-1
6. Gone... forever Take a look at some of our extinct animals and imagine what they might have been like.	Materials provided
7. Next in line? Just what biodiversity does Australia have, and how much of it is under threat?	See pp42–44 of the CSIRO book *Biodiversity: Science and Solutions for Australia*
8. Farming and biodiversity Explore how farming and biodiversity can co-exist. Can you find a way to balance them?	See p117 of the CSIRO book *Biodiversity: Science and Solutions for Australia;* Computer to watch video at www.csiro.au/en/Research/Environment/Biodiversity/Biodiversity-book/Chapter-7
9. The domino effect Consider the effect just one change in a food chain can make in the great web of life.	See p4 of the CSIRO book *Biodiversity: Science and Solutions for Australia*

Station One

What lives here?

1. Go to www.ala.org.au/species-by-location/ (the Atlas of Living Australia) and enter in your location. Select to display records within a 1km radius of your location.

2. How many species in total are known to live in your area? _____

3. How many species of plants live in your area? _____

4. How many animals live in your area? _____

5. Which group of animals has the most species living in your area? _____

6. Can you find any of the same species you found during your Biodiversity Blitz? If so, list them here. (Tip: click on the species name, then 'species profile', to see a picture.)

_____

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_____

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_____

Station Two

Biodiversity lucky dip

1. Be aware that in this activity you will be handling plants that may cause allergies in some individuals. Ask your partner first if they have any allergies and make sure you don't put any of the materials near your mouth or eyes.
2. Find a partner to work with.
3. Working independently (don't let your partner see what you are collecting), go outside and collect at least six different types of leaves in a container.
4. Person 1: Blindfold your partner and hand him/her one leaf to investigate.
5. Person 2: Carefully feel (and smell, if you like) the leaf that your partner hands you.
6. Person 1: Place the leaf back in the container and mix it with the other leaves, then take off your partner's blindfold.

Station Three

Making connections

1. Go to www.rigb.org/education/games/natural-world/pond-life
2. Follow the instructions to play the game 'Pond Life'.
3. Name a pair of organisms you found, that are:

   a) in a predator–prey relationship

   b) in a parasite–host relationship

   c) in a mutually beneficial (symbiotic) relationship

Station Four

What don't we know?

1. Look at Table 3.1 on page 41 of the CSIRO book *Biodiversity: Science and Solutions for Australia*. Use this table to fill in the first three columns in the table below.
2. For each group of living things, calculate how many more species there are left to discover, both as a number and as a percentage. Write your answers in columns 4 and 5 of the table.
3. a) Which group is thought to have the most species yet to be described?

   b) Why do you think this might be the case?
4. a) Which group is thought to have the least species yet to be described?

   b) Why do you think this might be the case?
5. How do you think you might feel if you were to discover a new species? (Would you name it after yourself?)

The numbers of species formally documented by scientists versus the number of species thought to exist in Australia

	Number of species described	Number of species estimated to exist	Percentage described	Number of species left to find	Percentage left to find
Mammals, birds, reptiles and frogs					
Fishes					
Insects					
Other terrestrial invertebrates					
Fungi					
Flowering plants					
Micro-organisms					

Station Five

Benefits of biodiversity

1. Refer to pp5–7 of the CSIRO book *Biodiversity: Science and Solutions for Australia*. Then go to www.amnh.org/ology/features/biobenefits/
2. In the space provided, list the benefits that biodiversity offers in each category.

'A livable planet':

_____

_____

_____

_____

_____

'The things we need':

_____

_____

_____

_____

_____

'The great outdoors':

_____

_____

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_____

_____

3. Prioritise each of your lists for each category: put the number 1 next to the most important benefit on your list, and continue by numbering them in order of importance.

4. Now have a think about your own day-to-day life. Make a simple mind map in the space provided below, to show all the ways you benefit from biodiversity. e.g. food: animals and plants you eat; clothing: plants and animals you use for clothing; your home: plants and animals used in your furniture and furnishings; and anything else you can think of.

Biodiversity and me

Station Six

Gone... forever

1. Look at the pictures of extinct Australian mammals and birds on p45 of the CSIRO book *Biodiversity: Science and Solutions for Australia.*
2. In your group, brainstorm what these animals might have been like when they were around. What can you infer about the animals and how they lived, just by looking at their pictures?
3. For each of the animals, write down your inferences in the table provided.

Name of animal	Type of food it might have eaten	Type of environment it might have lived in (e.g. forest, grassland)	How it moved around	Any other inferences

4. Draw a picture of your own extinct animal (one that you make up) and annotate it with some notes about what it was like, how it lived, and how it became extinct.

Station Seven

Next in line?

1. Look at Fig 3.2 on p42 and Fig 3.5 on p44 of the CSIRO book *Biodiversity: Science and Solutions for Australia*. These show how many different species (Fig 3.2) and how many threatened species (Fig 3.5) there are in different locations in Australia.

2. Compare the two Figures.

a) Name one similarity you notice.

_____

_____

_____

b) Name one difference you notice.

_____

_____

_____

3. a) Which regions (e.g. coastal, inland, northern, southern) appear to have the greatest species richness?

_____

_____

_____

b) Why do you think this might be?

_____

_____

_____

4. a) Which regions (e.g. coastal, inland, northern, southern) appear to have the most threatened species?

_____

_____

_____

b) Why do you think this might be?

_____

_____

_____

5. How is your state or territory doing? Do you have many threatened species where you live?

_____

_____

_____

_____

_____

_____

Station Eight

Farming and biodiversity

1. Study Fig 7.5 on p117 of the CSIRO book *Biodiversity: Science and Solutions for Australia*, which shows how farms can be designed so they not only produce food, but also support biodiversity.
2. Only 30% of the total area is dedicated to intensively growing pasture or crops. Why do you think this is not a higher percentage? (Tip: think about sustainability.)

_____

_____

_____

_____

3. Of the total area, 10% makes up the core conservation area. Why do you think farmers might want or agree to dedicate some of their land to conserving biodiversity?

_____

_____

_____

_____

4. Why do you think the core conservation area isn't one solid block, but is connected with other woodland to create a kind of corridor? (Tip: think about how species might move around/through the property.)

_____

_____

_____

5. Using the Figure as a guide, try sketching your own 'ideal farm' (aerial view) below, showing how you could balance biodiversity and production on the one property.

Station Nine

The domino effect

1. Look at Fig 1.1 on p4 of the CSIRO book *Biodiversity: Science and Solutions for Australia.*
2. In the space provided below, use the information in the figure to draw as many different food chains as you can. (e.g. phytoplankton → krill → fish → seal)

3. In the marine environment pictured, what would be likely to happen if:

a) the phytoplankton population was halved

b) the krill population was halved

c) the population of killer whales doubled

d) the decomposers completely disappeared

e) the sun was blocked out for a period of months (e.g. as a result of a giant volcanic eruption, or nuclear explosion)

Student literacy activities

Teacher instructions

In this section, we delve deeper into some of the issues associated with biodiversity and explain some of the science involved. Students read a series of articles and complete a number of linked literacy activities. These include:

- Brainstorming
- Glossary
- Comprehension and summarising questions
- Questioning toolkit

Articles

1. **An Indigenous perspective**
   Aboriginal and Torres Strait Islander people have many thousands of years of experience living on and managing the land. Here we read an Indigenous perspective on biodiversity. See the CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 6, p81. Watch the video *Indigenous perspectives on biodiversity* at www.csiro.au/en/Research/Environment/Biodiversity/Biodiversity-book/Chapter-6

2. **Australia's biodiversity**
   The Australian continent can be divided into biomes, each with its own distinctive fauna and flora. Here we take a look at the key features of our terrestrial and marine environments. See the CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 2, p13. Watch the video *Australia's biodiversity: major features* at www.csiro.au/en/Research/Environment/Biodiversity/Biodiversity-book/Chapter-2

3. **Managing biodiversity**
   Australia's modern record of biodiversity management so far has been far from perfect. However, although biodiversity continues to decline, scientists are working hard to improve things for the future. See the CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 4, p55. Watch the video *Tools for managing and restoring biodiversity* at www.csiro.au/en/Research/Environment/Biodiversity/Biodiversity-book/Chapter-4

Brainstorming

Think about the following scenario...
You were born an Aboriginal child in Australia's outback, near Uluru, many years ago. You had lots of territory to explore and time to roam freely. You watched and learned from the adults, and grew up understanding how to live life on the land and how to manage nature's resources for future generations.

Class discussion:

- How did your real childhood compare to that in the scenario?
- If your childhood was different, what do you think it might have been like, growing up in the kind of environment described in the scenario? [If it was similar, describe how it was similar.]
- How might you have felt about the animals and plants you relied on for survival?
- Do you think a child growing up on the land might have a different relationship with nature compared to a child growing up in the city?
- How do you think it might feel, knowing that you must rely on your knowledge (yours personally as well as that of your culture) to survive on the land?
- Imagine as you grew up, you noticed some changes on the land (e.g. cane toads appearing, native species declining, the land being mined or built on). What concerns might you have:

  a) for the native animals and plants you grew up with
  b) for yourself
  c) for your children's future

An Indigenous perspective

See CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 6, p81

Aboriginal people shaped Australia's pre-colonial environments for 50,000 years. Today, Indigenous people have much to contribute to biodiversity management and research. Below, we hear from Peter Christophersen and Sandra McGregor, Aboriginal managers of lands adjacent to Kakadu National Park in the Northern Territory.
[Their words are in italics, presented as one voice. Co-author and scientist Fiona Walsh, who recorded discussions with Peter and Sandra, and edited the text, then provides a wider perspective. The words have been further edited.]

What is biodiversity and why is it important?

We look at Country as everything all living together. When you look, it's healthy because everything's got order and connection. Everything living and non-living: the birds and the rocks, and the relationship things have with each other. It is not just animals and plants. It includes humans, weather and all – not just those things that are living there but also the relationships, how everything functions together. In our eyes, humans are a part of the system. Biodiversity is not a word we use.

For everything we do here, there's something that we get out of it. We're not just working with no benefit. This reward might be more or bigger geese, or it might be easier to hunt wallabies. A benefit for non-Aboriginal mob is to have this pristine-looking place with plenty of animals. Ours is the same, except that we also need to utilise the animals. We have an understanding of how all those pieces benefit each other. Then, at the point when those pieces stop benefitting, we've got to jump in and help nature along a bit.

Aboriginal people rarely separate people from ecosystems, or social from natural and spiritual worlds. Traditionally, native plants and animals provided all of life's necessities equivalent to those from supermarkets, pharmacies or hardware stores. Precise classifications often exist: for example, Yanyuwa people from around Borroloola in the Northern Territory recognised 21 categories of bony fish and eels classified by habitat and use.

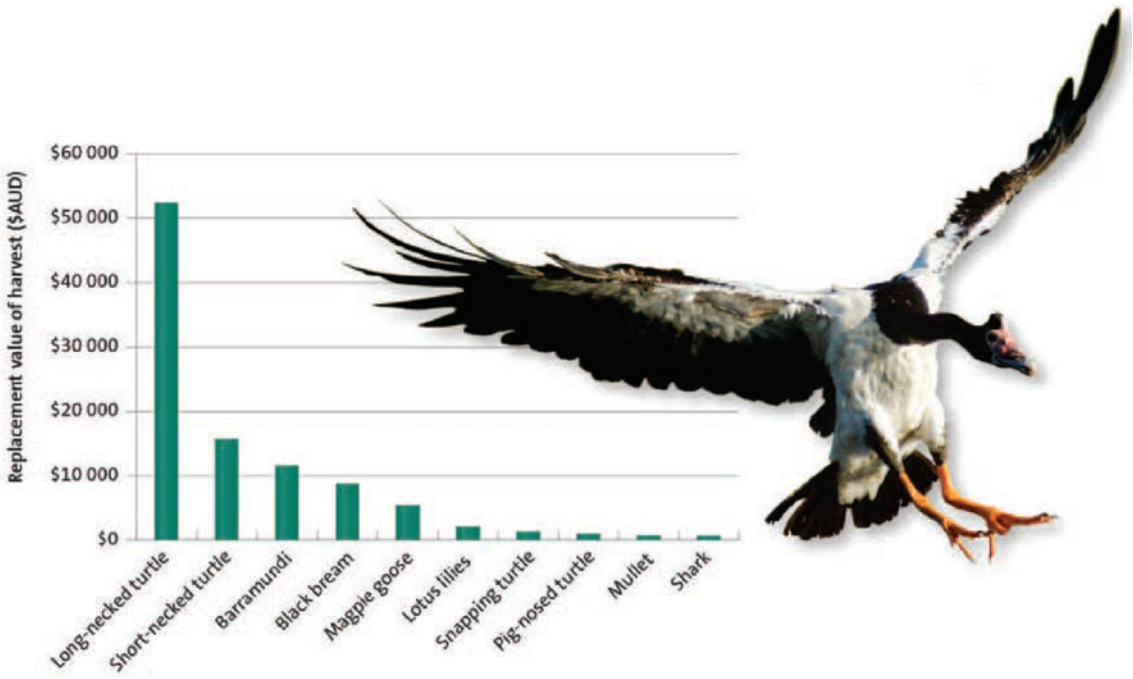


Figure 6.5: The volume of bush foods, such as magpie geese, Anseranas semipalmata, *turtles and fish, that were eaten by Aboriginal people at Daly River from 2008 to 2010 was equivalent to $100,000 of store-bought foods. This figure only shows the ten 'most valuable' species.*

Today, some Aboriginal people still depend on native species. For any one species used as a resource, several others are often needed to make it useful. To treat a burn, for example, a healer in desert Australia would apply the silk bag of a processionary caterpillar [iwepe, *Ochrogaster* spp.] with a poultice of emu bush [utnerrenge, *Eremophila longifolia*]. Five more species are also required after that for effective healing. Each of these species has many other interrelated uses.

How is biodiversity tracked?

We know how Country has changed from talking to old people like Sandra's grandmother. She's about 74 years old. Sandra took her to her place, where once there were freshwater billabongs.

The old lady said there used to be lilies; you could get turtles, millions of them. Now those billabongs are salt water, a different landscape. The old lady sort of knew the area but didn't know the place she'd landed, it had changed so much in 50 years. There are changes in our lifetime too. Sandra visited Boggy Plain in 1986, and then we both went there in 2000. Sandra looked at it and thought, 'No, this is not how it is supposed to be. It needs fire. It needs a helping hand to get back the numbers of plants and animals that should be here.'

We know how Country is changing by keeping an eye on what is happening. For example, we live a half-hour drive from the billabongs. Last night, there was a north wind and we could smell

salty mud. We knew what was happening out there. It is high tide. Salt water is going over the mud. The geese are digging the mud again and again. They are turning the mud to get food to condition themselves for one last flight before the Wet. This is going to be our last chance to get fat geese before they lose condition.

Aboriginal people living on or close to their Country make observations of species and ecological interactions over a lifetime and pass these across generations. In this way, changes over time are tracked and monitored. By contrast, scientists are usually short-term visitors who need historical documents to identify changes over time.

What is the condition of biodiversity?

There is a big decline in mammals. That's really bad. They are missing and we're not really sure what's doing it, whether it's been cane toads coming in or bad burning or other things; we just can't put a finger on it. We look at one area of woodland and it seems in bad condition, then another area looks in good condition yet still doesn't have mammals. That's confusing. But it does not directly affect us as we don't hunt and eat those little mammals.

But then you see little things tweaked that benefit an animal. The cane toad came in and the goannas and a lot of snakes are disappearing. That means now many ground-dwelling birds don't have those predators hammering them so there are more birds. Perhaps there is a new balance. The goannas used to dig up the long-necked turtle eggs, but now we're getting more little turtles. Maybe. We're just wondering about these links.

The goanna is very important to us. When the cane toad jumped in, we found dead goannas everywhere. That tore our heart out. We decided we can't hunt that goanna anymore. We've got to look at how this animal adapts to the toad. We've found some goannas are still mating, and killing cane toads. We've found baby goannas, so there's a hope that there might be populations in future.

Long-term recollections by Aboriginal people show that the diversity of bush resources is declining, and associated cultural knowledge is fragmenting. Species declines are strongly felt because they affect nutrition, health and psychological wellbeing – people speak of being wounded or struck ill by these losses. Aboriginal people recognise many factors that threaten the abundance of resources. For example, they say that bush food plants and animals are being pushed out by weeds ('stranger plants') and feral animals.

What solutions are there to biodiversity decline?

We're flat out trying to make a living and can't spend as much time managing this land as we want to. With more time, we'd be looking after cultural places, shooting feral animals, spraying weeds, burning, there's just never enough time. People's lives have changed and everyone is flat out doing other things. . . we can't put in the time and effort needed to look after Country in fine detail.

Karnu (Nancy Taylor) hunting on a recent burn with high species diversity bordering a long-unburnt area. dominated by spinifex in the Great Sandy Desert. Photo: Fiona Walsh, CSIRO.

The majority of Australians live in cities. They visit our Country, they say it's beautiful. They expect that a national park will be looked after well, but really you can't do it properly. There's value in keeping the land and improving its health. We know we could keep Country healthy if there was an economy built around that. Something like carbon farming, then there'd be a lot more Aboriginal mob out here working and looking after the place. Our primary role could be to manage the landscape and make sure it's all as good as we can make it. Surely that's got to be of benefit to all Australians.

On the wetlands, we look at everything. At a point, we say "Oh! This species of plant is not doing so well, and so there aren't enough geese here." Or "It's getting harder to get turtles. So in the next couple of years, we've got to burn this wetland." We jump in to reset the clock. We know that when those plants come back after a burn, the birds will be attracted back. We change the vegetation so that the goose benefits, the plants benefit, and we benefit.

For woodland, it's similar. We manipulate the grass with fire – it creates green pick to encourage animals to feed. We put a certain fire in and it'll help different grasses to grow and then it brings in the animals that we want – might be an agile wallaby, black wallaroo or other kangaroos.

Science can provide another layer of knowledge, particularly on long-term predictions. But sometimes we have different views. It is important in helping us make long-term decisions about Country. Science gives deeper understanding of future issues. Then we've got to work out how we work to adapt to all that change.

Many Indigenous people use both traditional and Western solutions to address the problem of biodiversity decline. For example, Sandra and Peter recognise that hunting feral animals can have value in managing Country. They also use local resources to operate a small-scale business, harvesting native seeds for mine-site rehabilitation. Enterprises such as this – businesses based on using natural resources for rehabilitation, or production of artefacts, niche foods or bush medicines – rely upon a diversity of species, and are very important to many Aboriginal groups.

What are your thoughts on the future?

I'm scared… because it's not going to pan out how I might want it to be. I'd like to see this country how it was before it was proclaimed as a park, where Aboriginal people are more active on their lands and live on their clan areas on outstations rather than in communities. Where we teach, pass knowledge on and preserve it. That's the only way I see biodiversity keeping in good order.

Connection and care inspire us. The more we do, the more we understand, the more knowledge we gain. It's interesting finding out more about how things work, how the plants, animals and weather interlink. Learning is really inspiring. So is teaching kids, teaching other people – sharing our little bit of knowledge and hopefully winning over another person to keep looking after this Country.

All people want a future for their children, and many Aboriginal people see the health of Country as integral to this. Feeling good about the future leads to action to make things better. The careful, pragmatic optimism expressed by Sandra and Peter points to a future that could benefit all Australians.

Activity 1 – Glossary

Define some of the terms used in the article, using the table provided.

Term	Definition
Biodiversity	
Biodiversity management	
Country	
Billabongs	
The Wet	
Ecological interactions	
Cultural knowledge	
Feral	
Carbon farming	
Wetland	
Woodland	
Biodiversity decline	
Rehabilitation	

Activity 2 – Summarising

Answer the following questions relating to the article.

1. Peter and Sandra talk in the article about 'Country'. Using your own words, explain what you understand this concept to mean.

_____

_____

_____

2. Compare the way Aboriginal people traditionally kept track of changes in their environment, with how today's scientists keep track.

_____

_____

_____

3. Sandra and Peter describe some changes they have noticed as 'bad' and others as bringing about a benefit of some kind. Give an example of each of these.

a) bad

_____

_____

_____

b) beneficial

_____

_____

_____

EXPLAIN (ARTICLE ONE)

4. The article describes how Aboriginal people sometimes changed the way they did things, in response to a change in their environment. Give an example of one such change.

5. Reading the words of Peter and Sandra, how do you sense they feel about the decline of species (loss of biodiversity) they have noticed?

6. Peter and Sandra talk about taking action to improve the health of the land. Give an example of such action.

7. How do the Aboriginal people speaking in this article view the contribution of science?

8. When Peter and Sandra talk about the future:

a) how do they feel about it, and why?

b) what do you think they see as the best way forward, and why?

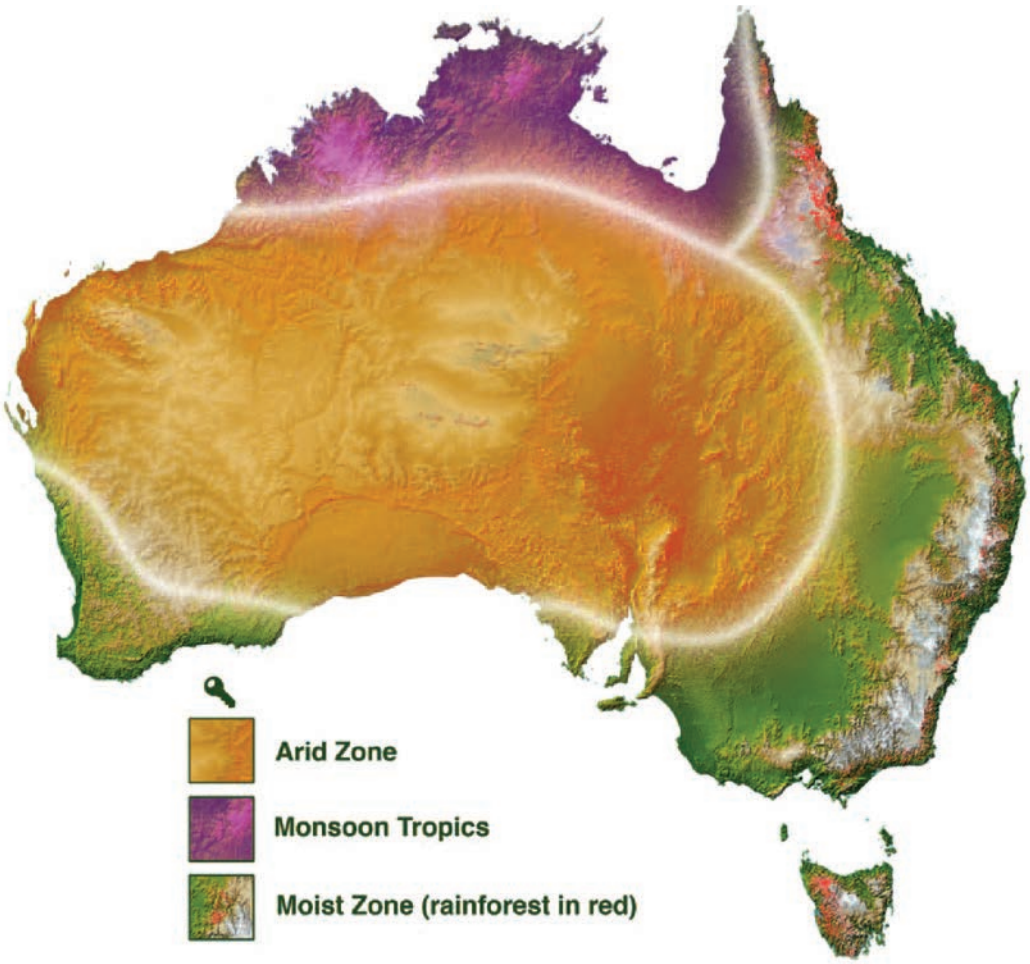
Australia's biodiversity

See CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 2, p13

Our terrestrial environment

The Australian continent can be divided into biogeographical regions called biomes, each of which has its own distinctive fauna and flora. These include the vast inland arid zone, the northern monsoonal tropics (spanning the continent's northern third), and the moist zone (wetter regions of tropical to temperate habitats in eastern and south-western Australia).

See Fig 2.4 on p19 of the CSIRO book *Biodiversity: Science and Solutions for Australia* for a map of Australia's biomes.



The arid zone

The arid zone covers most of the Australian continent, dominating the centre and west of the country. It is a series of deserts that appear to be largely infertile because of the long-term weathering of their soils. Yet, after rain, these deserts are lush with plant productivity. The greatest plant diversity exists at the edges of the arid zone, where species may arrive from other biomes.

Scientists used to believe that arid-zone species evolved from ancestors in wet forests and woodlands. But over time, it has become clear that the story is more complex. Genetic studies now show that Australia's deserts have been a 'cradle of animal evolution' – just as much as 'natural laboratories' like the Galapagos Islands. For example, desert lizards known as skinks have undergone one of the most strikingly diverse evolutions of any terrestrial vertebrate: just a few ancestors have given rise to more than 240 species.

Monsoonal tropics

This is a region of intense annual wet and dry seasons. It covers Australia's north and includes the Kimberley, Top End and Cape York Peninsula. Its most physically distinctive features are the basalt or sandstone escarpments and ranges of the Top End and Kimberley (that also protect isolated rainforest pockets); and grasslands known as savannas, which are the most extensive in the world.

Just as in the arid zone, genetics studies in the tropics have revealed that there is far more diversity here than was once thought. One of the best examples of this 'revolution' that has taken place in our understanding of biodiversity in monsoonal areas can be seen in the frog genus *Uperoleia*. This group is now known to include at least 27 different species, making it one of Australia's most species-rich frog genera. This wasn't understood until recently because these frogs are all small and look very similar to each other.

The moist zone

Compared to the rest of the continent, the forests and woodlands along Australia's east coast are rich in species. It might come as a surprise that diversity is generally higher in the eucalypt forests, woodlands and heaths of this biome than it is in the rainforests. This could be because there may have been higher rates of extinction (over evolutionary time) in the relatively small patches of remnant rainforest now left in Australia. In contrast, however, Australia's rainforests may retain some of the oldest branches of the evolutionary tree of flowering plants.

South-west Western Australia is an isolated and special region within this biome. It is a globally significant hotspot of plant biodiversity. More than half of the plant species here are endemic – meaning they do not naturally occur anywhere else. This area has been a major evolutionary refuge for Australia's two largest genera of plants, *Acacia* and *Eucalyptus*, as our continent has become increasingly drier.

There are also many endemic animal species in this special region. Gilbert's potoroo, *Potorous gilbertii*, is an example. This species was thought to have been extinct for more than 100 years, but was rediscovered in 1994. It is now the subject of successful community conservation and research projects.

Gilbert's potoroo, Potorous gilbertii, *is an example of a species found only in south-west Western Australia. Photo: Dick Walker, Gilbert's Potoroo Action Group (www.potoroo.org).*

Our marine environment

Scientists divide the marine environment into four depth-related zones: intertidal, coastal, neritic (the water column over the continental shelf) and abyssal (deeper than 2000m). Within these zones, a wide range of factors govern the evolution and distribution of marine organisms. These factors include water temperature, salinity, light, nutrients and the presence of habitat such as soft sediments. The distribution of marine organisms is also heavily influenced by whether their eggs remain on the sea floor or drift with the currents, and where their juvenile forms (larvae) eventually attach or settle down as adults.

Climatic and biogeographic differences among large regions of Australia's waters have the effect of creating a number of different zones, known as marine bioregions. These include the tropical, warm temperate, and cool temperate zones; as well as canyons and estuaries.

The tropical zone – Species diversity is high in the tropical zone, which is mainly made up of coral reefs and shorelines fringed with mangroves.

The warm temperate zone – Here, the shallow sea floor is dominated by seaweeds and seagrasses, and there are also different fish and invertebrate species. Along Australia's south coast, in particular, there are high numbers of endemic species of animals and seaweeds.

The cool temperate zone – The cool waters around Tasmania support fewer species than tropical waters, but may contain higher proportions of endemic species, such as giant kelp, *Macrocystis pyrifera,* which forms underwater forests.

Canyons – For millennia, sea water flowing across the continental shelf has tumbled into underwater cascades across Australia's continental slopes, carving deep canyons. The rocky walls of such canyons are habitats for a variety of invertebrate organisms, including soft corals, sponges, bryozoans and stalked crinoids. They are also home to many large fish species, and in some cases are important spawning or nursery areas for a range of commercial species.

Estuaries – Estuarine habitats straddle marine and terrestrial environments, and are where fresh and saline waters mix. One interesting example is Port Davey and Bathurst Harbour in Tasmania. The water here is cold and its surface is stained a dark colour from the tannins flowing in from nearby rainforests. As a result, the animals that live here resemble those found in deeper waters. Isolation allowed ancestral populations from those deeper habitats that became 'trapped' in this shallow water to evolve into distinctive but closely related species. One example is the Maugean skate (below), which occurs nowhere in the world except here and in nearby Macquarie Harbour.

Distributions of some southern hemisphere species may reflect historical linkages from before the break-up of Gondwana. The Maugean skate, Zearaja maugeana*, which is found only in two Tasmanian estuaries and has not been recorded from marine waters, is an example of such a species. Its two closest living relatives occur in New Zealand and South America. Photo: T. Carter, CSIRO.*

Activity 1 – Glossary

Define some of the terms used in the article, using the table provided.

Term	Definition
Biogeographical	
Biomes	
Arid	
Monsoonal	
Tropical	
Temperate	
Forest	
Woodland	
Remnant	
Heaths	
Hotspot	
Endemic	
Bryozoans	
Crinoids	

Activity 2 – Summarising

Complete the following tasks and answer the questions relating to the article.

1. Refer Fig 2.4 on p19 of the CSIRO book *Biodiversity: Science and Solutions for Australia*.

a) Using this as a guide, draw your own map of Australia (or use an outline of a map of Australia, if your teacher has one) and colour it in to show the three main biomes.

b) Which biome or zone do you live in? Mark your location on your map.

2. Fill out the table to show the main features of Australia's three terrestrial biomes. The arid zone has been done to get you started.

Biome	**Climate**	**Distinctive physical features**	**Distinctive living features**
Arid zone	Dry	Weathered soil	High plant growth after rain

3. Which part of Australia is considered the most biodiverse (richest in species)?

_____

_____

_____

4. Within the moist zone...

a) Where is biodiversity the highest, and why?

b) What makes south-west Western Australia such a special area?

5. Refer Fig 2.5 on p25 of the CSIRO book *Biodiversity: Science and Solutions for Australia*.

a) Using this as a guide, add the marine bioregions to your map of Australia (from Question 1).

b) If you live near the coast, which marine bioregion (e.g. tropical waters) do you live near?

6. Fill out the table to show the main features of Australia's marine bioregions.

Bioregion	Distinctive features

7. Identify seven factors that affect the distribution of marine organisms.

_____

_____

_____

_____

_____

_____

Managing biodiversity

See CSIRO book *Biodiversity: Science and Solutions for Australia* chapter 4, p55

Australia's tragic losses

Nearly 100 species of Australian organisms have become extinct since European settlement. This includes the Tasmanian tiger and 25 other mammals, which together account for 30% of all mammal extinctions worldwide in the last few hundred years.

Given that only 25% of Australia's organisms have been formally identified and that rare species are hard to find, it is likely there have been additional extinctions that have gone unnoticed; meaning that some animal and plant species are likely to have disappeared forever before we even knew they existed.

There are formal processes for categorising species according to their extinction risk by the States, Territories and Commonwealth. The categories – based on scientific data on species abundance and population trends – are: of least concern, common, rare, vulnerable, endangered or extinct. These categories help to determine the sorts of resources that should be used to address threats facing at-risk species. Of the 1600 Australian plant and animal species classified as rare or endangered, most are concentrated along the east coast and in southern and south-western Australia.

The main pressures on Australia's biodiversity – habitat fragmentation, altered fire regimes, invasive species, harvesting of species, and climate change – are increasing, and the rate of species decline is not slowing down. Many rare and threatened mammal species in Australia appear to be trending towards extinction, with their original ranges (the geographical area within which a species can be found) reduced between 80% and 99% since European settlement.

Gathering facts

To manage biodiversity more effectively, we need a better understanding of the status and trends of biodiversity. This, in turn, depends on our ability to monitor biodiversity over time.

Monitoring can be effective in two ways. It can be a routine surveillance activity to assess overall change, or it can be targeted to evaluate the performance of particular management actions.

Monitoring is important to track the status of a species or ecosystem listed as threatened under legislation such as the *Federal Environment Protection and Biodiversity Conservation* (EPBC) Act, and is identified as a priority in Australia's national biodiversity strategies.

Despite its importance, however, little effective ecological monitoring has been conducted in Australia. [One exception is the National Flying-fox Monitoring Program – see Case Study].

Scientists are striving to design more cost-effective and coordinated monitoring programs on larger scales. For example, the Terrestrial Ecosystems Research Network recently established long-term ecological monitoring sites across Australia. Similar marine programs exist, run by the Australian Institute of Marine Science, on the Great Barrier Reef.

Where to from here?

Australia continues to set itself challenging targets. The Australian Biodiversity Conservation Strategy (2010–2030) for example, aims to increase the area managed for conservation by 600,000km^2. To achieve such targets, effective long-term monitoring programs are required. The management and scientific challenges may be large, but so too will be the environmental and social benefits.

Drawing on international activities will also support our national effort. A global system of biodiversity observation networks called GEOBON was started in 2008 for detection of change using both on-site measurements and remote sensing techniques. The Intergovernmental Platform on Biodiversity and Ecosystem Services, established in 2012, also aims to provide an independent, scientifically sound, uniform and consistent framework to enable scientific knowledge on biodiversity to be translated into policy action.

Australia is well-placed to benefit from such global initiatives in responding effectively to the challenge of biodiversity decline.

Case Study: The National Flying-fox Monitoring Program

Two mainland Australian species of flying-fox are listed as vulnerable under the EPBC Act – the grey-headed flying-fox (*Pteropus poliocephalus*) and the spectacled flying-fox (*P. conspicillatus*). There are estimates that populations of these flying mammals may have declined by as much as 95% in the past century, with some researchers concerned that they could be extinct in the wild by 2050.

Flying-foxes are large bats that feed on fruit, flowers, pollen and nectar, and often congregate in camps made up of large numbers of individuals. Australians have an ambivalent relationship with flying-foxes. They are often unwelcomed because of the devastating impact that they can have on agricultural or horticultural crops, such as mangoes. Meanwhile, the urban camps that they set up are often perceived as smelly, noisy and disease-ridden. On the other hand, there has been much concern about the apparent population declines of these native Australian animals.

Ongoing conflict of values means that decisions about flying-foxes are invariably contested, and the debate is not helped by a lack of scientific information. To help resolve the issues, the National Flying-fox Monitoring Program was established in 2012 to determine exactly what is happening with flying-fox populations and their trends through time.

Flying-foxes are hard to monitor because they are highly mobile, regularly moving tens to hundreds of kilometres in short periods and clocking up thousands of kilometres over weeks. The monitoring program has been designed to account for these movements.

With the help of volunteers, about 500 flying-fox camps located across a distance of 3500km between Adelaide, in South Australia, and Cooktown, in far north Queensland, are visited within the same period each quarter, with each monitoring event completed in just three days. This minimises the possibility of missing or double-counting parts of the population.

It has been estimated that because of natural year-to-year variations in population size, 14 years of data will be needed to be able to accurately identify any human-induced change affecting these flying mammals.

Monitoring even just a couple of species, such as these flying-foxes, can be a time-consuming and expensive process. Photo: David Westcott, CSIRO.

Activity 1 – Glossary

Define some of the scientific terms used in the article, using the table provided.

Term	Definition
Species abundance	
Population trends	
Vulnerable	
Endangered	
Extinct	
Habitat fragmentation	
Fire regimes	
Invasive species	
Climate change	
Monitoring	
Surveillance	
Cost-effective	
Remote sensing	
Human-induced	
GEOBON	
EPBC Act	

Activity 2 – Summarising

Answer the following questions relating to the article.

1. How many species have become extinct in Australia since white Europeans settled here?

_____

_____

2. Draw and label the sections of a pie chart to show the proportion of world mammalian extinctions accounted for by Australia, and by the rest of the world.

3. Explain how it is possible that some Australian species may have become extinct before we even knew they existed.

_____

_____

_____

4. Identify the purpose of categorising species according to their extinction risk.

_____

_____

_____

5. What evidence is there to suggest that 'many Australian rare and threatened mammal species appear to be trending towards extinction'?

_____

_____

_____

_____

6. Using your own words, explain why monitoring is so important for managing biodiversity.

_____

_____

_____

_____

7. Fill in the following table to show some of the work being done to improve biodiversity management for the future.

Initiative / Organisation	Aims / What is being done
Terrestrial Ecosystems Research Network	
Australian Institute of Marine Science	
Australian Biodiversity Conservation Strategy	
GEOBON	
Intergovernmental Platform on Biodiversity and Ecosystem Services	

Questioning Toolkit

Bringing it all together

1. Create a mind map to show the main topics that the three articles address, and how these are related.

2. List five things that you have learned from reading these articles.

3. Complete the Questioning Toolkit below.

Write your ideas and opinions relating to each of the different types of questions.

[Inspired by Jamie McKenzie's Questioning Toolkit. Further reading on questioning toolkits: McKenzie, Jamie (2000) Beyond Technology, FNO Press, Bellingham, Washington, USA. www.fno.org/nov97/toolkit.html]

Type of question	Your ideas and opinions
Essential questions *These are the most important and central questions. They probe the deepest issues that confront us and can be difficult to answer.* Questions What is biodiversity? Why is it important? Why are we losing biodiversity? Why should we conserve biodiversity?	
Subsidiary questions *These questions help us to manage our information by finding the most relevant details.* Questions How can we best manage biodiversity? What can we do about biodiversity loss? How can scientific and Indigenous knowledge of the land be used together to help conserve biodiversity?	
Hypothetical questions *Questions designed to explore the possibilities, the 'what ifs?' They are useful when we want to test our hunches.* Questions What will happen if biodiversity continues to decline? What if our native species are completely replaced by feral and introduced species? If we lose some of our unique species, will tourists stop coming to Australia?	
Provocative questions *Questions to challenge convention.* Questions Do we take biodiversity for granted? Are we doing enough to protect our biodiversity? Who is ultimately responsible for managing biodiversity in Australia?	

About the Science Matrix

What is the Biodiversity Learning Matrix?

A Learning Matrix is a flexible classroom tool designed to meet the needs of a variety of different learning styles across different levels of capabilities. Students learn in many different ways; some are suited to hands-on activities, others are strong visual learners, some enjoy intellectually challenging and independent hands-off activities, while others need more guidance. The Matrix provides a smorgasbord of science learning activities from which teachers and/or students can choose.

Can I use the Matrix for 1 or 2 lessons, or for a whole unit of study?

Either! The Matrix is designed to be time flexible as well educationally flexible. Choose to complete one activity, or as many as you like.

Is there room for student negotiation?

Yes! Students can be given a copy of the Matrix and choose their own activities, or design their own activities in consultation with their classroom teacher.

What do the column headings mean?

Developing	**Extending**
Designed to enhance student comprehension of information by including research (other peoples' knowledge and ideas) into their activities.	Gives the student the opportunity to apply or transfer their learning into a new format where they have to create using their own design or evaluate using their own criteria.

What do the row headings mean?

First-hand investigations	Hands-on activities that follow scientific method. Includes experiments and surveys. Great for kinaesthetic and logical learners, as well as budding scientists.
Maker space activities	Hands-on building, troubleshooting and reviewing a design of their own.
Ethical thinking	Students learn to recognise and explore ethical concepts. They examine reasons supporting ethical decisions, consider consequences of ethical decisions and reflect on ethical actions. Students examine values, rights, responsibilities and points of view.
ICT	Students use searches to locate, access and generate digital data and information. Students generate ideas, plans and processes, and communicate these via ICT. They select and use software, manage data, understand social and ethical protocols, and understand the impacts of ICT.
Personal and social capabilities	Students recognise emotions, personal qualities and achievements in themselves and diverse perspectives and relationships with and between others. They learn self-management through working independently and learning how to express emotions appropriately. Students work collaboratively, make decisions, negotiate, resolve conflict and develop leadership skills.
Creative and critical thinking	Models the inquiry process. Students question, identify, clarify, organise and process information. They generate ideas, possibilities and actions, connect ideas, consider alternatives and seek solutions. Students also reflect on thinking (metacognition) and processes, apply logic and reasoning, draw conclusions, and evaluate procedures. Knowledge is transferred into new contexts.
Time travel	Here students consider scientific and technological development as a linear process by travelling back in time or creatively into the future.

Biodiversity Learning Matrix		
	Developing	**Extending**
First-hand investigations	What biodiversity do you have on your school grounds? See Linked Activity 1.	Are plant biodiversity and animal biodiversity related? Design an experiment to find out. See Linked Activity 2.
Maker space activities	Make a badge that can be worn (e.g. during Science Week) that promotes the biodiversity of Australia or your local area.	Using recycled materials, create a sculpture or other artwork that reflects how you feel about biodiversity.
Ethical thinking	Is the Aboriginal concept of 'Country' a good philosophy to have in managing the land? What do you think of traditional Aboriginal attitudes towards nature compared with European Australia's attitudes? Record your thoughts and feelings on paper or using audio. (Ref: p84–85, CSIRO book, *Biodiversity: Science and Solutions for Australia*)	Does it matter that biodiversity is declining? Is it okay if human actions are to blame? Debate the ethics involved.
ICT	Make a short internet video that explains to viewers how to: a) use the 'Atlas of Living Australia' to see what lives in their local area b) contribute to the Atlas as a citizen scientist. (Ref: p42–43, CSIRO book, *Biodiversity: Science and Solutions for Australia*)	Do some research then create a Prezi presentation that outlines Australia's National Reserve System and how it is managed. (Ref: p70–77, CSIRO book, *Biodiversity: Science and Solutions for Australia*)

Biodiversity Learning Matrix		
	Developing	Extending
Personal and social capabilities	Is there anything you personally could do to support biodiversity? Make a list of actions (big or small) that you could take in your own life to help biodiversity in some way.	Contact your local Council to find out if any native species in your area are under threat, then draw up an Action Plan showing what your local community could do to help. **OR** Interview/invite an Aboriginal representative (e.g. from National Parks and Wildlife Service) to talk to your class about local biodiversity.
Creative and critical thinking	Explore the main threats to Australia's biodiversity. See Linked Activity 3. (Ref: Table 4.1, p57, CSIRO book, *Biodiversity: Science and Solutions for Australia*)	What is 'connectivity conservation'? Does it work? Should we be doing more of it? Conduct some research, then produce a short magazine article (including pictures) that explains and critiques the concept. (Ref: p79 & 114, CSIRO book *Biodiversity: Science and Solutions for Australia*)
Time travel	Find out about an Australian animal that used to be common and has now become extinct (choose one of the animals pictured on p45 of the book). What happened? Why did it become extinct? Is there something that could have been done to prevent the extinction?	Write a diary entry for whichever year you are due to turn 50. How has your local area changed? Which species have become dominant? Which have disappeared? What else has changed about biodiversity since your childhood?

Linked Activity 1

Critter biodiversity

Aim

To investigate the diversity of critters (including insects and arachnids) at your school.

Introduction

In this activity, you will investigate the critter life at your school. As critters are living things, it is important that you do not harm them and that you try to return them to where you found them. It is also very important that you DO NOT TOUCH any potentially harmful insects or spiders. If you do somehow get bitten or stung, tell your teacher immediately.

Hypothesis

Make a statement about what you think the results of your investigation might be.

Materials

- 3 Petri dishes per student
- 1 tray (to hold used Petri dishes)
- Small twigs to help catch critters
- Gloves

Risk Analysis

Risk	Precaution	Consequence
Bite/sting from an insect or spider	Do not touch any critters – collect them directly into the Petri dish or use a small twig Wear gloves	Stinging, itching, possible allergic reaction

Method

1. Identify an area within the school grounds that would be suitable for this investigation.
2. Carefully collect a critter in each of your Petri dishes (or at least 1 or 2 of them). Take care while handling critters so you don't hurt them or yourself – if you are unsure, or have any difficulties, seek help from an adult. You will need to return the critters to their locations after your investigation, so draw a mud map to mark their location as a reminder. You may be able to collect some critters directly into the dish, while for others (e.g. small spiders) it may be easier to carefully use a twig. [Tip: look under leaf litter on the ground, on the bark of trees and on flowers, stems and leaves.]
3. Put each Petri dish in the tray and return to the classroom with your teacher.
4. Sort your Petri dishes into stacks: one for each kind of critter. e.g. make a stack of dishes containing different ants, another with beetles, another with spiders and so on.
5. Count the number of each type of critter, and record your data.
6. To ensure you have minimum impact on the environment, carefully return all critters to where you found them.

Note: Alternatively, if your teacher would prefer it, you can photograph the critters where you find them, avoiding having to catch them.

Results

1. Draw a data table in the space provided, showing how many of each type of critter your class found. [Remember to give the table a title.]

2. Graph the results shown in your data table (use a column graph) in the space provided.

3. Write a sentence summarising the results shown in your graph.

_____

Discussion

1. What do you understand to be the meaning of the term 'biodiversity'?

_____

_____

_____

2. Looking at your class results as a whole, how would you describe the critter biodiversity of your schoolyard?

_____

_____

_____

3. Do you think it is better for an ecosystem to have a large number of one or two species, or a large variety of different species? Give reasons for your answer.

_____

_____

_____

4. Can you think of anything that could significantly change the critter biodiversity of your schoolyard:

a) to improve it?

_____

_____

a) to decrease it?

_____

_____

ELABORATE

5. Do you think it would matter if one of the critter types you found (e.g. ants) were to completely disappear from the yard? Give reasons for your answer.

6. Why do you think you were asked to return the critter you collected back to where you found them?

7. Why do you think it is important not to harm living things or their habitats when conducting scientific investigations?

Conclusion

Write a concluding sentence that relates to your Aim.

Linked Activity 2

Are plant biodiversity and animal diversity related?

Aim

To explore the relationship between plant biodiversity and animal biodiversity.

Introduction

Your task is to design and conduct an experiment to address the Aim (above). Do areas with a good diversity of plants necessarily also have a good diversity of animals? Do areas with a poor diversity of plants also have a poor diversity of animals? Or are these things independent of one another?

Think about whether you will either set up two artificial environments to compare, or go out and find two naturally occurring environments to compare.

Hypothesis

Make a statement about what you think the results of your investigation might be, and why. (What do you think you will find about the relationship between plant and animal biodiversity?)

_____

_____

Materials

List the materials that you will need for your experiment.

_____

_____

_____

_____

Risk Analysis

List any risks and the precautions that can be taken to reduce these during the experiment.

Risk	Precaution	Consequence

Method

Write your own Method (as a numbered list), showing how you will test your hypothesis. Then follow your Method step-by-step to conduct your experiment. [Tip: remember that you need to control variables to make your experiment scientific.]

Results

1. Design a table to record your results.

2. Write a sentence or two summarising the results shown in the table.

_____

_____

_____

_____

Discussion

1. Did your results support your hypothesis? If not, explain why not.

_____

_____

_____

_____

2. Identify the variables in your experiment:

a) independent

_____

b) dependent

_____

c) controlled

_____

3. Identify any difficulties you had during this experiment.

_____

_____

_____

4. If you were to do this experiment again, what would you change and why?

_____

_____

_____

Conclusion

Write a concluding sentence that relates to your Aim.

_____

_____

_____

Linked Activity 3

Threats to biodiversity

In this activity, the class will break into groups, learn different aspects of a topic, then come together to share their learning with others.

Stage 1 – Researching and group work

1. Break into 6-8 groups of equal size.

2. Use p56–62 of the CSIRO book *Biodiversity: Science and Solutions for Australia* to find out about the main threats to biodiversity in Australia. Each group will research one threat:

Group 1: Habitat loss and fragmentation
Group 2: Invasion by non-native species
Group 3: Over-grazing
Group 4: Fire
Group 5: Over-harvesting
Group 6: Climate change

If you have enough people, you could form two additional groups:

Group 7: Disease
Group 8: Water pollution

3. During your research, consider these key points:

a) What is the threat? (describe it)
b) How is this threat a problem for biodiversity?
c) What is being done about it?

4. Each person in each group will be explaining what they learn to others, so will need to consider how they are going to teach what they learn e.g. how best to explain key points, whether any props (e.g. diagrams) are needed and how to check whether people understand.

Stage 2 – Sharing learning

1. Get together in new groupings which comprise one person from each original group (i.e. one person from Group 1, one person from Group 2, one person from Group 3, etc).
2. Give each person a chance to share what they learned during Stage 1. Answer any questions that people have.

Stage 3 – Class discussion and brainstorming

1. Come together for a whole-class discussion.

   a) Are there some threats that the class sees as more of a problem for biodiversity than others?
   b) Is there one threat in particular that the class recognises as a significant problem in their local area?
   c) Is anything being done about this threat? Is it enough?

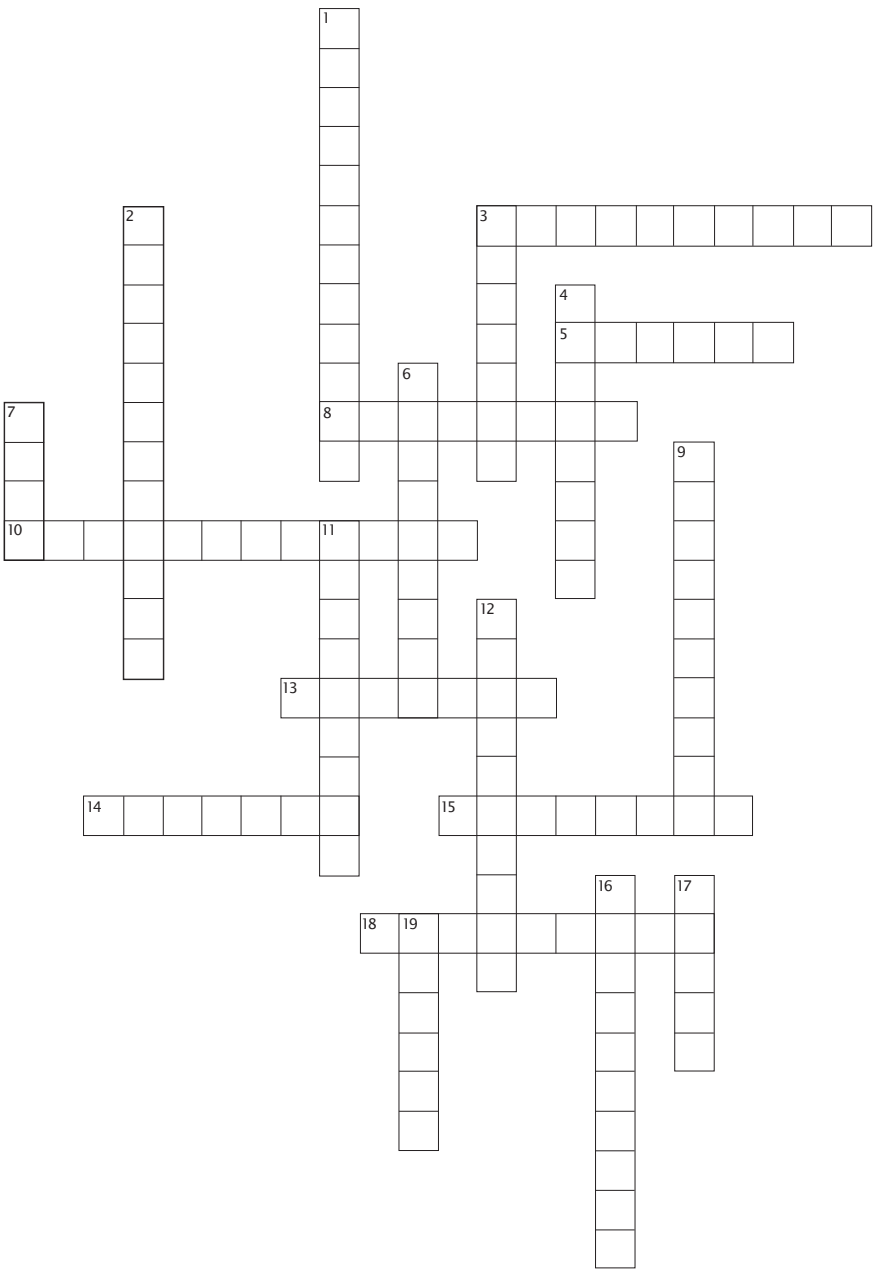
2. Brainstorm what action could be taken.

   a) Can the class think of anything they could do that might help the situation?
   b) Is there anything other people in your local community could do that might help?
   c) What could you as a class do to get your local community involved?

EVALUATE

Activities to allow students to show what they now know about biodiversity and to evaluate their learning.

Crossword (answers p69)



Across

3. In danger of becoming extinct
5. Originating and living naturally in a particular environment or country
8. Describing a region or climate that is consistently warm and humid
10. The geographical area within which a species is found
13. An ecosystem featuring land covered mostly with water and marshy areas
14. Having no living representative; having died out
15. An ecosystem featuring land covered with woods or trees
18. How many individuals or species; how common or rare a species is

Down

1. The variety of all life forms on Earth and the ecosystems in which they live
2. Preservation or protection of the natural environment
3. Native to a particular region, and found naturally in that region only
4. Non-native species that invades and disrupts native species
6. With intense annual wet and dry seasons
7. Having little or no rain; desert-like
9. A group of individuals of the same species and living in the same region
11. A region or climate with consistently mild temperatures
12. Activities to measure trends in populations or species through time
16. Describing the first people of a land; native people
17. Having returned to an untamed state after being domesticated
19. Biogeographical regions with their own distinctive fauna and flora

Biodiversity DIY quiz

1. Ask each student to call out a word or term that relates to biodiversity (e.g. feral). Record these on the board.
2. Each student picks 3 terms from the board and writes a definition for each.
3. Each student picks another 3 terms from the board, and writes one paragraph that includes each of these words.
4. Students create their own concept map, diagram, or other type of visual representation, to show what they have learned about biodiversity. They are to use as many words/terms from the board as possible, and show the connections between these.

Class debate

1. Choose one of the following statements as the topic for a class debate:

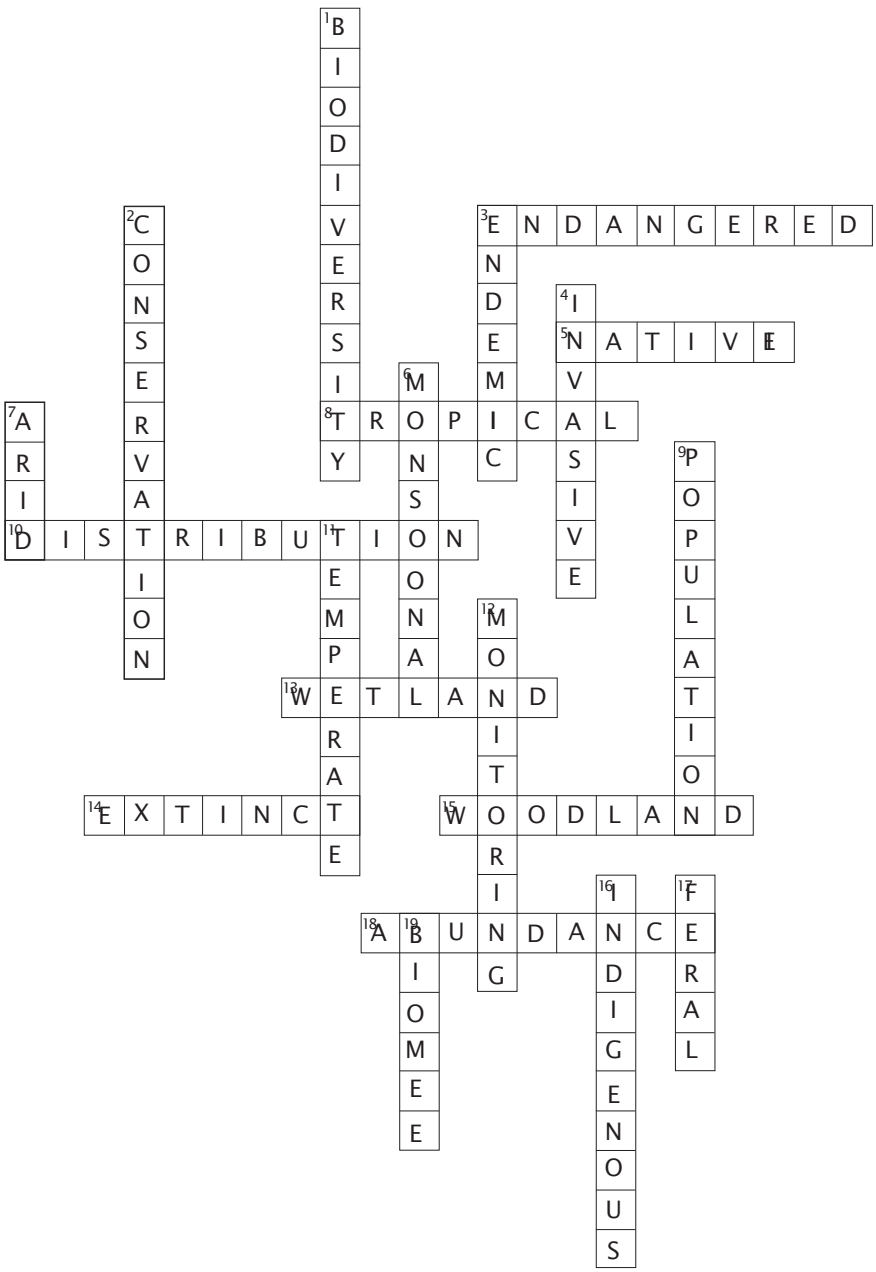
   a) We all have a vital role to play in biodiversity conservation.
   b) Further loss of biodiversity is inevitable.
   c) Extinctions are normal in nature, and nothing to feel bad about.
2. Divide the class into two groups. Group 1 will debate the affirmative and Group 2 will debate the opposing view.
3. Appoint an adjudicator, or an adjudicating team to decide which debating team presents the most compelling argument.

Group presentations

1. Place students into small groups, within which they will work to prepare and give a short presentation to the class. (Each member should have a few minutes to talk.)
2. Allocate a topic to each group, or have them choose their own, based on the activities they have been doing in this unit (e.g. local biodiversity; Australia's biodiversity; threats to biodiversity; managing biodiversity; Aboriginal perspectives on biodiversity; extinctions; threatened species.)
3. Give each group a mark for their overall presentation, and each group member an individual mark for their part of the talk.

Personal review of unit	
Personal summary	**Where to now?**
Make a dot-point summary, or a mind map, of all the things you learned during this unit of work. Highlight the things that you found most interesting.	Write down three things to do with biodiversity that you would like to learn more about (e.g. local threatened species) or three questions you have that you would like to know the answers to.ß
Something philosophical	**Something political**
Think of two ethical issues that came up during this unit of work, and propose some ideas about how these issues might be addressed.	If you were a leader in Australia today, what changes would you make to ensure our country's biodiversity was protected for the future?

CROSSWORD ANSWERS



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BIODIVERSITY

Australians have stewardship of a beautiful, diverse and unique environment. We have long had a sense that the biodiversity of this country is special. Yet, despite our sense of its importance, in many parts of our country biodiversity is in trouble.

Given the economic, ecological and social importance of biodiversity to our nation, CSIRO has been conducting research into Australia's biodiversity for nearly 90 years. This research has not simply focused on quantifying the challenge, but also on identifying practical solutions for its sustainable management.

Biodiversity: Science and Solutions for Australia aims to provide access to the latest scientific knowledge on Australia's biodiversity in an engaging and clear format. The book describes the ancient origins and unique features of Australia's species, as well as the current status of our biodiversity. It outlines tools for management and planning, highlights Indigenous perspectives on biodiversity, and looks at how Australia's biodiversity interacts with agriculture, the resources sector, cities, and with our changing global environment. Importantly, it also shows that biodiversity is in the eye of the beholder: for some it is our life support system, for others it is a resource to be used, for others it is a precious cultural symbol.

The book is also available electronically, featuring additional content including videos, case studies, and links to further information. The electronic version can be downloaded free of charge from www.csiro.au/biodiversitybook.

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