national science week 2024

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10-18 AUGUST 2024

SPECIES SURVIVAL

MORE THAN JUST SUSTAINABILITY

Australian Science Teachers Association

An Australian Government Initiative

Inspiring Australia


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OUR SURVIVAL DEPENDS ON THEIRS
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Welcome to the 40th edition of ASTA's annual teacher resource book, proudly supported by the Australian Government. In 1984, with sponsorship from CSIRO, the Australian Science Teachers Association launched an ambitious schools-based event and teacher booklet called Australian Science in Schools Week.

The week was a great success, and continued as an annual program until 1997, when the Australian Government and its partners established National Science Week – a national celebration encouraging Australians of all ages to become engaged with the sciences. I am proud to support the continued legacy of this annual teacher resource book, providing captivating science content and fostering scientific curiosity.

This year's theme, *Species Survival – More than just sustainability*, explores some of the critical challenges impacting Earth's human, animal and plant habitation, especially here in Australia.

We share our island home with more than 200,000 animal species – more than in any other developed nation – and around 24,000 species of native plants, each contributing to our rich biodiversity. Our custodianship comes with a great responsibility to protect their long-term survival.

Once the realm of science fiction, we now have extraordinary capabilities to research and tackle these challenges, from large scale carbon capture schemes to developing technology to combat species loss at a microscale. Scientists employ techniques to genetically manipulate species' resilience and are even attempting to use RNA to reintroduce extinct species, such as the thylacine.

Collaborative efforts across the STEM community, citizen scientists and Indigenous science specialists are unlocking new approaches to the existential threats faced by living creatures. Species survival is a truly global effort that demonstrates the best of what humanity can achieve together.

Looking back to 1984, as a high school student I couldn't have imagined the extraordinary leaps in science and technology that have not only underpinned our economic and industrial progress, but perhaps will now play a decisive role in our survival.

The Hon Ed Husic MP,
Minister for Industry and Science

> ***"We share our island home with more than 200,000 animal species."***

Australian Government | ANSTO
Science. Ingenuity. Sustainability.

Experience National Science Week with ANSTO

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Shorebirds 2024: *Flight for survival*

YEAR 3 to 6

Learn how many shorebird species are threatened with extinction and then design a postcard showcasing a shorebird and its wetland or coastal environment.

www.ansto.gov.au/shorebirds-2024-flight-for-survival

Think Science! 2024: *Bringing science skills together*

Think Science!

YEAR 3 to 10

Encourages students to develop their science inquiry skills. Working in small teams, they conduct a first-hand investigation on a topic of their choosing, then prepare a video sharing their process and findings.

www.ansto.gov.au/education/think-science-bringing-science-skills-together

2024 National Science Week Hackathon

ANSTO's National Science Week Hackathon

YEAR 7 to 10

An immersive experience where students compete in teams to develop diverse ideas and skills to rapidly design and build a solution to a problem that aligns with the National Science Week theme.

www.ansto.gov.au/national-science-week-hackathon

All competitions are free to enter with great prizes for the winning schools and students.

Win GREAT PRIZES

national science week 2024

CONTENTS

WELCOME!

The outstanding series of National Science Week resource books has been published annually by ASTA with Australian Government funding support since 1984. ASTA is proud of its contribution to National Science Week. The resource book is designed specifically for both teachers of F–10 and all community educators and this year's book provides stimulating lessons on *Species Survival – More than just sustainability*, and investigates some of the challenges that affect life on Earth. This is very relevant for Australian habitats and species survival.

The resource book could be used in planning for National Science Week 2024 but as it is fully mapped to the Australian Curriculum: Science and has a lesson plan for each year level, it is a resource that can be used every year. Gather inspiration from this resource and engage your students in authentic and relevant science topics.

I would like to thank all those involved in the production of the resource book *Species Survival – More than just sustainability* and in particular the teachers who have shared exemplary learning activities.

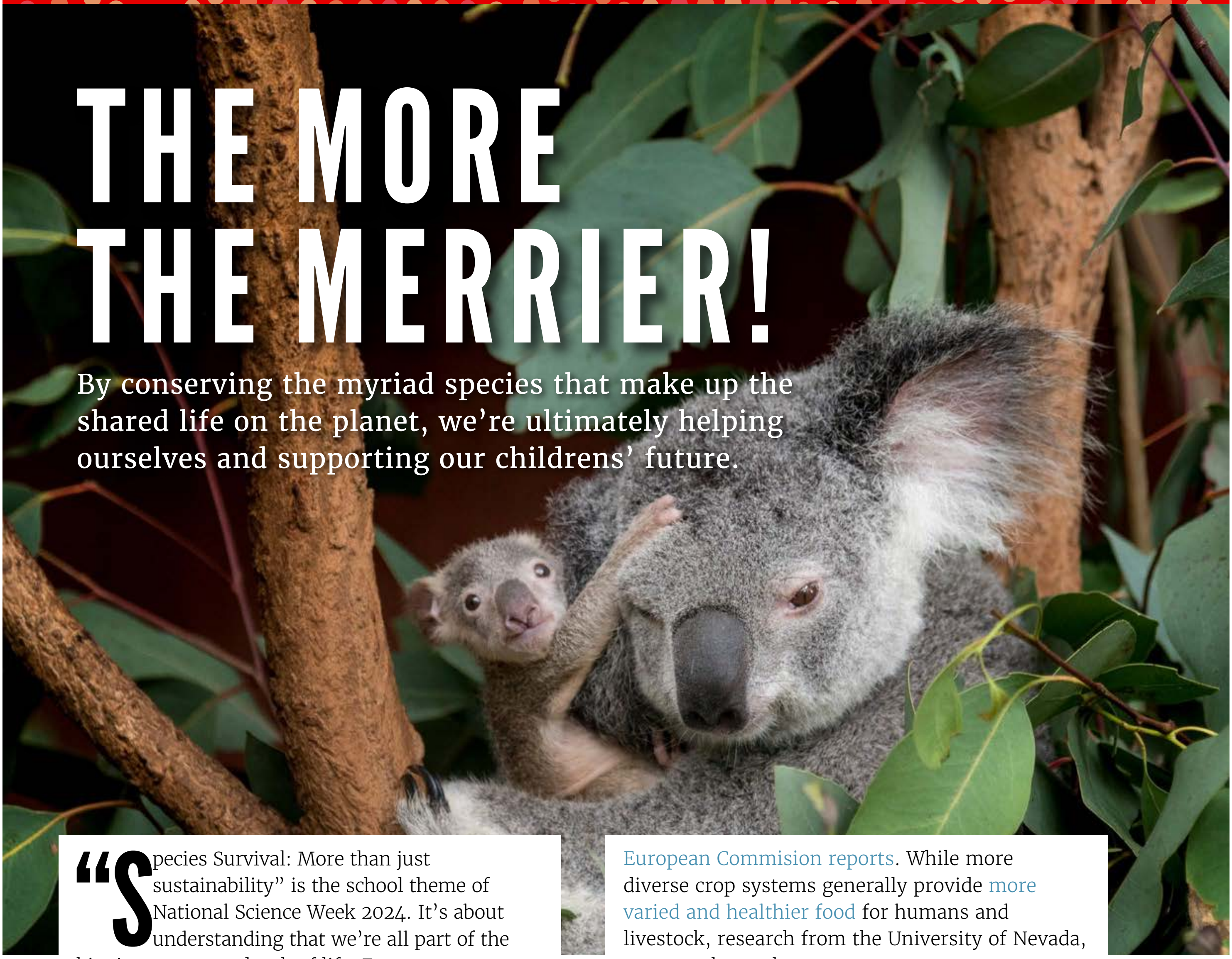
ASTA would like to acknowledge the eight state and territory Science Teachers Associations and their National Science Week representatives for their ongoing support of National Science Week in schools at the local level.

Margaret Shepherd,
ASTA President

Acknowledgements This online curriculum-linked resource was produced by the Australian Science Teachers Association (ASTA).

The materials in this educational resource have been developed by **Refraction Media**. Written by Sally Parker and Kate Kennedy-White, edited by Heather Catchpole and designed by Kat Power.

We wish to acknowledge: The scientific advisory group for reviewing this book for accuracy: Dr Vanessa Pirotta, Marine Predator Research Group, School of Natural Sciences, Macquarie University and A/Prof Kate Helmstedt, Associate Professor & DECRA Research Fellow, School of Mathematical Sciences, QUT, Leader, Applied Mathematical Ecology Group. Corey Tutt of Bilbara Education and Associate Professor Bradley Moggridge, University of Canberra for review of cultural materials. Geoff Crane, Questacon, for his assistance and feedback. **Cover image:** Kat Power Design.



THE MORE THE MERRIER!

By conserving the myriad species that make up the shared life on the planet, we're ultimately helping ourselves and supporting our childrens' future.

"Species Survival: More than just sustainability" is the school theme of National Science Week 2024. It's about understanding that we're all part of the big, interconnected web of life. Every creature, from the bees that pollinate our fruit trees to the worms that enrich our soil, plays an essential part. Their survival doesn't just protect nature's beauty, it ensures the health of the ecosystems that provide our food, clean water and the air we breathe.

Take a look at the United Nations' 17 Sustainable Development Goals – our "shared blueprint for peace and prosperity". At a glance, these are all quite human-focused, but many tie back to other species' survival. Here are a few examples:

"Zero Hunger" (Goal 2) goes beyond human nutrition. Sustainable agriculture supports balanced ecosystems and protects the pollinators crucial for our food crops. Without the tiny midges that pollinate cacao flowers, for example, we'd have no chocolate! The global decline in bees also threatens one-third of the food we eat every day.

There is growing evidence though, that monoculture crops can degrade soil, decrease biodiversity, and lead to overuse of pesticides, the European Commision reports. While more diverse crop systems generally provide more varied and healthier food for humans and livestock, research from the University of Nevada, among others, shows.

"Clean Water and Sanitation" (Goal 6) isn't just about human health. Clean water is essential for our homes, farms, schools and businesses. Healthy freshwater habitats support countless aquatic species, as well as migratory paths for wildlife. They also support cultural connections for First Nations People in Australia. Research has shown that increasing the diversity of species within water systems promotes clean water.

"Climate Action" (Goal 13) is about protecting our shared future, from supporting polar species and coral reefs to maintaining the natural cycles

> *"It's about understanding that we're all part of the big, interconnected web of life."*

on which many species rely. In our coastal areas, we are already seeing storm surges and tides eroding homes and land, while all of Australia is experiencing the effect of more extreme weather. Flying foxes, fish, bogong moths, marine turtles, possums and koalas are just a few examples of species that climate change is harming right now. Ultimately, the impact on humans will be just as devastating. Between 2030 and 2050, climate change is expected to cause about 250,000 additional deaths a year, through undernutrition, malaria and other problems.

"Partnerships for the Goals" (Goal 17) ensures conservation efforts are well funded and that valuable local and Indigenous knowledge is incorporated into our preservation strategies. In this guide, you'll find activities, information and resources to help integrate these goals into your community and school.

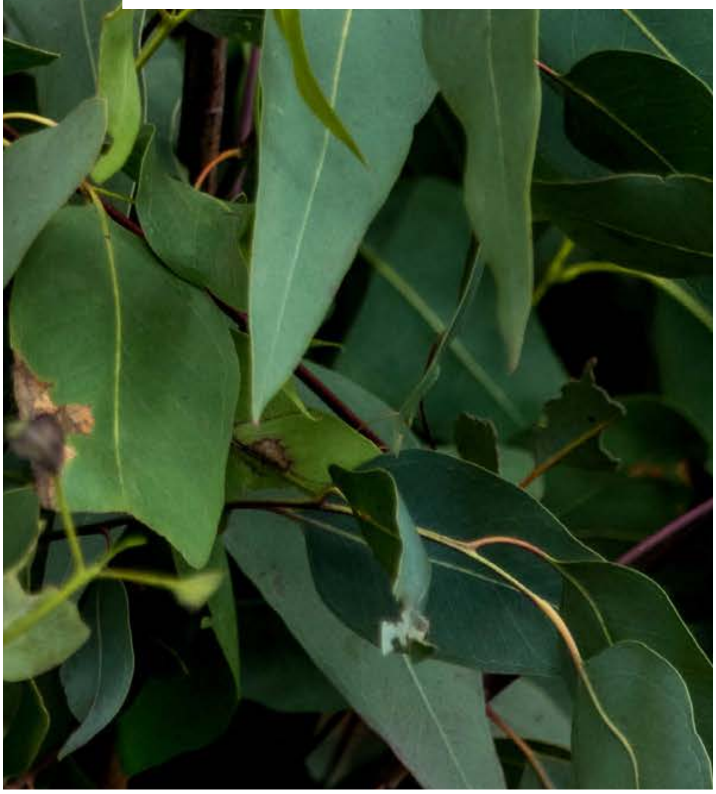
EVERYONE'S JOB

The job of protecting Earth's biodiversity – and ultimately ensuring our own wellbeing and survival – intersects with almost every field of knowledge and expertise. In the world of science, technology, engineering and mathematics (STEM) alone, each field has its unique role.

Science helps us understand ecosystems and unravel the genetic code of different species. Technology creates tools for conservation; for example, drones and artificial intelligence (AI) used to map habitats and count animal populations. Engineering design solutions, like wildlife corridors and living shorelines, address habitat destruction. Mathematics and data science help us predict and measure changes in species population numbers.

Beyond STEM, society and culture are deeply connected to species survival. Indigenous communities, for example, have coexisted with their environments for millennia, using cultural practices that sustain rather than exploit. Meanwhile, contemporary society shapes our values around consumption and conservation, like our evolving stance on the use of plastic and palm oil.

This Resource Book of Ideas for National Science Week gives communities, teachers and students Australian Curriculum-linked activities and resources to help explore these connections between species survival and our everyday lives. It delves into key topics, including food, data, culture, technology, biology and other advances in science. Find out how you can use our "Species Survival, Sustainability + X" formula – where X is the student's other interest or goal – to highlight these connections (see 'STEM + X and species survival' p8). Each 'X' area is linked tightly to the syllabus topics for each stage: Stage 1: Food, Stage 2: Data, Stage 3: Culture, Stage 4: Technology and Society, Stage 5: Biology.



FAST FACTS

- **28%** of all assessed species – plants and animals – are threatened with extinction. (Source)
- Only **39%** of Australia's unique plants have been assessed for extinction risk. (Source)
- Australia, Brazil and China are the **3** countries with the highest number of endemic plant species (meaning they grow nowhere else). (Source)
- **10%** of Australia's endemic land mammals have been lost to extinction in the last 200 years. (Source)
- **169.9 million** hectares: the area covered by Australia's National Reserve System (**22.1%** of our total landmass), protecting our natural landscapes and native plants and animals for future generations. (Source)

STEM+X AND SPECIES SURVIVAL

Our Species Survival, Sustainability + X formula connects the concept of species survival with other disciplines, interests and goals. Each 'X' is a lens through which we can better understand the complex challenge of species conservation and how, regardless of our personal interest or expertise, we can all play a role in the crucial mission of saving species from extinction.

Here are the Xs we will be exploring in this resource:

SUSTAINABILITY+FOOD

We rely on countless wild species for our food. How we eat affects the health of these species and their habitats. See p27 for Stage 1 student activities where the focus is on food and species sustainability.

SUSTAINABILITY+MATHS & DATA

By crunching numbers, we shed light on the state of species and habitats, helping us take action where it's needed most. See p32 for Stage 2 student activities where the focus is on data science.

SUSTAINABILITY+CULTURE

By embracing the wisdom of different cultures, especially First Nations People, we can learn to live in harmony with nature and champion the diverse lives sharing our planet. See p38 for Stage 3 student activities where the focus is on cultural practices.

SUSTAINABILITY+TECH & SOCIETY

From drones locating koalas after bushfires to tags that track sea life, tech tools are boosting our conservation efforts, including in citizen science, where we all have a collective role to play in species conservation. See p46 for Stage 4 student activities where the focus is on environmental technology.

SUSTAINABILITY+BIOLOGY

Through DNA studies, we're unlocking the mysteries of Earth's plants and animals, bolstering our efforts to protect them. See p54 for Stage 5 student activities where the focus is genetics, diversity and selection pressures.

3 SPECIES SUCCESS STORIES

1 SNIFFING OUT PLATYPUS BURROWS

Zoos Victoria is training sniffer dogs to find platypus burrows by their smell, helping scientists learn more about these shy animals. This project uses special tubes to capture the platypus scent and is a new way to gather information without bothering the animals. Even though the platypus is an iconic Australian animal, there's still a lot we don't know about them. (Source)

2 DROPPED OFF THE THREATENED SPECIES LIST

A study published in *Biological Conservation* in March 2023 found that between 2000 and 2022, 26 Australian species recovered enough to no longer be listed as threatened, thanks to conservation efforts. This included the greater bilby, burrowing bettong, western quoll, eastern barred bandicoot, sooty albatross, Bulloo grey grasswren and Murray cod. (Source/source).

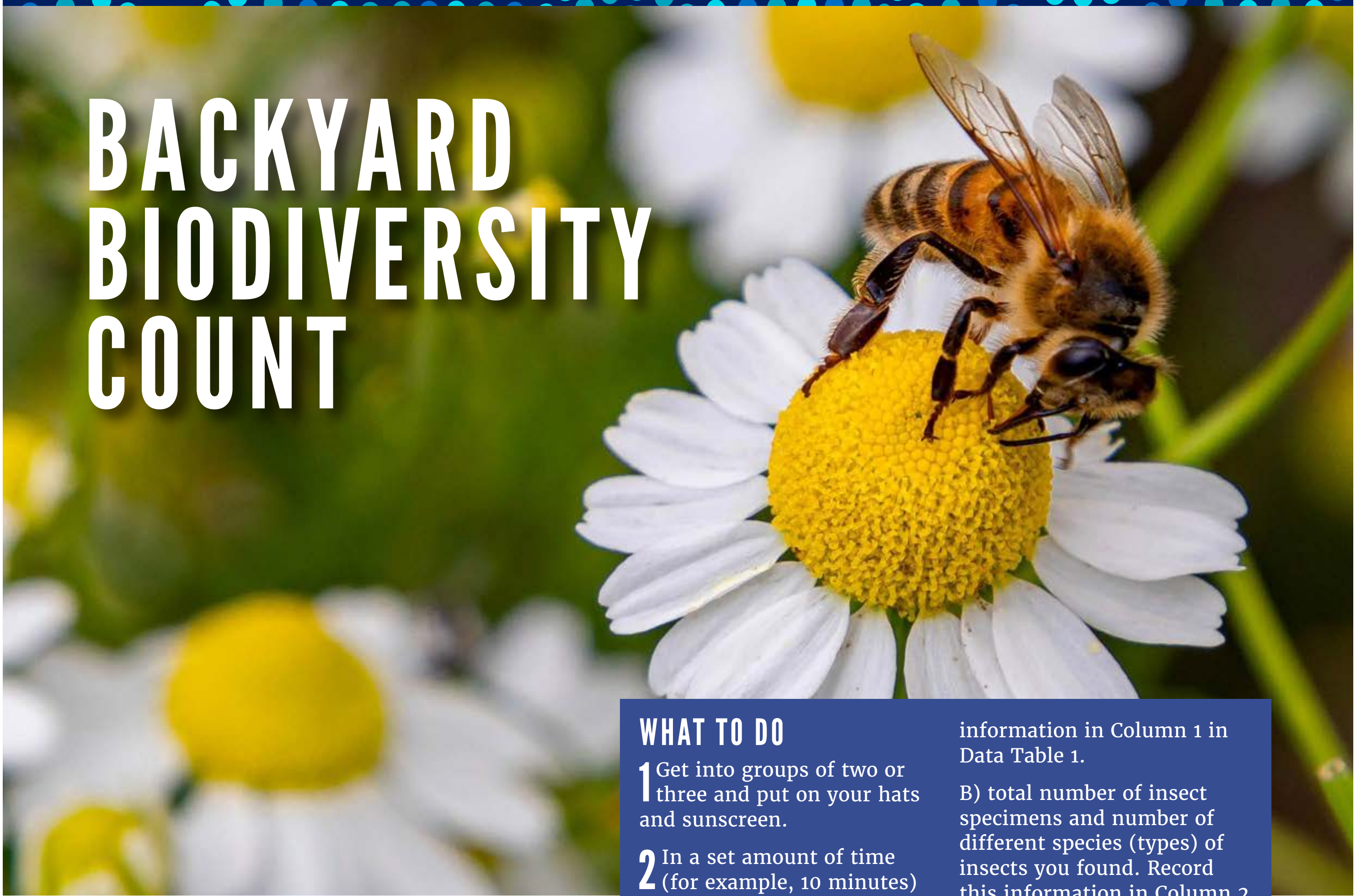
3 ALL'S WELL WITH WHALES

Once hunted to near extinction, with numbers plummeting to just over 100 in the sixties, the iconic humpback whales off Australia's east coast are a testament to conservation success. Following a 1963 ban on whaling, these majestic giants have rebounded impressively, reaching an estimated 40,000 by 2023, with their population growing at 10–11% every year. (Source)

DOWNLOAD ALL OF THE LINKS IN THIS BOOKLET AT WWW.SCIENCEWEEK.NET.AU/SCHOOLS/2024-RESOURCE-BOOK-LINKS/

PLATYPUS: TREVOR MCKINNON/UNSPLASH / GREATER BILBY: QUEENSLAND GOVERNMENT / HUMPBACK WHALE: THOMAS KELLEY/UNSPLASH

BACKYARD BIODIVERSITY COUNT

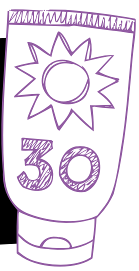


Community Activities

Going on a biodiversity count is a great way to get to know more about your local area, and the data that you generate is invaluable to researchers! There are many tools and projects you can use, from the Atlas of Living Australia to the iNaturalist or Frog ID app or the Aussie Bird Count.

You can also think about the scale of biodiversity. What might you find in a couple of shovels full of soil, or a jar or two from a local water system? Use the table on the next page to record your data.

SAFETY FIRST – TELL STUDENTS TO WEAR HATS AND SUNSCREEN BEFORE HEADING OUTDOORS ON THE BIODIVERSITY HUNT. REMIND STUDENTS NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS AT ALL TIMES.



WHAT TO DO

1 Get into groups of two or three and put on your hats and sunscreen.

2 In a set amount of time (for example, 10 minutes) 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, or evidence of species from as many different groups as possible (for example, birds, insects, spiders, plants, fungi).

5 When you find something, take a photo of it.

6 Remember, DO NOT TOUCH any insect or spider – your job is to take a photo of it, not catch it.

7 When time is up, go back inside.

8 In your group, go over all your photos and calculate:

A) total number of plant specimens and number of different species (types) of plant you found. Record this information in Column 1 in Data Table 1.

B) total number of insect specimens and number of different species (types) of insects you found. Record this information in Column 2 in Data Table 1.

C) total number of animal specimens and number of different species (types) of animals you found (or evidence of animals, such as feathers, poo or fur). Record this information in Column 3 in Data Table 1.

D) total number of other specimens not mentioned in columns 1, 2 or 3 and number of different species (types) you found. Record this information in Column 4 in Data Table 1.

9 Calculate the grand total of the number of specimens found by adding across columns 1 to 4 in Data Table 1. Add this total to the first row of Data Table 2.

10 Calculate the grand total of different species (types) by adding across columns 1 to 4 in Data Table 2. Add this total to the second row of Data Table 2.

11 Answer the discussion questions.

SPECIES DATA TABLE 1 – NUMBER OF SPECIMENS AND NUMBER OF SPECIES

COLUMN 1 – PLANTS	COLUMN 2 – INSECTS	COLUMN 3 – ANIMALS	COLUMN 4 OTHER/UNIDENTIFIED
e.g. eucalyptus trees x2	e.g. ants x55	e.g. possum poo = possum x1	e.g. spider x1 or mushroom x4
Total:	Total:	Total:	Total:
Number of different plant species (types):	Number of different insect species (types):	Number of different animal species (types):	Number of different 'other' species (types):

SPECIES DATA TABLE 2 – GRAND TOTAL OF SPECIMENS AND GRAND TOTAL OF NUMBER OF DIFFERENT SPECIES (TYPES)

Grand total of all specimens counted [add the number of specimens in columns 1 to 4]	
Grand total of different species (types) [add the number of different species in columns 1 to 4]	

DISCUSSION QUESTIONS

1. How many different species did each group of students find? Did every group find similar number of different species?
2. Was this more or fewer species than you expected to find? Justify your answer.
3. Are there other areas nearby (apart from where you looked) where you think you may have been able to find more or different species? Why do you think other areas may have more or different species?
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? What might cause their environment to change?
8. What influence might humans have in increasing or decreasing the number of different species?

USEFUL LINKS

- ATLAS OF LIVING AUSTRALIA
- PLANTNET APP - APP STORE OR GOOGLE PLAY
- INATURALIST APP - APP STORE OR GOOGLE PLAY
- CSIRO INSECT ID
- STATE AND TERRITORY FIELD GUIDE APPS

Community Activities

COMMUNITY HABITAT PROJECTS

In this activity, you'll use human-centred design thinking to understand a habitat loss issue in your area. You'll examine existing habitat restoration projects (such as possum boxes, Sydney seawalls) and design your own idea for habitat restoration in your community. Put it to your community or council and get some feedback on your idea.

WHAT IS DESIGN THINKING?

Design thinking is a smart approach to making things better. It's all about understanding and then focusing on what's really needed in a situation.

Imagine you're building a new zoo enclosure from scratch. Instead of just building a zoo enclosure with cool features, you'd talk to lots of animal experts and environmental scientists to find out what the animals that will live in that enclosure really need. The aim is for them to have an enjoyable and stimulating life where they thrive rather than just survive. During the design process, you'd ask questions like, 'How much space do they need?', 'What is their natural diet and habitat?' or 'Are they endangered in the wild and, therefore, require space for a breeding program?'

Then, you'd take all those ideas and come up with a bunch of different zoo designs with spaces best suited to the animals. You'd test aspects of the design and make changes and keep improving until you have an enclosure that's just right for the animals.

Design thinking is all about empathy, creativity and problem-solving. It helps make products and services that are useful and feel good. So, whatever the end product, this approach focuses on making things that fit specific needs and desires best.

DESIGN THINKING

EMPATHISE | DEFINE | IDEATE | PROTOTYPE | TEST

WHAT TO DO

1. In groups of 2–5, start brainstorming about the area where you live. Ask questions like: Who uses this area? What do they do? What are the ways wildlife uses the area? What might they need? How might we make their lives better?
2. Write out a statement that defines the problem of how we can best share space with wildlife in your area. You might like to write out several 'define' statements and then choose the one from the group you'd like to work on.
3. 'Ideate' is the fun part! Use Post-it notes, or an online brainstorming tool to write ideas – lots and lots of ideas. At this stage, there are no bad ideas!
4. During the 'prototype' stage, rough drafts or models are created to test and refine potential solutions, allowing designers to iterate quickly and gather valuable feedback.
5. Testing allows you to try out your prototype. You don't need a complete model for this, you can sketch the idea and run it past as many people as you can. This can be other groups working on the project, people you see walking in the area, scientists who know about the habitats and biology of the organisms in your area, local council, conservation volunteers – the more feedback you get at this stage the better.
6. Once you've gathered feedback, make changes to your prototype. Consider writing to your council, working with conservation volunteers or finding other ways to make the idea a reality.

USEFUL LINKS

- JUNIOR WORM FARM ACTIVITY (JUNIOR LANDCARE WEBSITE)
- LIVING SEA WALLS WEBSITE
- BUILD A POSSUM BOX ACTIVITY (BACKYARD BUDDIES WEBSITE)
- CONSERVATION VOLUNTEERS AUSTRALIA WEBSITE

SPECIES GAME: CONSERVATION CRISIS!

START HERE ...

TEACHER INSTRUCTIONS

AIM OF THE GAME

To provide a scientific model of species change within an ecosystem driven by natural environmental conditions and human actions.

OUTLINE

Students work as a team of 3 to 5 to set up a model ecosystem. This ecosystem is then exposed to simulated scenarios based on real-life examples that have the potential to increase or decrease species biodiversity over time.

SET UP THE ECOSYSTEM

A printed landscape becomes the ecosystem where paper cut out organisms can be added or removed. You can also copy and use the game as set up on Scratch.

PLAYING THE GAME

Students flip a coin or counter that directs them to select a Positive card or a Negative card. You can also generate a random number using Scratch. Here's how to set up the project [p13].

The Positive cards contain scenarios that have the potential to increase species diversity. The Negative cards contain scenarios that have the potential to decrease species diversity. As students follow the instructions on the cards, they add or remove species from their ecosystem.

Students keep a running log of the species change in their model ecosystem on the Game Card Record Sheet. Here, each team records the action and consequence required of each card selected. At the end of the game, students can answer curriculum and stage-linked questions related to their experience of the game.

Aspects of the game represent features of the real world, for example:

- **Game itself** – model of species change in an ecosystem over time.
- **Printed image of an Australian ecosystem** – the ecosystem.
- **Cut out species icons** – a variety of possible organisms living in the ecosystem.
- **Positive cards** – real-life scenarios that could increase the number of different species or total number of organisms in a particular species.
- **Negative cards** – real-life scenarios that could reduce the number of different species or the total number of organisms in a particular species.
- **Coin** – flipped to represent the often random nature of events that could affect species diversity in an ecosystem.
- **Addition or removal of species** – death, birth or migration in and out of the ecosystem.
- **Game Card Record Sheet** – data collection for the student working as a scientist by recording changes in the ecosystem as they take place.
- **Questions for Conservation Crisis!** – analysis of the data collected during the species diversity game.

TEACHER PREPARATION

1. Make a photocopy of the Ecosystem Sheet for each team of students participating in the game. See **p19**. This can be kept in the classroom for the duration of Science Week while the game is being played.
2. Make a photocopy of the Game Card Record Sheet for each team of students. This is where the data from the game is recorded to analyse later. See **p20**.
3. Make multiple photocopies of the different species icons to keep in the classroom. See **p21**.
4. Provide scissors to cut out the species icons and Blu Tack (or equivalent) to allow students to remove or add species to the ecosystem. Note: Do not glue the icons to the Ecosystem Sheet, as they will be difficult to remove from a card if required later.
5. Print 1 copy of all the Positive and Negative chance cards. If possible, print on thick paper for durability. See **pp15–18**.
6. Cut out the Positive and Negative chance cards along the lines. Stack the Positive cards in one pile and the Negative cards in another pile, face down on the teacher's desk.
7. Provide coins, double-sided counters (marked + – on back) or a spinning wheel with a binary option and randomly select either a Positive or Negative chance card for each round of the game.
8. Make copies of the instructions available to the students, **p14**.
9. Make copies of game analysis questions for the relevant stage available to the students. Stage 1 **p27**, Stage 2 **p31**, Stage 3 **p38**, Stage 4 **p46**, and Stage 5 **p53**.
10. Check that students understand the words ecosystem, diversity and species.

EXTENSIONS/ACCESSIBILITY

For younger students or students with physical disabilities: tape the organisms to foam blocks or LEGO and use counters to track the number of organisms added or removed from the system. You could also make the animals in playdough or craft materials with different textures.

For vision impaired students: use Braille versions of cards and raised or tactile versions of markers. Use a 3D printer to print tokens or create solid versions of the organisms and create or use tactile counters for counting.

STUDENT INSTRUCTIONS

1. Form a group of 3 to 5 students.
2. Decide on a species-related team name, such as Fabulous Frogs, Awesome Owls, and add it to the top of both the Ecosystem Sheet and the Game Card Record Sheet.
3. Add your individual names to the top of both the sheets also.
4. Set up your starting ecosystem by collecting the following species and Blu Tacking each one of them on your Ecosystem Sheet:

- **4 worms**
- **4 snails**

- **3 bees**
- **3 butterflies**
- **3 moths**
- **3 flowers**

- **2 parrots**
- **2 shore birds**
- **2 trees**
- **2 shrubs**
- **2 frogs**

- **1 owl**
- **1 lizard**
- **1 koala**
- **1 possum**

5. Flip a coin (or spin a wheel) to randomly indicate the selection of a Positive or Negative chance card. For example, if you flip ‘heads’ on a coin, select a Positive card, if ‘tails’ select a Negative card.
6. Once you have selected a card, read the scenario and carry out the instructions by either adding or removing species from your ecosystem. If you don’t have any left of that species to be subtracted, just ignore the card.
7. In the Game Card Record Sheet, record the details of the change in species due to the action on the card.
   a. At Column 1, write the number at the top of the card. Each card has a specific number identification.
   b. At Column 2, add or subtract the total number of organisms added or taken away. This is a running total so will change each time you action a card.
   c. At Column 3, subtract any total loss in species; for example if you lose all the sea birds, then -1 from this total on the previous row. If you lose an owl or a koala as well, this becomes -2.
   d. At Column 4, write a few words to describe the event on the card, such as ‘clean up Australia’ or ‘bushfire’.
8. Replace the card back in the pile randomly, face down, so it is shuffled.
9. Flip the coin again to select another Positive or Negative chance card. Carry out the action on the card and record it in the Game Card Record Sheet.
10. Repeat steps 8 and 9 several times before using the data in your Game Card Record Sheet to answer the questions related to your experience with this Species Diversity Game.

SAFETY FIRST – WHEN USING SCISSORS, STUDENTS MUST HOLD THEM BY THE HANDLES, CUT AWAY FROM THEMSELVES, STORE WITH THE BLADES CLOSED, CARRY THEM WITH THE BLADES CLOSED AND FACING DOWN AND ALERT THEIR TEACHER IF THEY HAVE ANY QUERIES OR CONCERNS.

GAME CARDS – PRIMARY – POSITIVE CARDS

CARD 1

You participate in Clean Up Australia Day to help create a healthy habitat for wildlife.

Add 1 more of each different plant and animal you have in your ecosystem.

CARD 2

You have long, grassy areas of the lawn covered with clover flowers that attract bees. You leave old pieces of wood there, too, where insects and lizards make their home.

Add 4 more flowers, 2 more butterflies and 2 more bees, and 1 lizard that comes in to eat the insects.

CARD 3

Your friends get together to build some possum boxes for the park.

Add 2 more possums to your ecosystem and 1 shrub, which has been nourished by the possum poo.

CARD 4

You help clean up rubbish and weeds from the beach or river.

Add 3 shore birds to your ecosystem.

CARD 5

The spring weather has been perfect, with plenty of warm sunshine and plenty of light rain.

Add 2 of each of your plant species to your ecosystem.

CARD 6

You plant some herbs on your balcony or window box.

Add 2 more of each insect, 2 snails that like to eat the herbs, and 1 lizard that comes in to eat the insects and snails.

CARD 7

You install a pond in your garden to attract the local frogs.

Add 2 frogs, 4 worms and 10 more insects to your ecosystem, as well as a parrot and a koala, which sometimes come to drink from the pond.

CARD 8

Your family has a compost bin, which you put in your garden to promote healthy plant growth.

Add 4 worms and 2 flowers to your ecosystem.

CARD 9

You collect and use the water from showers and baths to water your garden, instead of using tap water. This reduces how much water you use.

Add 1 tree, 1 shrub, 3 worms and 2 snails.

CARD 10

With your friends and neighbours, you help remove weeds from a bushland or park. This means there's more space for the plants and animals that live here to do better.

Add 1 flower, 1 shrub and 1 tree to your ecosystem. Also add 1 possum and 1 owl that come to use the tree.

GAME CARDS – PRIMARY – NEGATIVE CARDS

CARD 2

Your house keeps bright lights on all night, confusing insects, and attracting moths which think the light is the Moon. An owl eats the moths attracted to an outside light.

Remove all of your moths.

CARD 1

Mum mows the lawn very short each week. There are no hidey-holes left for insects to live.

Remove 4 insects from your ecosystem, 1 snail that would eat some of the insects and all the flowers.

CARD 4

An oil spill nearby affects your ecosystem. The oil gets into the feathers and food of the shore birds and they die.

Remove all the shore birds from your ecosystem.

CARD 3

Your dog runs loose at the beach, scaring off shore birds and their babies.

Remove 1 shore bird from your ecosystem.

CARD 6

You let your cat out at night, and it kills some of the animals that are nocturnal.

Remove 1 possum and 2 birds.

CARD 5

Climate change causes bushfires, which are happening more often than they used to occur. There's less time for plants to recover between fires and many animals are killed.

Remove 1 koala, 2 birds, 2 snails and all the flowers in your ecosystem.

CARD 8

People who don't know that prickly pear is a weed start growing prickly pear plants at home and then sell them online to people in the local area.

Remove all of your shrubs or all of your flowers due to them not having space to live with all the extra prickly pear growing.

CARD 7

You feed the local wildlife but the diet of white bread and crackers actually ends up causing harm to them.

Remove 1 of each type of bird from your ecosystem.

CARD 10

A flood in the area leaves many plants under water for days and kills many land-dwelling animals.

Remove 2 flowers and 1 lizard.

CARD 9

Pollution in the soil and waterways poison plants and animals.

Remove all the trees, 1 shrub, 2 worms and snails, and 1 bird that eats them.

GAME CARDS – SECONDARY ADDITIONAL POSITIVE CARDS

CARD 11

You make a bird feeder for your garden that parrots use to feed.

Add 5 parrots to your ecosystem.

CARD 12

You use a fly swat instead of fly spray, reducing the use of toxic chemicals that harm other insect life.

Add in 2 insects, 1 snail and 1 lizard.

CARD 13

You plant some bird and insect-friendly flowers.

Add 4 insects, 4 flowers and 1 bird to your ecosystem.

CARD 14

After volunteering at your local animal conservation park, the number of koalas increases.

Add 2 more koalas to your ecosystem.

CARD 15

You help set up a wetland park that attracts a range of wildlife.

Add 2 more of each bird, 2 of each insect and a frog or a lizard.

CARD 16

Biologists have genetically engineered a drought-resistant tree.

Double the number of trees in your ecosystem.

CARD 17

Scientists work out how to use the preserved DNA of extinct organisms to make them de-extinct.

Return 1 of any species that have been 100% removed or lost back into the ecosystem.

CARD 18

The local council creates a green space for residents by planting lots of native trees.

Add in 5 trees one of each kind of tree-dwelling organism.

GAME CARDS – PRIMARY SECONDARY ADDITIONAL NEGATIVE CARDS

CARD 12

An extended summer heatwave makes it difficult for many plants and animals to survive without water.

Remove 2 shrubs, a bird, 2 butterflies and all the snails.

CARD 11

You neglect the houseplants on the balcony, leaving the plants suffering and removing habitat for small animals.

Remove 2 flowers and 1 lizard.

CARD 14

A flu-like disease spreads through the bird population.

Remove all but 2 of your birds.

CARD 13

Natural Australian bush land is cleared near your ecosystem to make way for food production and housing. This means that the natural habitat of many species is reduced.

Remove 1 koala, 1 possum and 1 each of the different birds you have in your ecosystem.

CARD 16

Cane toads outcompete local frogs for resources.

Remove any frogs from your ecosystem.

CARD 15

Animals suffer from eating plastic because they think it is food.

Remove 1 lizard and 2 birds from your ecosystem.

CARD 18

A developer clears land to prepare a building site.

Remove all tree dwellers that can't fly elsewhere such as koalas and possums.

CARD 17

The local bee community is infested with a parasitic mite called *Varroa destructor* that is killing all the bees.

Remove any bees from your ecosystem.

SPECIES DIVERSITY ECOSYSTEM SHEET

TEAM NAME: ______________________ **STUDENT NAMES:** ______________________

____

BEES	MOTHS	BUTTERFLIES
OWLS	**PARROTS**	**SHORE BIRDS**
WORMS	**SNAILS**	**FROGS**
KOALAS	**POSSUMS**	**LIZARDS**
TREES	**FLOWERS**	**SHRUBS**

GAME CARD RECORD SHEET

TEAM NAME: ______________________ **STUDENT NAMES:** ______________________

____

FOR EACH CARD YOU SELECT, SUMMARISE THE CHANGE IN YOUR SPECIES OVER TIME.

1. CARD NUMBER	2. TOTAL NUMBER OF ORGANISMS LEFT	3. TOTAL NUMBER OF DIFFERENT SPECIES LEFT	4. SUMMARY OF SCENARIO: WHAT HELPED OR HARMED THE NUMBER OF SPECIES?	OVERALL, IS THERE A POSITIVE OR NEGATIVE IMPACT ON THE SPECIES DIVERSITY?
STARTED WITH	34	15		

Add in any extra rows if you use more than eight cards.

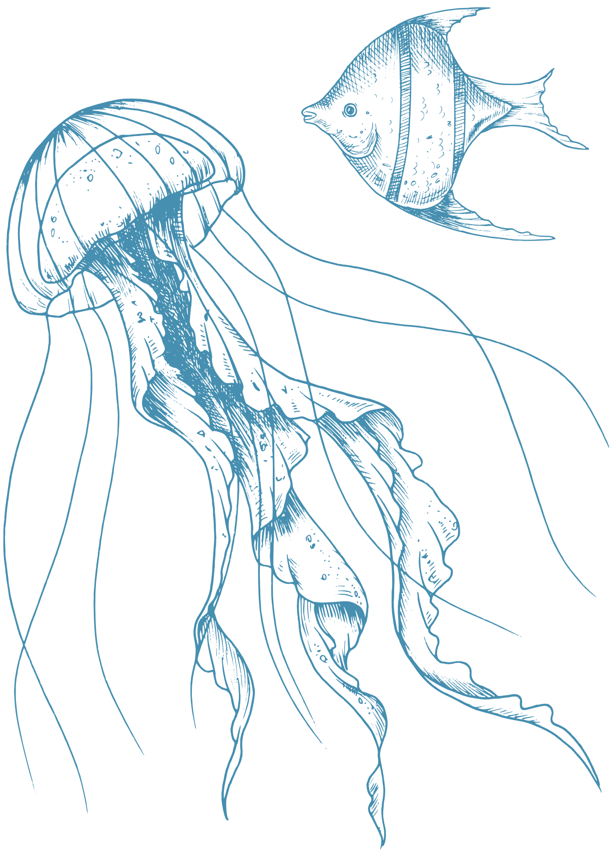
FOOD + SPECIES SURVIVAL INTRODUCTION

FOOD FOR ALL

There are countless examples of how our food and water are related to species survival.

F to Year 2

An ecosystem is like a big community of living things (plants and animals) that all work together to create a special environment. It's like a big team where everyone has a job to do!



Habitat: This is the special home where all the plants and animals live. It can be a forest, a desert, a pond, or even your backyard.

Plants: These are mostly green things that grow in the soil. They can be big trees, tiny flowers, or even the grass you play on.

Animals: These are the living creatures that move around. Birds flying in the sky, fish swimming in the water, and bugs crawling on the ground are all part of the ecosystem.

Sun: The Sun gives light and warmth to the plants and helps them grow. The Sun is like the ecosystem's own superhero!

Water: Ecosystems need water, too. It can be a river, a lake, fog, dew or even rain. Plants absorb and animals drink water to stay healthy and the water can be the animals' home.

Air: Just like you breathe in and out, some plants and animals need air to live. The air has a gas called oxygen that helps animals stay alive, and plants need carbon dioxide. These gases are also dissolved in water and used by most of the animals and plants that live there.

Think of the ecosystem as a big team where each member plays a part. Plants make leaves, fruit, nuts and seeds that some animals eat, and they get eaten by other animals. Everything has a role to play.

The *Very Hungry Caterpillar* by Eric Carle follows the journey of a little caterpillar as it eats various foods before transforming into a beautiful butterfly. While the book doesn't explicitly focus on ecosystems, it indirectly introduces young readers to the interconnectedness of living things in nature, showcasing the life cycle of a butterfly and emphasising the importance of balance and harmony within ecosystems for the wellbeing of all creatures.

CLIMATE CHANGE, FOOD AND ECOSYSTEMS

Climate change affects species survival, which in turn affects our access to food and clean water. Clean water is a basic human right, yet climate change is already affecting our access to clean water; for example, it causes more floods and droughts to occur globally. Climate change, pesticide use and habitat loss are causing us to lose many species, and also decreasing the overall population of many insects. Globally, up to 40% of insects are threatened with extinction over the next few decades. This affects the birds and animals that rely on insects for food, and us as we rely on insects to pollinate the plants that we eat.

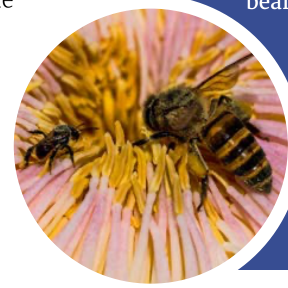
Bogong moths that once gathered in millions in the caves around NSW have dropped dramatically. Dr Ken Green, a scientist at the Australian National University, monitored the bogong moths for 40 years and found numbers had dropped from millions to just a few individuals.

Mountain pygmy possums rely on bogong moths for food, as do many other alpine lizards, frogs and birds. The moths are also culturally important to multiple clans and language groups of Indigenous Australians. Losing these moths isn't just about losing food – it alters an entire ecosystem.

FOOD, BUGS, BIRDS AND US

CHOCOLATE AND MIDGES

Did you know that without the biting midges of the genus Forcipomyia, we wouldn't have chocolate? These tiny creatures are perfectly adapted to pollinate cacao flowers, which rely on the midges for their ongoing survival, as we rely on them in turn to create the cacao beans we rely on for delicious chocolate.



NATIVE BEES

Our amazing Australian bees have been busy helping our native plants grow for a long time. They help fruits like mangoes, watermelons, and lychees grow big and tasty in Queensland.

CHOCOLATE AND MIDGES: A MALE FORCIPOMYIA MIDGE. CHRISTOPHE QUINTIN VIA FLICKR. CACAO BEANS. UNSPLASH/LY LE MINH / NATIVE BEES: DAVID CLODE/UNSPLASH / SHUTTERSTOCK

DOWNLOAD ALL OF THE LINKS IN THIS BOOKLET AT WWW.SCIENCEWEEK.NET.AU/SCHOOLS/2024-RESOURCE-BOOK-LINKS/

READ MORE

- SUGARBAG BEE HONEY A FEAST FROM NATURE, WITH STINGLESS INSECTS CREATING DELICIOUS OUTBACK BUSH TUCKER (ABC NEWS)
- WHY LOSING AUSTRALIA'S BIODIVERSITY MATTERS FOR HUMAN HEALTH (COSMOS MAGAZINE)

FOUNDATION ACTIVITIES

REAL-WORLD CONNECTIONS

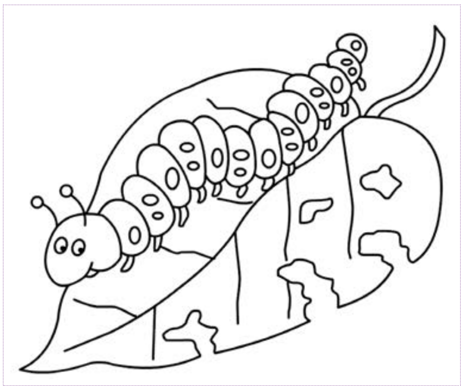
TEACHER-GUIDED QUESTIONS AND ACTIVITIES RELATED TO FOOD AND INSECTS

Community Activities

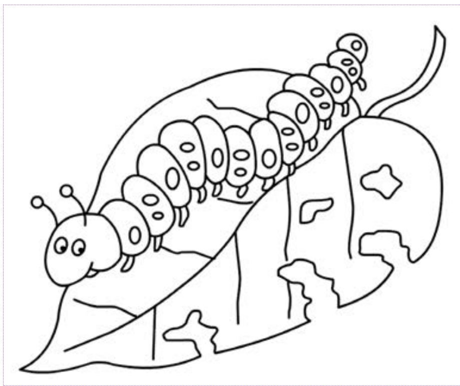
SHUTTERSTOCK

HIDE AND SEEK WITH CATERPILLARS

1. Can you name some insects?
2. What do caterpillars eat? What eats caterpillars?
3. Read *The Very Hungry Caterpillar* by Eric Carle. Why is a caterpillar important? (food, pollination, egg laying)
4. Using the templates provided, colour one caterpillar so that it is easy for a bird to find and eat. Colour the other one so that it is hard for a bird to find and eat. What makes them hard or easy to see? Is it better for a caterpillar to be seen or not seen?



I AM HIDING ON A LEAF

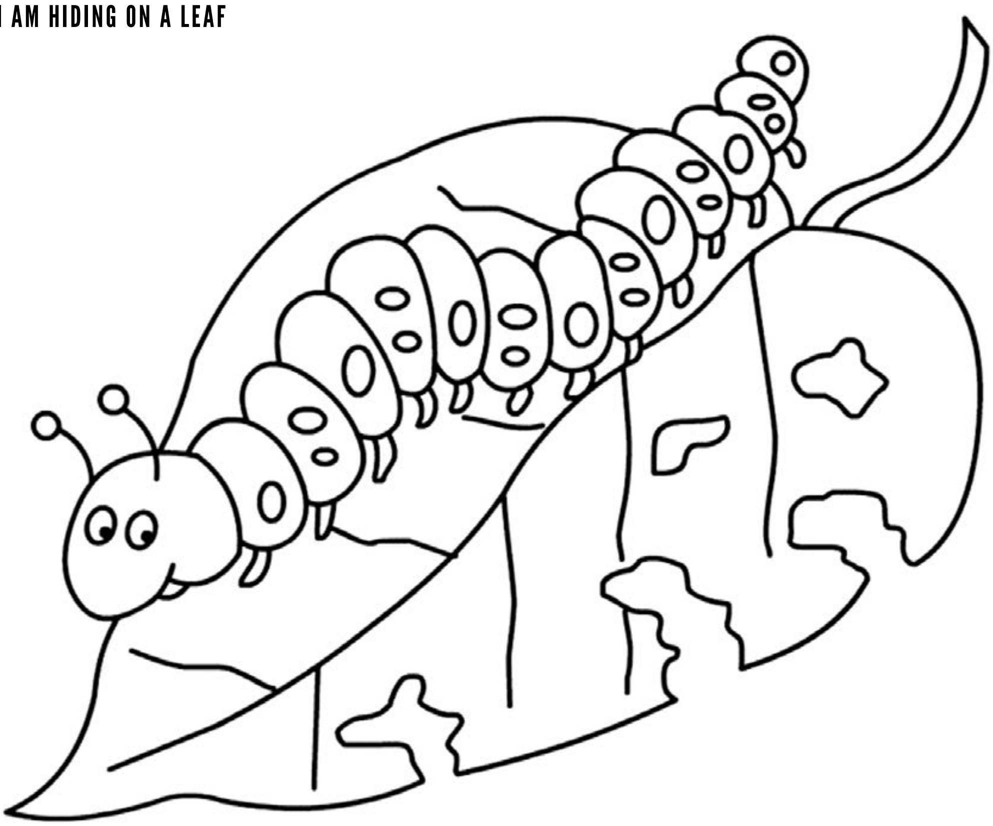


YOU CAN SEE ME ON THIS LEAF

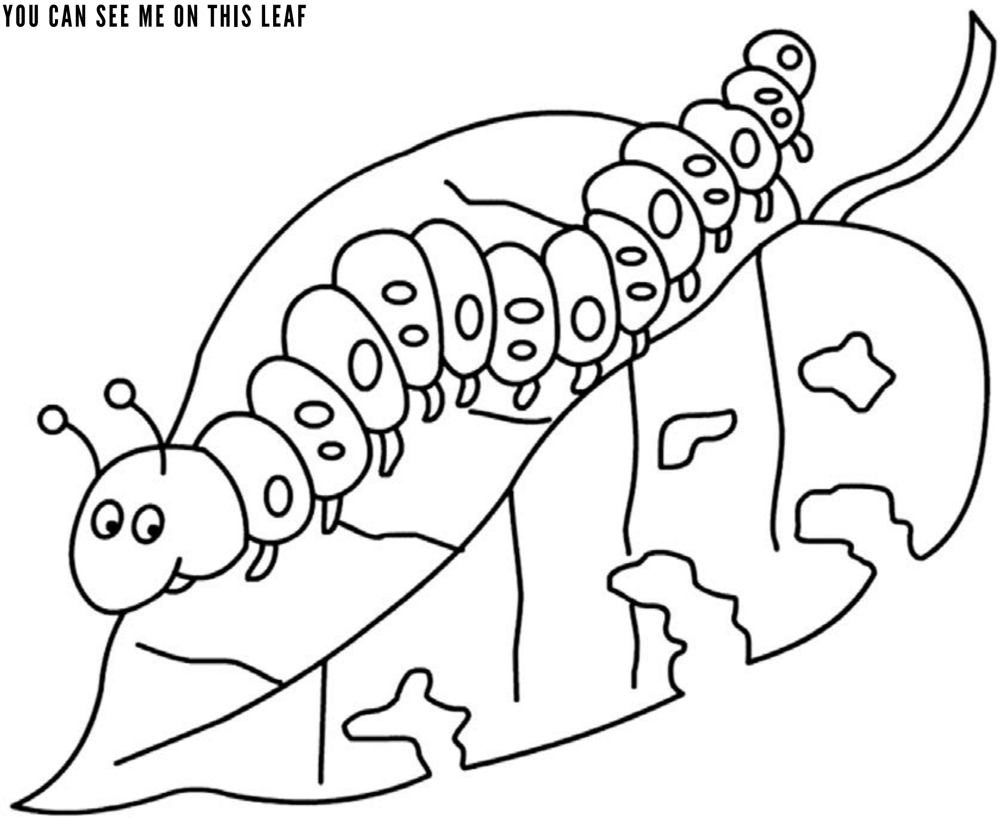
5. Make a caterpillar using a range of material such as coloured pipe cleaners, colourful strips of paper, popsticks, coloured paper dots and coloured pencils. Place the caterpillars in an outdoor garden area and discuss whether they might be easily spotted or easily hidden (camouflaged). Don't forget to put on a hat and some sunscreen before heading out doors.
6. Go outside to try to spot living caterpillars. How many were found? Did you see any other insects? Discuss: How do small insects survive? Which ones were easy to find? Which ones were hard to find and why? Did the colour help the caterpillar or other insect survive? Watch the ABC's bug hunt video with Costa.
7. Introduce the word 'camouflage'. Read *The Mixed up Chameleon* by Eric Carle.
8. How do plants and insects help each other? Make a nature drawing of an insect in the garden on a plant that shows how they may help each other. Does the plant provide protection or food for the insect? If it provides food, what type: nectar, leaves, fruit? What does the insect do for the plant?

SAFETY FIRST – TELL STUDENTS TO WEAR A HAT AND PUT ON SOME SUNSCREEN BEFORE HEADING OUTDOORS TO PLACE THEIR CATERPILLARS IN THE GARDEN OR WHEN ON THE BUG HUNT. REMIND THEM NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS.

I AM HIDING ON A LEAF



YOU CAN SEE ME ON THIS LEAF



SCIENTIFIC INVESTIGATIONS

CREATE A LEAF COLLECTION

Scientific Investigation

AIM: STUDENTS COLLECT AND OBSERVE DIFFERENT TYPES OF LEAVES

WHAT TO DO

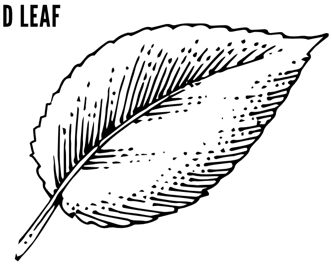
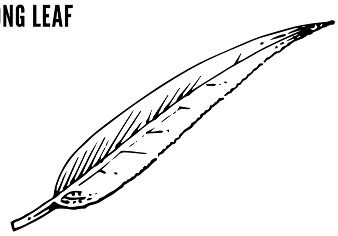
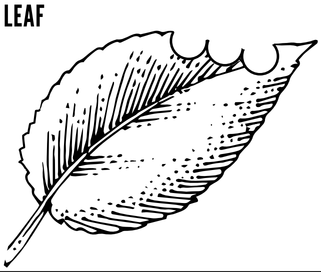
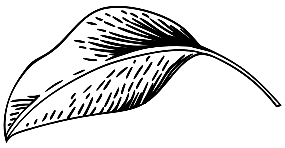
1. Over the course of Science Week, students collect leaves from the school yard, park or home garden that show a variety of traits, such as: a long one, a round one, nibbled by a caterpillar, dead leaf, a blade of grass, a favourite leaf.
2. As they collect them, they stick them to the template on the matching outline of a leaf. Who is able to collect all the different leaves?
3. Students are encouraged to put on a hat and sunscreen before heading out doors to collect leaves.

WHAT YOU NEED

- Craft glue to stick the leaves to the template sheet

RESULTS

NAME: ______________________________

ROUND LEAF 	LONG LEAF 
EATEN LEAF 	BLADE OF GRASS 
DEAD LEAF 	FAVOURITE LEAF

SAFETY FIRST – REMIND STUDENTS TO WEAR A HAT AND PUT ON SUNSCREEN BEFORE HEADING OUTDOORS FOR THE LEAF COLLECTION. TELL THEM NOT TO TOUCH ANY ANIMALS OR PICK UP ANY LEAVES WITH INSECTS OR SPIDERS, AND REMIND THEM TO FOLLOW THEIR TEACHER'S INSTRUCTIONS AT ALL TIMES.

DISCUSSION QUESTIONS

1. Where did you find your leaves?
2. Which is your favourite leaf and why?
3. What are the similar features of your leaf set? What are the differences among the leaves in your set?
4. Which leaf/leaves could be food for a caterpillar or other animals?
5. What other parts of plants provide food?
6. Can a dead leaf still be food for an animal?
7. Do plants need food, too? Food gives us the energy to grow, so how do plants get the energy to grow?
8. Is a blade of grass a leaf? Why or why not?
9. What might cause the caterpillars in the garden to decrease?
10. What could you do to increase the number of caterpillars in a garden?

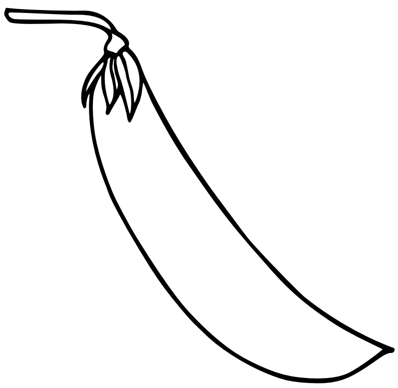
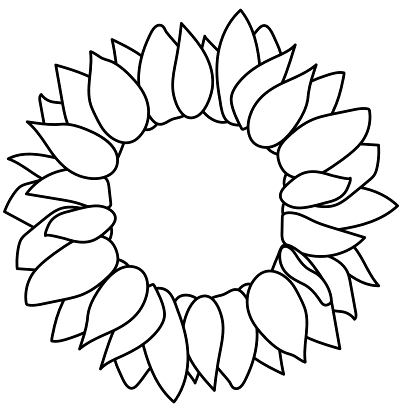
YEAR 1–2 ACTIVITIES

Real-World Connections

STAGE 1
REAL-WORLD CONNECTIONS

MAGIC IN A SEED

1. What are seeds and where do they come from?
2. What food do we eat that has seeds or pips inside?
3. What kinds of seeds are food that we can eat?
4. As a class, collect seeds from food (apples, bananas, tomatoes, peas, beans, oranges, mandarins, corn etc) and from flowers that are edible (nasturtiums, parsley, sunflowers, marigolds, pine nuts).
5. Make a seed bank by sticking them on a poster in the classroom with their name. How many seeds can you collect by the end of Science Week?
6. Draw seeds on the following images:

STRAWBERRY	SNOW PEA
	
SUNFLOWER	CORN
	

SHUTTERSTOCK

STAGE 1 CONSERVATION CRISIS! QUESTIONS

1. Did you end up with more animals or fewer animals by the end of the game?
2. Did you end up with more plants or fewer plants by the end of the game?
3. Which activities in the cards allowed you to increase the number of plant and animal species in your ecosystem?
4. Which activities caused you to lose plant and animal species from your ecosystem?
5. Do you think the chance element of the cards is something that happens in nature?
6. What kinds of things can you do at home in the garden or at school to increase the number of plants and insects that live there?
7. Why do you think it is better to have more plants and animals in an ecosystem, rather than fewer?
8. How did you feel about losing some species compared with others? Were there species you wanted to keep more than others?

SAFETY FIRST - DON'T FORGET TO CHECK IF ANYONE IN YOUR CLASS HAS ALLERGIES TO DIFFERENT FOODS. DO NOT BRING FOOD TO CLASS THAT MIGHT TRIGGER ALLERGIES.

7. What do seeds need to help them grow? What might stop them from growing?
8. Read the story *Peep Plants A Seed* by Joe Fallon, or watch the Peep Plants a Seed video on their website.
9. Students each have a paper envelope and choose a seed. They examine the seed and draw examples on the envelope of the kind of plant they think it might become. Put the envelope next to the planted seed to see if it matches. The seed can be grown to find out what kind of plant it grows into.
10. Why is it good for the environment to plant more seeds?

STAGE 1 - DIGITAL ACTIVITY

- PRESCHOOL/KINDY: COUNT AND CLICK ON THE TADPOLES IN THIS ONLINE ACTIVITY FOR AGES 4-6, TINY TADPOLES.
- YEAR 1: IN THIS HOUR OF CODE VIDEO TUTORIAL, LEARN HOW TO CREATE A SCRATCH GAME TO GROW A PLANT.

STAGE 1 – SCIENTIFIC INVESTIGATION

SPROUTING SEEDS

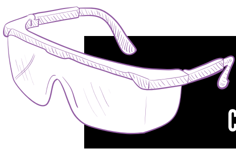
TEACHER PREPARATION:

- Ask students to bring in jars from home
- Cut circles out of clean cloth to act as a lid over the mouth of the jar

AIM: TO OBSERVE THE SPROUTING OF CRESS AND MUNG BEANS

MATERIALS

- 1 small or medium sized glass jar
- Cloth to act as a lid to the jar
- Rubber band to hold the cloth on the jar
- 1 small plate
- Paper towel or cotton wool
- Access to water
- Cress seeds
- Mung beans
- Ruler
- Permanent marker



SAFETY FIRST – GLASS SAFETY GLASS CAN BREAK. BE PREPARED AND APPROACH THIS AS A LEARNING OPPORTUNITY FOR STUDENTS TO MANAGE THE RISK. IF WATER IS SPILT ON THE FLOOR, ENSURE THAT IT CAN BE CLEANED UP BEFORE SOMEONE SLIPS ON IT. REMIND THEM TO FOLLOW THE TEACHER'S INSTRUCTIONS AT ALL TIMES.

WHAT TO DO

CRESS SEEDS SET UP

1. Place some cotton wool on the small plate.
2. Wet the cotton wool so that it is moist but not dripping.
3. Sprinkle with 10 cress seeds evenly spaced.
4. Put your name on a piece of paper to identify your seeds.
5. Place your plate in the sunlight.
6. Add water to the cotton wool each day to keep it moist.
7. Monitor your sprouts in the data table.

MUNG BEAN SET UP

1. In the morning, add 10 mung beans in the small glass jar.
2. Add water to cover the seeds and soak for the whole day.
3. In the afternoon, drain the water off and rinse with fresh water.
4. Place a piece of material over the mouth of the jar and secure with a rubber band.
5. Write your name(s) on the glass jar.
6. Place the jar in the dark.
7. Rinse the seeds with water and drain once or twice a day.
8. Monitor your sprouts in the data table.

Note that other seeds can also be sprouted, such as alfalfa, kale or chickpea.

RESULTS: SPROUTING SEEDS PROGRESS CHART

		CRESS SEEDS		MUNG BEANS	
Day	Date	Draw what you can see. Are they white or green? Short or long? Straight or curly?	How many seeds have sprouted out of the 10?	Draw what you can see. Are they white or green? Short or long? Straight or curly?	How many seeds have germinated out of the 10?
1					
2					
3					
4					
5					
6					

DISCUSSION QUESTIONS

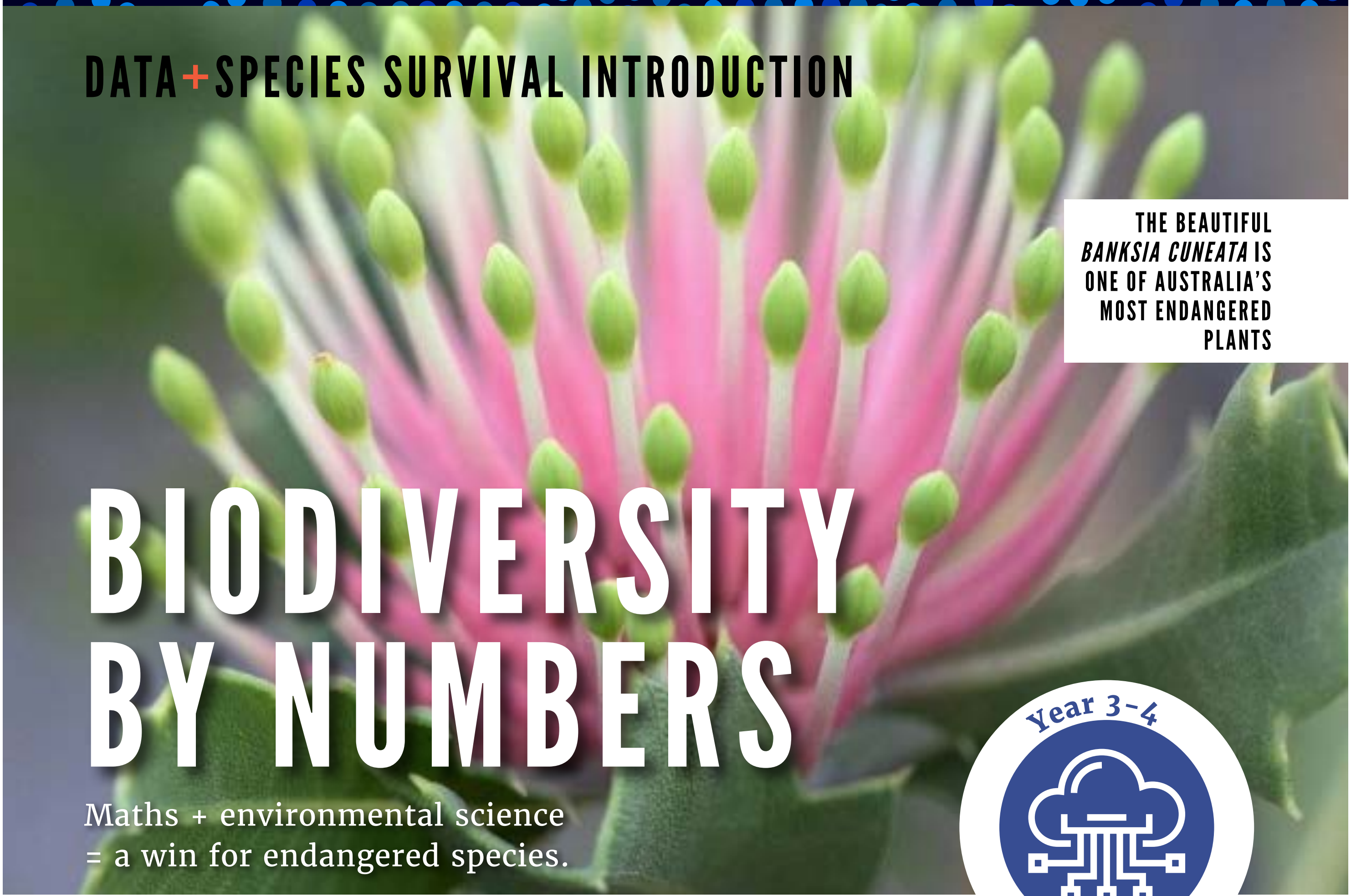
1. How many of your cress seeds sprouted into food?
2. How many of your mung beans sprouted into food?
3. What did you have to do to the seeds to help them grow into sprouts?
4. Why do you think some of the seeds did not grow and become sprouts?
5. What recipes could you make with the different sprouts?
6. What other seeds might you like to try to make sprouts with?

OTHER IDEAS

- Collect the seeds from edible flowers and vegetables and package them up to make a magic gift for a special friend.
- Start a flower garden or kitchen garden at your school.

SAFETY FIRST – STUDENTS SHOULD WEAR A HAT AND PUT ON SOME SUNSCREEN BEFORE HEADING OUTDOORS TO FLOWER GARDENS OR KITCHEN GARDENS. REMIND STUDENTS NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS. ALWAYS CHECK FOR STUDENT ALLERGIES TO ANY SEED, FLOWER OR VEGETABLE ALLERGIES BEFORE ACTIVITIES SUCH AS THIS.

DATA+SPECIES SURVIVAL INTRODUCTION



BIODIVERSITY BY NUMBERS

Maths + environmental science = a win for endangered species.

THE BEAUTIFUL *BANKSIA CUNEATA* IS ONE OF AUSTRALIA'S MOST ENDANGERED PLANTS

PHOTO BY ANDREW CRAWFORD/DBCA

Students tend to assume that maths skills are exclusively reserved for the classroom. But in fact, data has become essential to next-gen conservation efforts.

Climate change is bad news for our native plants and animals, accelerating the extinction of plant and animal life – 55 local wildlife species and 37 plants have been driven to extinction since colonisation – and impacting our natural resources.

Forests and rivers are disappearing at a rapid rate, and reports state that it's something 83% of us regularly stress about. So where is the land deteriorating the most? How many species are crying out for help? And what's going on with the weather?

The answers to all of the above lie in maths – from probability and statistics to measuring and model populations, to geometry to calculate land areas to financial maths to determine budgets for conservation programs.

Maths can reveal insights into almost any type of environmental issue. Scientists use their data fluency when counting wildlife, monitoring seasonal weather patterns, and testing water and soil quality. And with citizen science so readily accessible, researchers are increasingly encouraging us to help them out from home.

BUSH BLITZ

Bush Blitz offers an exceptional opportunity for teachers to actively engage in conservation efforts while enriching their classroom experiences through the 'Bush Blitz TeachLive' program. As Australia's largest biodiversity survey, Bush Blitz allows educators to join scientists in the field, actively participating in surveys and gaining firsthand knowledge of the country's diverse ecosystems.

TeachLive empowers teachers to bridge the gap between the field and the classroom, enabling them to "teach live" by sharing real-time discoveries and experiences with their students. This immersive program not only enhances educators' understanding of biodiversity but also inspires a passion for conservation, fostering a deep connection between teachers, students, and the natural world.

WE'RE ALL SCIENTISTS

Citizen science engages citizens in the data collection process – counting species in their neighbourhoods or logging weather patterns from their bedroom windows. It's often as easy as taking photos or uploading data so scientists can keep track of the wildlife that is and isn't thriving in an area.

As well as assisting scientists, it's a great way for younger students to get real-world research experience before they start high school. And with citizen science findings making up half of Australia's national biodiversity database, it's proving key to conservation research.

FrogID asks users to upload frog calls from their smartphones and Aussie Bird Count gets participants to tally up all the birds they can spot in 20 minutes. And then there's ReefCloud, where submitting photos of nearby coral reefs can help researchers assess their condition.

Last year, 9.6 million of the 10 million reported observations of species in Australia were collected via these avenues, with amateur naturalists proving invaluable to ongoing monitoring, too.

Keen to get students involved? The Australian Citizen Science Association has a list of current projects calling out for collaborators.

DOWNLOAD ALL OF THE LINKS IN THIS BOOKLET AT WWW.SCIENCEWEEK.NET.AU/SCHOOLS/2024-RESOURCE-BOOK-LINKS/

THE LIVING PLANET INDEX

When it comes to protecting native species, sophisticated data is a major plus. One of the biggest data-led resources is The Living Planet Index (LPI).The LPI is perhaps the world's most widely quoted metric on global biodiversity, measuring the state of native species by publishing observations on population trends – size, density, abundance and growth. Released every two years, it tracks animal populations, providing a comprehensive measure of how they're responding to pressures in their environment.

The 2022 report analysed almost 32,000 species populations, and reported a 69% decrease in monitored wildlife since 1970. Habitat loss and barriers to migration routes were shown to account for half of the threats to these species groups, with freshwater populations clearly hit the hardest.

Observations like these prove pivotal when combating species loss, as they have the power to steer the direction of conservation efforts in the future.

READ MORE

- **HOW MATHS IS USED IN CONSERVATION (NATURE CONSERVANCY CANADA)**
- **MATHS MODELS TO IMPROVE FISHERIES AND OCEAN BIODIVERSITY (UNIVERSITY OF QUEENSLAND)**

CONSERVATION CRISIS! QUESTIONS

Conservation Crisis! Questions

1. You started the Species Diversity Game with 9 insects. What had happened to the number of insects by the end of the game?
2. What were some changes with other plants and animals in your ecosystem? Which species increased in number and which decreased in number?
3. Everyone in the class started with the same number of different species. Did everyone end up with the same number of species at the end of the game? Why do you think there was a difference at the end of the game for each team?
4. Make a line graph to show the change in the number of birds in your ecosystem. On the x- (horizontal) axis, record the number of cards you used in the correct order, and on the y- (vertical) axis place the number of birds. Remember the starting number of birds was five.
5. Choose four of your species that changed in number during the game and make a column graph of their number at the beginning of the game compared with their number at the end of the game. On the x-axis, add the different species, such as 'possum', 'worms' etc.

   On the y-axis, include the number of species.
6. What if we took two cards instead of one card each time? What effect might that have on the rate of species change over time?
7. If you lost all of the plants in an ecosystem, what effect would that have on the animals that live in that ecosystem?
8. Why do you think species diversity is important? Think broadly, such as how it is important for humans, for nature and for our gardens and parks, for our farms and for our planet as a whole.

STAGE 2 – REAL-WORLD CONNECTIONS

Real-World Connections

1. How do you think maths can be used to help scientists understand species diversity? What sort of things might scientists need to count or calculate?
2. What is 'citizen science' and what do you have to do to become a citizen scientist?
3. Have a look at some citizen scientist projects related to species diversity at the Australian Citizen Science Association website. Choose one project that you think looks the most interesting and describe its aim and what you would have to do to help.
4. Become a data scientist in your own school, backyard or park. Over several days, collect data on the number of birds at or near your school during recess or lunch, or along a walk around or near the school. Design a data table to collect all your data. Here are some questions to help guide your bird data collection:
   a. How many birds were counted each day?
   b. How many birds were counted in total over a week?
   c. How many different species of birds did you see each day?
   d. Were the same species of birds seen every day over five days?
   e. What type of birds are they? Use a bird identification website (such as this one) to help find the names of the birds you see, or download an app such as Merlin BirdID or iNaturalist to use the bird's photo or song to help identify it.
   f. Were the birds alone or in groups? If in groups, how many birds were in the group?

SAFETY FIRST – REMIND STUDENT TO WEAR A HAT AND PUT ON SOME SUNSCREEN BEFORE HEADING OUTDOORS TO BIRD WATCH. ALSO REMIND THEM NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS.

5. Design, build and start using a bird feeder in a garden space at school. Count and record the total number of birds and the number of different species of bird that use the feeder over a period of time. Did the feeder encourage more birds into the area? If your classmates made a different bird feeder, or used different feed, which was the most popular with the birds?

SAFETY FIRST – ASK STUDENTS TO PREPARE A RISK ASSESSMENT FOR ANY TOOLS USED TO MAKE THEIR BIRD FEEDER, E.G. IF USING A SAW ALWAYS CUT OR SAW AWAY FROM YOURSELF. WEAR GLOVES TO AVOID SPLINTERS FROM WOODEN MATERIALS.

6. Other than a bird feeder, what other methods could be used to encourage more species of birds (or insects) into the school garden or park in order to increase the species diversity?
7. Start a citizen scientist project by asking friends and family members to count the number of birds, or to collect images of birds (or other animals or plants) for you from a specific area. How will you record the citizen science data that others collect for you? How much more data can you collect with the help of others? Why is it generally a good idea for a scientist to collect as much data as possible?
8. Research a bird sanctuary near you and identify all the ways it supports the protection and diversity of bird species. Is there enough space for the bird to exercise its wings? Is there a successful breeding program? Does it focus on helping any endangered species? Does it provide a natural and healthy diet?

STAGE 2 – SCIENTIFIC INVESTIGATION

ECOSYSTEM IN A JAR

AIM: TO CREATE AN ECOSYSTEM IN A JAR

WHAT YOU NEED

- A Mason jar, ideally with a wide neck so you can put your hand in it. Otherwise, any medium to large glass jar with a lid.
- Small rocks or pebbles, soil, moss, seeds or small plants
- Access to water
- Spray bottle
- Small pieces of apple
- Permanent marker

WHAT TO DO

1. Add some small rocks or pebbles to the bottom of the jar for drainage.
2. Cover the rocks with a layer of soil about ⅓ the way up the jar.
3. Add any seeds or small plants.
4. Add a layer of moss to the top of the soil.
5. Add a small piece of fruit, such as a square of apple, to encourage insects.
6. Add a decoration – a rock you like, a small toy, etc to create a feeling of place.
7. Spray water in your ecosystem to keep it moist.
8. Label with your name(s) and place it in a sunny spot. You can place a lid on your ecosystem if you wish.
9. Watch it as the moisture condenses and then drips back – a self-contained ecosystem in a jar!

SAFETY FIRST – GLASS CAN BREAK. BE PREPARED AND APPROACH THIS AS A LEARNING OPPORTUNITY FOR STUDENTS TO MANAGE THE RISK OF GLASS BREAKING. IF WATER IS SPILT ON THE FLOOR, MAKE SURE THAT IT CAN BE CLEANED UP BEFORE SOMEONE SLIPS ON IT. DO NOT TRY TO WASH ANY MATERIALS, SUCH AS DIRT OR MOSS DOWN THE SINK.

QUALITATIVE DATA OBSERVATIONS

A qualitative observation describes any changes. What do you see or smell in your ecosystem at the beginning and after a week or a few weeks?

DRAWING OF ECOSYSTEM WHEN FIRST SET UP	DRAWING OF ECOSYSTEM AFTER ____ WEEKS

QUANTITATIVE DATA OBSERVATIONS

A quantitative observation uses numbers to measure some aspect of your ecosystem. For example, you can use a thermometer to measure the temperature inside and outside your ecosystem, or source some universal indicator from your local high school science lab to measure the pH of the soil at first and after a few weeks. Record at least one quantitative measurement in a data table.

WHAT IS BEING MEASURED? (Temperature? pH? Length of a plant shoot?)	READING 1	READING 2

DISCUSSION QUESTIONS

1. What do we mean by an 'ecosystem'?
2. An ecosystem has living and non-living features. List some living and non-living features of a healthy and thriving ecosystem.
3. Describe how your ecosystem changed over time. What qualitative changes did you observe that were added to your drawing in the data table? For example: Did the plants grow bigger or did they turn brown and die? Did water build up on the inside of the sealed jar? Did the ecosystem attract or become a breeding ground for insects?
4. Did everyone's model ecosystem change in the same way? What were some changes in your classmates' ecosystems that you didn't see in yours?
5. How is your ecosystem in a jar similar or different to a real ecosystem?
6. What kinds of activities do humans carry out that harm ecosystems?
7. How can humans protect ecosystems?
8. If we have an ecosystem in nature that isn't working, what do you think might happen to the plants or any animals that might try to live there?

FURTHER INVESTIGATIONS

Instead of an ecosystem in a jar, you may want to make an insect hotel – a place for insects to hide and maybe lay some eggs. See the following video on how to build an insect hotel. You can make before and after drawings similar to the ecosystem investigation, as well as estimate the number of insects that come to live in the hotel.

- Watch the video of Costa on creating a bee hotel

STAGE 2 – DIGITAL ACTIVITY

Create a smart garden device to monitor the health of your plants, measuring temperature and wiring up a simple soil moisture sensor using micro:bit and Blockly in this Digital Technologies Hub activity. Sketch your concept below.

Digital Activities

OTHER IDEAS

- Imagine you are an environmental scientist. Take a closer look at the conservation methods used to rescue a particular species, such as the corroboree frog. Conduct some secondary research and present it as a case study.
- Have a discussion related to the use of artificial intelligence and image recognition with regards to the use of drones to find koalas or map forests. What are the possible benefits and drawbacks of using this kind of technology?

CULTURE + SPECIES SURVIVAL INTRODUCTION

CONSERVATION ON COUNTRY

We have a lot to learn from Australia's first scientists.

Year 5–6

As the traditional owners of the land, Indigenous Australians are some of the world's first – and most legendary – scientists.

Aboriginal communities have been living, hunting and farming on Country for 70,000 years. When it comes to navigating species decline, their centuries-old observations are changing the game for the next generation of land care experts.

CULTURE CONNECTIONS

As a proud Murri man, University of Canberra associate professor and Kamilaroi water scientist Bradley Moggridge spends time with Elders in the remote Kamilaroi region of Australia listening to some of the world's oldest Indigenous water stories. And it's no surprise that these local mobs know how to best use our ancient waterways – where they're located, how far they run and the cultural significance they have for local communities.

"Much of our [current] policy was developed through colonial settler laws, without even considering traditional knowledge. Now however, there seems to be a growing recognition of the importance of embedding Indigenous knowledge into managing our natural resources."

"Water is always going to be a key topic for Australia, as it is the driest inhabited continent on Earth, and here we have thousands of generations of observation to take advantage of." – *Kamilaroi water scientist Bradley Moggridge*

DID YOU KNOW?

The names of many of our iconic plants and animals come from Aboriginal words, including:

- **Kookaburra:** from the Wiradjuri word gugubarra
- **Kangaroo:** from the Guugu Yimithirr word gangurru
- **Bilby:** from the Ullaroi word bilba

READ MORE

- DOWNLOAD THE GURRAY APP ON THE APP STORE, WHICH TRANSLATES ENGLISH WORDS INTO SEVEN ABORIGINAL LANGUAGES.
- READ MORE ABOUT BRADLEY'S WORK AS A KAMILAROI WATER SCIENTIST ON THE CAREERS WITH STEM WEBSITE.

BRADLEY MOGGRIDGE. CREDIT: SUPPLIED

NATURAL INSTINCTS

Indigenous methods in land care are important to combat ecological issues like species decline and how to encourage bush regeneration. Traditional Indigenous seasonal calendars are now being used in land care, tracking which species are active and when.

In NSW's Barwon River, Brewarrina fish traps made of stones were employed to avoid overfishing – Murdi Paaki Regional Assembly.

Cool burning or cultural burning is the practice of using small fires to manage ecosystems to clear areas of land but also ensure seed regeneration and deliver soil nutrients. You can learn more about this practice in this ABC video. Or read more on the Watarrka Foundation website.

DOWNLOAD ALL OF THE LINKS IN THIS BOOKLET AT WWW.SCIENCEWEEK.NET.AU/SCHOOLS/2024-RESOURCE-BOOK-LINKS/

Conservation Crisis! Questions

STAGE 3 – CONSERVATION CRISIS! QUESTIONS

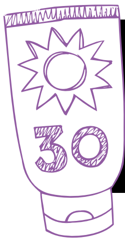
1. By the end of the game, which species had increased in population number and which had decreased in population number?
2. Did the overall number of different species drop, that is, did you completely lose any of the species that were there at the beginning? If so, which species did you have left at the end of the game and which did you lose?
3. List some of the situations on the cards that gave you an increase in species number. How many of them were due to human efforts and how many were due to natural environmental conditions?
4. List some of the situations that reduced the species number in your ecosystem. How many of these were due to human impacts and how many were due to natural environmental conditions?
5. Of your responses provided in question 4, which actions by humans do you think could be avoided?
6. If you continued the game, what do you think might happen in the future?
7. Suggest ways that Indigenous knowledge, such as sustainable hunting, could be used to help avoid the reduction of biodiversity of species.
8. Could Indigenous practices such as cultural burning support or reduce species diversity in an ecosystem? Think broadly, such as the immediate effects of the burning and the long-term effects of the burning.
9. How did playing the game help you learn about how species diversity can change over time?
10. What changes could you make to the game to make it a more realistic model of species change over time?

STAGE 3 – REAL-WORLD CONNECTIONS

INDIGENOUS KNOWLEDGE AND SPECIES LOSS

Real-World Connections

1. What knowledge do Indigenous people have of the land and the species that live on it that might be missed by non-Indigenous people?
2. Who is Bradley Moggridge and what special knowledge does he have of the land?
3. How might Bradley be able to help improve the way we look after the land and water so that different species can survive more sustainably?
4. Find out about some local plants that have cultural meaning or are food to the local First Nations People.
5. Which plants are native to your area? Make drawings of some native flowers and plants that grow in your area.
6. Conduct some research from the local council where you live to find out about the plant species in your area. Who planted the trees in the street or in the park? Are they native? How long have they been there? Were they chosen for a particular reason?
7. Consider what trees you would choose for planting in public places and why. Design a plan for your local park to plant native species that would help encourage birds and insects in order to increase species diversity.
8. Visit a park in your local area and observe the bird life and the trees. Are the trees native to the area? In what way do they have a positive impact on the area?



SAFETY FIRST – TELL STUDENTS TO WEAR A HAT AND PUT ON SOME SUNSCREEN BEFORE HEADING OUTDOORS TO CONDUCT THEIR RESEARCH. TELL THEM NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS.

STAGE 3 – SCIENTIFIC INVESTIGATION

EXAMINING THE EFFECT OF WATER AVAILABILITY ON SPECIES DIVERSITY

AIM

To create a model wetland in order to investigate whether access to water increases the number of species living in an area.

BACKGROUND

Water is vital for survival and building wetlands is just one way to help increase species diversity. An example of a wetland can be found at Gayini. Gayini is an environmentally and culturally significant property on the Murrumbidgee floodplain, referred to as the 'Kakadu of the south'. It was a privately owned 88,000 ha property in NSW that was handed back to the Nari Nari Tribal Council to ensure the protection of ecologically vital wetlands and Aboriginal heritage sites. Watch the plan here: Exploring Gayini, Nari Nari Country

Also look at an aerial view of the wetlands.

GAYINI AERIAL VISION

In this investigation, you will set up and monitor two sites – one with access to water (Site 1) and one without water (Site 2). The site with water can include a pond (water in a container), rain (hosing water on the site), flooding (creation of a puddle), or any other ideas you have that can model a wetland and is suitable to carry out in your learning environment. If you do not have access to a suitable outdoor area and are able to set up a few similar plants indoors then providing water to some and not to others will also help observe the need for water in order to support living things. The following instructions assume access to an outdoor area.

SAFETY FIRST – REMIND STUDENTS TO WEAR A HAT AND PUT ON SOME SUNSCREEN BEFORE HEADING OUTDOORS TO SELECT AND PREPARE YOUR RESEARCH SITE(S) AND WHEN GATHERING YOUR DATA. ALSO REMIND THEM NOT TO TOUCH ANY ANIMALS AND TO FOLLOW TEACHER INSTRUCTIONS AT ALL TIMES.

WHAT YOU WILL NEED

- One large or two smaller distinct undercover sites around your school that have similar amounts of shade, soil type, exposure to wind, temperature, leaf litter etc. Make sure each site is not in a busy area, such as near a footpath.
- Two waterproof containers that are the same shape, colour and size, such as a couple of clean, recycled food containers.
- Access to tap water with a hose or watering can to deliver water.

WHAT TO DO

1. Decide on the site or sites you will use for the investigation.
2. Bury a container in the soil at each end of the chosen site(s). The containers should be buried so that the rim is just above the soil (so that it looks like a miniature pond).
3. Record the initial biodiversity around these artificial 'ponds' – they should be similar at the beginning of the investigation due to the sites themselves being similar. Record your observations in Data Table 1 below.
4. Now fill one of the containers with water. Call this Site 1. Call the site without the water Site 2.
5. Spray water at Site 1 around the area near the water-filled container. This will act as 'rain' and keep water in the 'pond' container.
6. Each day, return to the two sites and continue to monitor any changes in biodiversity. This can include actual organisms at the site, or evidence of their presence, such as droppings. Add the observation record to the data table. Look at the plants around the 'ponds' and record any observations. This could include scats (poo), tracks, fur or feathers, or direct observations of plants, animals or fungi.
7. During the course of your data collection, keep the container full of water at Site 1 and the area around it regularly watered.
8. Continue to observe any species found at the sites by recording the type of observation (and an identification, if possible) in Data Table 1.
9. On completion of the investigation, remove the containers from the soil and examine underneath for evidence of organisms living there. Add any species and the number found to Data Table 1.
10. At the end of your observation period, add up the total number of species at each site and record in Data Table 2.

RESULTS

Data Table 1 – different organisms observed at each site over time

OBSERVATION TYPE AND ORGANISMS FOUND AT SITE 1 – ADDED WATER	OBSERVATION TYPE AND ORGANISMS FOUND AT SITE 2 – NO ADDED WATER

Data Table 2

TOTAL NUMBER OF ORGANISMS AT SITE 1 – ADDED WATER	TOTAL NUMBER OF ORGANISMS AT SITE 2 – NO ADDED WATER

QUESTIONS TO ASK

1. Make a 'Before' and 'After' bar graph of the number of organisms at each site. The number of species can be added to the Y-axis. On the X-axis, add labels for the two sites, showing the number of species both before and after.
2. As has been shown around wetlands, it is expected that a greater number of species can be found when there is access to water. Did your results support this? If yes, was there a significant increase in the number of species at Site 1 at the end of the experiment? If not, do you think monitoring your sites over a longer period of time would have made a difference to the results?
3. Do you think this investigation acts as a model for a mini pond or mini wetland? Justify your response.
4. Why do you think a container was buried at Site 2 but not filled with water?
5. Do you think the results of this investigation would be the same if conducted in different seasons or different climates?
6. Identify any problems you encountered during this investigation and describe how you overcame them.
7. If someone else wanted to set up this investigation, what advice would you give them?
8. Write a conclusion for this investigation that addresses the aim.

STAGE 3 – DIGITAL ACTIVITY

You've been tasked to be a conservation detective for the Nari Nari Tribal Council. These traditional custodians are using modern and ancient techniques to monitor and improve wildlife conservation, water use and food production. Gayini is a vast 88,000 ha property owned and managed by Nari Nari Tribal Council. With the not-for-profit organisation The Nature Conservancy and tech company Nearmap, they are using traditional land practices and technology to better manage this important wildlife area that's part of the Murray Darling Basin.

Research a land management plan that uses digital technologies to help the council manage this area. Create a presentation to share with your class.

OTHER IDEAS

- Research an Indigenous land management practice, such as fire management, seed collecting or fish traps.
- Associate Professor Bradley Moggridge from the University of Canberra and Brett Rowling from ANSTO are Indigenous scientists who are combining Indigenous knowledge with advanced technologies to improve our understanding of species survival in water systems. Invite an Indigenous person to speak with your class about protecting species in nature.
- Create a database of different plant and animal species in your local area, including their scientific names, common names and Indigenous names.

TECH & SOCIETY + SPECIES SURVIVAL INTRODUCTION

THE RED FOX HAS PLAYED A BIG PART IN THE DECLINE OF GROUND-NESTING BIRDS, SMALL TO MEDIUM- SIZED MAMMALS (LIKE THE BILBY), AND REPTILES (SUCH AS THE GREEN TURTLE).

SHUTTERSTOCK

TECH TO THE RESCUE

Drones, sensors, AI and people power are all pitching in to preserve species diversity.

Year 7–8

Technology, and the people who create it, play an important role in addressing species survival.

This is particularly true when it comes to the threat of feral animals – one of the biggest contributors to species extinction. Predators such as red foxes and cats have a hugely destructive impact on native wildlife, with the Invasive Species Council stating that these animals have probably contributed to the extinction of all but two of the 21 completely extinct marsupials and rodents in Australia. Cane toads, introduced by humans to control pest beetles, have caused a devastating decline in native species by poisoning goannas and quolls. Feral rabbits, horses and deer are also causing ecological and agricultural problems across Australia.

While people caused many of these issues, we're also adept at helping fix them. Researchers and managers use sensor technology (attached to collars) to track feral animals, and farmers use pig traps equipped with cameras and motion sensors to remotely capture feral pigs.

Science also plays a big part, through biological control methods. For example, back in 1996, rabbit calicivirus disease was introduced in Australia to reduce rabbit numbers. This kept numbers low for a decade before the rabbits developed immunity. Another strain of the virus was introduced in 2015. Since rabbits compete with so many native mammals for food, it's essential to try to keep the population low.

UP TO 23.5 MILLION FERAL PIGS ARE SPREAD ACROSS ABOUT HALF OF AUSTRALIA. QUEENSLAND GOVERNMENT

FERAL CATS HAVE ALREADY DIRECTLY CONTRIBUTED TO EXTINCTIONS OF THE RUSTY NUMBAT, THE DESERT BANDICOOT, THE BROAD-FACED POTOROO AND THE CRESCENT NAIL-TAIL WALLABY. SHUTTERSTOCK

ZOOS, GARDENS AND PARKS

Another way society is preserving species diversity is through zoos and marine and national parks. These settings educate the public about specific animals' conservation status, provide research and aid species conservation through breeding programs. For example, Taronga Zoo works with research institutes, government and universities on everything from creating bilby breeding sanctuaries to counter local extinction due to introduced predators, to developing scent-based management tools for dingoes and wild dogs, to manage their movements with the aim of protecting livestock.

Similarly, botanic gardens and arboretums are effective at conserving different species of plants. The world's botanic gardens hold at least 30% of all known plant species, and protect 41% of those classed as threatened. Locally, scientific researchers at the Royal Botanic Gardens Victoria are working on the propagation of endangered native orchids, while the Botanic Gardens of South Australia are collaborating with the South Australian Seed Conservation Centre to have at least 90% of their state's threatened plant species in a seed bank by 2025. The global seed bank holds over 1 million crop samples!

SAY CHEESE!

Technology can directly assist endangered species, too. Camera trapping is used to keep track of long-tailed dunnart populations sharing the same location as a feral fox, and acoustic monitoring gathers data on breeding by platypuses – a species that's preyed upon by foxes, cats and dogs.

Drones are used to identify, count and measure endangered native animals like scalloped hammerheads and western quolls, and AI has even located and identified koalas by analysing infrared images drones have captured.

Smart phones can help as well. Through citizen science apps, everyone can collect data for scientific researchers, who then gain insights into animal and plant populations. FrogID is an initiative of the Australian Museum Research Institute. Over 1 Million frogs and 220 species have been recorded in Australia since it was launched in 2017.

"We aimed to gather the data that we need to help make more informed conservation decisions on behalf of Australia's frogs and the environment in general, and we've done that," explains Dr Jodi Rowley, the lead scientist of FrogID. "But the job doesn't end now, we need a long-term dataset so that we can better understand the impact of a changing environment. Alongside creating a long-term data set and gathering frog records from across the country, we're hoping to incorporate machine learning/artificial intelligence into the project."

THE ARTHUR RYLAH INSTITUTE IN VICTORIA HAS USED WHITE-FLASH CAMERAS TO DETECT THREATENED SPECIES SUCH AS LEADBEATER'S POSSUM AND LONG-FOOTED POTOROOS.

ARTHUR RYLAH INSTITUTE FOR ENVIRONMENTAL RESEARCH

DRONES USE ARTIFICIAL INTELLIGENCE TO SCOUR FORESTS FOR KOALAS.

NSW WILDLIFE DRONE HUB/NSW DEPARTMENT OF PLANNING AND ENVIRONMENT

DR JODI ROWLEY, CONSERVATION BIOLOGIST AND LEAD SCIENTIST OF FROGID.

AUSTRALIAN MUSEUM/JAMES ALCOCK

READ MORE
- FROGID (AUSTRALIAN MUSEUM)
- TRACKING FERAL ANIMALS WITH SENSOR TECHNOLOGY (CSIRO)

DOWNLOAD ALL OF THE LINKS IN THIS BOOKLET AT WWW.SCIENCEWEEK.NET.AU/SCHOOLS/2024-RESOURCE-BOOK-LINKS/

RIBBIT-ING STUFF

Dr Jodi Rowley is a conservation biologist who's helping frogs through a citizen science app.

Jodi is based at the Australian Museum and the University of New South Wales in Sydney. Her main focus is on amphibian diversity, ecology and conservation. Through her research, she seeks to uncover and document biodiversity and inform conservation decisions. She's also the lead scientist of FrogID, a national citizen science project that launched in 2017.

FrogID is an app that allows users to record frog calls that experts then listen to and identify. The aim of the project is to gather data to make conservation decisions for Australia's frogs and to understand the impact a changing environment has on them.

"The most exciting thing to me is the sheer volume of data [the app has captured]," Jodi says. "It still blows my mind that we are reaching almost 1 million records of frogs in only six years."

She says the biggest threat to frogs is habitat loss and modification, but that disease, introduced species and, increasingly, climate change, are also huge threats.

AUSTRALIAN MUSEUM/SALTY DINGO

VANESSA PIROTTA.

WHALE-Y GOOD TECH

Dr Vanessa Pirotta is a wildlife scientist who uses technology for wildlife conservation.

As part of her job, Vanessa works with whale snot!

"Whale snot can provide a snapshot of whale internal health," she says. "This can be used with measurements of whales such as how long and wide they are. If you have enough samples from the population, you may be able to better understand the health of a whale population and compare samples over time."

As Vanessa explains, tech plays a role, because drones can measure whales from the air and collect their snot.

"In conjunction with drone experts, we have developed a low-cost system that incorporates a sterile petri dish with a remotely operated and novel 'flip lid'. This can be attached to a drone along with a GoPro camera to sample whale blow with minimal disturbance to the whales." she says.

This means they have an uncontaminated sample that can then go to the lab to be sequenced for the DNA – that is, using DNA extraction and analysis techniques to get biological information about the bacteria (microbiota) that live in the whale snot – all without bothering the whale by taking a sample with a needle.

"Gathering baseline information of whale lung microbiota provides a snapshot of health information from an animal that is uncatchable. This means we will be better able to monitor the health of recovering whale populations over time and look for changes in their environment," Vanessa explains.

Vanessa has also used a drone to capture whale snot from the air! See the drone collect snot in a petri dish at 6'50" into the TedX video in the link at left.

WATCH

- WHAT "WHALE SNOT" TELLS US ABOUT WHALES AND THE OCEAN (TEDXMELBOURNE)
- WATCH THIS VIDEO OF VANESSA'S WORK (ABC IVIEW)

STAGE 4 – CONSERVATION CRISIS! QUESTIONS

1. Describe the overall trend of the species diversity in your ecosystem over the course of the game.
2. Did you gain more or lose more organisms overall? That is, was the total number of organisms greater or smaller at the end of the game?
3. Did you lose or gain species? That is, was the number of different types of species greater or smaller at the end of the game?
4. Create a food chain with at least three of the species that were in your ecosystem.
5. What abiotic, or non-living, factors such as weather or shelter, affected your species diversity over the course of the game? Give two examples of abiotic factors mentioned in the game cards and their effects on your ecosystem diversity.
6. What biotic, or living, factors such as predators or disease, affected your species diversity over the course of the game? For example, what effect does an invasive species, infectious disease or predators have on the species in your ecosystem? Give an example of how another living thing may have affected one of the species in your ecosystem.
7. Why do you think having a greater range of species is preferable to having fewer species, but more members of each?
8. Do you think different ecosystems (such as an ocean or desert ecosystem) would result in the same outcomes with the same Species Diversity game cards that you encountered? Why or why not?
9. How could a botanic park or other conservation organisation protect one of your species? If so, how?
10. How might technology be used to track the number of species in an ecosystem over time?

STAGE 4 – REAL-WORLD CONNECTIONS

UNDERSTANDING SPECIES DIVERSITY

1. What is meant by the term 'species diversity'?
2. Why do you think it is so important to preserve species diversity?
3. What is meant by the term 'feral species'?
4. List some feral species we have in Australia.
5. Outline the problems caused by one of the feral species named in your response to question 4 and describe what is being done to reduce one or more of those problems.
6. Complete the table below to describe how each of the following technologies is used to help reduce the impact of feral species:

NAME OF TECHNOLOGY	DESCRIPTION AND/OR IMAGE OF TECHNOLOGY	DESCRIPTION OF HOW IT WORKS	DESCRIPTION OF HOW IT HELPS REDUCE THE IMPACT OF FERAL SPECIES
TRAP			
VIRUS			
SENSORS			
DRONES			

7. Write two questions to ask scientists Dr Jodi Rowley or Dr Vanessa Pirotta if they came to your school for Science Week.
8. Discuss or debate the benefits of investing in the prevention of overpopulation of feral species, compared with having to spend time and resources culling them afterwards.

STAGE 4 – SCIENTIFIC INVESTIGATION

CHEMICAL ANALYSIS OF WHALE SNOT – FOR TEACHERS

Scientific Investigation

Note – if you don't have access to a lab, you can adjust pH by using kitchen vinegar. Glucose sticks and glucadin are available at pharmacies and litmus paper to test pH can be ordered online. You could also make a universal indicator using cabbage juice.

TEACHER PREPARATION

Each student, or team of students will need a Whale Snot Testing Kit containing:

- 4 mL of whale snot. Prepare the simulated whale snot by gently mixing 2 parts clear washing up liquid with 1 part water. Adjust to a pH of 7 and prepare the final solution so that it contains 0.1% glucose or Glucodin Powder, which should place it around the range of about 100 mg/dL.
- A plastic 1 mL pipette
- Small beakers and/or petri dishes to store and test samples
- pH test – universal indicator and colour chart
- Protein test – Biuret (0.1 M $CuSO_4$ and 1 M NaOH)
- Glucose test – Glucose sticks

copper(II) sulfate 0.06-0.38 M (1-6% wt/wt) $CuSO_{4(aq)}$

CAS: 7758-99-8

Class: nc **PG:** none **Users:** K-12 **Training:** 1-6

GHS data:

WARNING

Causes mild skin irritation
Toxic to aquatic life with long lasting effects

Potential hazards
May irritate skin and eyes. Not recommended for use by K-2 students; teacher demonstration only.

Disposal
<20 mL/day may be poured down the drain. Larger quantities should be placed in a Copper waste container.

sodium hydroxide 0.51-1.3 M (2-5% wt/wt) $NaOH_{(aq)}$

CAS: 1310-73-2

Class: nc **PG:** none **Users:** 11-12 **Training:** 1-6

GHS data:

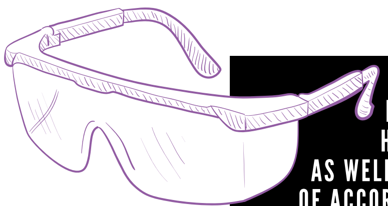
DANGER

Causes severe skin burns and eye damage

Potential hazards
CORROSIVE TO EYES AND SKIN.

Standard handling procedures
WEAR SAFETY GLASSES!

Disposal
<2 L/day may be poured down the drain. Larger quantities should be placed in an Alkaline waste container.



SAFETY FIRST – STUDENTS, TEACHERS AND LAB STAFF MUST WEAR SAFETY GOGGLES WHEN HANDLING CHEMICALS AND ENSURE STUDENTS DO AS WELL. CHEMICALS MUST BE HANDLED AND DISPOSED OF ACCORDING TO THE LABELS ON THE BOTTLES.

CHEMICAL ANALYSIS OF WHALE SNOT - FOR STUDENTS

AIM

To examine the health of a whale by testing its snot.

BACKGROUND INFORMATION

When we want to test for symptoms of illness, a doctor can send our body fluids – such as blood or urine – to the clinical testing laboratory for analysis. A vet can do the same for our pets. Whales are not only hard to collect the usual blood and urine samples from because of their size and location, but can also be dangerous to be around when conducting invasive health tests. Dr Vanessa Pirotta's method for collecting whale snot makes it easier and safer to access than any other body fluid. In this activity, you will chemically test simulated whale snot.

WHAT YOU WILL NEED

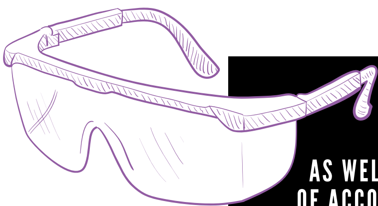
- A few mL of whale snot
- Plastic pipette
- Petri dishes
- Small beaker
- Material for each test – see Data Table 1
- Safety goggles

WHAT TO DO

1. Complete the risk assessment with your teacher before you start the experiment.
2. Put on a pair of safety goggles to protect your eyes from splashes.
3. Protect / cover any open cuts with medical tape.
4. Collect a 4 mL sample of whale snot from your teacher and place in a small clean beaker.
5. Pipette out about 0.5 mL of whale snot from the beaker into each of 4 petri dishes and label them 1, 2, 3 and 4.
6. Use the instructions in the data table to carry out each test in the data table below and then record your results in the space provided.
7. Return all equipment and chemicals to your teacher. DO NOT pour chemicals down the sink. Wipe down your bench and return the safety goggles.
8. Answer the questions on p50.

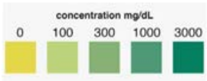
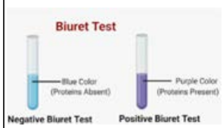
RISK ASSESSMENT

RISKS OR HAZARDS	HOW YOU WILL AVOID OR REDUCE THE RISK
• SHARP BROKEN GLASS • SPILT LIQUIDS • NaOH • $CuSO_4$ • UNIVERSAL INDICATOR	



SAFETY FIRST – STUDENTS, TEACHERS AND LAB STAFF MUST WEAR SAFETY GOGGLES WHEN HANDLING CHEMICALS AND ENSURE STUDENTS DO AS WELL. CHEMICALS MUST BE HANDLED AND DISPOSED OF ACCORDING TO THE LABELS ON THE BOTTLES.

RESULTS
DATA TABLE – WHALE SNOT TEST RESULTS

TEST NUMBER	TEST NAME	MATERIALS NEEDED	TEST METHOD	RANGE OF POSSIBLE RESULTS	YOUR RESULT	RANGE FOR A HEALTHY WHALE	IS THE WHALE WITHIN THE NORMAL RANGE? YES/ABOVE/BELOW
1	pH	Universal indicator and colour chart	Dip the universal indicator stick in the whale snot sample			6.5 -7.5	
2	Glucose	Glucose sticks and colour chart	Dip the glucose stick in the whale snot sample			94 to 115 mg/dL*	
3	Protein	$CuSO_4$ and NaOH	Mix 2 drops of each solution with the whale snot			Pale blue (negative)	
4	Colour of snot	Snot on its own		Clear or cloudy/coloured		Clear – healthy cloudy or coloured – possible contaminants, such as an infectious agent	

*See Hematology and serum chemistry values in the beluga (*Journal of Wildlife Diseases*)

DATA ANALYSIS AND DISCUSSION QUESTIONS

1. How healthy was the whale that the snot was collected from? Was it within the normal range for some or all of the tests?
2. Did your results match those of other class members? If not, how can you find out who might have the more accurate result?
3. What is meant by an 'invasive' or 'non-invasive' medical test?
4. What makes the collection of whale snot by drone non-invasive?
5. Is a chemical test a form of technology? Check your ideas by looking up the definition of 'technology'.
6. What other information do you think scientists can learn about whales from their snot?

CONCLUSION

Write a sentence or two to summarise your results by reporting whether the whale is within the normal range for each of the tests.

STAGE 4 – DIGITAL ACTIVITY

RANDOM EVENTS IN PYTHON

You can use Python to create some code to choose one of the positive or negative benefits in the Conservation Crisis! game.

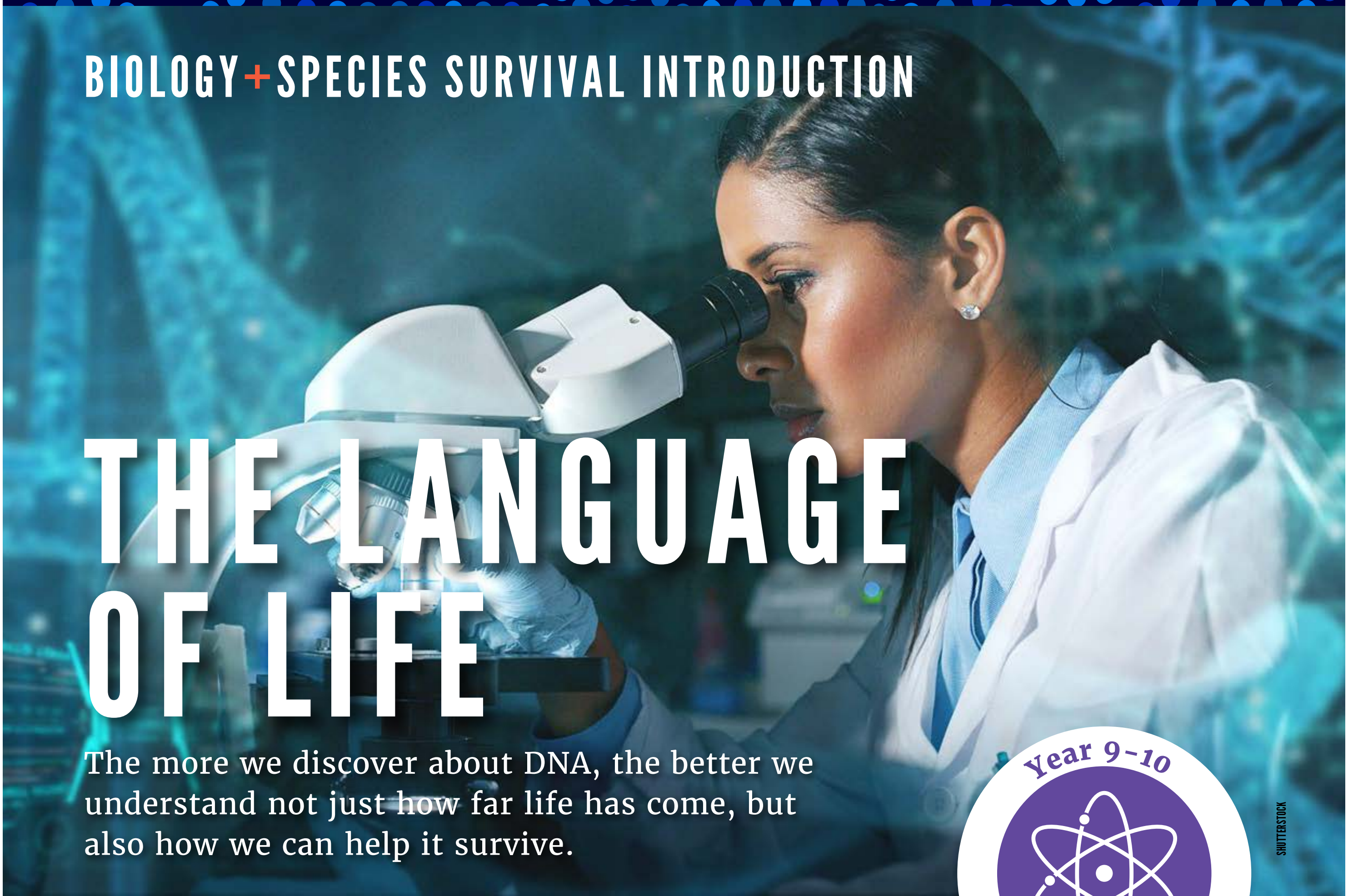
You could do this by assigning a number to the event (say 0 for negative and 1 for positive) and then using the function random.randint(0,1) to choose an integer of either 1 or 0. This is like flipping a coin to choose from two options in real life. Or, you could create the entire list of events as a set of data and use random.choice to choose a data point from a list. This is like rolling dice to choose a specific event.

- Watch a tutorial on using Python for random numbers and choices to get started: Python – Random numbers and choices
- You can also follow this tutorial in the github repository.
- Need help getting started with Python? Check out this great module on getting started in Python: Tutorial on Python (Digital Technologies Hub)

OTHER IDEAS

- Create a poster or digital presentation about an animal that you identified from the citizen science apps or your own research.
- Select a feral species and research when, where and why they were introduced, the damage they cause and the current measures taken to control them. Are these measures successful or not? Are there any suggestions you could make to reduce the damage caused by the feral species? Species include cats, pigs, foxes, horses, cane toads and camels.
- Conduct your own research on a specific successful project that has protected a specific species. Examples include: pygmy blue-tongue, greater bilby, numbat, western quoll.
- Meet scientists using technology and biology to understand species loss: Dr Vanessa Pirotta (whale snot) and Dr Jodi Rowley (FrogID). Write a series of questions you could ask them in an interview to learn more about the amazing work they do looking after animals.
- Examine the role of zoos, botanic gardens, and national and marine parks in maintaining species diversity. How do they help protect our endangered species?
- Take photos of different habitats using a drone.

BIOLOGY + SPECIES SURVIVAL INTRODUCTION



SHUTTERSTOCK

THE LANGUAGE OF LIFE

The more we discover about DNA, the better we understand not just how far life has come, but also how we can help it survive.

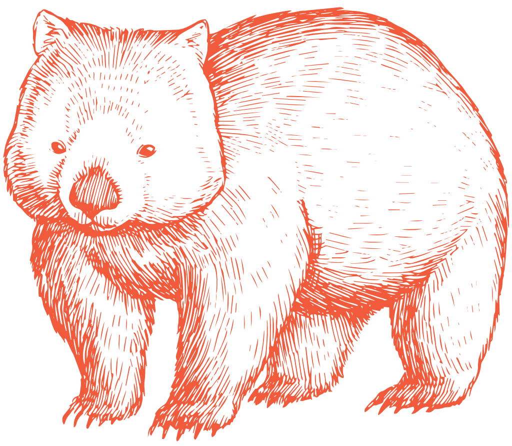
Year 9–10

Around 3.5 billion years ago, life on Earth began with single-celled organisms. Today, scientists estimate there are over 8.7 million different living things in existence, including everything from humans to plants, bacteria and other animals.

This incredible diversity is all thanks to evolution. But to understand evolution, we first need to understand genetics. Deoxyribonucleic acid (DNA) is a very long molecule that's made up of two strands twisted around each other. Each strand consists of different sections called genes. Every individual within a single species shares similar genes, but none are exactly identical – not even in 'identical' twins!

Genes are what make living things unique. They determine things like how tall a tree will grow, when a flower will bloom and what colour eyes we have. These genetic variations can occur for a few different reasons, but mutations – changes in the sequence of genes – are the most common.

Often, genetic mutations can lead to disease or cancer, but occasionally, they cause a physical or behavioural change that helps an organism survive. The next time you see an echidna, take a closer look at its hind legs. They point backwards! This mutation helps echidnas push dirt out of the way when they're burrowing. When a mutation helps, rather than hinders, it becomes an adaptation – and it's passed down to future generations. Eventually, a population of organisms might develop a set of genes, which we call a genome, that is so different to that of its closest relatives that we consider it to be an entirely new species.



ONE (VERY BIG) FAMILY

We can estimate how long ago (or how recently) two species diverged from each other by comparing how many genes they have in common. The human genome contains around 20,000 genes, 99.9% of which are identical to genes in other humans. We share around 90% of our genes with chimpanzees because they're our closest relatives – we became different species 4–6 million years ago. 75% of genes that cause disease in humans are also found in fruit flies, making them an ideal model organism to study human disease.

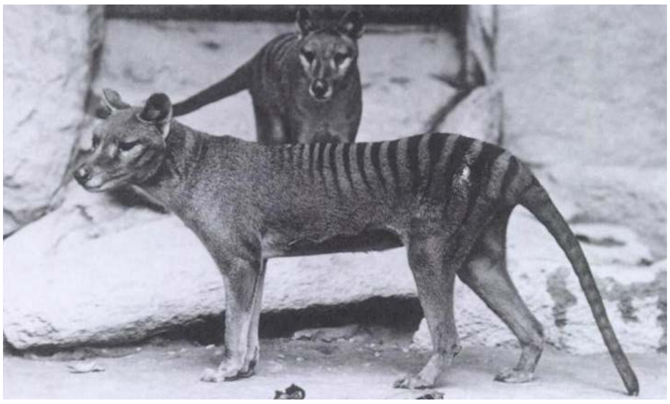
To come up with these numbers, scientists used a process called genome sequencing, which involves sequencing, every single gene in a species' genome. Genome sequencing allows conservationists to identify new species of plants and animals so they can be protected, and it's even helping to resurrect lost species.

THE DE-EXTINCTION CHALLENGE

Bringing species back from the dead used to be the stuff of science fiction, but it's becoming less far-fetched the more we learn about genetics. Here in Australia, researchers are working to bring back one of our most iconic animals: the Tasmanian tiger, or thylacine.

Thylacines were declared extinct in 1982 (though none had been seen since 1936). Their DNA, however, lives on through hundreds of museum samples. Using these samples, University of Melbourne researchers created a first draft of the thylacine genome in 2018. Now, they're filling in the gaps, thanks to genome sequencing of the thylacine's closest living relative: the numbat!

Ultimately, they hope to use this information to genetically engineer a creature that's almost an exact thylacine match.



FEMALE THYLACINE (FRONT) WITH JUVENILE MALE OFFSPRING (REAR). CREDIT: BAKER; E.J. KELLER. REPORT OF THE SMITHSONIAN INSTITUTION. 1904 FROM THE SMITHSONIAN INSTITUTION ARCHIVES. WIKIMEDIA/PUBLIC DOMAIN.

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ECHIDNA. CREDIT: ENGUERRAND BLANCHY/UNSPLASH

THE THYLACINE DILEMMA

Although thylacines were hunted to extinction by humans, the genetic diversity of thylacines began to diminish about 70,000 years ago. Reduced genetic diversity makes a population more susceptible to disease and can ultimately cause it to go extinct. Usually, it occurs when populations get smaller or are isolated from others in their species. In the case of thylacines, it was probably both; scientists think that thylacine numbers began to decline around the last Ice Age, and then more when the species was isolated in Tasmania. Paying attention to the genetic diversity of today's species could be the key to saving them. If scientists can identify that a species' genetic diversity is declining, they can act to reverse it through captive-breeding programs and translocations. Zoos Victoria, for example, bred more than 650 eastern barred bandicoots in captivity to help re-establish wild populations after the species was declared 'extinct in the wild'. Today, these furry little marsupials are recovering; in 2021, the species made international headlines when it became the first in the world to have its conservation status upgraded to 'endangered'.

Extinction is a natural part of evolution, but human activities have dramatically increased the rate at which Earth is losing species. Habitat destruction, roads, introduced species and climate change are all having a big impact. But thanks to our growing understanding of DNA and genetics, we now have some tools up our sleeve to help our fellow Earth-dwellers survive.

MEET THE RELATIVES

Did you know? We share 69% of our genes with platypuses and 24% with rice!

READ MORE

- WE'VE DECODED THE NUMBAT GENOME – AND IT COULD BRING THE THYLACINE'S RESURRECTION A STEP CLOSER (THE CONVERSATION)
- DNA SPELLS EVOLUTION (KHAN ACADEMY VIDEO)

STAGE 5 – CONSERVATION CRISIS! QUESTIONS

1. Describe some of the main changes in species diversity in your ecosystem over the course of the game.
2. Did any of the species in your ecosystem increase in numbers? If so, what allowed them to be so successful?
3. Share your answer to Question 2 with your peers and collate a list of all the human activities and environmental conditions that are potentially helpful for species and may assist their diversity and survival.
4. Did any of the species in your ecosystem become extinct (none were left) or endangered (only 1 was left)? If so, what was the cause of the pressure that led to their extinction or endangerment?
5. Share your answer to Question 4 with your peers and collate a list of all the human activities and environmental conditions that are potentially harmful for species diversity and survival.
6. Which activities and actions do you undertake in your everyday life that promote species conservation and diversity? What actions could you take?
7. Would each of the scenarios on the cards always have only a positive or only negative effect on species diversity? Give reasons and examples to support your answer.
8. Scientists propose that life on Earth is at the beginning of a new major extinction event – how might this game play out in a way that helps demonstrate or model the possible mechanism or consequences of another major extinction event?
9. In what ways do you think the game is an accurate model of how species diversity changes in an ecosystem over time?
10. In what ways do you think the game is NOT an accurate model of how species diversity changes in an ecosystem over time?

STAGE 5 – REAL-WORLD CONNECTIONS

UNDERSTANDING DNA

1. How is the genetic information of organisms coded in their DNA?
2. Describe how the mutation(s) in echidna DNA that led to the backward facing legs help their survival.
3. Suggest how a mutation in the DNA of a single organism that helps its survival might become more common in the species population over time. In other words, how might that helpful mutation be passed on to other individuals in the group?
4. Scientists hope to be able to bring the extinct thylacine species back to life. How do they plan on doing this? Provide a brief outline as described in the text.
5. If the technology to bring back extinct species such as the thylacine is successful, what do you think are the benefits and drawbacks of using this genetic technology? Think broadly, such as, how the DNA engineered animal(s) might be treated, how society might react, and whether any new laws need to be made. Could or should the technology be used to bring back other extinct organisms?
6. Which human activities mentioned in the text contribute to species reduction and destruction? Suggest other human activities that have the potential to create harm to different species that we should avoid or reduce.
7. Why is it important for survival of a species to have genetic variety?
8. What do scientists mean when they say they have 'sequenced' or 'de-coded' a species?

STAGE 5 – SCIENTIFIC INVESTIGATION

USE DNA DATA TO DESIGN A CONSERVATION PLAN FOR AN ENDANGERED SPECIES

You are a genetic conservationist working in a wildlife sanctuary and your job is to analyse the DNA of a small population of koalas in order to identify the best genetic partner for Kiki, one of the breeding females.

Scientific Investigation

BACKGROUND INFORMATION

Each individual has a unique DNA code made up from the sequence of four letters, known as nucleotide bases. The four bases are referred to as A, T, G and C. It is the difference in this DNA genetic code of bases that makes us all different. The greater the difference in the DNA sequence of individuals, the more genetically diverse they are. Having genetic diversity in a species is preferable, as this promotes a greater variety of characteristics within that species, which is an advantage if environmental pressures change. Breeding programs with a small gene pool, that is, organisms with similar DNA, have low species diversity and vice versa.

AIM

To compare the DNA sequence of three different breeding males to identify who has the greatest genetic diversity from female Kiki.

METHOD

1. Compare the sequence of DNA bases A, T, G and C for Kiki with Male 1.

KOALA IDENTIFICATION	DNA BASE SEQUENCE
KIKI (FEMALE)	TAC GGG CTC GGT AAT CGT CCG TAT GAT CAT
MALE 1	TAC GGT GTC GGT TAT CGT CCG TAA GAT CTT
MALE 2	TCC GGT GTC GAT TAT CGT CCA TAT GAT CTT
MALE 3	TAC GGT GTC GGT AAT CGT CCC TAT GAT CAT
MALE 4	TAC GGT GTC GGT TAT CGT CCG TAA GAT CTT

2. Highlight or circle the DNA bases for each male that do not match with the sequence of DNA bases for Kiki. Male 1 has been done for you as an example.
3. Repeat step 2 for Males 2, 3 and 4.

RESULTS

Data Table – Comparison of koala DNA sequences

NUMBER OF DNA BASES DIFFERENT TO KIKI			
MALE 1	**MALE 2**	**MALE 3**	**MALE 4**
5			

DISCUSSION QUESTIONS

1. A change in the DNA bases is known as a gene m______________________________

2. Using the DNA evidence available, which male is most genetically similar to Kiki?

3. Using the DNA evidence available, which male is most genetically different to Kiki?

   Scenario 1 – All animals in the same enclosure select their own mates.

4. Kiki breeds with Male 1, who is her favourite. But is he the best genetic match for the future of the species? Explain why or why not.

   Scenario 2 – Scientists set up a breeding program for the koalas in the enclosure.

5. The scientist in charge of a selective breeding program chooses Male 3 as a genetic partner for Kiki. Do you think this is a good choice for encouraging greater genetic diversity in the species? Why or why not?

6. How can breeding programs help species maintain or increase genetic diversity over many generations? Give some examples in your response.

7. Male 4 is a close relative of Male 1. What evidence in their DNA sequence suggests this?

8. A second female koala at the wildlife sanctuary, Lillie, has the following DNA sequence:

   TAC GGA GTC GAT TAT CGT CCA TAT GAT CTT

   Which male would make a suitable breeding partner for Lillie in order to maximise genetic variability in their offspring?

9. Why are breeding programs valuable in regards to increasing species diversity?

10. Explain to someone who doesn't know about the genetic technology DNA sequencing how it has helped set up successful breeding programs in zoos, sanctuaries and wildlife parks that increase genetic diversity.

STAGE 5 – DIGITAL ACTIVITY

CALLING FOR CAMPAIGNS!

In this activity from the Digital Technologies Hub, Year 9–10 students can investigate, develop and implement a digital campaign to raise awareness of an environmental issue. Some examples of environmental issues to investigate are included, you can also look at some of the examples suggested below and create a list for students to draw from, or ask them to brainstorm an environmental issue important to their own locality.

In each of the examples, evaluate the digital technologies used and estimate the reach of the campaign.

9–10 Collaborative project (Digital Technologies Hub)

Example campaigns

CAMPAIGN	DIGITAL TECHNOLOGIES USED	TYPE OF DATA GATHERED	PURPOSE OF CAMPAIGN	REACH OF CAMPAIGN
The Aussie Bird Count app	App, form (on website)	Photos, descriptions	To raise awareness of bird species and gather data on Australian bird populations.	Australia-wide
Bush Heritage Australia				
iNaturalist				

OTHER IDEAS

- Research previous extinction events, such as what might have happened to the Australian megafauna.
- Create a timeline using the fossil record of how a species, such as the kangaroo or the horse, has evolved over time.
- Select a species that has been saved from the brink of extinction. Research how conservation efforts saved this species.
- Imagine a perfect future in species conservation. If money were no object, what would this look like in Australia?
- Investigate laws related to protecting native species. Examples include: domestic pet registrations, banning of artificial lawns, protection of and within national parks, breeding programs.
- Use a method in your textbook or one found online to extract DNA from a piece of fruit such as a kiwi or strawberry. DNA extraction activity (National Science Week)

SCIENCE

Year F–K SU: Features of plants and animals (AC9SFU01) – SHE: Using observations (AC9SFH01) – SI: All

Year 1–2 SU: Needs of plants (AC9SIU01) Seasonal and daily changes (AC9SIU02) – SHE: Using science to make predictions (AC9S1H01, AC9S2H01) – SI: All

Year 3–4 SU: Comparing characteristics of living things (AC9S3U01), Roles and interactions of consumers and producers (AC9S4U01), Water sources (AC9S4U02) – SHE: How people use data (AC9S3H01, AC9S4H01), Use science to solve a problem (AC9S3H02, AC9S4H02) – SI: All

Year 5–6 SU: Survival of living things (AC9S5U01), Survival and change (AC9S6U01) – SHE: Scientific advances due to collaborations (AC9S5H01, AC9S6H01), Science used to identity problems (AC9S5H01, AC9S6H01) – SI: All

Year 7–8 SU: Biotic and abiotic factors, models (AC9S7U02) – SHE: Cultural practices (AC9S7H02, AC9S8H02), Scientific responses to contemporary issues' impact on society (AC9S7H03, AC9S8H03) – SI: All

Year 9–10 SU: Use evolution to explain diversity (AC9S10U02) – SHE: Advances in technology have advanced science (AC9S9H02, AC9S10H02), Values and needs of society influence focus of scientific research (AC9S9H04, AC9S10H04) – SI: All

DIGITAL TECHNOLOGIES

Year 7–8 Random events in Python – Data representation (AC9TDI8K03), Acquiring, analysing and measuring data (AC9TDI8P01) Acquiring, analysing and measuring data (AC9TDI8P02)

Year 9–10 Calling all Campaigns – Generating and designing (ACTDIP039), Generating and designing (ACTDIP040), Collaborating and managing (ACTDIP043), Collaborating and managing (ACTDIP044)


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