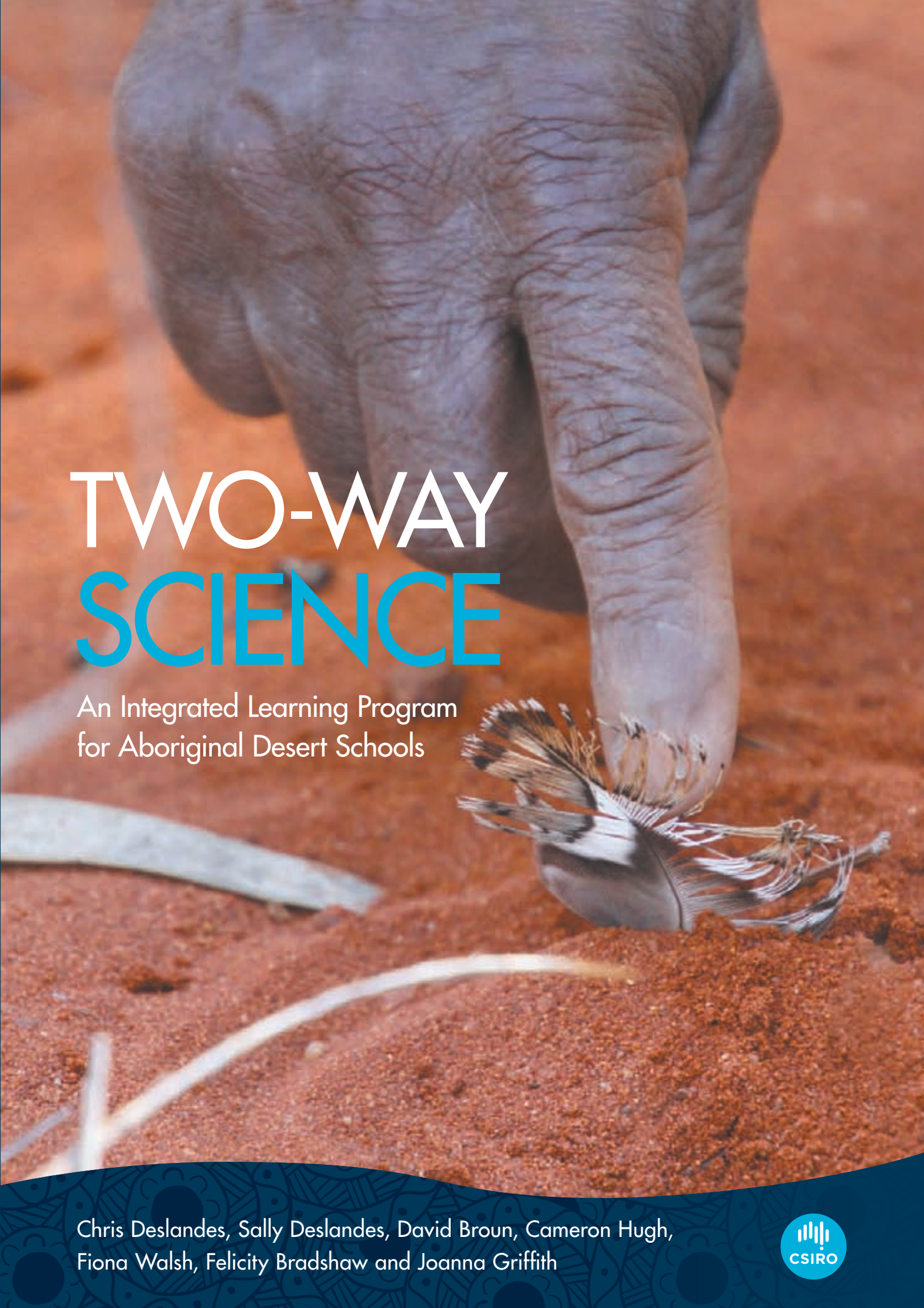


A close-up photograph of an elephant's trunk reaching down to touch a small, white and brown feather on a surface of fine, reddish-brown sand. The elephant's skin is wrinkled and grey, and the feather has a fan-like structure with white and brown patterns. The background is a blurred expanse of the same red soil.

TWO-WAY SCIENCE

An Integrated Learning Program
for Aboriginal Desert Schools

Chris Deslandes, Sally Deslandes, David Broun, Cameron Hugh,
Fiona Walsh, Felicity Bradshaw and Joanna Griffith



© CSIRO 2019. All rights reserved.
Reprinted with corrections 2020.

Except under the conditions described in the *Australian Copyright Act 1968* and subsequent amendments, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, duplicating or otherwise, without the prior permission of the copyright owner.

With the exception of photographs, images and logos, CSIRO is pleased to allow this material to be reproduced in whole or in part for educational and non-commercial use, provided the meaning is unchanged and its source, publisher and authorship are acknowledged. Specific permission is required for the reproduction of photographs. Please contact CSIRO Publishing for all permission requests.

This work embodies the traditional knowledge and traditional cultural expressions of First Nations communities. It was created with the consent of the custodians of the communities. Dealing with any part of the images for any purpose that has not been authorised by the custodians is a serious breach of the trust and customary law of these communities and may also breach the *Copyright Act 1968* (Cth).

The authors assert their moral rights, including the right to be identified as an author.

A catalogue record for this book is available from the National Library of Australia.

ISBN: 9781486313082 (pbk)
ISBN: 9781486313099 (pdf)
ISBN: 9781486313143 (epub)

Published by:
CSIRO Publishing
Locked Bag 10
Clayton South VIC 3169
Australia

Telephone: +61 3 9545 8400
Email: publishing.sales@csiro.au
Website: www.publish.csiro.au

Text design and layout by Carbon Creative
Cover design by James Kelly
Printed in Australia by Courtney Colour

CSIRO Publishing publishes and distributes scientific, technical and health science books, magazines and journals from Australia to a worldwide audience and conducts these activities autonomously from the research activities of the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The views expressed in this publication are those of the author(s) and do not necessarily represent those of, and should not be attributed to, the publisher or CSIRO. The copyright owner shall not be liable for technical or other errors or omissions contained herein. The reader/user accepts all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from using this information.

TWO-WAY SCIENCE

An Integrated Learning Program for Aboriginal Desert Schools



Chris Deslandes, Sally Deslandes, David Broun,
Cameron Hugh, Fiona Walsh, Felicity Bradshaw and Joanna Griffith



Acknowledgement of country

Aboriginal and Torres Strait Islander peoples have long-standing scientific knowledge traditions. These traditions have developed knowledge about the world through observation, using all the senses; through prediction and hypothesis; through testing (trial and error); and through making generalisations within specific contexts. These scientific methods have been practised and transmitted from one generation to the next and contribute to particular ways of knowing the world that are unique as well as complementary to Western scientific knowledge.

A deep respect for these Aboriginal and Torres Strait Islander cultural practices and knowledge underpin the philosophy and practice of the Indigenous STEM Education Project. Recognition of traditional contexts for technologies and concepts, their application in the past, present, and future—including supporting modern STEM career pathways for Aboriginal and Torres Strait Islander students—reaffirm the ingenuity and creativity of Aboriginal and Torres Strait Islander peoples' knowledge systems.

The Indigenous STEM Education Project team acknowledges the Traditional Owners with whom this Project is collaborating and their vibrant living cultures and knowledge systems. We pay our respects to Elders past and present and thank all community members who are providing the leadership to ensure meaningful and effective engagement with Aboriginal and Torres Strait Islander communities for the six distinct but complementary STEM education programs that make up this Project.

CSIRO acknowledges that Aboriginal and Torres Strait Islander peoples make extraordinary contributions to Australia in cultural, economic and scientific domains; for example, incorporating Indigenous knowledge of ecological and social systems is vital to the achievement of sustainable development.

(cover): A Martu Elder placed a Nganamarra (Malleefowl) feather in the top of a replica egg incubation mound constructed by Wiluna School students during a Two-way Science activity. Photo by David Broun, CSIRO.

(opposite): Photo by David Broun, CSIRO.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.csiro.au

Indigenous STEM Education Project

w www.csiro.au/indigenous-education

Other acknowledgements

CSIRO wishes to acknowledge the significant knowledge and leadership of Aboriginal Elders, educators, rangers and community members that have made the development and implementation of the Science Pathways for Indigenous Communities program possible. The authors would also like to thank the schools and communities in Western Australia that were engaged in the program and worked alongside the Science Pathways team to develop, adapt, trial and review the content of this publication. The authors would like to acknowledge the Aboriginal organisations, conservation and land management groups, and scientists who partnered with schools and communities in the development and trial of Two-way Science activities and programs in Western Australia.

Two-way Science was produced by the Science Pathways for Indigenous Communities program, which is part of the Indigenous STEM Education project delivered by the CSIRO and funded by the BHP Foundation.



Editor and Project Coordinator: David Broun.

Contributing authors: Chris Deslandes, Sally Deslandes, David Broun, Cameron Hugh, Dr Fiona Walsh, Felicity Bradshaw, and Joanna Griffith.

Schools who took part in the Science Pathways for Indigenous Communities project in Western Australia during the development of this book from 2016–2019: Strelley Community School (Warralong and Strelley campuses), Wiluna Remote Community School, Leonora District High School, Rawa Community School (Punmu and Kunawarritji campuses), Parnngurr Community School, Tjuntjuntjara Remote Community School, Jigalong Remote Community School.



Contents

Places, maps and country	13
Water	51
Animals	96
Plants	180
Seasons, weather and astronomy	246
How to make a video story	274
References	277
Index to topics	281



Glossary

Aboriginal expert: an Aboriginal person with cultural knowledge of country, plants and animals.

Aboriginal knowledge: cultural knowledge of Aboriginal people.

Community: the local Aboriginal community where there are close connections with family, culture and Language.

Country: the regional lands and waters associated with traditional owners or clan groups that they have responsibility for. This term is used at a regional scale rather than meaning Australia as a whole country.

Ecology: the branch of biology that deals with the relationships of living things to one another and to their physical surroundings.

Elder: someone who has gained recognition as a custodian of knowledge and lore and who has permission to disclose knowledge and beliefs.

Field trip: an excursion for Learning on Country.

Indigenous ecological knowledge (IEK): cultural understanding of the ecology of the country.

Learning on Country (LoC): an activity outside the classroom where Aboriginal people are teaching aspects of culture, country and Language.

Science Pathways: Science Pathways for Indigenous Communities—a pilot Two-way Science project for selected remote WA and NT desert communities, part of the broader Indigenous STEM Education Project funded by the BHP Foundation and delivered by the CSIRO.

Traditional Owner (TO): an Aboriginal person who is recognised by their community as having ownership and knowledge of a particular area or 'country'.

Two-way Science: a science pedagogy for remote Aboriginal students that links Indigenous ecological knowledge with Western science.

Preface

These Two-way Science education resources were developed between 2016 and 2019 as part of the Science Pathways for Indigenous Communities program (Science Pathways). Science Pathways is one of six elements of the Indigenous STEM Education project delivered by the CSIRO and funded by the BHP Foundation. Science Pathways staff worked with remote Aboriginal schools and communities in Western Australia, and a team of education and science consultants, to create a set of Two-way Science activities tailored to the unique cultural and environmental conditions of the Western and Central Desert regions of Australia. The activities build on the work of Meg Mooney and others from Tangentyere Council's Land and Learning project, their pioneering efforts over two decades in the connection of Western science to local Language and culture programs in central Australian schools.

‘We are teaching all our children about their country. They see and learn about all the waterholes. They are seeing and knowing their grandmothers’ and grandfathers’ country ... Children will see and know their country forever. They will know their own country.

Our old people have all gone now.
My words are for the children.
Their country is the right school
for the children.’

—Muuki Taylor, Senior Cultural Advisor,
Kanyirninpa Jukurrpa (KJ 2016)



Under guidance from Martu Elder Rita Cutter, students look at the anatomy of a quail found on the side of the road during ‘Warlawurru Week’ north of Wiluna. This incidental teaching opportunity led to Rita relating Tjukurrpa (Dreaming) stories about different birds and their habits. Teachers connected this to a study of the anatomy and adaptations of different birds. Photo by David Broun, CSIRO.

(opposite): Photo by David Broun, CSIRO.

About Two-way Science

Two-way Science is a pedagogy, a way of teaching and learning that connects Aboriginal knowledge of the environment to Western science and the school curriculum. Many disciplines of science have parallels in Aboriginal knowledge systems—ecology, astronomy, meteorology, geology, hydrology and more. Both forms of knowledge are valuable learning, one taking a holistic view of the way the environment works, the other being a system of knowledge based on questioning and testing to understand the world.

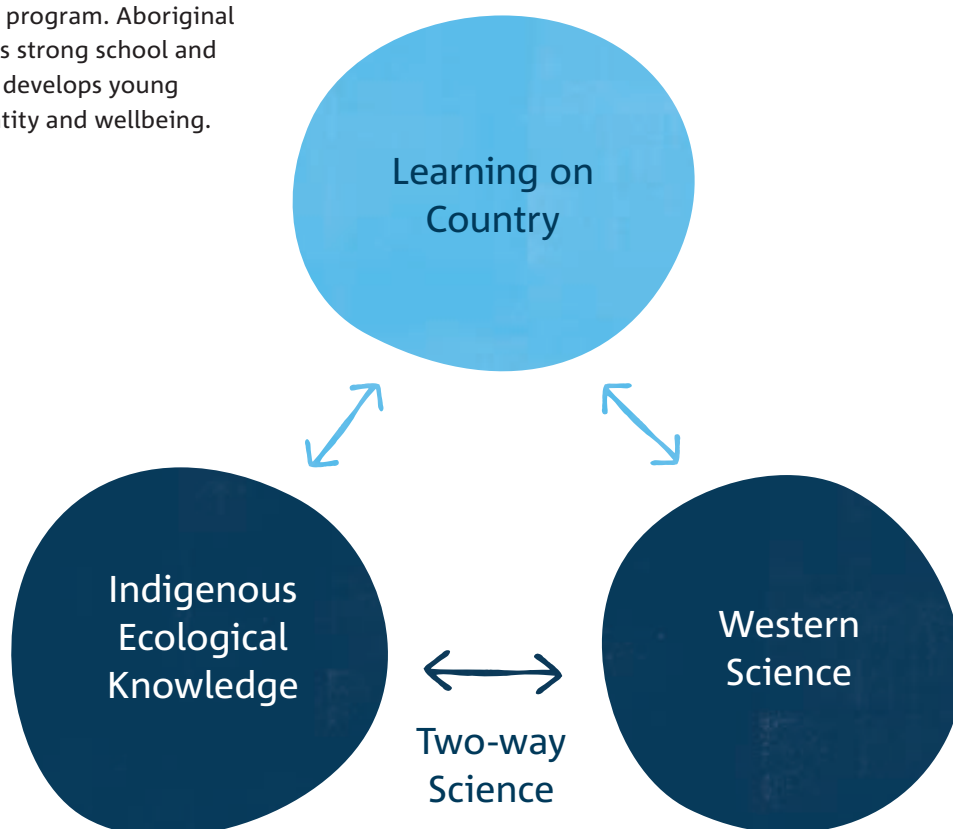
A Two-way Science approach uses science as the vehicle for connecting Indigenous ecological knowledge to the wider curriculum. This connection is used to inform the whole school learning program with many opportunities to integrate other learning areas.

The foundation of Two-way Science is Learning on Country. Learning on Country involves Aboriginal experts teaching cultural knowledge of country to students outside the classroom. Aboriginal people decide what to teach, how to teach and where to teach students from their communities.

A Two-way Science program involves Aboriginal people making decisions about the direction and content of the school learning program. Aboriginal leadership of education fosters strong school and community relationships, and develops young people's sense of cultural identity and wellbeing.

‘The kids are learning who they are. And when they find out who they are, they’re going to be stronger people. If they have success out here, then they’re going to have success in the classroom. It’s a flow-on: out bush, into the classroom, we can do it.’

—Fifi Harris, Aboriginal and Islander Education Officer, Two-way Language educator (ACARA 2019)



How this book is structured

This book is organised into topics, units and activities. Topics are based around the important elements of the environment from an Indigenous cultural perspective: Water; Plants; Animals; Seasons, weather and astronomy; and Places, maps and country. There is crossover and connection between these topics consistent with a holistic Indigenous world view.

Each topic is organised into units. The units provide activities based around a teaching and learning cycle of planning, preparation, Learning on Country, follow-up and reflection. The activities in the unit can be taught in order, or mixed and matched with other units as circumstances dictate. The activities provide a combination of Aboriginal-led and Western science activities. There are suggestions for activities that connect to other learning areas including literacy, numeracy, humanities and social sciences, arts and technologies.

Science inquiry skills are developed in science investigation activities throughout the resource. Two-way Science promotes an inquiry approach that encourages questioning. Opportunities for this are built into the structure of each unit.

At the end of each unit is a set of curriculum links. These describe ways that Aboriginal knowledge can provide student learning that meets science curriculum outcomes, as well as the inquiry skills and content covered in the activities. The index at the end of the book can be used to identify relevant topics, units and activities to support the planning of Two-way Science.



(above left and bottom right): A Tjuntjuntjara Elder teaches students to dig for Honeyants. Students learn about the habitat and life cycle of the Honeyant through the teaching of Aboriginal knowledge. Photos by Chris Deslandes, CSIRO (above left), and David Broun, CSIRO (bottom right).

(above right): A student writing questions about the Wedge-tailed Eagle after Learning on Country. These questions can be used for further investigations or research in class. Photo by David Broun, CSIRO.



Two-way Science teaching and learning cycle

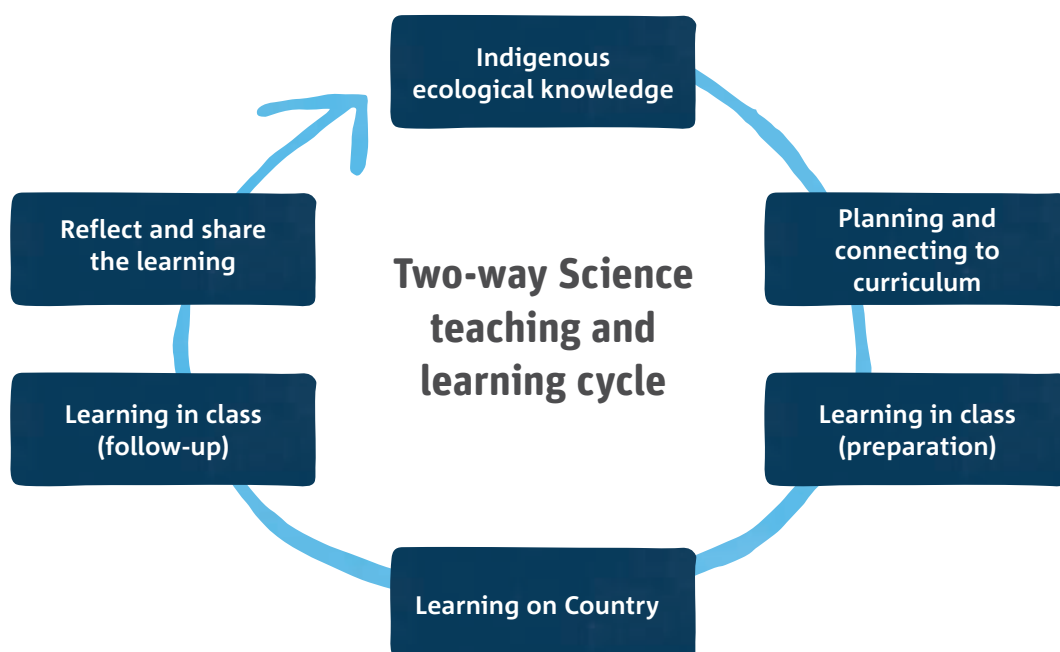
The units in this book are structured on the Two-way Science teaching and learning cycle. This cycle maximises the educational benefits of Indigenous knowledge and the engagement of Learning on Country by developing a program of integrated activities before and afterwards in the classroom. Each stage is described in turn below.

Indigenous ecological knowledge

The foundation of Two-way Science is the cultural knowledge of Aboriginal people from the local community. Aboriginal people decide what cultural knowledge they want to be included in the school learning program.



Wiluna Martu Elders Rita Cutter and Lena Long describe how seed from Kalaru (*Tecticornia verrucosa*) is collected to grind and make damper. Photo by David Broun, CSIRO.



Planning and connecting to the curriculum

Local Aboriginal people and teachers plan the Two-way Science program together. This could include Aboriginal education workers, elders or Indigenous rangers. They decide on a topic based on Aboriginal knowledge of the current season, a location, or a focus area of cultural learning. They use the Two-way Science education resources to identify units and activities, and plan a program that includes Learning on Country. Planning can take place in the school or on country. Planning Two-way Science on country facilitates deeper understanding of cultural knowledge for teachers and allows Aboriginal experts to share examples in context.



(left): Aboriginal and Islander Education officer Fifi Harris and teacher Katrina Lane from Leonora discuss Karlkula (Silky Pear) growing conditions during preparation for the Bushfood unit in the Plants topic. Photo by David Broun, CSIRO.



(right): Principal Adriano Truscott and Aboriginal and Islander Education officer Anthea Cutter from Wiluna discuss Martu Wangka (Language) to be included in Two-way Science activities. Photo by David Broun, CSIRO.

Learning in class (preparation)

Students engage in activities to prepare for Learning on Country. This may include a visit from an Elder, a class brainstorm to share prior knowledge, or research about a topic. Students should become familiar with scientific and Aboriginal Language, learn how to use equipment and practise numeracy skills required by activities on country.



(left): An Aboriginal education worker from Parnngurr teaches students Martu Wangka (Language) before Learning on Country. Photo by Monica Chahal.



(right): A student writes a prediction about a Malleefowl nest. Photo by David Broun, CSIRO.

Learning on Country

Aboriginal experts lead the learning. Aboriginal Language should be used wherever possible. Focus the learning by taking videos and photos, and collecting samples, to take back to class. Western science activities can happen alongside cultural knowledge transfer.



(left): Ngalia Elder Kado Muir shows students bush food during a Learning on Country field trip. Note the bag to collect samples to take back to class for follow-up activities. Photo by Fifi Harris.



(right): Wiluna Martu Elder Rita Cutter leads a Learning on Country field trip. Photo by David Broun, CSIRO.

Learning in class (follow-up)

Students use the knowledge and engagement of Learning on Country in a range of integrated activities. For example, students could recount their trip or activities on country; conduct related STEM investigations; collate and analyse data; document learning in media or art projects; or conduct further research on a topic or question.



(left): Aboriginal education worker Jesiah Robinson teaches measurement during a Two-way Science follow-up activity after Learning on Country. Photo by Moemai Hook.



(right): Students compare the weight of an Emu egg with a chicken egg. How many chicken eggs will it take to balance the scales? Photo by Monica Chahal.

Reflect and share

Students reflect on the process and outcomes of their work. The school and community reflect and strengthen their ways of working together. Student and school learning can be shared with the community, promoting and valuing both Aboriginal knowledge and the school learning program.



Video and art projects have been used successfully to share student learning with the community and beyond. Here is a mosaic tile made with students showing a Kangaroo as part of a Martu seasonal calendar project, and the title screen of a video made by Wiluna student Keshaya Long about her mother Miranda digging for Lunki (Witchetty grub). Photo by David Broun, CSIRO.

Safety

A Two-way Science program requires Learning on Country activities in the desert regions of Australia. Sensible precautions need to be taken to reduce risk. Schools should follow their own safety principles and policies as they would with any excursion. Experienced local Aboriginal people should be engaged to identify risks and help to avoid them. Teachers should respect local knowledge and consult with their community in the planning of activities.

Travel in remote locations should only be conducted by people with a good knowledge of the local area and who are suitably prepared with appropriate vehicles and communications equipment. The Science Pathways for Indigenous Communities project has developed a remote travel guide to give good practical advice around planning, preparation and procedures to minimise risk in remote travel.



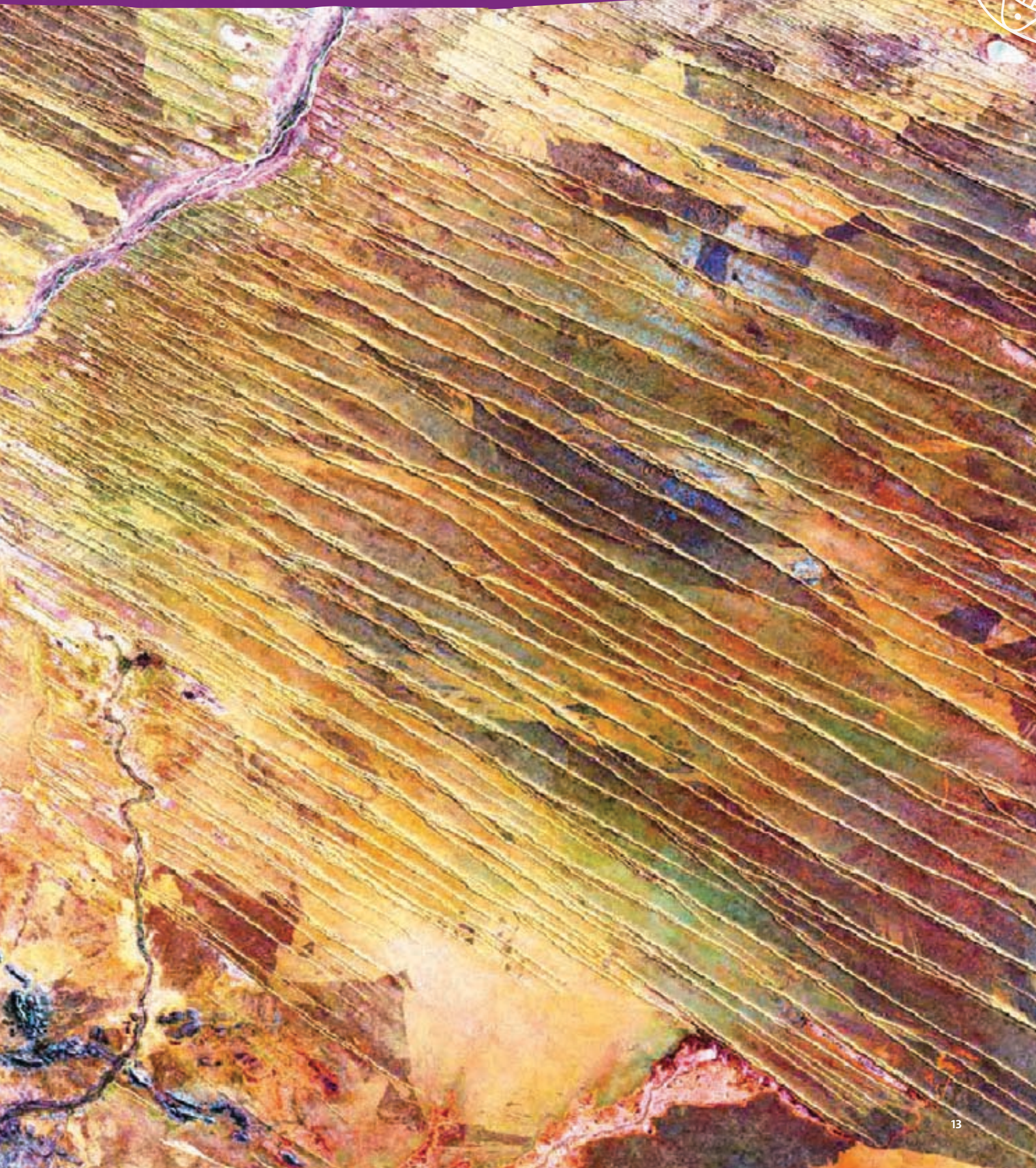
Classes from Strelley Community School head out for Learning on Country at a nearby creek. Photo by Moemai Hook.

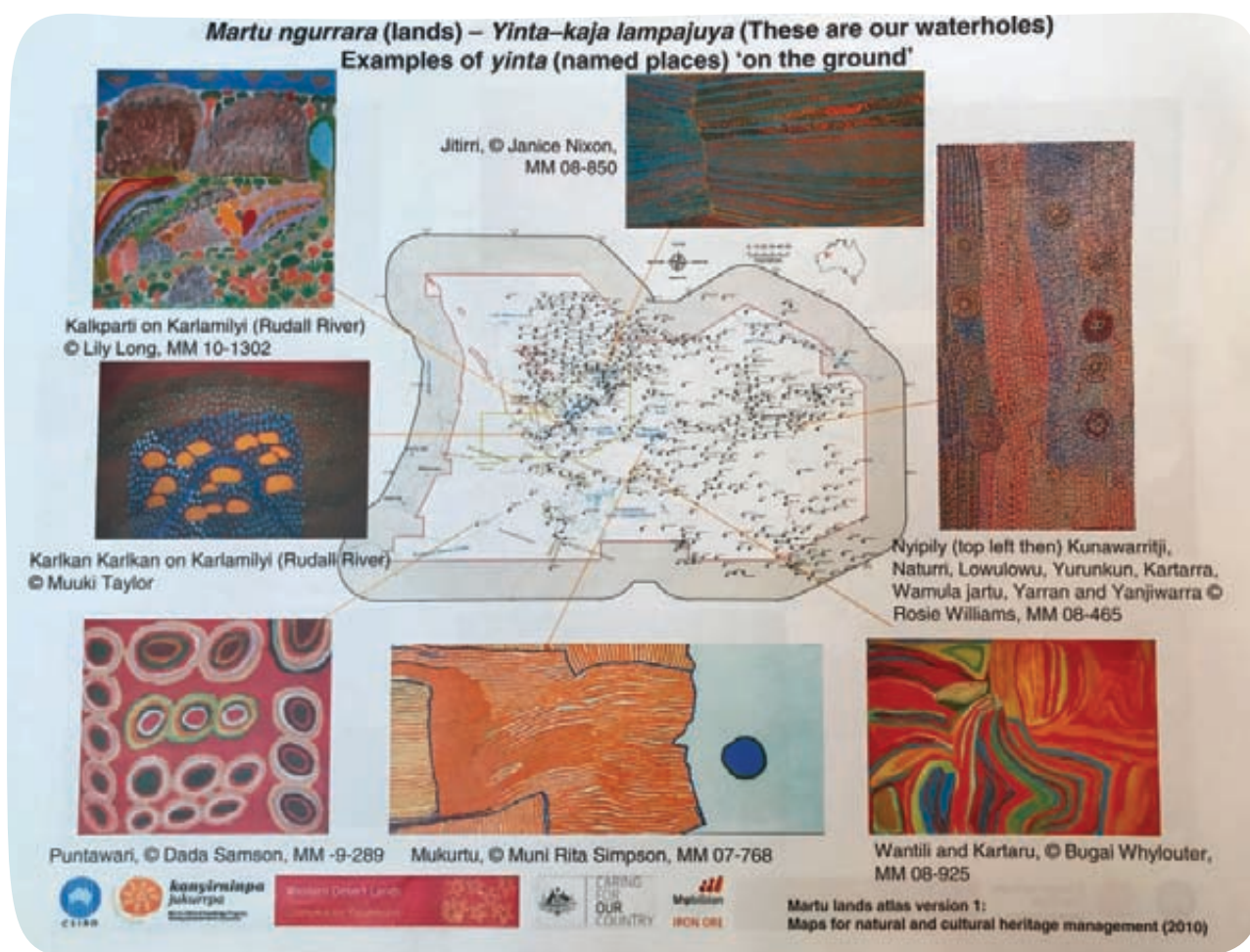


Compare the paintings *Jitirri* (top) by Janice Nixon (2008), and *Mukurtu* (bottom) by Rita Simpson (2007) with the satellite image. Can you see the lines of sand dunes, vegetation and drainage lines in the satellite image and paintings?

(opposite): Karlamilyi satellite image (2007), extracted by Nat Raisbeck-Brown. Landsat high-level products courtesy of the U.S. Geological Survey Earth Resources Observation and Science Center.

Places, maps and country





Martu people name hundreds of places across their lands, here the Martu Native Title Determination Area. Martu artworks often relate to specific named places or lines of related places. (Walsh FJ *et al.* 2009).

'Humans have always mapped their world, recorded knowledge and passed it on to others as a template for wayfinding ... Story became the means through which country was known and remembered. Story was patterned into songs that told the names of the country, told when and where the edible plants grew, where Marlu, Kipara and Parnajarrpa lived, told of grasslands and sand dunes and salt lakes and the ancestral beings that inhabited them and water, always water. Yinta and Jurnu and Jila, the life forces of the desert.'

So the songs mapped the country and the children learned the songs as they travelled to the places named in the songs. The rhythm of walking and breathing took the song into the body. Through the body the song became dance, which in turn became ceremony.

Since the very recent introduction of paint and canvas to the Martu all this knowledge has been given another means of expression ... The paintings enter the same realm as the song and the story, becoming another way of remembering.'

—Kim Mahood (2014)

Background

An understanding of the spatial aspects of place and country are as critical to Aboriginal knowledge as they are to Western science. Aboriginal knowledge systems include navigation and memory of country in song, dance and ceremony. Many scientists rely upon the interpretation of spatial information often presented as maps. Most people use maps to navigate, plan for travel or to explore familiar and unfamiliar places—how often do you use Google Maps or look at Google Earth?

Aboriginal people hold a deep cultural connection to country and places. Knowledge of the location and names of waterholes and sacred places continues to be taught by Elders to younger generations. This includes more contemporary history. The individual tree where a grandmother was born, the site where a large ceremony was held or the station camp where a father grew up all form part of the important cultural history of people and place. Aboriginal people often ask: Who is your family? Where are you from? All students have a family. All families come from somewhere. These important places can be 'invisible' for non-Aboriginal people as many aren't shown on standard maps.

Teachers may be familiar with Aboriginal art. Much desert Aboriginal art illustrates the location of water sources and places across a landscape. Often these locations are spatially accurate relative to each other in terms of direction if not distance. Art often encodes the geography of a landscape.

In the past, Aboriginal people made maps in many ways. They drew maps in the sand. They carved and created maps in timber and other materials. They had mind maps that helped them sing special songs that listed the lines of water holes that a traveller might follow. These maps can be transferred to paper, satellite imagery and other media.

Today, Aboriginal organisations have large mapping sections (similarly government organisations do). Aboriginal rangers use and make a variety of maps—these range in size from as large as a wall, to that fitting in a glovebox, to Google Maps on their phone. Familiarity with mapping is essential knowledge for all students, especially those interested in ranger or land management careers.

This unit is designed to move students from the familiar to the unfamiliar. Students will begin with learning sunrise and sunset as these shape learning of compass points. Then maps of the local familiar area are made. Next is a visit to Aboriginal rangers to see how they use maps in their work. A Learning on Country visit with Traditional Owners and Aboriginal rangers helps students learn about places in their country and how they are mapped. Then students learn about landforms which shape the geography of their country. Finally, the school is encouraged to collaborate in making a large map of its region marking the school, community or town, main rivers and lakes, sites or places named by Aboriginal people and other content. This can be built upon as a long-term or permanent feature of the school.



Story map of Sturt Creek painted by Sturt Creek traditional owners and Kim Mahood, 2006. The map represents the sites visited with information and oral histories recorded during a back-to-country trip in 2006. The legend (left) explains the symbols used and (right) the route of a women's Bird Dreaming story line and walking route.

Places, maps and country: Planning

Aboriginal experts hold traditional knowledge about direction, ways of mapping and navigation. In many cases there are specific people who have the cultural rights to speak for certain locations. It may be that the people that work with the school are not Traditional Owners of nearby country, but rather speak for country in another place because of family and cultural connections. Teachers should always ask and be respectful of these cultural rights in discussion and planning about places to visit and cultural information about songlines and stories about important places. It may be that this knowledge is not able to be shared for cultural reasons.



Mural from Wiluna school showing North Pool and the Jila (waterhole/snake) from a Tjukurrpa (Dreaming) story. Photo by Sandy Chambers. Mural by Samantha Wortelhock, Breakaway Art (2015).

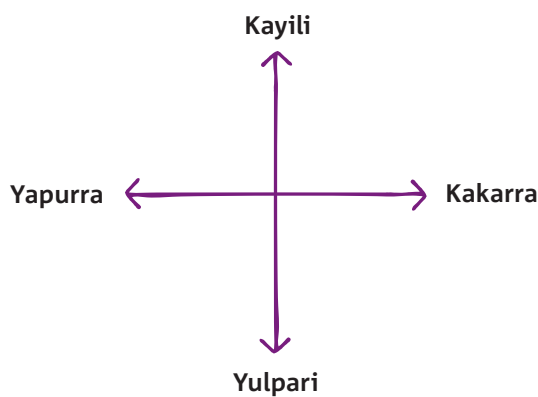
Unit 1: Sunrise, sunset and compass points

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

In this activity, students learn about sunrise and sunset directions (east and west) and compass points (east, west, north, south) in the local Aboriginal Language. Older students could also learn about the way that the angle of the Sun changes with the seasons (Sun inclination) and intermediate compass points (south-east, north-west, etc.).

BACKGROUND

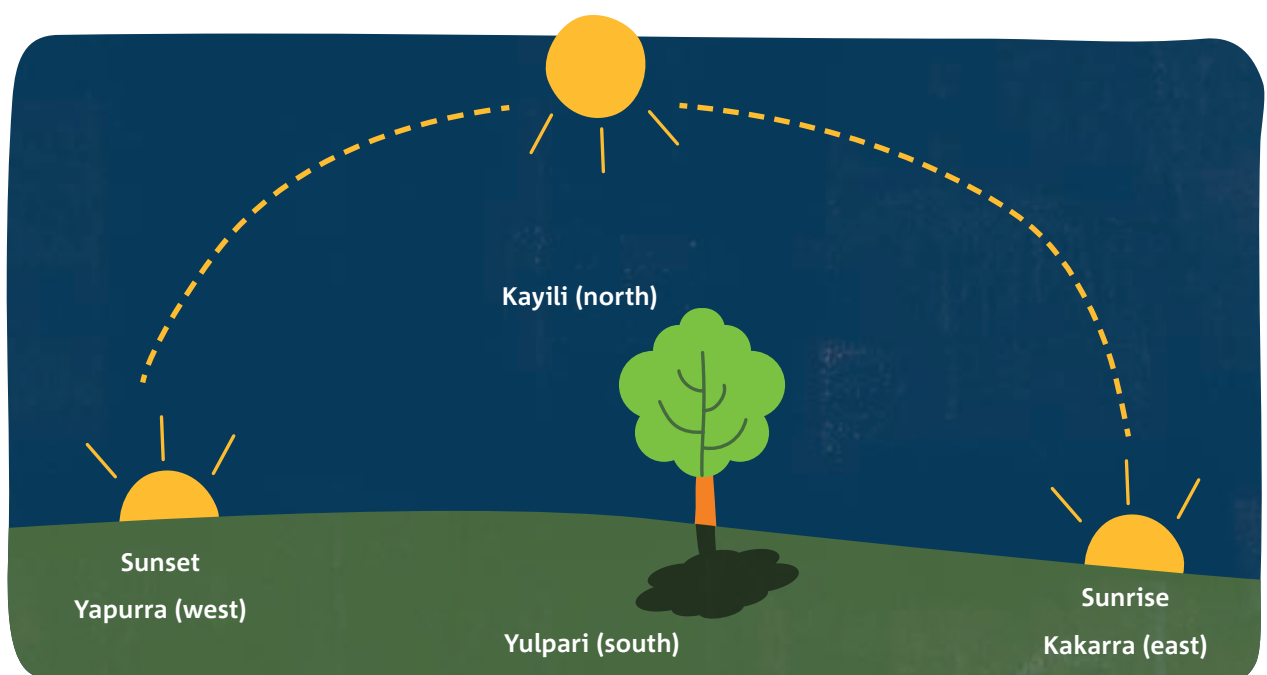
Compass points on a compass are east, west, north and south. Like many cultures around the world, Aboriginal people use compass points to navigate across the landscape.



Compass points featuring Martu Wangka (Language).

To determine the compass points, Aboriginal people observed the direction of sunrise and sunset, and daily shifts in the fall of shadows. They did not use compasses and sundials. From infancy, children learnt the directions of east and west from sunrise and sunset. From east and west, north and south can be determined.

Desert people draw these directions in sand diagrams like a compass rose or they indicate them by pointing with their hand or their head. Knowledge of where these directions lie is deeply intuitive.



Even in recent times, a student standing at one point may refer to their east hand and west hand rather than their right hand and left hand. Linguists have observed Aboriginal students describe the movement of a computer mouse by compass points rather than up and down.

Sunrise is generally east and sunset is generally west but not exactly. Because the Earth's axis is tilted, the angle of the Sun to a place on Earth (inclination) changes throughout the year as the Earth rotates around the Sun. This means that sunrise and sunset are not usually due (or 'true') west and due east. In Australia in winter, the Sun rises and sets north of east and west. In summer, it rises and sets south of east and west. People blended these observations with knowledge of the direction of a named place relative to another. They also used markers like single individual trees as 'sign posts' or specific piles of rocks to indicate direction and distance to a place.



The fall of shadows indicates the direction of the Sun. Look at the shadows extending from this tree a couple of hours after sunrise. Which way is east? Photo by David Broun, CSIRO.

Sunrise, sunset and compass points: Planning

Teachers and Aboriginal experts:

Discuss the best way to teach students about directions (east, west, north and south).

Teachers could ask Aboriginal experts questions like:

- Where is your country?
- What direction is it from school?
- How did older people teach younger people about directions on country?
- How did people know how to find their way from place to place?

Arrange for an Aboriginal expert to teach students about direction, and the names for east, west, north and south.

Activity 1: Compass points

Students learn the names of the compass points (east, west, north, south) from an Aboriginal expert.

Ask the students:

- How do you know which direction you are facing?
- What things around you tell you about direction?
- What tall straight things give you shadows to read? (e.g. people, trees, poles)
- What do shadows do during the day?

Listen for students talking about sunrise or shadow fall or orientation from a point or points they know to be in a certain direction (e.g. the shops are north of us).

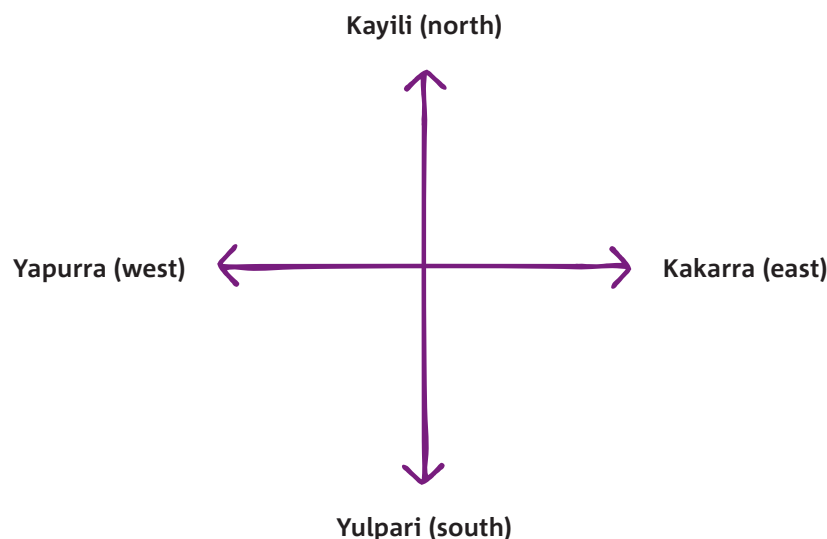
An Aboriginal expert explains the compass points in Language and how they know how to find them. This may be according to sunrise and sunset, or another method. This could happen in the classroom, schoolyard or on country.

Draw a compass rose on the ground with chalk or in the sand and mark with Language names.

Standing near the middle of the compass rose, talk about the things that can be seen in each direction (e.g. a classroom desk, the goal posts on the oval, the swings in the playground, the big gum tree).

Ask students to complete a compass rose in Language and Standard Australian English.

Attach labels to the walls or corners of the class that face in that direction.



Classroom direction photo.
Photo by David Broun, CSIRO.

Activity 2: Shadows and direction

In this activity students mark the shadows that fall from a pole at different times during the day. They learn about sunrise and sunset directions as a marker of east and west. This activity could be simplified for Early Years students. They can trace around their shadows on a large piece of paper in the morning, at midday and in the afternoon and look at how their shadow has moved and changed.

EQUIPMENT

- Stick to cast shadow. Stick is about 80–100 cm high and 3–5 cm diameter.
- A sandy or clear patch to dig the stick into and mark.
- Pointer or slimmer stick to mark the shadow fall or a large sheet of paper to draw it on.
- Three fixed points around the school.
- Compass (magnetic or mobile device).
- Compass rose worksheets.

To learn about sunrise and sunset directions:

- 1** Dig a tall very straight stick into a sand patch and stand it perfectly vertical.
- 2** Rake the sand clear so shadow lines from the stick can be marked.
- 3** Mark in the sand where the shadow of the stick falls at hourly or 2-hourly intervals during a day from the start of school to the end of school. Alternately lay a large piece of paper and mark the fall of the shadow and the time of day on it. Ensure a mark at midday when the Sun is overhead when the shadow is smallest.
- 4** At the end of the day ask students to predict the position of the shadow at sunrise and sunset.
- 5** Teacher can use a compass to check the directions of east and west and discuss how sunrise and sunset show east and west. Research directions for using a compass on the internet.

Note: Start and finish this activity as early and late in the day as possible to give the best indication of east and west. The teacher can make marks before or after school as necessary following student predictions. Note also that during winter the Sun is on an angle from the north; this will influence the angle of the shadow. Shadows will only fall directly east and west at the equinoxes (variable dates in March and September); however, the general direction will be indicated in this activity.

There are opportunities here to extend students and connect to Earth and Space Sciences curriculum outcomes relating to the solar system and astronomy.



This photo was taken at about 10 am in the morning.
Can you tell from the shadow which way is east? Photo by David Broun, CSIRO.

Activity 3: Estimating direction

Students play a game to practice estimating direction.

- 1 Make a large compass rose on cardboard with the four directions named in local languages and English. Take it outside.
- 2 Revisit the questions: Which way are you facing, how do you know? What direction is sunrise and sunset? You may ask older students: Is the Sun rising and setting further north now? Is the Sun rising and setting further south now?
- 3 Ask students to orient the compass rose according to their knowledge of direction.
- 4 Ask all of them to stand and close their eyes.
- 5 Teacher calls out one direction in Language and students turn to face that direction. Then they open their eyes. Those who are not facing most of their body in that direction sit down and the remainder continue with the remaining directions.

Note: A teacher can use a compass on their phone to check and fine tune the orientation of the compass rose.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about compass points and using the movement of the Sun and shadows to determine their bearings.	- F Daily and seasonal changes in our environment affect everyday life (ACSSU004). - Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y3 Earth's rotation on its axis causes regular changes, including night and day (ACSSU048). - Y5 The Earth is part of a system of planets orbiting around a star (the Sun) (ACSSU078).
Learning how the angle of the Sun changes with the seasons.	- Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y3 Earth's rotation on its axis causes regular changes, including night and day (ACSSU048). - Y5 The Earth is part of a system of planets orbiting around a star (the Sun) (ACSSU078).
ACTIVITY	SCIENCE UNDERSTANDING—PHYSICAL SCIENCES
Learning how the angle of the Sun changes with the seasons.	Y5 Light travels in straight paths; forms shadows and can be absorbed, reflected and refracted (ACSSU080).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning about compass points and using the movement of the Sun and shadows to determine their direction.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). - Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). - Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). - Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Using shadows to determine east and west.	Y1/2 Pose and respond to questions, and make predictions about familiar objects and events (ACSI024, ACSI037).

Unit 2: Maps and mapping

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn how maps are made and used. They visit an Aboriginal ranger group to learn how rangers use maps in their work. Students create a ground map of their school, community or nearby location.

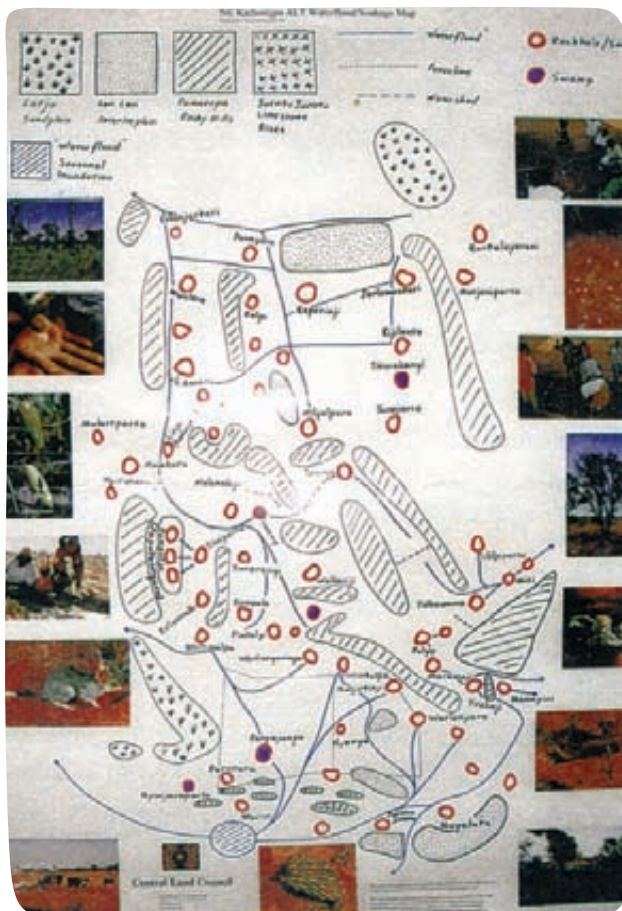
BACKGROUND

Country is fundamental to Aboriginal identity. So mapping of country is a critical element of knowledge maintenance and Aboriginal land care.

‘... waterholes, topographical features, cultural sites, historical events, family connections and language boundaries—the locations of all of these are critical to the application of strong cultural knowledge.’
—Kanyirninpa Jukurrpa website 2018

Aboriginal people make maps, use maps and work with maps. Rangers work with maps so they can know the lands for which they are responsible. They learn about places far from their homes where their parents or their grandparents camped and travelled.

Aboriginal people often use sand drawings to describe and map country. The location of places is often shown as circles. The lines between places may mark the routes that people travel between places or the routes of Dreaming lines between places. Sand drawing allows a speaker to quickly rub out, shift, adapt and change the map and the story that goes with it.



(above): Warlmanpa people made a map to teach their children about their country. The map started as a sand drawing and was transferred to paper. Then people made a map of a wider area using sand drawings again plus stones, sticks and moveable materials. This was again copied to paper. Traditional Owners then visited some of the sites and made GPS records of these places.

(left): The A0 sized final map was mounted in the community hall. It has been used to teach three generations of Warlmanpa people to know places on their country.

Photos from Walsh FJ and Mitchell P (2002).

Maps and mapping: Planning

Aboriginal people and teachers plan the unit together and arrange for a visit to a local ranger base.

Questions for Aboriginal experts:

- What maps did Aboriginal people have of their country in the old days?
- How did they make maps?
- How do local artists show country in paintings and artworks?
- What maps do Aboriginal people and Aboriginal rangers use nowadays? What do these maps show?
- What does the 'map in your head' look like for a place that is important to you? Can you draw it on paper?
- If we take the students to talk with the rangers and see the maps they use, what shall we look for?

Visit the local ranger base or Indigenous land management organisation. Discuss the unit with senior rangers and ranger coordinators and plan a visit to the ranger base to look at maps.



Martu organisation Kanyirninpa Jukurrpa has built a special spatial database of places and water holes. This includes exact or approximate locations and associated families, stories, management of the place and more. An extraordinary 1,500 sites are recorded in the database with more being added as trips happen. Photo from Kanyirninpa Jukurrpa.

Maps and mapping: Learning in class (preparation)

Activity 1: Making a ground map

In this activity, students make ground maps of places they know well, such as the school, town, community or places nearby. Although these places may be familiar, it is likely different students will identify different features and have quite different drawings.

Ground maps help people and students orientate themselves more easily than if drawing on a vertical surface such as a whiteboard or wall. Ground maps can be made with easy-to-find local materials that can be moved so students can discuss and work out what is where before 'fixing' it with pen or paper. Ground maps can also be made by drawing basic elements (roads, buildings, trees) in sand or dirt, or drawing with chalk on a canvas tarp or a concrete verandah.



Simon Cherriman, 'the Eagle Man', works with Wiluna Martu rangers and students to monitor Wedge-tailed Eagles and their nests. Here he draws a sand map to show nest locations within the Matuwa fenced area. Photo by David Broun, CSIRO.

Ground maps can be made as a cooperative activity. The map should be large enough for all students to see and add to. It might be 5 m by 5 m or more or less.

People 'see' areas in very different ways as influenced by their interests and life experience. One student might mark the trees they like to climb or sit in the shade of. Another student might mark the football ground. One student might mark the home of their grandmother. Another student might show where the cemetery is.

This activity would also be a good introduction for a teacher new to the region. So students can make the map to show the teacher the places where they live, walk and play.

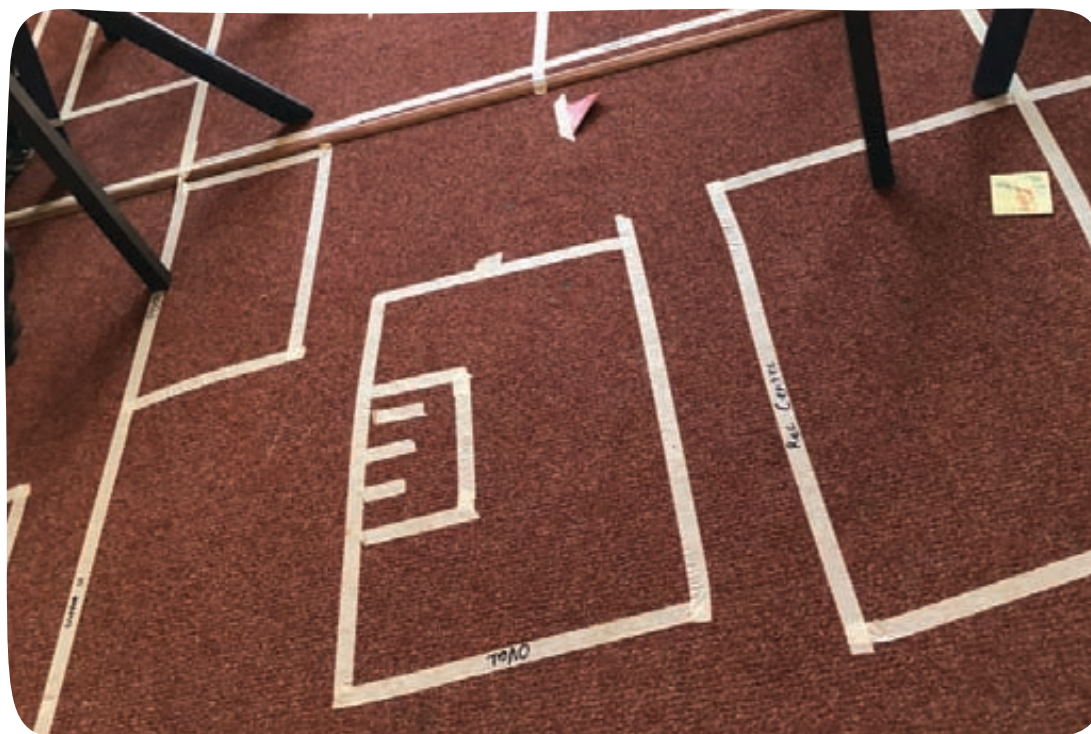
EQUIPMENT

- Bare clear area more than 5 m square. It could be a verandah or an area of sand. Rake the sand to make it level and clear.
- Stones or objects to mark the school building and houses.
- Rope, sticks, etc., that can be used to mark roads, rivers or creeks.
- Other moveable materials that can be used to represent certain features (e.g. plant parts).
- Masking tape and markers so that names can be put on moveable things.
- Buckets or tubs to hold the moveable objects.

Gather the moveable objects in buckets or tubs so they are near the map-making area. Students use moveable objects to make the ground map. The importance of moveable materials rather than writing direct on butcher's paper, etc., is that it allows the flexibility for things to be moved before they are fixed. Dimensions and relative locations can be adjusted as students develop the map's content and their understanding of the process of map-making.

PROCEDURE

1. Clear and rake a large bare area of ground at least 5 m square.
2. Ask students to work together in small groups of three or four people. This activity requires students to cooperate and it benefits from a local Aboriginal person guiding them. If there are two or three groups of students, that is OK as it will allow the groups to compare and contrast their maps with each other.
3. Ask students: 'You are going to make a map of your town with your school, your homes and other features—what things are important to you?' These things might be a playground, a camp, a tree, the footy oval, the store, your home, the school, the tracks you walk to and from school.
4. Discuss the direction for east and west (sunrise and sunset), north and south.
See the activities in the previous unit: 'Sunrise, sunset and compass points'.
5. Students could draw in sand first to rough out what they want to put on and where.
6. Use stones or similar moveable objects to mark the school, houses and other buildings.
7. Use rope or similar objects to mark roads or other features such as creeks and lakes.
8. As the numbers of objects grow, label and write names on labels to show what the object represents (this is helpful for late-comers or people not present as the map is made).
9. Expand the dimensions and adjust the placement of objects as students add more places further away.
10. When the activity is finished, have someone copy the map(s) to a large sheet of paper.
Older students could do this by a grid transfer drawing technique.
11. Photograph the whole map section by standing high over it on a chair.
12. Keep drawings and photos of maps as reference for classroom follow-up.
Also, the map may later be expanded to include places in the surrounding region, especially places that are not on conventional cartographic maps.



A ground map of Wiluna made over the classroom floor in masking tape. Students labelled the streets and places using markers on the tape, and Post-it Notes. Photo by David Broun, CSIRO.



Detail from a ground map showing a creek line with sandy soil washed from the rocks and a line of cypress pines growing along the creek banks. The creek flows from right to left. Students used samples of the actual plants and materials near to the site to make their map. Photo by David Broun, CSIRO.

Activity 2: Draw the ground map on paper

Use the photos and sketch of the ground map(s) made by the class to redraw it/them as a better map on paper. Keep this and attach it to the classroom wall. It is good if the top is north and it is attached to the north wall.

Discuss with students:

- Where were some of the places students thought were important?
- Do people 'see' an area in the same ways?
- How did the maps made or drawn by individuals compare to the maps made by the group?
- How big an area did the maps cover?
- Imagine you have a new visitor to your classroom and use the map to show them around your town. Where would you show them? What would you pass by on your tour of the town? Would it be different if you walked compared to if you drove in a car?

Activity 3: Maps of the community

Collect local maps of the school or community. Look at the community on Google Earth. Compare these with the students' map. What things are shown on the maps? What is the same? What is different?

Students should consider that people make maps for different reasons. People who make maps choose to show what is important to them. What is important is different for different people.



A student map of the community. Students designed this as a group. They added further pages as they redesigned the map and changed the scale, orientation and details of their town. Photo by David Broun, CSIRO.

Maps and mapping:

Visit Aboriginal rangers to learn about maps

BACKGROUND

Rangers use maps across many aspects of their work looking after country. They use maps to plan and review their land management activities. They have maps of: place names including wetlands and sacred waters; roads and tracks so they can plan travel routes; satellite maps that show landforms; fire maps that show burn patterns; maps of where threatened species are found and more. Sometimes rangers drive for days on their lands. They blend modern maps with their memories of country from the ground level. Sites on Aboriginal lands are mapped by Indigenous ranger groups and other organisations.

The knowledge of rangers and the memories of Elders are complemented by these maps. Wall-sized maps are made for ranger stations in some communities. This allows rangers to learn about their region and plan land management activities using it.

Maps are a good topic to link Aboriginal rangers and school students. Most ranger offices have a good variety of paper maps and electronic maps. Rangers can also draw maps in sand and sketch maps on paper or whiteboards.

Before the visit to see the rangers and their office, ask students:

- What maps are used by rangers? What do these maps show the rangers?
- Why do the rangers use maps? (e.g. to know distant places, to show the way there, to plan land management activities such as controlled burns)
- How do rangers make maps?
- To the students—where is the country of your mother? Your father? Each of your grandparents? Will you see their places on maps used by the rangers? What other maps show their places?

EQUIPMENT

- Take a camera to photograph the maps or mapping equipment that the rangers show the students. This can be used for follow up in class.
- Take any equipment that students have been using such as a compass, and any maps the students have made to show the rangers.
- Students should also take their Two-way Science journal to record important information.

AT THE RANGER OFFICE OR BASE

The rangers will lead the visit to their base and decide how they present information. Here are some questions and activities that will help students to maximise learning during the visit:

- Ask rangers to show students the different maps they use to know and manage their country. The media of these maps might be large paintings by senior people, large printed wall maps, paper maps, Google Earth maps, and other sort of maps. The content of these maps might include: story and songlines, sites and important places, settlements, roads, fire or burn history, satellite images, vegetation types, locations of rare and threatened species, etc.
- Encourage the rangers to take maps off the wall and put the maps horizontal on the floor or a table if possible (this has two purposes—so the map can be moved to orientate it and so students can look down on it like one looks down on country).
- Ask the students: Which way is Kakarra (east or sunrise side)? Ask about other compass points.
- Ask the students or rangers to rotate the maps so that the top of the map is to the north.
- Ask the rangers: Which maps do they like the best? Why? Which maps do you use the most in your work? For what?

- Ask the rangers to explain what is on some of the maps. How are the maps different? How do you 'read' the maps? What helps make it easier to 'read' the maps (e.g. if you've visited the places on the ground? If you've flown over them? If you've seen artworks of them?). What do the symbols and codes on the different maps mean?
- Ask the students: Are there any places on the map that you have been to, that you have heard about? Invite students to point to those places and trace the journey with a finger.
- Ask the students: Where is your family's country? Where is your mother's country? Where is your father's country? etc.
- Ask the rangers: For some students here, where do their families come from? Where is your grandfather's country? Where was grandmother's country? etc.
- Ask the rangers: How were these maps made? Do you do any mapping as part of your ranger work? How?
- Ask the students: What sort of maps would you like to make? What country or areas would you show on them?
- Ask the rangers: Can we go on a trip to find places, make a map or add to your maps? How will we do this trip? Where can we go?

Plan a Learning on Country activity with the rangers (see 'Unit 3: Mapping country').

Maps and mapping: Learning in class (follow-up)

Activity 4: Reflect and recount

Look at photos from the visit to the rangers and their different maps.

Recount the visit and discuss student learning:

- What maps were used by rangers?
- What did these maps show the rangers?
- How do rangers make maps?
- Take a photocopy of a map of the region. Students can:
 - mark the country area of their mother/father/each grandparent, etc.
 - mark on it places that they have been to and places that they know about.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Making a map of the community and surrounding country that shows where different animals/plants can be found.	- F Living things have basic needs, including food and water (ACSSU002). - Y1 Living things live in different places where their needs are met (ACSSU211). - Y4 Living things depend on each other and the environment to survive (ACSSU073). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—EARTH AND SPACE SCIENCES
Making a map of the surrounding country and identifying various landforms and features.	- Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y4 Earth's surface changes over time as a result of natural processes and human activity (ACSSU075). - Y6 Sudden geological changes and extreme weather conditions can affect Earth's surface (ACSSU096).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Visiting rangers to learn about how maps are used to look after country, e.g. they may show areas that have a particular habitat where threatened species live.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). - Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). - Y3/4 Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062). - Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Discussing with rangers about how using maps is important for managing country.	- F Engage in discussions about observations and represent ideas (AC SIS233). - Y1/2 Pose and respond to questions, and make predictions about familiar objects and events (AC SIS024, AC SIS037).

Unit 3: Mapping country

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students, teachers, rangers and Aboriginal experts plan a journey for a day or overnight. They map the expected journey to show sites and things likely to be seen along the way.

This unit is designed to be used with Unit 2 'Maps and mapping' in sequential order so that students develop mapping knowledge and skills to apply on country. Students visit country identified by local Aboriginal rangers, Traditional Owners or Aboriginal people working for other land management organisations.

BACKGROUND

'We are teaching all our children about their country. They see and learn about all the waterholes. They are seeing and knowing their grandmothers' and grandfathers' country ... Children will see and know their country forever. They will know their own country. Our old people have all gone now. My words are for the children. Their country is the right school for the children.'

—Muuki Taylor, Chairman, Kanyirninpa Jukurrpa KJ Annual Report 2015–16

Mapping is a useful way to have an introduction to a place before you go. Nowadays, maps are essential tools to help navigate to places. But, as Muuki says above, the best way to learn about the spatial relation between places is to travel and visit them in a vehicle, then on foot with Elders, experts, rangers and others.

Aboriginal ranger groups, cultural heritage programs and Aboriginal art centres have 'return to country' programs that support people to visit distant places in their lands and re-engage with country. These are family pilgrimages to sacred places. Ranger groups drive or walk along lines of sites, visit and record stories about the sites and a few do helicopter mapping of distant sites. In recording stories, layers of different types of knowledge are built up and integrated. Many Aboriginal people say that to travel to sites and know the stories of those places is the most important part of Aboriginal ranger programs. (Text adapted from the Kanyirninpa Jukurrpa website 2019.)



Martu locate and record important waterholes using maps. Photos from Kanyirninpa Jukurrpa.

(opposite): Students created a map of a creek system after visiting the site and under instruction from Elders. They included landmarks, important sites and information about the movement of people in the old days. Photo by David Broun, CSIRO.



Mapping country: Planning

Planning for this unit should be done with the consent and involvement of Traditional Owners of the country to be visited and mapped.

Traditional Owners, Aboriginal experts and teachers plan the unit together:

- Select a destination or destinations and journey routes for a trip.
- Discuss the route to be travelled. It is common for Aboriginal people to take different routes to and from a location. This is advantageous as people can monitor and potentially collect resources from a larger area. Also, it would be excellent if there were some relation between two sites on the trip, e.g. two places in a songline, or an old homestead and outstation camp, or two waterholes on the same drainage system.
- Identify some of the significant features students are likely to see on the way to and from the selected sites.
- Look together at Google Earth images of the route and places.

Mapping country: Learning in class (preparation)

Activity 1: Introduction to mapping country

Aboriginal expert:

- Talk to students about the trip to map country and introduce or consolidate Aboriginal Language names for different places along the way.
- Look at ranger maps of the country and point out features on the maps.

Teacher:

- Focus the Learning on Country.
 - Connect to students prior knowledge of the places on the field trip:
 - What places will we visit?
 - Have you been to these places before?
 - What will we find there?
 - What will we see on the way?
- Prepare equipment and go through the field trip plan.
- Introduce the task—you are making a map of the country that we visit. Learn from Aboriginal experts about the important places and where they fit on the map.

With Traditional Owners, Aboriginal experts and/or teachers, look at Google Earth showing the places to be mapped. Identify landmarks, places and the route to be taken.

Activity 2: Sketch map

Students do a sketch map of the things and places they expect to see on that journey. What will be where? At the beginning, it is possible and reasonable that students might only have one or two points—the school where they are now and the main place to which they're headed. This map will be a useful base to compare what they've learnt after the trip. They might take their map with them, a notebook or journal, or remember places then draw from memory when back in the classroom.



A Martu boy shows a map of the route they travelled to a named place on a trip with KJ Rangers. Photo from Kanyirninpa Jukurrpa.



Look carefully for things to put on your map, e.g. crossroads, hills, large trees, rocks, broken down motor car, Mulga trees. Write down Language names. Make a note in your journal or take a picture to remember for later.

Sketch a map in the sand and take a photo.



Mapping country: Learning on Country

1. **Learn about mapping country from an Aboriginal expert.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
2. **Students make a map of the country visited.**
3. **Collect information you need for the map—take notes, photos, climb to a high point and draw in your journal.**

Equipment

Large paper maps of the place or area to be visited, cameras/iPads, Two-way Science journal, pencils/clipboards, compasses.

Top photos and bottom right photo by David Broun, CSIRO.
Bottom left photo from Kanyirninpa Jukurrpa.



Look on a map at different places—where do you think we are?

Collect materials that relate to the place to incorporate into a map.



Mapping country: Learning in class (follow-up)

Reflect, recount and write.

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in English and Language to the class word wall.

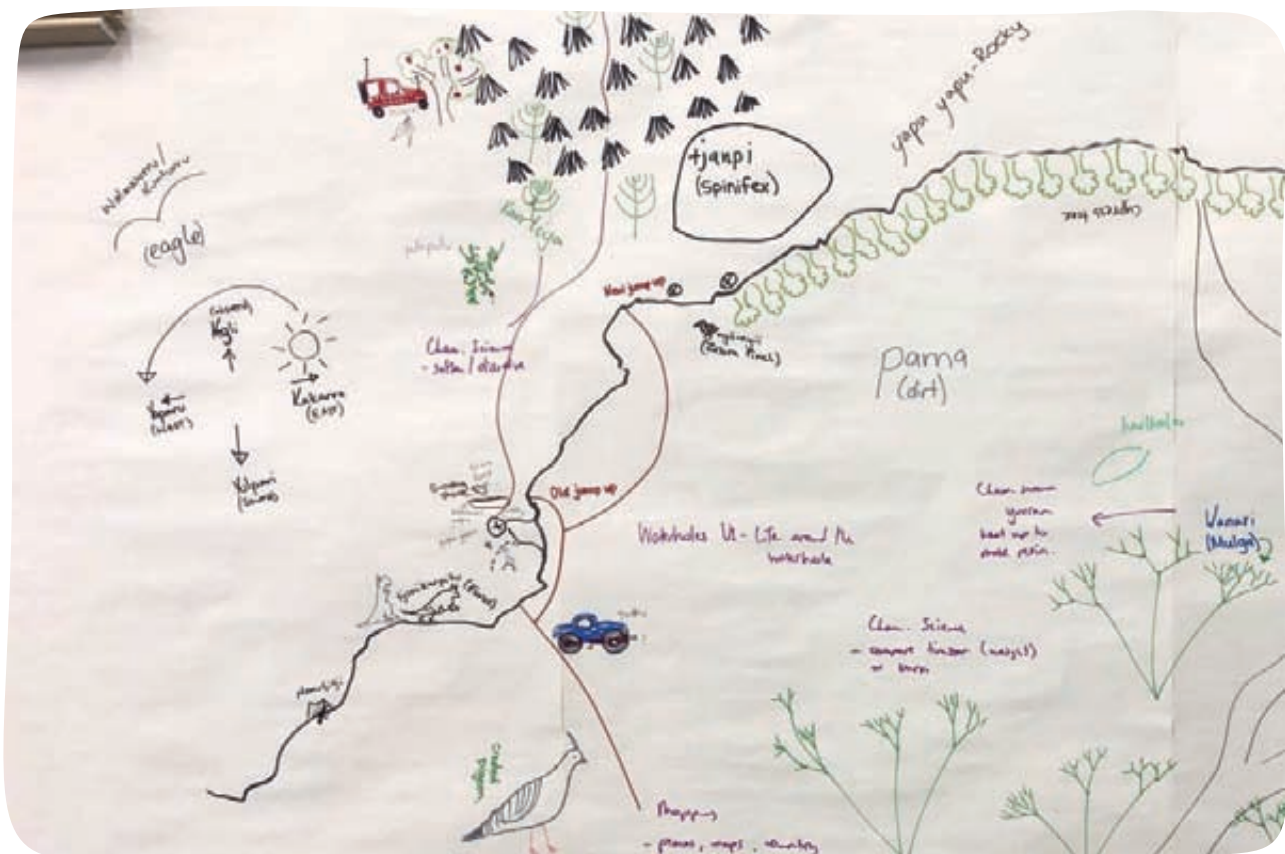
Activity 3: Make a map of country

Back in the classroom students make their map of the journey and the sites they visited.

Give them options for different media to make the map in:

- a ground map with similar materials done for school and the town—see ‘Unit 2: Maps and mapping, Activity 1: Making a ground map’
- a sand map that can be photographed or recorded
- a paper map in pencil, textas or other media.

Also give options for the content of the map. Students may choose to focus on particular things. They could also create the map in pairs or small groups. Note that this map can be used as a starting point for further work in the following unit on landforms.



This map of country was created by teachers during a Two-way Science workshop featuring this activity. It has ideas for follow up activities with students from these resources added in purple. Photo by David Broun, CSIRO.

Activity 4: Reflect and share maps

Look at other maps of your school's region, the state and Australia as a nation including the AIATSIS map of Indigenous Languages and the Tindale map of tribal boundaries.

Ask students:

- Where are you on these maps?
- Where does the student's map fit on the larger maps?

This gradually introduces maths concepts of scale and ratio (i.e. representation of one unit of measure for another unit of measure like 1 cm–10 km and what proportion relative to what, e.g. 1:10 ratio).

When the maps are completed, invite students to explain their map and then compare and contrast the content of maps from different students.

Share the maps with the rangers that took students on country.



A motorbike becoming part of a termite mound makes a striking landmark near Strelley Community. Photo by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Making a map showing the plants and animals that grow in different areas.	- Y1 Living things live in different places where their needs are met (ACSSU211). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—EARTH AND SPACE SCIENCES
Making a map including landmarks such as trees, creeks, etc.	- Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y4 Earth's surface changes over time as a result of natural processes and human activity (ACSSU075). - Y6 Sudden geological changes and extreme weather conditions can affect Earth's surface (ACSSU096).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Discussing the features of the class map and the relationships between the features.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). - Y3/4 Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062).
ACTIVITY	SCIENCE INQUIRY SKILLS
Analysing, discussing and comparing each students' map.	- F Pose and respond to questions about familiar objects and events (AC SIS014). - Y1/2 Compare observations with those of others (AC SIS213, AC SIS041).

(opposite): This illustration shows Martu names for different landforms associated with salt lakes (from Hill and Turk 2016, p. 7).

Unit 4: Landforms and country types

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn about landforms and the different types of country from Aboriginal experts. They learn the names for different landforms, about the flow of water and the way different types of country are used or are important to Aboriginal people. They create a map or diagram showing the different types of country.

BACKGROUND

There are waterholes, wetlands and named places within country. Within and between these wetlands there are other landforms. Landforms are natural features of the Earth's surface such as hills, plains, mountains and rivers. The types of landforms are named and classified by Aboriginal people and by scientists. There are differences and similarities in the ways each group classifies landforms. The naming, mapping and descriptions of land types and land units is part of the study of Australian geography. Scientists have made maps and diagrams of landforms near many desert communities.

For Aboriginal people, one purpose in naming landforms was to describe the habitats where bush foods and other resources could be found. For example, the Tjul tjul (dense Mulga shrublands) are where Marlu (Red Kangaroo) can be found as they prefer shade and shelter there. They feed on the grassy open plains nearby. Or another example is—on the slopes and crests of some sand dunes grows the Malkapuru or Jakapiri (Green Bird Plant) used to make bush sandals. Another purpose in naming land types was to help locate places and describe travel routes.

1 **warla:** salt lake

2 **yinta:** permanent water source

3 **tamun:** mound

4 **linyji:** claypan

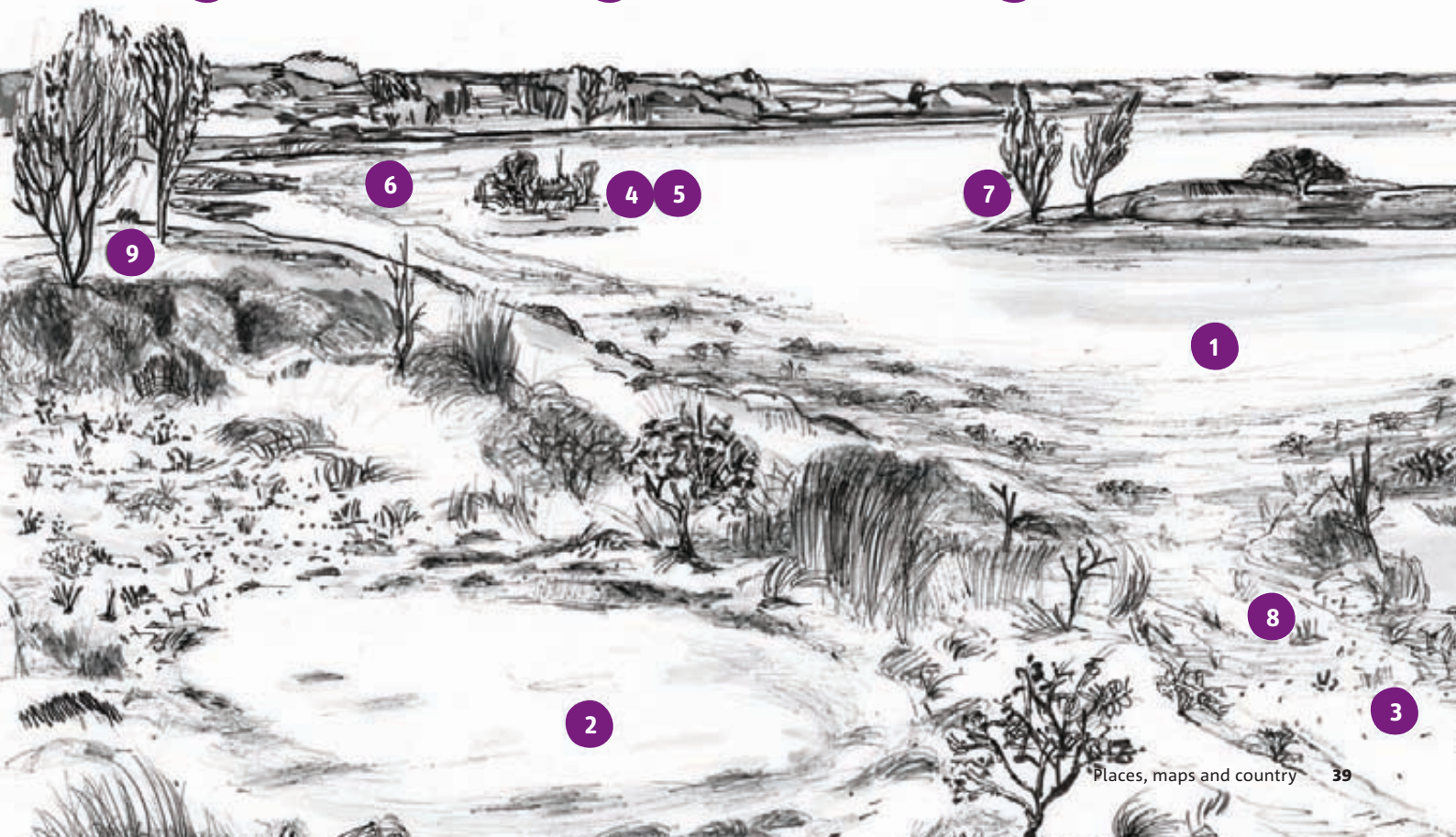
5 **jilyin:** overflowing water

6 **takarru:** depression

7 **warli:** gully

8 **jijimarra:** flood area

9 **yintiri:** sandridge



Aboriginal artists paint landforms in many ways. As they do these paintings they often think of the form of the country in relation to the places they paint. Consider the following images: a painting and satellite image of overlapping areas. The painting is closer to the ground or finer scale than the satellite photo. In both you can see the same landforms including the salt lake (white), the long straight lines of sand dunes in the east side, the plains between the dunes (green in the painting). Muni's painting shows the blue round circles of water or jurnu (soaks) that can be found in the surface of the salt lake by Punmu. Students could look at different Aboriginal art to interpret the landforms that artists have painted.



(above): Painting by artist: Rita Simpson (Muni); birthplace: Jupunkinja, Percival lakes region; Language: Manyjilyjarra; title: *Rawa* (with body paint design), 2008. This painting shows sites on Lake Dora, which include Rawa and Wilara. Lake Dora is a site of great ancestral significance, and many Dreaming stories converge here. The Jila Kujarra, or Two Snakes, travelled through Rawa, and Wilara is the site of a number of small mineral springs in the bed of the salt lake. The springs have healing properties, and are still used today. Wilara is the Martu name for the Moon, who laid down here and created the largest of the springs. Around him slept his dogs, who dug sleeping hollows and created the smaller springs. Mahood K (2012) in Bennion I 'We Don't Need a Map Education Resource' Art on the Move.

(bottom): A satellite photo of the area shown in the painting *Muni* by Rita Simpson above (Google Earth 2019).

For students, the early steps in learning about landforms is to think of water and especially water flow. Where does water flow from? Where does water flow to? Water flows from higher ground to lower ground. That is, it flows from ranges, hills and rises, to creeks, rivers and lakes.

Looking from above on a hill top or on Google Earth, you can tell upstream from downstream by the joining of creeks and rivers—the wider end of the join is always upstream, e.g. imagine a cutlery fork: the prongs are the streams who join the tang or handle, which is like the river. Also, looking on the ground, the piles of debris against a tree tell you about direction of water flow. The piled up side of the tree is upstream and the emptier side is down stream.



(above left): This shows people sitting at a jurnu or soak near Rawa, which features in the painting opposite by Rita Simpson.

(above right and bottom): Yintiri is a Martu word for sand dunes. They are also known as tali and tuwa in other Martu dialects. (from *Manyjilyjarra—English Pictorial Dictionary of Landscape Terms*, Hill and Turk 2016, p. 27).

Landforms and country types: Planning

Traditional Owner, Aboriginal experts and teacher:

Discuss planning another trip on country so students can learn about the different landforms or types of country, how people use them and what species they collect from them. The Traditional Owner or Aboriginal expert should select a destination or destinations and journey routes for a trip.

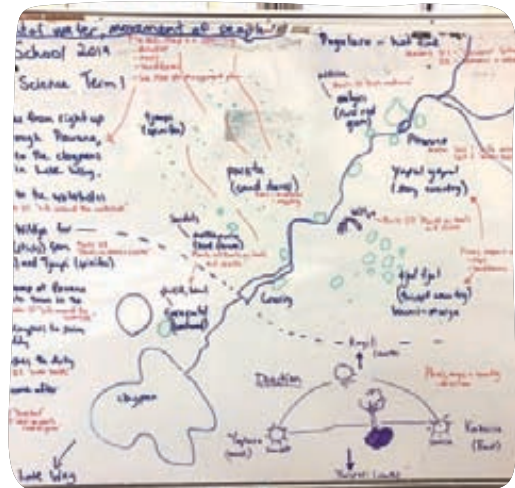
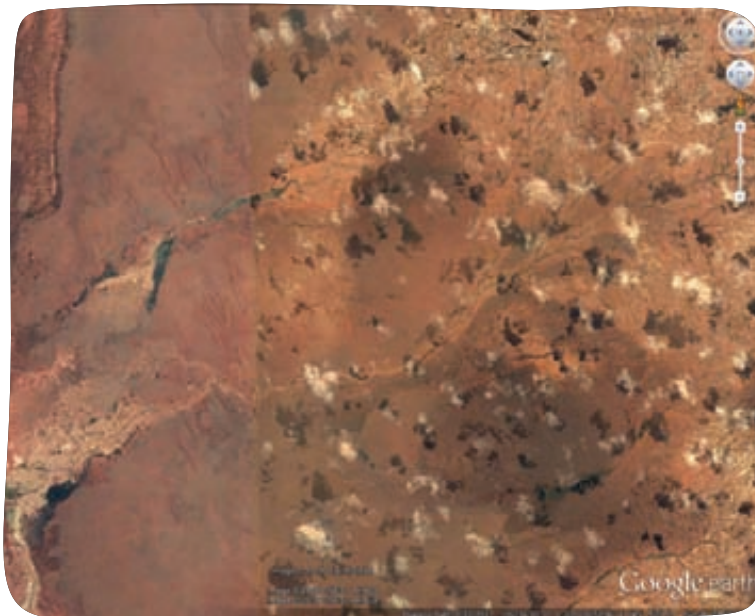
It is common for Aboriginal people to take different routes to and from a location. This allows people to monitor and collect resources from a larger area. For the Learning on Country trip, it would be good if there was a watercourse to follow and it is often easier to travel the same direction as the water, from upstream to downstream. Remember that the flow of water in desert regions is very subtle and more obvious to people who've lived there a long time than to visitors.

Look at a Google Earth image of the country and identify some of the landform types students are likely to see when travelling to and from the selected sites.

Discuss the following questions:

- What are the local names of those landform types?
- How did people use them in the past?
- How do people use them now?
- How did people travel through the country?

Choose a route for a journey with sites along the way. The journey could be to the same places visited in the previous activity or it could be somewhere else that is familiar or it could be to a new place.



(left): A satellite image of a creekline near Wiluna in Western Australia. Wiluna Martu took teachers on a trip through this country during a Two-way Science workshop. The map on the whiteboard below was used to connect learning activities and Two-way Science education resources to Martu knowledge using the theme 'Movement of water, movement of people'.

(right): Photo by David Broun, CSIRO.

Landforms and country types: Learning in class (preparation)

Activity 1: Introduction to landforms and country types

Aboriginal knowledge expert: talk to students about the trip to look at different types of country and introduce or consolidate Aboriginal Language.

Teacher and Aboriginal Education Worker and/or Aboriginal expert:

- Focus the Learning on Country.
 - Connect to students prior knowledge of the country types. Look at photographs of different country and landforms. These might be photos taken on a different Learning on Country trip.
 - What places will we visit?
 - Have you been to this type of country before?
 - What plants grow there?
 - What animals live there?
 - How do people use this type of country now or in the old days?
- Introduce the task—you are making a map to show the different types of country.
- Learn from Elders the names of the different types of country, what plants and animals live there, how people used them in the past and how people use them now.

Activity 2: Satellite images of country types

On Google Earth, look at the likely route of the journey and mark or trace the road to the place(s) to be visited. Discuss what features students recognise on Google Earth or a map.

Discuss with students:

- Is the land all the same? How does it change?
- Is the land flat?
- Are there hills? Where?
- Are there rivers or creeks? Where?
- What connects the plains, hills and creeks?
- Where does the water flow from?
- Where does the water flow to?
- How do you tell upstream from downstream in a creek or river?
- What are the different country types near the place we are going to?

From Google Earth, make A3 print outs of satellite images of the area to be visited for each student. Slip them into sheet protectors. Students can mark some important features that they already know on their satellite image. These will be used on country.

Prepare equipment and go through the field trip plan.



What landmarks and landscape features can you see?

Find them on the map and learn their names.

What different types of country do you see (Mulga plains, spinifex sandplains, sand dunes, salt lakes, pebbly ground, etc)?

Find them on your map and learn their names.



Landforms and country types: Learning on Country

1. **Learn about different types of country from an Aboriginal expert.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
2. **Travel through country, get out and walk around in different places.**
3. **Ask students to look carefully and describe what they see as different landforms.**
4. **Students find and mark the location and country type on the satellite image.**
5. **Take photos of the different types of country to take back to class.**

Equipment

Printed Google Earth map in sleeves, clipboards, large paper maps of the area, cameras/iPads, Two-way Science Journal, compasses.

Top photos and bottom left photo by David Broun, CSIRO.
Bottom right photo by Fiona Walsh.



Look for the highest points (hill tops). Look for the lowest points (river or creek beds). Imagine water is flowing from the high points to the low points. Where do the creeks flow? *Look for the lines of trees that show creeks. Find them on your map and learn their names.*

What are the Language names for the different types of country? What bush foods and medicines grow there? What animals live there?



Landforms and country types: Learning in class (follow-up)

Reflect, recount and write.

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in English and Language to the class word wall.



Landforms and vegetation described by Martu students at Rawa school.
Photo by Chris Deslandes, CSIRO.

Activity 3: Draw or paint a country type

Students draw or paint pictures of what they saw, including country types, and then write a sentence to go with their picture.

Activity 4: Label landforms on a map

- 1 Use a projector to project onto a wall the image of the satellite image used on the field trip.
- 2 Recount students learning and write down the names of country types, land features, places and what students learnt about them.
- 3 Students use a fresh copy of the map to label the features identified on the trip using the words and terms they have provided.

Activity 5: Making a class scale map of the landforms

- 1 Cut the Google Earth satellite image into a grid (e.g. eight squares).
- 2 Use a grid transfer technique on eight blank A3 paper sheets. The students or teacher 'transfer' or copy from the satellite image to blank paper the road route taken, other roads, creeks, wetlands, hills on the image and 'scale them up' as they go.
- 3 Each student then works on one square. They interpret and transfer what they can see on the satellite image.

Ask them about the features they are drawing. They can also add what they saw as they travelled. They can add to the road route taken and other features they saw on the drive or walk. Some students might choose to draw from different angles rather than just aerial views looking downwards.



(left): This image from Leonora District High School shows two printed satellite images with a grid drawn on them (top centre). One copy has been cut into eight squares mounted on orange cards ready to transfer. There is also a practise grid transfer activity featuring a picture of a horse. Photo by Wayne Jones.



(right): Students transferred the features from the smaller satellite images to a larger square sheet of paper, then painted the different landforms using watercolour paints. The grid lines are visible on the larger sheets. This activity introduces concepts of landform type and map scales. Photo by Wayne Jones.

Activity 6: Make a school map of the region

Students work together with the school, Traditional Owners, rangers and the wider community to create a large-scale map of the region incorporating their Two-way Science learning in the ‘Places, maps and country’ topic and other topics that follow. This should have a strong cultural focus showing places, landforms and features identified by Traditional Owners that are important to local people. It should feature local Aboriginal Language and iconography. It can be a collaborative work made with the support of a range of local community members, artists, scientists or others relevant to the school.

Imagine a map of your school within its wider region as seen from Aboriginal perspectives. What would this map look like? Start with a broad framework or outline of the landscape and features. Students and collaborators can fill in detail over time as their learning grows. The case studies from Mulan in Western Australia and Ti Tree in the Northern Territory give examples where Aboriginal staff, teachers, students and helpers have made maps of important places in their region.

Case study: Map making at Mulan School



An art and mapping project with students from John Pujangka-Piyirn Catholic School in Mulan community. Photo by Kim Mahood.

The local lake system was projected onto 48 small canvas boards and the template painted by local artists Veronica Lulu and Shirley Yoomarie with Kim Mahood. The boards were laid out for students and two rangers, Hansen Pye and Chamia Samuels, identified the plants and animals associated with each area. The boards were allocated to individual children and painted over several weeks with the support of the community.



(top left): Jamie Brown, Senior Ranger, working with school children, 2011. Photo by David Leece.

(top right): Mulan school children with the finished map, 2012. Photo by Kim Mahood.

(bottom): Hansen Pye and Kim Mahood working on a map with Mulan school children, 2011. Photo by Mandy Martin.

(opposite): Part of the Anmatyerr Ti Tree school map. Photo by Margaret Carew/Centre for Aboriginal Languages and Linguistics.

(opposite inset): Teacher April Campbell, Ti Tree school. Photo by Margaret Carew/Centre for Aboriginal Language and Linguistics.



Case study: April Pengart Campbell talks about making the Ti Tree school map

For almost 30 years, April Pengart Campbell has been a teacher at Ti Tree school north of Alice Springs. She thinks murals are good ways to share information about their country with school students and also to show visitors. Here, she describes how a map can be used for science activities too.

'We did a big map. I drew waters, lakes, wrote the countries, foot prints, people hunting. I did it on map. Maggie (the mural artist) made a grid and set it out. We painted the map big taller than a person (about 2 m by 4 m). It is on the verandah in the shade and safe away from rain and sprinkler water. We made it about 2010 or after.

Kids look at the map when playing on the veranda. Land and culture teaches them about their Dreamings. We take the kids to the big map. We tell them where their dreaming lines go. We show and say to them their skin names and the places where they are connected too.

We use the map to take class photos of the students. Each year they stand in front of it for the school book. The students look at the big map. From it, the students, teachers and I make ground maps. On the ground maps we use coloured sand. And we label places with pop sticks. We make ground maps from the wall map.

We use the big map for maths. Like we make a graph of the area covered by hills and creeks. We use the map for science like looking at the areas where we find bush foods. Different bush foods they grow in different places. We use the map to connect to science about Emus or Witchetty grubs like where do these animals live, their homes and where they travel. We use the map to teach about directions and seasons.

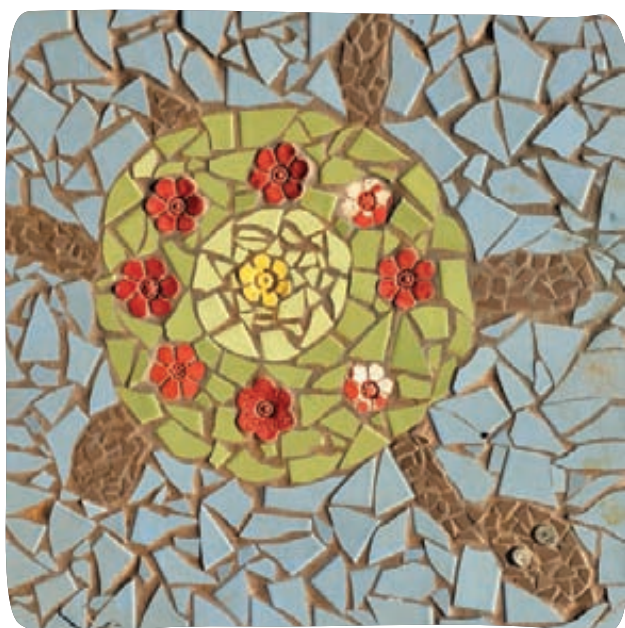
We use the map so the students know their kinship, dances and songs. I'm using the map so kids know where they come from. The places that skin name and family connect too. I tell them what the dances for those places are and what the body painting designs are. They must learn these things.

We show the map to our visitors and new teachers. We have students from sisters schools. They learned from the map. We use the map to organise trips to places in our country to show everyone where we're going. To show everyone where we went. We use the map to talk about country, places and kinship.

You, other teachers and visitors are welcome to come to Ti Tree to see our map.'

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Making a map showing the plants and animals that grow in different areas.	- Y1 Living things live in different places where their needs are met (ACSSU211). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—EARTH AND SPACE SCIENCES
Making a map showing landforms and their features.	- Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y4 Earth's surface changes over time as a result of natural processes and human activity (ACSSU075). - Y6 Sudden geological changes and extreme weather conditions can affect Earth's surface (ACSSU096).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Making a map with Elders showing various landforms, their features and how the areas are used by Aboriginal people.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). - Y3/4 Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062). - Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).



Turtle. Mosaics from Wiluna Remote Community School.

(opposite): Photo by David Broun, CSIRO.

Water



Background

'This rockhole we gotta look after it. Animals like the kangaroo or the camel might get into it and make it bad for drinking'.

— *Lena Long, Wiluna Western Australia*

Waterholes, rockholes, rivers, lakes, claypans, wetlands, soaks and springs have special significance to Aboriginal people. They have been used for thousands of years as an essential source of life-sustaining water in arid Australia and continue to be of sacred importance. Waterholes are named, and connected to stories that are passed on to children and grandchildren. Aboriginal ranger teams visit water places to monitor them, clean them out when needed and share stories with the younger generation. Aboriginal families often visit wetlands for weekends, special occasions, cultural responsibilities, and other reasons.

Water sources also support a variety of plants and animals which rely on water for survival. Animals concentrate around waterholes in times of low rainfall. Plants and animals around water are sources of food and medicine for people.

Today many water places are being damaged by feral plants and animals. For instance, camels can drink

an entire waterhole and foul the water; and Buffel Grass (introduced as stock feed from Africa) can outcompete native plants growing near waterholes.

The term 'water' for this unit of work includes waterholes, rockholes, rivers, lakes, wetlands, soaks and springs. For simplicity, we will often use the term 'waterhole' but the content applies equally to all the different water sources. Aboriginal people have local Language names for the different types of water places.

The cultural significance of waterholes mean that there are important protocols for visiting these sites. As wetlands were critical to desert survival, areas near them were kept very clean with no camping or discard of waste nearby. Many desert Aboriginal people see wetlands and waterholes as living waters where spirit or ancestral beings live. Some of these beings are giant snakes, others are animals or people. They are powerful beings so visitors have to approach them quietly and with respect to stay safe. People visit waterholes carefully as others might visit a church, mosque or other place of worship. Teachers should always consult with Aboriginal peoples about cultural protocols when planning activities in this unit.





(clockwise from top left): A young woman wets her hair as a cultural protocol when visiting a waterhole (photo by Fiona Walsh). Approaching a waterhole in single file (photo by Fiona Walsh). Wirlarra near Punmu, Martu Country, East Pilbara (photo by David Broun, CSIRO). Ephemeral lake, Martu Country, East Pilbara (photo by David Broun, CSIRO). Coolbro Creek, Martu Country, East Pilbara (photo by David Broun, CSIRO).

(opposite): Parnngurr Rockhole, Martu Country, East Pilbara (photo by David Broun, CSIRO).

Unit 1: Life around the waterhole

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

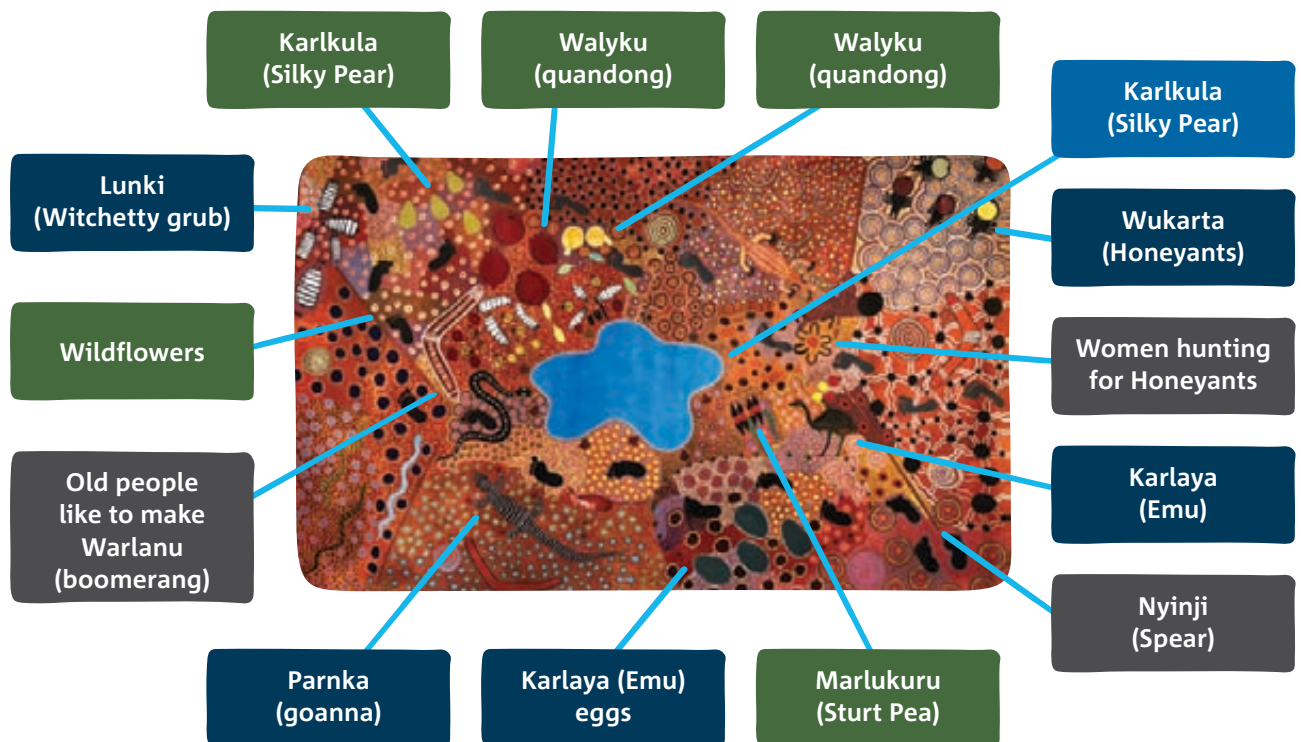
This unit outlines several activities for investigation of life around a waterhole. The unit can be done in sequence, or activities can be selected in response to seasonal conditions (e.g. Activity 10: Frog life cycle). These activities can connect to activities in other topics based on the interests of students or other Aboriginal people from the community. Read the activities and background knowledge. Talk through these activities with local Aboriginal people to see what suits the local area, season and levels of students.



Look at these images taken around Malcolm Dam in Leonora during a 'Life around the waterhole' activity. What do they tell you about the way that people and animals use this place now and in the past?

In this integrated activity Aboriginal experts lead a field trip to a waterhole and help students to identify animal tracks, birds, plants and artefacts that were used in the old days. This information is used to create a painting using traditional images and symbols. Recording student observations and learning in this way facilitates the intergenerational transfer of knowledge and is also a cultural way of recording data and communicating information with direct connection to science inquiry skills from the Australian Curriculum. This activity is designed as an introduction to waterholes and is suitable for all year levels. The learning here can be a springboard for other activities in the topic of 'Water'; it can also connect to other activities from Animals, Plants, and Seasons, weather and astronomy.

'Everything on the painting is a picture of what was at Ullala, everything the old people done in Ullala. Painters had the idea to put it all together in one painting.'
 —Martu Elder Rita Cutter



Painting *Wati Kutjara* by Wiluna Artists, Tjukurba Gallery. Included in this painting are the way people use Ullala rockhole and the plants and animals found there. Ullala is a series of deep depressions in a rocky outcrop. A painting can be used by Aboriginal experts and students to record their learning during this activity using symbols to represent people, activities, plants and tracks.



Ullala Rockhole near Wiluna. A meeting place for people in the past and today. Photo by David Broun, CSIRO.

(opposite): Photos by David Broun, CSIRO.

Life around the waterhole: Planning

Aboriginal experts and teachers plan the unit together and arrange for a Learning on Country field trip to a waterhole.

Questions for Aboriginal experts:

- Who are the artists in the community that paint waterholes, plants and animals?
- Which waterhole(s)/river/lake/wetland should students visit?
- Who is allowed to visit the waterhole?
- What should students learn about this waterhole?
- Who is the best person to take the students?
- Is there always water here?
- What plants and animals use the waterhole?
- What happens at the waterhole at this time of the year?
- How did people use the waterhole in the old days?

Life around the waterhole: Learning in class (preparation)

Activity 1: Introduction: What do we know about water?

This activity introduces students to the theme of water. Students explore their own knowledge of water and how it is used around the community.

Ask students about the water they use at home and at school.

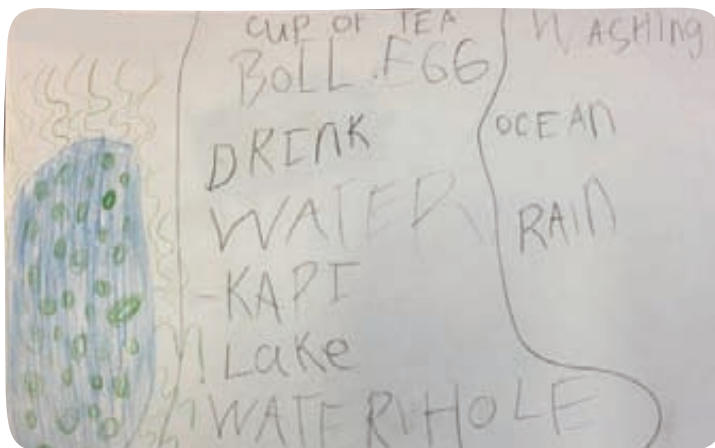
- What is this water used for?
- Where does the water come from?

Ask students to think about places on country where you find water.

- What relies on this water to live?
- What do you think we will find when we visit a waterhole?

Brainstorm student responses and develop questions that can be followed up in water related activities later on. Early Years students could record this in a large class Two-way Science Journal.

Add any words in Standard Australian English and local Language to the class word wall.



Student brainstorm about water. On the left is a waterhole. Photo by Chris Deslandes, CSIRO.

Activity 2: Look at paintings featuring waterholes

If possible, arrange a trip to visit an artist in the community at the local art centre, painting shed or gallery to look at examples of paintings of waterholes and the symbols used to represent people, plants and animals.

Take photographs of the painting that show images and symbols that the students can use in their own paintings.



(left): Student showing goanna tracks in a painting. Photo by David Broun, CSIRO. Images of artworks appear courtesy of Tjukurba Gallery, Wiluna, WA.

(right): Goanna tracks leading to a waterhole. Photo by David Broun, CSIRO.

Activity 3: Prepare for Learning on Country

Aboriginal expert:

- Talk to students about the animals that visit the waterhole and the plants that grow there.
- Show students an example of a painting featuring a waterhole and symbols for plants, animals and/or people.
- Tell stories about the old days.

Teacher:

- Introduce the task (for example):
 - We will find out what animals and plants live near the waterhole.
 - We will use everything we learn to make a painting about the waterhole.
- Focus the Learning on Country.
 - Connect, question and predict—students will have knowledge and personal connections to waterholes on their country using them for recreation, swimming, hunting, collecting bush food, lore and ceremony.
 - What do you already know about the waterhole?
 - Who has been there before?
 - What did you do there?
 - How did people use the waterhole in the old days?
 - Will there be water in the waterhole?
 - What tracks will we find?
 - What birds will we see?
 - What bush foods will we find?
- Prepare equipment and go through the Learning on Country field trip plan.

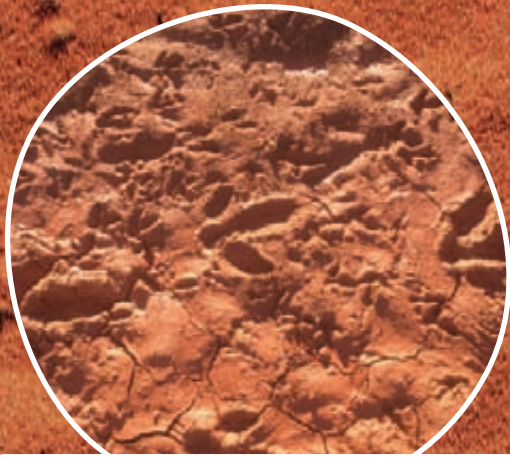
BACKGROUND: ARTEFACTS AROUND WATERHOLES

Waterholes are gathering places for people and evidence of occupation dating back thousands of years can be found in the form of artefacts such as stone flakes, cutting tools and grindstones. On the rock slabs near wetlands there will often be ancient grinding patches and on walls there may be paintings and engravings. Artefacts provide valuable teaching opportunities to educate young people about cultural practices past and present. Artefacts of any sort are subject to heritage legislation and heavy penalties apply for taking or moving artefacts. Take a photo and leave them where you found them for future generations.



(left): A grindstone found near a waterhole being used to grind seed under instruction from an Elder. Photo by David Broun, CSIRO.

(above): A stone flake approximately 2 cm long made during the creation of a cutting tool. Photo by David Broun, CSIRO.



What animal tracks or scats do you find?

Draw the different tracks.

What birds can you see or hear?

Write a list.



Life around the waterhole: Learning on Country

1. Learn about life around the waterhole from Elders.

- Record stories.
- Write down Language names.
- Take photos.

2. Students find out what plants and animals live around the waterhole and how people used it in the old days.

3. Take photos, drawings and samples back to class.

Equipment

iPad/camera, journals, painting or drawing equipment if required.

Top left photo and bottom photos by David Broun, CSIRO.
Top right photo by Brenton See.



What plants grow around the waterhole? *Take photos of each plant.*

What artefacts can you see?

How did people use them?

Take photos and leave artefacts there.



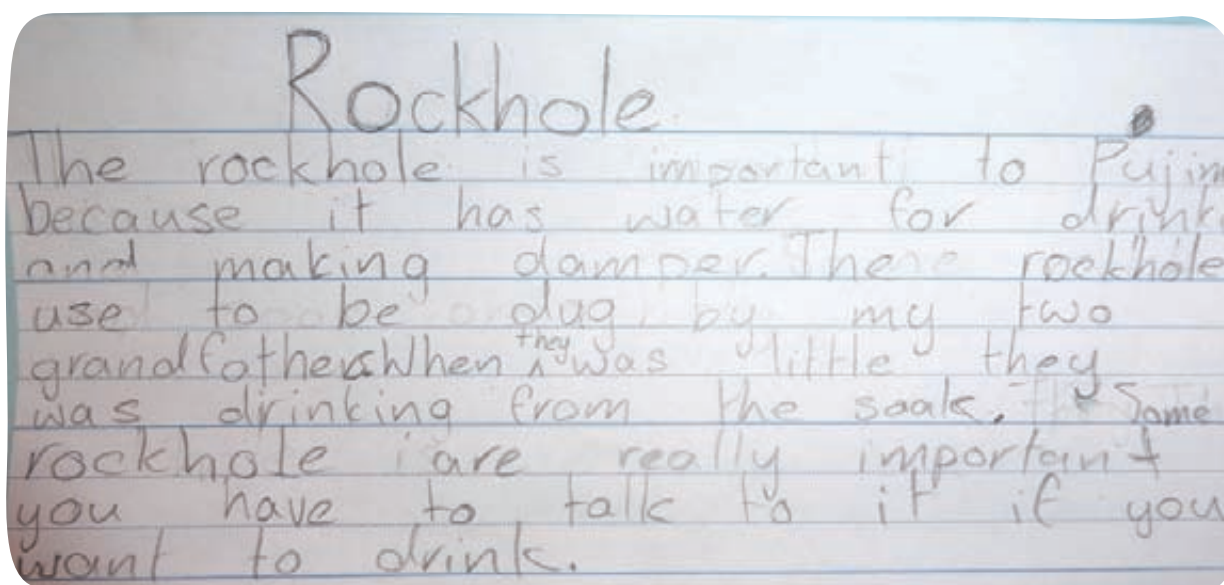
Life around the waterhole: Learning in class (follow-up)

Activity 4: Recount the learning

Reflect, recount and write:

- Listen to/view any photographs, recordings and videos and recount important pieces of information.
- What plants did you find?
- What animals did you see or hear?
- What tracks did you find?
- What did you learn from Elders?
- Add new words in Standard Australian English and Language to the class word wall.

Make a list of the names of the animals and plants in a table. Count the number of different types of animals. Count the number of different types of plants.



(above): Student work sample, Rawa School, after learning from Elders about history, looking after waterholes, and cultural protocols around important waterholes. Photo by Chris Deslandes, CSIRO.



(left): Early Years model and play-table after Learning on Country at Malcolm Dam, Leonora. Photo by CSIRO.

Activity 5: Painting of a waterhole

This activity should be done with the same Elders, rangers or Aboriginal education workers that took students to the waterhole. They may show students symbols that represent animals, plants, tracks or activities. You can include labels in Language or Standard Australian English and writing that students have done.

Students make a painting that shows what they learnt about the waterhole.

- Start with an outline of the waterhole and surrounding area.
- Add colours and shapes for the different ground surfaces.
- Add images or symbols for the plants, animals and tracks found there.
- Add pictures that show how people use the waterhole now and in the past.

Ask students to explain what they have learnt. The painting could become a mural in the school or used for ongoing investigation of the waterhole.



(above): Students painted this creek system under instruction from Elders. Note the flow of water through a series of waterholes, and the footprints showing the way people walked through country in the old days. They added animals, tracks and vegetation based on their observations around the creek. How many different animals can you count? Can you see the Dinner Plate Turtles? Photo by David Broun, CSIRO.

(left): Tjuntjuntjara students documenting their learning about camels fouling a waterhole. Photo by Chris Deslandes, CSIRO.

Activity 6: Class big book

Make a class big book with cuttings, pastings, drawings and/or photographs and information about the plants and animals found. Include labels in both local Language and Standard Australian English, locations, and other information learnt about the different species.

Follow up with related activities from animals and plants sections of these resources.

Activity 7: Science investigation: Motion sensor camera survey

Students use motion sensor cameras to survey animals visiting a waterhole. They record data and create a report.

This inquiry is designed for upper primary school students and involves using motion sensor cameras to find out what animals visit a waterhole. Results of this survey can be shared with younger students who might also be learning about waterholes.

This project should be done during times of low rainfall and when conditions are dry. These conditions cause animal populations to be concentrated at waterholes. The second half of the year is usually an appropriate time. After rain, animals will spread out across the country and have less need to visit a waterhole.

Note that this project should be done after an initial visit to the waterhole to record animal tracks. See 'Water Unit 1: Life around the waterhole' and 'Animals Unit 2: Tracking'. Teachers should seek support from an Indigenous ranger group or scientist to train the teacher and students to use the motion sensor cameras and undertake the survey. The activity should be planned and completed with an Aboriginal expert.



Motion sensor camera. Photo by David Broun, CSIRO.

MOTION SENSOR CAMERAS

Motion sensor cameras are used by scientists and rangers to monitor animals. This includes threatened or endangered animals and birds, and feral animals. Motion sensor cameras allow photographs to be taken without people being present. Motion sensor cameras are triggered by movement or heat and a photograph or video is taken automatically. Motion sensor cameras use infra-red technology to take photos at night as well as during the day, allowing them to record nocturnal animals. Cameras can be set and left for days, weeks or months, limited only by battery life and memory card size. The skills and knowledge developed in this survey can be applied in training toward a career as a ranger or scientist. Be aware that some states have ethics requirements around the use of motion sensor cameras. Consult your local jurisdiction about this.



Emus and kangaroos are regular visitors to waterholes. Note the time and date stamp on the motion sensor camera pictures. One photograph was taken during daylight, the other at night using the built-in infra-red camera. How many kangaroos can you count? Look carefully! Photos by David Broun, CSIRO.

PLANNING

Aboriginal experts and teachers plan the unit together and arrange for a field trip to a waterhole to set motion sensor cameras.

Questions for Aboriginal experts:

- Which waterhole should students visit?
- Is there water in the waterhole?
- Will there be animals coming to drink at the waterhole?
- Who is allowed to visit the waterhole?
- Who is the best person to take the students?
- What else should students learn about this waterhole?

INTRODUCTION

Introduce the task (for example):

- We will find out what animals visit the waterhole using motion sensor cameras.
- We will collect data and write a scientific report about the survey.

MAP THE WATERHOLE

- Use maps of the area to locate the waterhole and other features.
- Draw a bird's eye view map of the location (e.g. roads, windmill, waterhole, tracks, fence).
- Use this map to mark where the cameras will be placed later.

See 'Places, maps and country' for mapping activities.

Students should already have completed a tracking survey ('Animals Unit 2: Tracking') at the waterhole before undertaking this inquiry.

The map and tracking survey will form part of the report.



Student indicating survey location on a map.
Photo by Cameron Hugh, CSIRO.

USING THE MOTION SENSOR CAMERAS

Using the cameras requires several scaffolded lessons for students to understand how the camera operates and what it is used for. If you are having difficulties with the camera ask for help from a ranger coordinator or other expert.

1. Introduce cameras—what they are, how they work, what we use them for.
 - a. Show students a photo of an animal taken by a motion sensor camera and students label the parts.
 - b. Students should create a procedural text using a sequence of images showing how to use them based on what they have been shown by the teacher, ranger or other expert.
2. Set the camera at school overnight—students predict what they will see.
 - a. Write down predictions.
3. Retrieve cameras and look at photos.
 - a. Compare to predictions.
 - b. Recount setting up cameras and what was recorded.
4. Divide the class into four groups to set up a camera following their procedure.

USING THE MOTION SENSOR CAMERA DATA SHEET

Students will need practice recording data in the data sheet before going out on country. The full-page data sheet is at the end of the 'Water' topic.

1. Run through whole sheet explicitly (this will take time as a few concepts are covered).
2. Use a set of mock data with a photos of different animals such as <http://www.kj.org.au/mankarr-bilby/>.
3. Fill in the data sheet together.

Motion sensor camera survey data sheet

Address/Community:

Name:

Camera Number:

Date set:

Date picked up:

Group members:

Location:

Animals found:

NATIVE		TERRA	
Name	Tally	Name	Tally
Kangaroo		Cat	
Dingo		Mouse	
Emu		Canal	
		Bullock	

Photos saved (x/5):

Camera working (x/5):

Batteries OK (x/5):

QUESTION AND PREDICT

- What animals visit the waterhole?
- What animal tracks have you seen at the waterhole?
- What animals will we see on the motion sensor camera photos?

EQUIPMENT

- Motion sensor cameras, SD memory card, batteries, motion sensor camera data sheet, star pickets, sledge hammer, clip boards, camera or iPad.
- Make sure that the batteries have enough charge and that the memory card is empty.

PLAN AND CONDUCT

Work with your local ranger team, Aboriginal expert or scientist.

1. Choose suitable locations for the cameras.
 - a. Cameras should face south away from the Sun to avoid silhouette images.
 - b. They should be at least 3 m from the place where animals will be seen.
 - c. The larger the animal, the further away the camera should be.
 - d. Make sure the cameras are secured with straps or other means.
2. Make sure that the camera settings are correct (date/time stamp, photo/video, photo frequency, etc.).
3. Leave the cameras in place for at least a week.
4. Return and retrieve the cameras.

ANALYSE DATA

It is advisable that the teacher, ranger or scientist looks at the photos before sharing with the class. See how many photos have been taken and how many have animals in them. Edit the images to around 80, mostly with animals in them. This avoids going through 100s of photos and losing student interest, and keeps the numbers within the range of students' numeracy levels. Save the images and return cleared memory cards to cameras.

1. Discuss predictions.
2. Have students display images on a class smartboard or TV.
3. Identify any animals.
4. Fill out data sheets—each student should have a data sheet for each camera.
5. Students should tally the number of each animal. This will help in making an estimate of the most common animals visiting the waterhole.

Students should record the following information in their Two-way Science journal.

- Make a list of all the different animals found during the survey—the number of different species is the 'species richness'.
- Make a graph using the tallies of animals in the photo—this helps to estimate how many of each type of animal appeared on the camera—the number of individuals of each species is the 'species abundance'.

Talk through the students results.

1. What can they find from their data?
2. Which was the most abundant animal?
3. How many different species of animal did they find?
4. Were there more feral animals than native animals?

5. Which animals were nocturnal?
6. Which animals visited during the day?
7. Where do the animals live?
8. Why were they visiting the waterhole?

REFLECT

Students reflect on their investigation.

- What went well, what didn't work?
- Is there anything we should do differently next time?
- Did we record the right data?
- Is there anything else we could have done?
- What other questions did we think of?

SHARE

Students should produce a scientific report that details:

1. Information about the cultural importance of the waterhole.
2. A map of the location.
3. The question they were trying to answer.
4. The procedure for setting the cameras.
5. The initial tracking survey.
6. The completed motion sensor camera data sheets.
7. A picture of each animal.
8. A graph of abundance.
9. A summary of their findings.

The report can be done as a class big book, an eBook, or an individual written report depending on the students literacy levels. A class report could be displayed together on the classroom wall showing all the elements of a scientific report. Present the report to the local ranger group and thank them for their support.

Activity 8: Follow up inquiry: Compare in another season

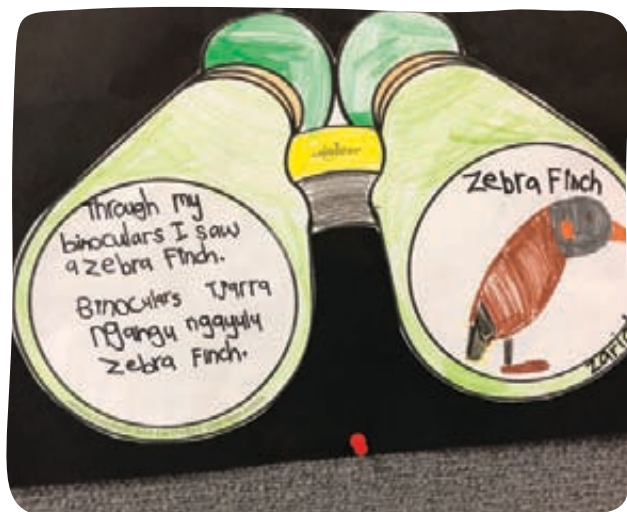
Return to the waterhole in another season and compare the difference (e.g. after a big rain).
Did you find the same animals? Why is there a difference?



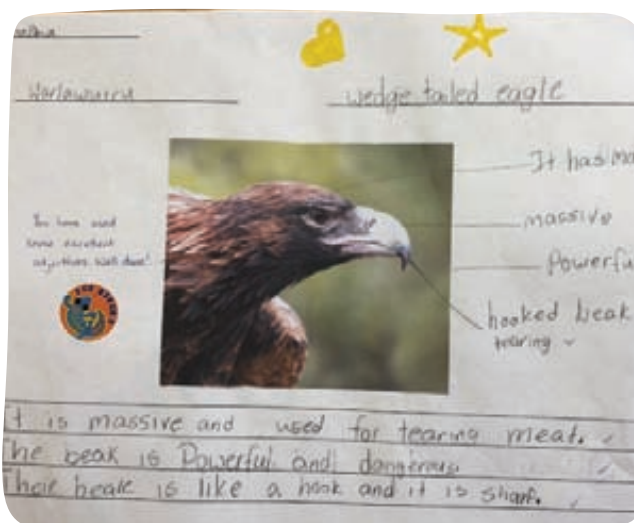
The first image was taken in the late afternoon (5 pm, 17/2/2018) at Malcolm Dam near Leonora. The next image was taken the following morning (8 am, 18/12/2018). Note the vegetation in the top left hand corner in the first image is completely surrounded by water in the next. The Dam increased in diameter from 100 m to approximately 500 m overnight. Photo by David Broun, CSIRO.

Activity 9: Bird survey

Water in the desert is a magnet for many bird species. During times of seasonal rain, migratory birds can visit rivers, lakes and wetlands in enormous numbers to feed and breed. Recording the type and number of birds is an activity undertaken by scientists and rangers to monitor the health of bird populations. Work with a local ranger group or expert to undertake a bird survey. Remember that there are many ways to record evidence of birds. This can be done through sight, sound (bird calls), tracks, feathers and scats (droppings). Aboriginal people will provide expert knowledge and should be involved throughout the planning and implementation of this activity.



Students wrote sentences in Aboriginal Language and Standard Australian English after a bird survey.



Students followed up a bird survey with an investigation into the adaptations of beak size and shape with a focus on descriptive language.



Students undertaking a bird survey near Leonora. Photos by David Broun, CSIRO.



(above): Students from Wiluna Remote Community School, Wiluna, worked with Wiluna Martu rangers and ornithologists from BirdLife Australia at Matuwa Kurrara Kurrara Indigenous Protected Area to undertake a bird survey and investigation. They recorded their learning on a 4 m long sheet which was brought back to school for follow-up activities in class. Photo by David Broun, CSIRO.

(bottom left): Look down as well as up! Raptors such as eagles, falcons, hawks and owls regurgitate indigestible parts of their prey. These are called pellets. The type of prey of the Wedge-tailed Eagle can be seen in this pellet found near a waterhole. Bones and fur of a kangaroo and the skin of a goanna are clearly visible. This pellet could be a springboard into an investigation into eagle diet and habitat. Photo by David Broun, CSIRO.

(bottom right): Wiluna school students learnt about the Jaralji (Bowerbird). Students made a version of the bower using sticks and found examples of the material that the male Bowerbird collects to impress the female during courting. Photo by David Broun, CSIRO.

BACKGROUND: ANIMALS THAT APPEAR AFTER THE RAIN

After a big rain, animals such as frogs and turtles can suddenly appear in certain conditions. These animals have been in a state of dormancy called aestivation. Aestivation is similar to hibernation but is a response to hot dry conditions when animals are at risk of drying out. Rainfall wakes animals up from aestivation and this is why they seemingly appear from nowhere.



(above left): Dinner Plate Turtle (*Chelodina steindachneri*) fresh from the water. Photo by David Broun, CSIRO.

(above right) Dinner Plate Turtle deep in the dried mud waiting for rain. Photo by Simon Cherriman.



(left): Spangled Perch are the most widespread freshwater fish in Australia and turn up in surprising places. They can survive extremes of temperature and salinity and then breed quickly when conditions improve, seemingly appearing in large numbers out of nowhere. Photo by Moemai Hook.

BACKGROUND: FROGS

Frogs are interesting and important occupants of waterholes. They are a good indicator of water quality, and disappear if the water becomes too polluted. Brown Tree Frogs and Green Tree Frogs live near permanent and semi-permanent waterholes, and in tanks and cisterns. If the water dries up, they shelter in moist spots under stones, in crevices or in Redgum hollows. They huddle in a ball to preserve moisture and come out again after rain to feed and breed.

Other frogs burrow into the soil during dry times. Main's Burrowing Frog, the Trilling Frog and the Desert Spadefoot Toad store water, make waterproof cocoons around their bodies and go into a state of suspended animation called aestivation. When it rains, these frogs dig their way to the surface again to feed and breed.

Some Aboriginal people ate frogs in the old days. One of the main species eaten was the Desert Spadefoot Toad (*Notaden nicholsii*). These frogs are still eaten in some areas west and north of Alice Springs. People dig large numbers of them from communal burrows in sandy drainage lines or near soakages in sandy areas, lightly roast them in hot ashes and eat them whole.



Experts can locate the Desert Spadefoot Toad and its valuable parcel of drinking water in sandy areas. The toad can remain deep under the ground for years waiting for the rain. Photos by Fiona Walsh.

As frogs are nocturnal, you will see more if you can look at night, and you will also hear them calling. Use a torch to look for their eye shine around the edge of the waterhole. (Watch out for snakes.)

You should also be able to find frogs during the day, sheltering in vegetation near the water's edge. Sit and listen carefully for the sound of frogs, as well as look for frogs. Record what you hear with a recording app on a smartphone, or other sound recording device. If possible take a photograph of any frogs you see or draw and write down any physical characteristics such as colour, markings and size.

There are many apps and websites with information, education activities and citizen science projects about frogs, e.g. <http://museum.wa.gov.au/explore/frogwatch/regions/arid-zone>, <https://www.frogid.net.au/>.

Activity 10: Frog life cycle

Note: The collection of tadpoles for educational use may be subject to ethics approval—check your local education jurisdiction policy for guidance around this.

Students learn about frogs. They collect frog eggs or tadpoles from a waterhole and observe the changes in their life cycle.

- Organise a field trip with an Aboriginal expert to collect frog eggs from a waterhole or swamp.
- Collect the frog eggs or tadpoles using fine mesh nets.
- Carefully carry them back to the classroom in water from the waterhole and place them in an aquarium or large plastic container. This should be filled with water from the home waterhole of the frogs, aquatic plants, rocks and other items so that when they hatch they will have a place to hide and not become stressed. Leave them until the eggs hatch.



Photos by Stella Gray Broun.

The newly hatched tadpoles will feed on algae from the waterhole or very small pieces of boiled or frozen lettuce or spinach. Make sure you renew the water (from the home waterhole) every now and then. Some species will need small pieces of lean, raw meat when they start to change into frogs. At this stage, you should lower the water level and put in a large rock and some sand, so the froglets can emerge from the water to breathe. You will also need to cover the aquarium to stop them hopping out. Once they have turned into frogs, you will need to start feeding them live meal worms and insects. This is a big job ... you might want to take them back to the waterhole at this stage! Observe the changes carefully with the students.

RECORD THE LIFE CYCLE OF THE FROGS

Students cut out pictures to illustrate the life cycle of a frog. They recorded the number of days it took for the frogs to change between stages. This activity can be done with existing images or students could draw based on their own observations.



MAKE A CALENDAR OF FROG EVENTS

Students observe the changes in the appearance of tadpoles during a frog's life cycle. They note the number of days for each stage (see above) and transfer this on to a calendar.



Photos by Fiona Webb.

(bottom): Photo by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Identifying animal tracks and plants around the waterhole.	F Living things live in different places where their needs are met (ACSSU211).
Learning when animals come to the waterhole and how this changes over the seasons.	- Y1 Living things have a variety of external features (ACSSU017). - Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044).
Investigating the life cycle of a frog.	- Y4 Living things depend on each other and the environment to survive (ACSSU073). - Y4 Living things have life cycles (ACSSU072). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Predicting the animals and plants that will be at the waterhole at different times of the year.	- Y1/2 Science involves observing, asking questions about and describing changes in objects and events (ACSHE021, ACSHE034). - Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061)
ACTIVITY	SCIENCE INQUIRY SKILLS
Predicting the different animals that live at the waterhole.	- Y1/2 Pose and respond to questions, and make predictions about familiar objects and events (ACSI024, ACSI037). - Y3/4 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSI054, ACSI066).
Drawing tracks of animals found around the waterhole.	Y1/2 Use informal measurements to collect and record observations, using digital technologies as appropriate (ACSI026, ACSI039).
Counting the number of different types of animals and plants, and recording them in a table.	Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate to make and record observations accurately (ACSI055, ACSI066).
Summarising data from the motion sensor camera survey.	Y5/6 Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSI090, ACSI107).
Recording animal tracks and plants in drawings.	Y1/2 Use a range of methods to sort information, including drawings and providing tables through discussion, compare observations with predictions (ACSI027, ACSI040).
Making a painting to record observations about the plants and animals that live around the waterhole.	Y1/2 Compare observations with those of others (ACSI213).
Writing a motion sensor camera survey report.	- Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029). - Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). - Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways (ACSI093, ACSI110).

Motion sensor camera survey data sheet

School/community:		Name:	
Camera number:	Date set:	Date picked up:	
Group members:		Location:	

Animals found:

NATIVE		FERAL	
Name:	Tally:	Name:	Tally:
Kangaroo		Cat	
Dingo		Horse	
Emu		Camel	
		Bullock	

Photos saved (tick):	Camera working (tick):	Batteries OK (tick):
----------------------	------------------------	----------------------

Unit 2: Water health

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

In this unit students will learn from Aboriginal experts about healthy and unhealthy water and how to look after waterholes. This knowledge will be connected to Western scientific investigations of water quality including surveying waterbugs in a waterhole.

BACKGROUND: WATER QUALITY

Water quality is an important factor in the health of a waterhole. Aboriginal desert people had very particular vocabulary and knowledge of different types of waters. They could distinguish underground connections between surface waters based on similarities in the taste of the waters. It is likely that people discerned tastes of waters with different mineral compositions. In translation, waters were described as variants of salty, sweet, smooth and in other ways.

Aboriginal experts maintain waterholes as a source of drinking water for people and animals. This can mean digging out a soak; securing loose soil with posts or a drum; clearing a waterhole of organic matter such as plant material, animal faeces and carcasses; providing sticks as an escape route for reptiles and small mammals that fall in and get trapped; and covering waterholes to reduce evaporation and keep water cool and clear.

Following the colonisation of Australia, animals such as cattle, camels, horses and donkeys have been introduced to the landscape. These animals can trample and foul waterholes with their large hooves and dung, and become trapped and die, spoiling the water for animals and humans alike. The reduction of plants through grazing can lead to erosion, with topsoil washed into rivers, lakes and waterholes.



(above left): A gnamma hole in rock near Wiluna in WA. A gnamma hole is a deep, narrow fissure or hollow in rock that collects water from runoff or underground. The narrow top reduces surface area and hence the evaporation of valuable water. Note the extensive bird droppings and the heavy stone cover made to keep animals out and reduce evaporation. Photo by David Broun, CSIRO.

(left): Cleaning out a gnamma hole near Wiluna. Photos by David Broun, CSIRO.

Water health: Planning

Aboriginal experts and teachers plan the unit together and arrange for a Learning on Country field trip to clean out a waterhole.

Ask Aboriginal experts:

- What should students learn about keeping waterholes clean and healthy?
- Which waterhole should students visit?
- Who is the best person to take the students on a field trip to this place?

Teachers:

- Collect example images of healthy and unhealthy water from a range of local and international sources.
- Talk to the local rangers about water quality and waterhole monitoring in the local area.



Examples collected to illustrate healthy and unhealthy water. Photo by Chris Deslandes, CSIRO.

Water health: Learning in class (preparation)

Activity 1: Describe water using five senses

Students develop language to describe water at the waterhole. This can be done in Standard Australian English and/or in the local language with an Aboriginal Language speaker.

- Find some examples of different bushfoods, foods, drinks, herbs, sauces, spices.
- Ask students to describe them using their senses.
- Write down the words that are used in both Language and Standard Australian English.
- Discuss the words that they might use when they are at the waterhole.

Standard Australian English language words might include:

- What does the water look like? Clear, murky, greenish, brownish.
- What does the water smell like? Smoky, fishy, eggy.
- What does the water taste like? Sweet, salty, sour, bitter, brackish.
- What does the water feel like? Smooth, thick, slimy, soft.
- What does the waterhole sound like? What can you hear? Zebra Finch tweet, wind blowing, quiet.

Activity 2: Prepare for Learning on Country

Aboriginal expert: talk to students about keeping waterholes healthy and introduce or consolidate Aboriginal Language.

Teacher:

- Focus the Learning on Country.
 - Connect, question and predict:
 - What does healthy water look like, smell like, taste like, feel like, sound like?
Revisit the descriptive words from Activity 1: Describe water using five senses in both Standard Australian English and Language.
 - What does unhealthy water look like, smell like, taste like, feel like, sound like?
Give examples, and introduce descriptive words in both Standard Australian English and Language.
 - Have you cleaned out a waterhole with your family?
How did you do it? Why is it important to look after waterholes like this?
 - Will the water be healthy or unhealthy at the waterhole? Why?
- Prepare equipment and go through the Learning on Country trip plan.
- Introduce the task of writing a report about keeping a waterhole healthy.
- Older students to complete a water monitoring data sheet at the waterhole (see data sheet at the end of the 'Water' topic).



Using a thermometer may require some practice to read the scale. Photo by David Broun, CSIRO.



What season is it?
When does the
waterhole fill up?

What does the water look
like? (e.g. clear, murky,
greenish, brownish)
Put some in a clear
container and hold
it up to the light.

How do people
keep the
waterhole clean?

What does the
water smell like?
(e.g. smoky,
fishy, eggy)

Water health: Learning on Country

- 1. Learn about water health from Indigenous knowledge holders.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
- 2. Answer the questions in your journal.**
- 3. Complete a water monitoring data sheet (older students).**
- 4. Take some water back to class.**

Equipment

iPad/camera, water monitoring data sheet, clear containers, pens, clipboard.

Photo by David Broun, CSIRO.

What does the
water feel like?
(e.g. smooth,
thick, slimy, soft)

What sounds
can you hear?

What does the
water taste like?
(e.g. sweet, salty,
sour, bitter,
brackish)

What temperature
is the water?

Is there
anything in
the water?

Water health: Learning in class (follow-up)

Activity 3: Five senses report

Early Years students draw and write about the water at the waterhole. What did it sound like? Look like? Feel like? Smell like? Taste like? Older students can write sentences using the describing words.

Activity 4: Under the microscope

Look at the water sample under a microscope—what can students see? Is there anything alive? Are there things floating in the water? What colour and shape are they? Write a description of the water in their journals. Photograph or draw anything that they find. See Activity 7: Science investigation: Waterbug survey to follow up any living things found in the water.

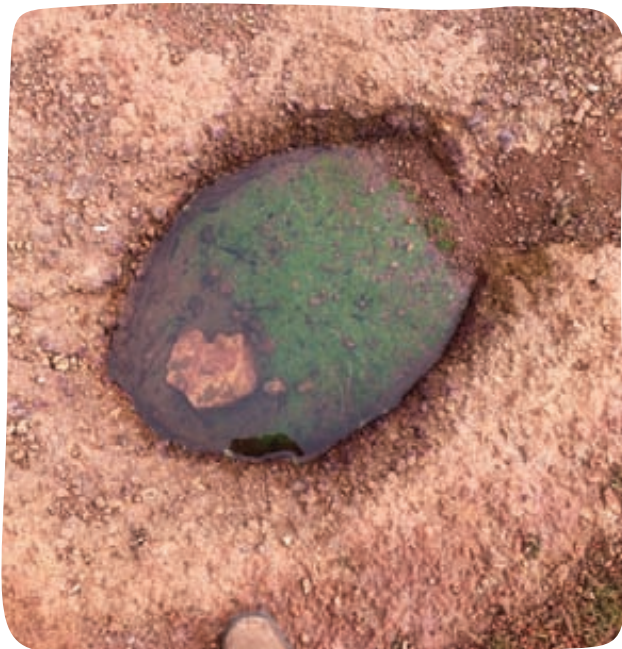
Activity 5: Write a report

Write a report about the water at the waterhole. This should include a description of why it was healthy or unhealthy, and what they learnt from the Aboriginal expert about looking after the waterhole.

Activity 6: Develop another investigation

What questions do the students have after learning about water health? Use this to develop an investigation or research activity. This can connect to:

- waterbug survey
- adopt a waterhole
- investigation into:
 - evaporation
 - filtration
 - pollution.



(left): A small rockhole near Leonora in Western Australia, filled with recent rain in the cool season. Note the colour of the plant growth, the clear water and a surface free of floating scum or debris. What will happen as the temperature increases and the volume of water is reduced through evaporation? How will the colour, clarity, smell and taste of the water change? Photo by David Broun, CSIRO.

(right): Butterflies drink from water at a soak. Photo by Fiona Walsh.

Activity 7: Science investigation: Waterbug survey

Students collect and identify waterbugs to assess the quality of the water in a waterhole. They count the number of different types of waterbugs (biodiversity), then use this information to judge water health.

BACKGROUND: WATERBUGS AND WATER QUALITY

Water quality can be determined scientifically in a variety of ways. Scientists and Indigenous rangers use specialised instruments to test and monitor water quality. Waterbugs can also indicate how healthy a waterhole is. Generally, the more different types of waterbugs, the healthier the water. Some waterbugs, like mayfly and stonefly nymphs, are very sensitive to pollution from both natural and human causes. If you find those species it can tell you that the water is healthy for both animals and people.



What is a waterbug?

‘Waterbug’ is a broad and non-scientific term for small water animals that live in or on water. They can include insect larvae, nymphs, spiders and crustaceans. Many water animals are the aquatic life cycle stages of flying insects such as dragonflies or mosquitoes. When a dry waterhole is filled with water, the dried eggs of hardy crustaceans such as brine shrimps, shield shrimps or seed shrimps hatch first. In turn these attract insects such as dragonflies who lay eggs. The eggs hatch and the larvae of the insects feed on the shrimps, and frog eggs hatch into tadpoles who feast on the increasing range of animal life, microplants and algae. More permanent waterholes attract other animals such as fish and yabbies.



(above left): Water Boatman, Leonora, WA. Photo by David Broun, CSIRO.

(above right): Students identifying waterbugs using an ID key. Photo by David Broun, CSIRO.

(bottom): Photos by David Broun, CSIRO.

Common waterbugs



Seed Shrimp



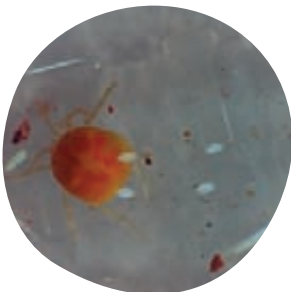
Brine Shrimp



Clam Shrimp



Shield Shrimp



Water Mite



Whirligig Beetle larva



Soldier Fly larva



Midge larvae



Leaf-tailed Damselfly nymph



Mudeye/Dragonfly nymph



Diving Beetle



Mayfly nymph



Back Swimmer



Water Scavenger Beetle



Water Scorpion



Predacious Diving Beetle

Photos by David Broun (CSIRO), Fiona Webb (CSIRO) and Cecil Ellis (Nature Navigation).

EQUIPMENT

One of each of the following per student or small group:

- net
- ten litre bucket
- shallow tray
- ice cube tray
- specimen jars
- magnifying glasses
- spoon
- pens/pencils
- camera (mobile device is fine)
- thermometer
- Waterbug identification key (page 85) printed in plastic sleeve or laminated.
- Water health data sheets (page 94)

QUESTION AND PREDICT

Explain that waterbugs are invertebrates that live in, or on the water.

See *Animals: Invertebrates, Activity 5: Compare invertebrates with vertebrates* (page 148) to familiarise students with this language and concept.

Ask students:

- What bugs have you seen in the water?
- How do waterbugs move?
- What do waterbugs eat?
- What eats waterbugs?
- How many different waterbugs will we find in the water?
- Which part of the waterhole will the waterbugs live?

Record answers in a class brainstorm or journal.

Practise using the waterbug identification key (page 85) with pictures of waterbugs from this document or an internet site such as www.waterbugblitz.org.au/.



Adult Diving Beetle. Photo by David Broun, CSIRO.

PLAN AND CONDUCT

1. Go to the waterhole.
2. Complete a water health data sheet.
3. Drag nets through different areas and depths of the waterhole (habitats).
4. Capture waterbugs in the nets and put them in a bucket.



Photo by David Broun, CSIRO.

5. Empty most of the water out of the bucket. Be careful not to empty the waterbugs.
6. Tip the waterbugs into a large, shallow tray.



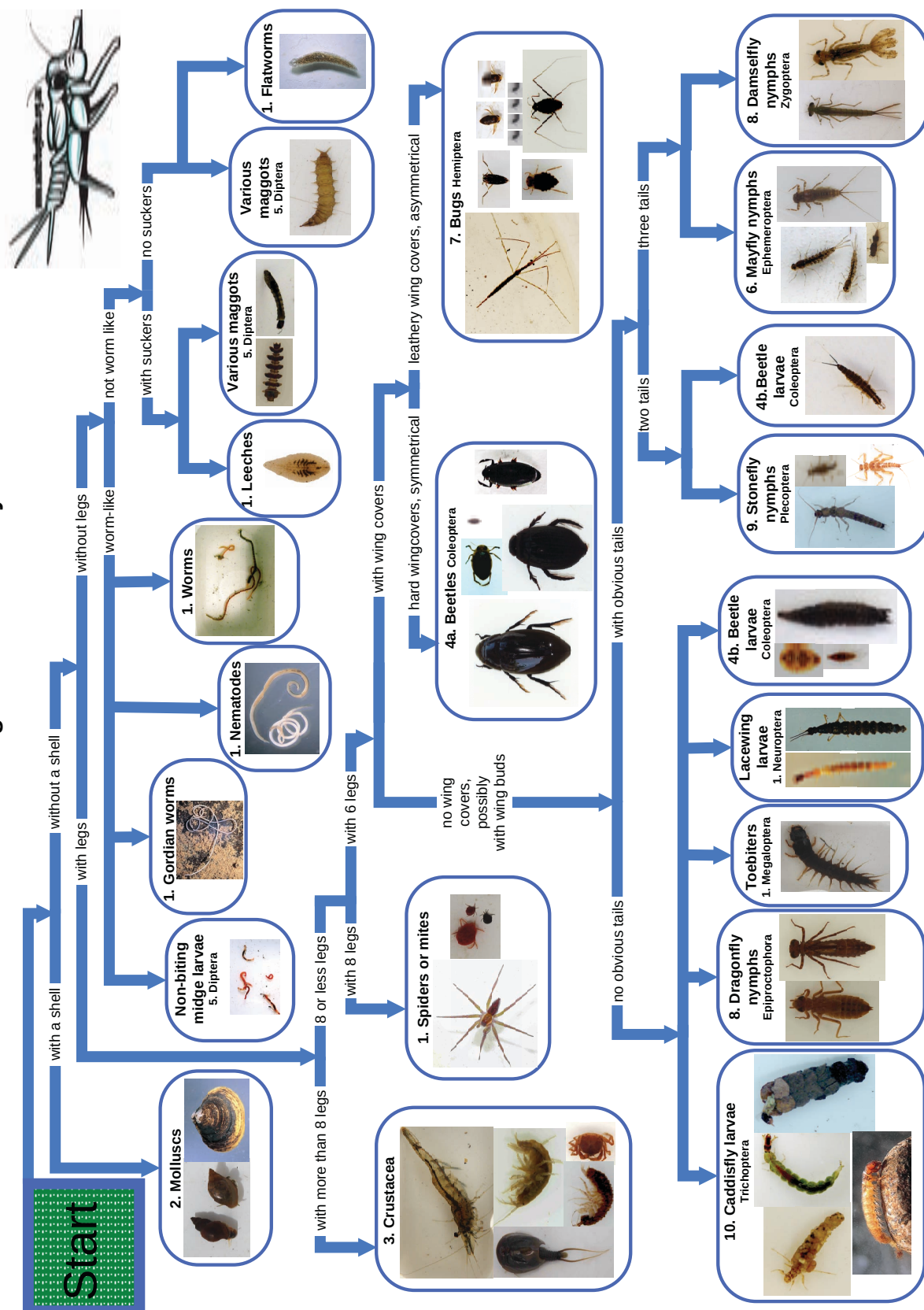
Photo by David Broun, CSIRO.

7. Sort out the different waterbugs from the large tray into an ice cube tray. Keep one or two of each type.



Waterbug Blitz Google Drive Media Pack images.

Waterbug identification key



Agreed Level Taxonomic Order Key reproduced with permission of John Gooderham and Waterbug Blitz.

ANALYSE DATA

Take a picture of each different type of waterbug using a mobile device or camera. Put fast moving waterbugs in a small drop of water to make photography easier. Take the photograph in good light for better results.

1. Observe and sort

Students can look at the different waterbugs, discuss their features and movement, and describe how they are similar or different. They can count the number of legs, and describe their colour, size or shape. The images of the waterbugs can be used back in the class for oral language and literacy exercises.

2. Identify waterbugs

Students can identify the waterbugs using the Waterbug identification key. Students should be encouraged to go through the process of using the key rather than finding a picture of the waterbug that looks like the one in the ice cube tray. The process introduces the concept of taxonomy and classification which can be applied in other activities. Early Years students can be guided through this process, older students can work towards using the key independently.

3. Assess biodiversity

Students count the number of different types of waterbugs to assess biodiversity. Generally, the higher the waterbug biodiversity, the healthier the water. The waterbug survey can be repeated in different waterholes or at different times of the year and students can compare the data to draw conclusions about changing water health.

Use the photographs of the different types of waterbugs to make an individual or class report.

Include:

- the name of the waterhole
- the names of the waterbugs
- the number of different waterbugs
- the water health data sheet
- a paragraph about the health of the water

Once the investigation is complete the waterbugs can be returned to the waterhole from where they came or drained in a dry area. Do not empty the contents into another waterhole to avoid spreading harmful algae or aquatic pathogens across the landscape.



Photo by David Broun, CSIRO.



Photo by Wayne Jones.

REFLECT

Ask students to reflect on the waterbug survey. What worked well and what could be changed next time? Was it easy to catch the waterbugs? Is there a better way to collect them? How does the waterbug survey impact on the waterhole?

SHARE

- Make a waterbug mask and act out a play about waterbugs and water health.
- Make a class display showing the different waterbugs in the waterhole.
- Write a report on the health of the water and show it to parents or the ranger group.

Photo by David Broun, CSIRO.



Follow-up activities

Activity 8: Science investigation: Grow your own waterbugs

Some waterbugs leave dried eggs in the sand waiting to hatch with the next rain. In this science investigation, students collect soil from a dry waterhole, add water and observe changes in an aquarium over time to see what emerges.

The aquarium should be observed over several weeks. Expect to see algae appear first, then small crustaceans and possibly some larger crustaceans. Ask students to make a prediction about what will happen, then make simple daily observations to record the changes over time.

The activity demonstrates the start of the food chain in waterholes, rivers and creeks after rain. The emerging algae and invertebrates are food for other insect larvae, crustaceans, turtles, birds, fish and other animals.

Once the investigation is complete the aquarium can be emptied in the same waterhole from where it came or drained in a dry area. Do not empty the contents into another waterhole to avoid spreading harmful algae or aquatic pathogens across the landscape.

You will need:

- A container with a lid for river sand
- A small shovel or stick to loosen the soil
- A small aquarium or suitable clear container of around 10–15 litres in volume. If you have a larger aquarium, collect more dirt.
- Unchlorinated water—this could be from bottled water, or water that has been treated for aquarium use

Procedure:

1. Find a dry creek bed or waterhole
2. Find the last area that the water dried out
3. Loosen the dirt with a spade or stick down to about 10–15 cm
4. Place around 2–3 handfuls of the loosened soil into a sealable container
5. Take the dirt back to the classroom
6. Position the aquarium so it receives direct sunlight for several hours each day
7. Place the dirt and unchlorinated water in the aquarium so there is plenty of water for waterbugs to swim
8. Observe and record changes to the water and emerging life each day

Students can undertake this activity at different locations and compare the results.

Photos by Cecil Ellis (Nature Navigation).



Activity 9: Science investigation: Compare data in another season

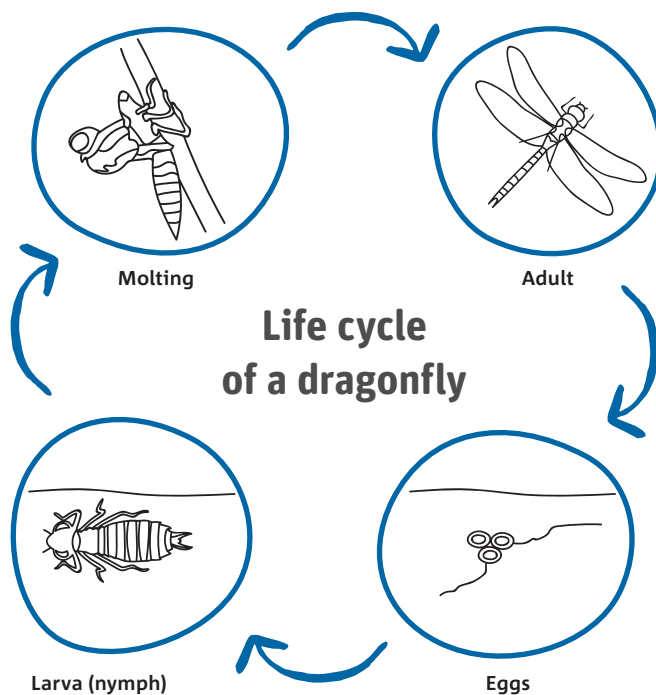
Visit the waterhole in a different season, or survey another waterhole and compare the results in a table or simple graph.

Ask students:

- What will happen to the waterbugs if the waterhole is unhealthy or dries up?
- Are the waterbugs the same or different? Why is this?

Activity 10: Waterbug life cycle

Research the life cycle of a waterbug, then make a poster that shows the different stages. Look for the different stages when you are out on country. What animals eat the waterbugs at different stages of their life cycle?



Activity 11: Research a waterbug

Research a waterbug. Look at videos or pictures. How does the waterbug move? What does it eat? Where does it live? How does it breathe? Write an information report based on observations of the waterbug and research in class.



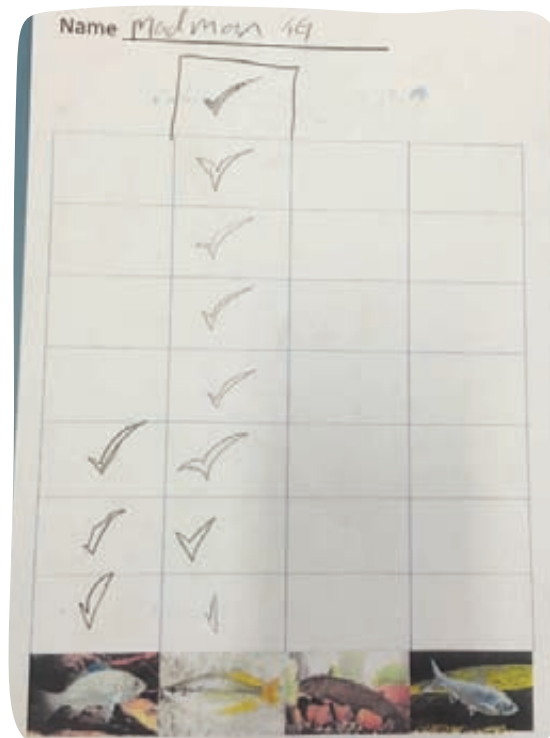
(left): The Water Strider moves delicately on the surface of the water.

(right): The Backswimmer uses paddle-like legs to swim in bursts. Photo by David Broun, CSIRO.



(above): Students in Warralong made baited remote underwater video cameras (BRUVS) to survey fish in their local river. Photos by David Broun, CSIRO.

(right): Students made a pictograph while counting the number of fish captured on the baited underwater remote video camera (BRUV). Photo by Cameron Hugh, CSIRO.



Activity 12: Adopt a waterhole

Students can adopt a waterhole to look after in consultation with Traditional Owners or a ranger group. This can form an integrated STEM learning program over several weeks or months. Students can use all the activities of the Water unit to create a comprehensive picture of the waterhole and create an action plan under the guidance of a ranger group to show how the waterhole can be cleaned up and looked after.

Work with students to list the resources, help and permission that will be needed. Help students to find out what resources are available in the community. The plan might include making posters about pollution to put up around the community, putting up signs at the waterhole, planning a clean-up etc. Make a big poster, display or painting about the waterhole.



Location/features	What we do	Who does it?
Dirt	Locals mow it { mow }	Everyone
Wild Life	Discover new things ?	Everyone
Trees	Eat birdseed	Everyone
Plants	Look at things that have been there for a long time	Everyone
The Dam	Take pictures	Everyone



Students from Leonora used Malcolm Dam as a venue for Two-way Science for the whole year. Local Aboriginal experts and scientists taught students about the history of the Dam, bushfoods and animals. They did a bird survey, monitored change over the seasons, learnt about invertebrates, had bird murals painted in the school and used fyke nets to survey feral fish. Note that a fisheries approval is required to capture fish using fyke nets in Western Australia. Photos by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Identifying waterbugs.	• Y1 Living things have a variety of external features (ACSSU017). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things have life cycles (ACSSU072).
Investigating invertebrate life cycles. Investigating waterbug habitat. Growing and observing waterbugs from dried soil.	• PP Living things live in different places where their needs are met (ACSSU211). • Y4 Living things have life cycles (ACSSU072). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning how to clean and maintain a waterhole from elders. Adopting a waterhole.	• Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). • Y3/4 Science knowledge helps people to understand the effects of their actions (ACSHE051, ACSHE062). • Y5/6 Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE082).
Collecting data about water health. Learning from Aboriginal experts about traditional ways of maintaining water health. Using waterbug diversity to assess water health.	• Y1/2 Science involves observing, asking questions about and describing changes in objects and events (ACSHE021, ACSHE034). • Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y5/6 Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081).

ACTIVITY	SCIENCE INQUIRY SKILLS
Planning and conducting a science investigation about waterbug diversity and water health.	• Y1/2 Pose and respond to questions, and make predictions about familiar objects and events (AC SIS024, AC SIS037). • Y1/2 Participate in guided investigations to explore and answer questions (AC SIS025, AC SIS038). • Y3/4 With guidance, identify questions in familiar contexts can that be investigated scientifically and make predictions based on prior knowledge (AC SIS053, AC SIS064). • Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate to make and record observations accurately (AC SIS055, AC SIS066). • Y5/6 With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (AC SIS231). • Y5/6 With guidance, plan appropriate investigation methods to answer questions or solve problems (AC SIS086).
Using a digital microscope. Recording waterbug biodiversity.	• Y1/2 Use informal measurements to collect and record observations, using digital technologies as appropriate (AC SIS026, AC SIS039). • Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate to make and record observations accurately (AC SIS055, AC SIS066). • Y5/6 Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate (AC SIS087).
Recording results in a table. Using a key to identify and classify waterbugs. Assessing water health through waterbug diversity. Comparing results with others. Comparing waterbug diversity at different sites or in different seasons.	• Y1/2 Use a range of methods to sort information, including drawings and providing tables through discussion, compare observations with predictions (AC SIS027, AC SIS040). • Y1/2 Compare observations with those of others (AC SIS213). • Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS060, AC SIS071). • Y3/4 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (AC SIS057, AC SIS068). • Y5/6 Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (AC SIS090).
Reflecting on experimental methods.	• Y3/4 Reflect on investigations, including whether a test was fair or not (AC SIS058, AC SIS069). • Y5/6 Compare data with predictions and use as evidence in developing explanations (AC SIS218). • Y5/6 Suggest improvements to the methods used to investigate a question or solve a problem (AC SIS091).

Water health data sheet

Name:.....

Waterhole name:Date:..... Time:

1. Waterhole type (rockhole, soak, spring, lake, claypan, etc.):

.....

.....

2. Weather:

☐ sunny ☐ cloudy ☐ raining ☐ windy

3. Waterhole colour:

☐ clear ☐ muddy ☐ green ☐ brown

4. Water flow:

☐ still ☐ flowing slowly ☐ flowing quickly

5. Water temperature (feel it or use a thermometer; measure at different depths):

.....

.....

.....

6. What does the water:

Look like?

.....

Feel like?

.....

Smell like?

.....

Taste like? (if it is OK to drink).....

.....

Sound like? What can you hear?

.....



Photo by Moemai Hook.



Lunki or Witchetty grub. Mosaics from Wiluna Remote Community School.

(opposite) Photo by David Broun, CSIRO.

Animals



Background

The arid zone of Australia is alive with unique species of animals that have adapted for survival in patchy and unpredictable conditions. Remote Aboriginal communities are surrounded by animals living in a healthy environment full of educational opportunity for students. Many animals are nocturnal and live in burrows, under the cover of the spiky spinifex plant or in tree hollows. Aboriginal people in remote communities are experts in understanding the behaviour and relationships between animals, plants and people.



Traditionally animals were an essential part of survival for Aboriginal people and many are still hunted today. The availability of animals for food varies with season and habitat. Because seasons are not consistent in the desert, knowledge of country, seasonal change and conditions allow people to find food throughout the year. This regional ecological knowledge has allowed Aboriginal people to live in extreme conditions for thousands of years and continues today.

Aboriginal people's knowledge of their country includes an understanding of what Western science calls ecosystems. Ecosystems include all non-living things such as weather, soil, rocks, waterholes and rivers as well as living things, including plants and animals. Animals include groups such as mammals



(left): Witchetty grubs are the larvae of the cossid moth. They are an important food source for Aboriginal people in the desert and a prized nutrient-rich delicacy today. Experts can find Witchetty grubs in the roots or trunks of specific shrubs and trees. Photo by David Broun, CSIRO.

(above): Goannas are an important cultural food source for Aboriginal people in the desert. They dig deep burrows to escape extremes of heat and cold. There are at least four species of edible goanna in desert regions. This one is the Yellow-spotted Monitor (*Varanus panoptes*). Photo by David Broun, CSIRO.

(including humans), reptiles, insects, spiders, birds, fish, snails, worms and micro-organisms. All of these living and non-living things interact with each other and each plays an essential role in a balanced ecosystem. One way that Aboriginal people keep ecosystems healthy is by burning small sections at a time when conditions are right. This promotes healthy regrowth of plants and provides the right habitat for native animals to thrive.

Animals have become extinct or reduced in number due to a variety of complex human and biophysical factors. This can include the introduction of feral animals such as foxes and cats that hunt and eat. Horses, donkeys and camels are destructive plant eaters and can cause waterholes to be severely polluted and degraded. The introduction of weeds and the occurrence of large uncontrollable wildfires have also impacted on native animals.

Indigenous ecological knowledge of country is a vital part of the management of threatened animal species. Elders and ranger teams are working with scientists to better understand threatened species and how they can be protected and sustained. This can include practices of collecting information through trapping, tracking, filming with sensor cameras, strategic burning to improve the habitat for some animals, and baiting of feral animals. People also record cultural accounts and stories about the animals to complement scientific information.



Feral animals and habitat loss have reduced the distribution of the Bilby (*Macrotis lagotis*). Once found across most of Australia, they now exist only in areas of the arid zone largely managed by Aboriginal people through Indigenous ranger programs. Rangers work with scientists to monitor Bilby populations, reduce the impact of feral animals and manage country to ensure the ongoing survival of the Bilby. Photo courtesy of Save the Bilby Fund.

(below) Tracking is an important cultural skill now being used in the management of threatened and feral species across large areas of Australia. Tracks help monitor the presence of species and indicate their behaviour. Here an echidna makes tracks across the sand north of Wiluna. What parts of the animal can you see in the track? Its foot pad, toes and spines are visible here. Which way is it walking? From left to right in this photo. Photo by David Broun, CSIRO.



Unit 1: My special animal

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

In this activity students choose an animal they are interested in. Students can choose an animal each or focus on one animal as a class. They will talk and write about what they already know and then learn more about the animal from Aboriginal people on country, and through further research. Teachers and students can share the learning journey with Elders and others in the community. This activity can be a springboard for further investigation into animals, habitat and education projects with Indigenous rangers.

BACKGROUND

Around remote community schools, people see animals, or signs of animals such as tracks. Some animals are hunted by Aboriginal people and have food value. Other native animals might be pets, like pink and grey galahs or Dingo–dog crosses. Some people might have totem animals inherited through family connections to Dreaming stories, songlines and places. Older people might have warned children away from some animals. Animals that are known and observed are useful for study.

In the old days, Aboriginal people could name hundreds of animals that were important as food, friends, foes or had other values. Scientists have names for animals too. There are too many animals to learn about them all, so it is good to start with those that are known to students.

People see things as 'special' for different reasons. Commonly, scientists, for example, are more concerned for, or interested in, animals that are rare or threatened, whereas Aboriginal people might be more interested in a threatened species that was once used as a food source. Or a scientist might be interested in a certain stick insect because it has characteristics very different to those in another state, whereas a child might be curious about a moth because it is bright yellow and woolly. This activity connects a child's interest in an animal to further learning with Elders, scientists or research using books or the internet.

This activity is about native animals rather than animals from overseas. It does not include animals introduced to Australia by Europeans (horses, cattle, camels). However, if a student feels strongly about these introduced animals perhaps they could start with them and then move on to do 'native animals'.

EQUIPMENT

- Cards with pictures of local animals—mammals, birds, reptiles and insects.
- Books with photos of local animals, plants and insects.
- Internet for access to further photos and information.

My special animal: Planning

Teachers and Aboriginal people plan the unit together. Teachers could ask an Aboriginal expert about the animals that are important to them and that are likely to be seen on a bush trip or in the community nearby. It will be easiest for the Aboriginal expert and teacher to do this on country with animal tracks or signs and/or with the animal cards or other photos and books. Choose the way that suits Aboriginal people and context. Western science uses groups like 'mammals, birds, insects, reptiles or fish'. Aboriginal people have other ways to groups animals.

Within these groups ask an Aboriginal expert to pick those animals that students are likely to see. In one example of this activity, people reduced the bird cards from 44 birds to 21 local birds. All the nocturnal birds were put aside. Fewer options will make it easier for students to choose. The animals likely to be seen will vary from area to area, habitat to habitat and season to season.



A Wedge-tailed Eagle. Photo by Simon Cherriman.



Debbie Wongawol and others talk about Karlaya.

We go bush to hunt and eat Karlaya.

How to find their eggs? Track their foot. Follow them backwards to lead to the nest. Which one is the father's foot? The father's foot is wider, flatter.

Follow the fresh track.



Responses to this activity in October 2018 in Wiluna with a group of mixed age people. Some were Birrilburru and Matuwa-Kurrara IPA rangers. Mosaics from Wiluna Remote Community School. (top) Photo by David Broun, CSIRO. (left) Photo by Fiona Walsh.

What type of country do they live in? It is mixed country. Karlaya walk a long way. They feed in the burnt country. They eat in the Mulga if there is fruit there. They nest in the open.

The Karlaya fat was used for bush medicine.

The Karlaya eat Quandong, other fruits.

My special animal: Learning in class (preparation)

Activity 1: What do we already know about animals?

This activity should include students, Aboriginal people and teachers.

- 1 Shuffle the selected animal cards so that they are well mixed and spread them on the floor or desk so all students can stand or sit around them.
- 2 Ask students to look carefully at animals on the cards, think about them and then pick one card of an animal they are interested in.

If two students pick the same animal, that is OK. It will allow the class to later hear and compare what the students think. A photocopy or drawing of the animal card can be given to one of the students who picked the same animal.

If a student can't or doesn't want to pick an animal, then someone else can choose it for them.

The student then writes, draws or thinks of a way of showing what they know about that animal. This might be because it is an animal they see often on bush trips with family, an animal their family hunts to eat, an animal a relative keeps as a pet or an animal that has a Dreaming story. Or it might be an animal with pretty colours or unusual behaviour.

- 3 In a group, all students listen to each other. Each student shows the others the card of the animal that they chose. They tell the group what animal they chose and why.
- 4 The teacher then asks them to consider questions about their animal.

Questions (for example):

- What local animals do you like?
- What do you know already about this animal?
- What does it look like?
- Where do you see it?
- Where does it live?
- Does it live by itself or with its family?
- What does it eat?
- When do you see it?
- What more do you want to learn about this animal?
- And other similar questions.

Introduce the task—students can use this information to start an eBook or write key information in their Two-way Science journal. They will learn more about the animal from Elders on country and add this to their eBook, journal or report.



Photo by David Broun, CSIRO.



Listen for your animal.



Look for nests
and burrows.

My special animal: Learning on Country

1. Students learn about the chosen animal from Elders.

- Look for the animal as they walk or drive.
- Take photos, record stories or write down what is learnt.
- Bring feathers or other signs of the animal back to the classroom.
- Help each other to find the chosen animals.

Equipment

iPad/camera, journals, animal cards.

Photos by David Broun, CSIRO.



Look for the food
your animal eats.



Look for tracks
and scats.



Collect feathers or other
signs of your animal.

My special animal: Learning in class (follow-up)

Activity 2: Record the learning

Students go back to the drawing, writing or other recording of their animal that they made before in class. They add to this the things that they have learnt from their bush observations of the animal and what they have learnt from Elders.

These questions can be used as prompts when recording information about the chosen animal:

- What are the names of the animal—local names, English names?
- What does it look like?
- Where is its home or habitat?
- Was the animal by itself or with its family?
- What was it eating?
- What season is it?
- Any other questions.

The student might look for more information about their chosen animal. They could look in books or online.

Activity 3: Share the learning

Show parents and the community the records made by students. Listen and share between students and visitors.



Marlu or kangaroo. Wiluna School mosaic. Photo by David Broun, CSIRO.

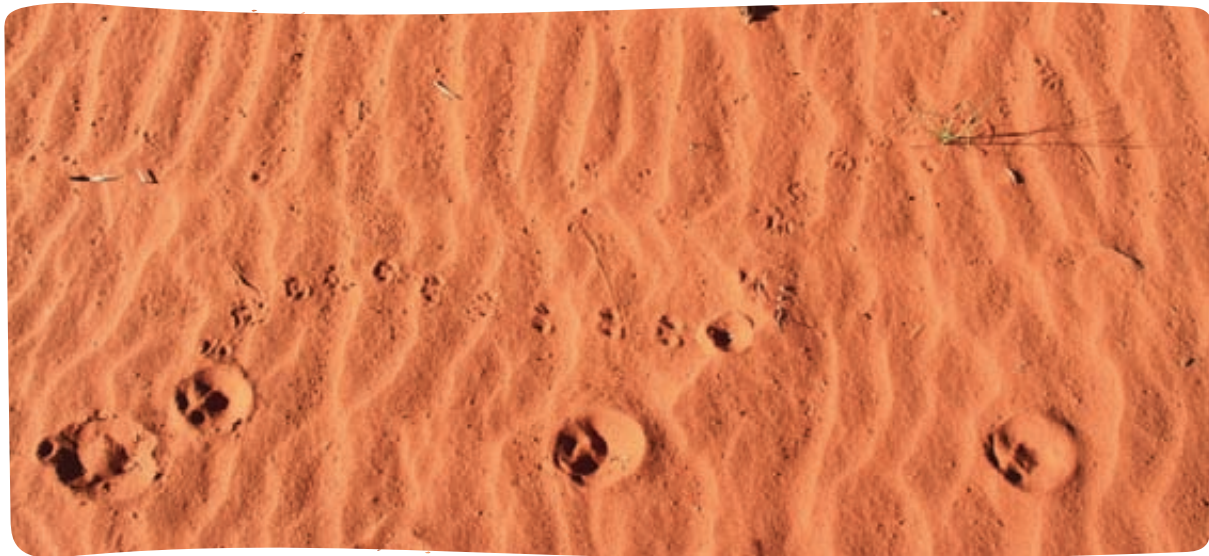
Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Describing and identifying the characteristics and behaviours of different animals.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043).
Learning on Country. Identifying signs of animals by their tracks, droppings, etc.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning on Country. Identifying signs of animals by their tracks, droppings, etc.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021 ACSHE034).
ACTIVITY	SCIENCE INQUIRY SKILLS
Describing and identifying the characteristics and behaviours of different animals.	• F Pose and respond to questions about familiar objects and events (ACSI014). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025, ACSI038).
Learning on Country. Identifying and recording signs of animals by their tracks, droppings, calls, etc.	• F Participate in guided investigations and make observations using the senses (ACSI011). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026 ACSI039).
Sharing your 'special animal'.	• F Share observations and ideas (ACSI012). • Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029 ACSI042). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060 ACSI071).

Unit 2: Tracking

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

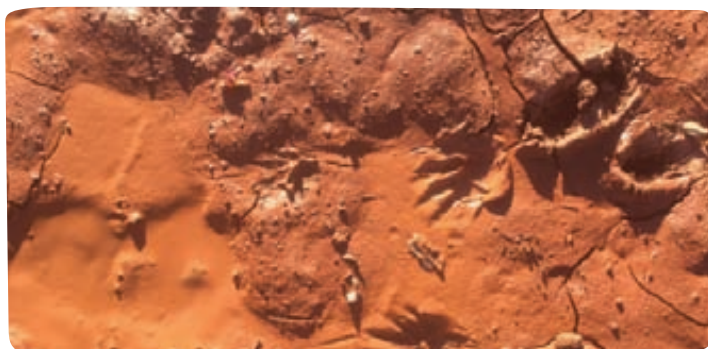
Students learn the traditional skills of tracking from an expert tracker. They learn how tracking is used for hunting and also how it is used today to support conservation projects on Aboriginal-managed land. Students learn about the habits and movement of animals by learning to make animal tracks in the sand. Expert trackers lead students on a field trip where students will use a data sheet to record the animal tracks, scats and burrows they identify.



How many animal tracks and signs can you see in this photo? There are at least four animals here: a feral cat walking from left to right, a hopping mouse going from top to bottom, a beetle wandering, and the pit and track of an antlion. Photo by David Broun, CSIRO.

BACKGROUND

Tracking is a cultural skill used by Aboriginal people to identify and hunt for animals. Many Aboriginal people can tell the species, size, sex, and behaviour of animals from their tracks as well as the time the tracks were made. Tracking is a key skill used by Aboriginal rangers working with scientists to determine if threatened and feral species live in an area.



(left): Rangers follow a Bilby track to burrows in Warralong. Photo by Blair Parsons.

(right): Front paws of a kangaroo in the mud. Photo by David Broun, CSIRO.

(opposite): Wiluna Martu rangers deliver training in trackplot monitoring to teachers from Wiluna Remote Community School during a Two-way Science workshop. Photo by David Broun, CSIRO.

Tracking: Planning

Meet with an expert tracker to plan the unit. Ask them:

- What do they think students should learn about tracking in the local area, in the current season?
- Where should students visit to learn about and survey animal tracks?
- Who is the best person to take the students on a field trip to this place?

Note: The activities in this unit have been adapted from 'Training in Tracking' developed by the North Tanami rangers, the Warlpiri rangers, Elders from the Lajamanu Community and the CLC Bilby Blitz project. The 'Circling of tracks' exercise is based on a concept shared with the rangers by the San people of Namibia at the World Parks Congress in 2015. The tracking data sheet is adapted from material supplied by the Tangentyere Council from its Land and Learning program.

Tracking: Learning in class (preparation)

Activity 1: What do we already know about tracks?

Students share what they already know about tracking. Ask students:

- What animal tracks do you know?
- Can you make animal tracks in the sand?
- What tracks do you want to learn about?
- What are the animals called in Standard Australian English? In Language?

Students ideas can be documented in individual or whole class Two-Way Science journals through drawings/writing, or a class chart.



Activity 2: Talk about animals and their tracks

Invite one or more expert trackers to talk to the students about tracking in the old days and how tracking is used now. Ask permission to record the talk so the students can listen to it again, and later write about what they learn.

The expert trackers may talk about:

- tracking when hunting
- tracking to find water
- tracking to know who was around
- tracking if someone was missing.

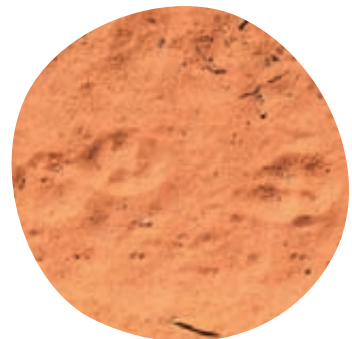
Arrange with a local ranger group or Aboriginal expert to work with students. They can use pictures of local animal and their tracks to:

- teach students animal tracks and names in Language
- run a quiz for the students using the pictures.

Use the pictures of animals, tracks and Language names to create cards for sorting and classifying activities in class, and to place on the class word wall.



**Can you match
these animals with
their tracks?**



Australian Bustard photo by Tony Castro. Animal tracks photos by David Broun, CSIRO. Red Kangaroo photo by Rileypie. Dingo photo by Newretreads.



Activity 3: Draw animal tracks

Aboriginal people have developed particular techniques, using different parts of their hands, to replicate tracks in sand, as part of teaching others about tracks.

- Find a flat sandy place, or collect sand and spread it out on a tarp.
- Ask students to sit around it.
- Use the photos of the animals and their tracks for Elders to talk about each animal, where it lives and what it eats.
- Aboriginal expert demonstrates how to make the track of each animal, and students copy.

Activity 4: Game: What animal are you?

Play a game where students make the tracks in the sand, and show how the animal is moving. Other students guess the animal, and what they are doing.

Activity 5: Plaster casts of tracks

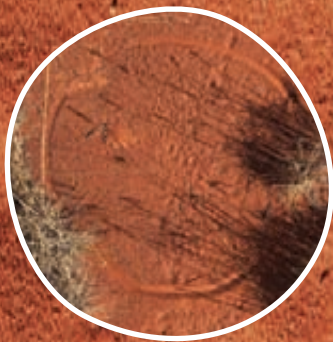
Tracks can be recorded using plaster. Start by making casts of students' own feet, then record animal tracks on country. An expert tracker can describe the way that animals make different tracks depending on how they move, their weight and how heavy they are. Tracks can be different when made on different ground. Ask the students: Why is sand good for tracking?



(above): Martu Elder Rita Cutter prepares the sand for drawing tracks during planning with teachers. Photo by David Broun, CSIRO.

(middle): Photo by Christine Reid, supplied by the Central Land Council.

(bottom): Photo by Michelle MacRae.



Which way
was it going?

How big is
the animal?

What animal
made the track?

How old is
the track?

Tracking: Learning on Country

- 1. Learn about tracking from Indigenous knowledge holders.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
- 2. The expert tracker heads out before students and circles any interesting tracks, scats and burrows.**
- 3. Students follow the expert tracker's footprints in the sand to find circled animal tracks. Don't step on the tracks in the circles!**
- 4. Students learn from the expert tracker how the tracks and scats tell the story of the animal.**

Equipment

iPad/camera, journals.

Photos by David Broun, CSIRO.

What was
it doing?

Why has it left
the scat here?

Is it going
fast or slow?

If there is more than
one track, which one
was there first?



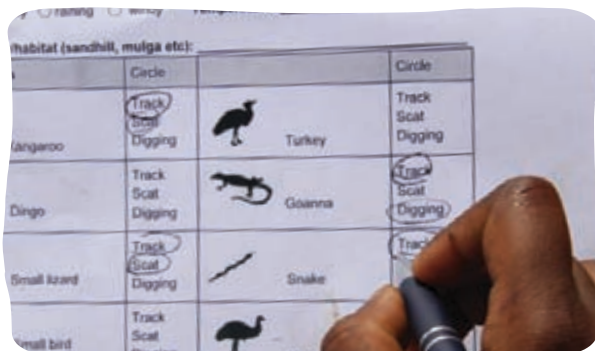
Activity 6: Recording tracks

Indigenous rangers use traditional tracking skills in work with scientists to research animal biodiversity, threatened species and the impact of feral animals. In this activity students record data about the tracks they find.

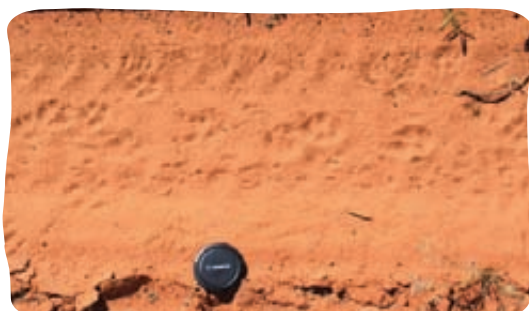
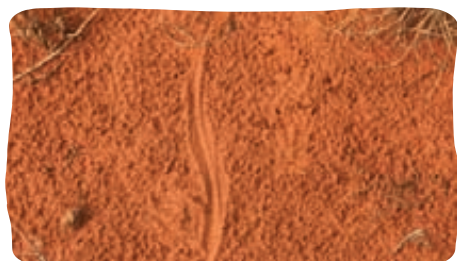
- 1 Students follow an expert tracker around a tracking site for 20 minutes. If there are several experts, each tracker can work with a small group of students.



- 2 Students work with the expert tracker to identify tracks of animals living in the area.
- 3 Students record tracking data using the 'Tracking data sheet'.



- 4 Take a photo of each track to use back in class.



(clockwise from top)
Emu track. Dingo scat.
Perentie track. Bilby
burrow and track. Dingo
and bilby track together
photographed with a
camera lens cap. A known
object can be used to
reference the size of the
tracks in photos. Photos
by David Broun, CSIRO.

Tracking: Learning in class (follow-up)

Activity 7: Data sheet

Look at the results in the data sheets and photographs. Discuss with students:

- What animals did we find?
- How many different animals did we find?
- Were there any surprises?
- Compare the number of feral and native animals (see the 'Feral animals and threatened species' unit).

Record the data:

- Make a list of the animals found at the tracking site.
- Make a chart with each animal name and a printed photo of the track, scat or digging.



Student draws a Malleefowl track on the whiteboard (left) and a Malleefowl track (above). Photos by David Broun, CSIRO.

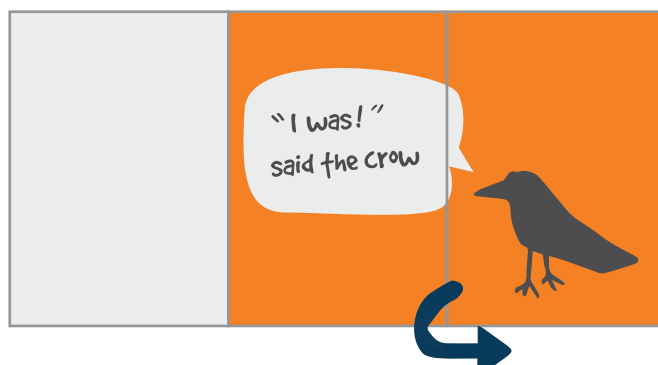
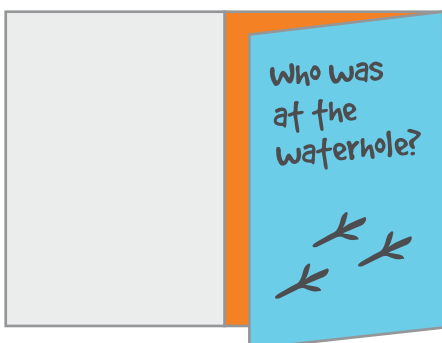
Activity 8: Recount

Make a book with the students that shows what they found on the field trip.

This could be a class big book: 'Who was on the sandplain?' For example:

- Fold a page over and on the outside section of the folded page students draw or paint the scat or track of the animal along with the words 'Who was at the waterhole?'.
- When the page is opened the students draw the actual animal and write the words, e.g. 'I was!' said the crow.

Or, it may be an information book that tells all about a focus animal, including information in both Standard Australian English and Language, stories told by the Aboriginal expert, and other information learnt.



Activity 9: Tracks, scats and burrows

- Make cards with track/scat/digging on one side and an animal name on the other. Use these to classify scats, tracks and burrows in differing ways, for example:
 - by animal
 - by size
 - by type.
- Match animal cards with their tracks/scats/burrows.

Activity 10: Compare tracking sites

Take photos and/or complete data sheets to compare tracks at two or more sites, e.g. a sandplain and a sandy river bed. Or compare the same site at different times of the year. Make a simple chart to show the difference. Are the results different or the same? Why? This activity can be run as a science investigation.

Activity 11: Nocturnal animal tracks

Many animals in the arid zone are nocturnal. They are active at night to avoid the heat of the day or to reduce visibility to predators. Students can select an area in the community to investigate tracks. Students can smooth an area of sand near a place they have seen animals and record the animal tracks made during the night.

Activity 12: Track symbols hunt

Visit the local place where artists paint or make things. Ask an artist to lead students through some works to look for evidence of animals in the artwork. This can be recorded in a data sheet.



Here a Martu teacher points out to a student the red marks that show Bush Turkey (Australian Bustard) tracks. She asked the student which direction the bird was walking. He said it was going from top to bottom. Photo by David Broun, CSIRO. Images of artworks appear courtesy of Tjukurba Gallery, Wiluna, WA.

Activity 13: Trackplot monitoring with a ranger group

Indigenous rangers work with scientists to research threatened species and feral animals on their country. Ask your local ranger group if students can accompany them on a trip where they use tracking as part of their work (see the 'Feral animals and threatened species' unit).

Looking for tracks

Name:

Write the Language name for the animals you find and draw their tracks.

Native animals:



Kangaroo



Turkey



Dingo



Goanna



Little lizard



Snake



Little bird

Other animal

Feral animals:



Rabbit



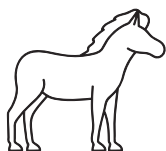
Camel



Cat



Fox



Horse/Donkey

Other animal

Tracking data sheet

Name:

Location: Date: Time:

1. Weather:

☐ sunny

☐ cloudy

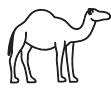
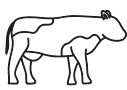
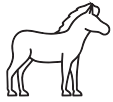
☐ raining

☐ windy

2. Country type (in Language or English):

.....

NATIVE		CIRCLE		NATIVE		CIRCLE	
Kangaroo		Track Scat Digging		Turkey		Track Scat Digging	
Dingo		Track Scat Digging		Goanna		Track Scat Digging	
Little lizard		Track Scat Digging		Snake		Track Scat Digging	
Little bird		Track Scat Digging		Emu		Track Scat Digging	
Hopping Mouse		Track Scat Digging		Other		Track Scat Digging	
Other		Track Scat Digging		Other		Track Scat Digging	

FERAL		CIRCLE		FERAL		CIRCLE	
Rabbit		Track Scat Digging		Camel		Track Scat Digging	
Cat		Track Scat Digging		Cattle		Track Scat Digging	
Horse		Track Scat Digging		Other		Track Scat Digging	

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Identifying and recording animal tracks and behaviour.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044).
Comparing animal tracks at two different sites.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y4 Living things depend on each other and the environment to survive (ACSSU073).
ACTIVITY	SCIENCE UNDERSTANDING—PHYSICAL SCIENCES
Learning how animals make different tracks depending on their size and weight, and that tracks from the same animal change in different types of ground.	• F The way an object moves depends on a variety of factors including its size and weight (ACSSU005). • Y2 A push or pull affects how an object moves or changes shape (ACSSU033). • Y4 Forces can be exerted by one object or another through direct contact or from a distance (ACSSU076).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning on Country. Identifying signs of animals by their tracks, droppings, etc.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021 ACSHE034). • Y2/3 People use science in their daily lives, including when caring for their environment and living things (ACSHE022 ACSHE035).
ACTIVITY	SCIENCE INQUIRY SKILLS
Photographing and recording tracks in a data sheet.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029 ACSI042). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025 ACSI038). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026 ACSI039). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060 ACSI071).

Unit 3: Animal habitat

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students go on a field trip with an Aboriginal expert to learn about an animal and its habitat.

Aboriginal people can share stories of the old days including how to hunt and cook the animal, and why the animal is important to people. Students learn from Aboriginal people about the place where the animal lives, its food, shelter and what it needs to breed. They will collect material from the site for an investigation into animal habitat and represent their learning through an integrated art and STEM project using models and a mural. This activity is ideally suited to a study of a bird and its nest. However, the activity can be applied to any animal.

BACKGROUND

Western science understands habitat as a place where a particular type (species) of plant or animal has all of the things it needs to survive including food, shelter and a place to reproduce. Aboriginal people have developed an intimate understanding of habitat through their stewardship and management of country. Traditional burning is used to promote conditions for animals to shelter, feed and breed.



Wiluna Martu Elders taught students about the Mantlangaku (Bilby). Bilby habitat in this case is spinifex sand plain country. This habitat provides food in the form of grubs in the roots of plants, insects, fruits and seeds. Bilbies shelter from predators and the desert heat in deep burrows in the sand. Bilbies can survive away from water sources because they get water from the food they eat. To breed they need other Bilbies and shelter for their young once they leave the pouch. Photos by David Broun (CSIRO) and butupa.



Malleefowl habitat is in thicket country which has dense leaf litter. Thicket country provides food in the form of insects, small lizards and fruit, shelter from larger predators such as eagles, and the material for their mound nests to keep the birds' eggs at an even temperature in the extremes of hot and cold. Photos by David Broun (CSIRO) and Benard Dupont.



Zebra Finches are an important indicator of nearby water in the desert as they never travel far from a reliable source. Zebra Finches get seeds and stalks to build nests from the grasses in their habitat. Zebra Finches nest in thorny trees for protection from predators. Photos by David Broun (CSIRO) and Brenton See.

Animal habitat: Planning

Aboriginal people and teachers plan the unit together and arrange for a Learning on Country field trip to find out about an animal and its habitat.

Questions for Aboriginal experts:

- What animal do you want students to learn about?
- What do you think the students should learn about that animal, in the current season?
- Where can we go to on a field trip to learn about this animal?
- Who is the best person to lead the students on a field trip to that place?
- What other plants and animals live at this place?

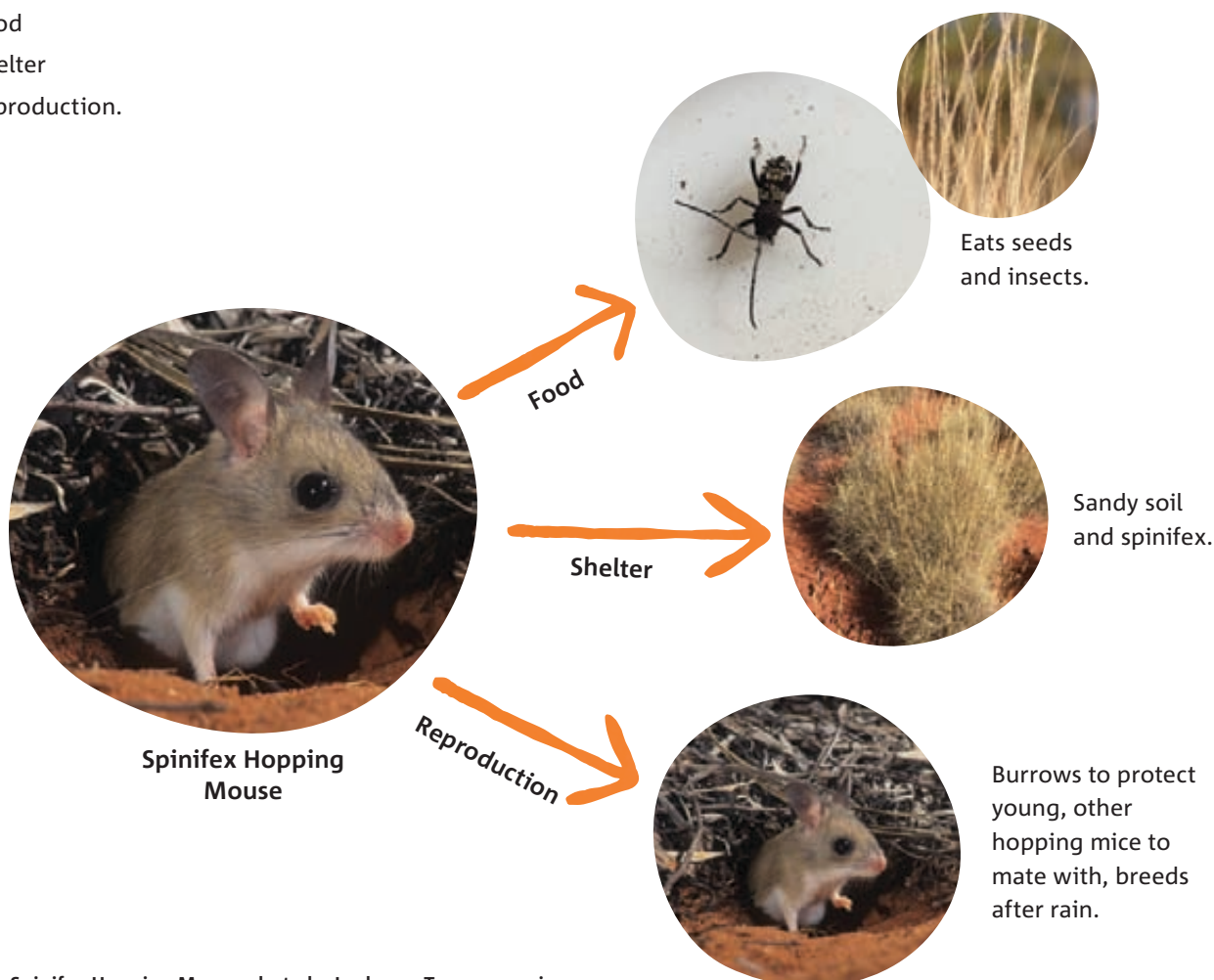
Teachers: research the animal and its habitat. Find videos and books about the animal to use in class to supplement the teaching from Aboriginal people.

Animal habitat: Learning in class (preparation)

BACKGROUND: WHAT IS A HABITAT?

A habitat is a place where a particular type (species) of plant or animal has all of the things it needs to survive:

1. food
2. shelter
3. reproduction.



Spinifex Hopping Mouse photo by Lochman Transparencies.
Other photos by David Broun, CSIRO.

Activity 1: What is my habitat?

1 Talk to the students about the place that they live. This may include:

- food and water
- a home that is a shelter when it is cold, or hot, or raining
- family nearby—mother, father, aunties, uncles, brothers and sisters.

Explain that this is their habitat. There are three parts to habitat—food, shelter and reproduction.

2 Make a table (chart) to display in the classroom that includes simple pictures and headings for each identified need.

Activity 2: Habitats of other animals

Students learn about the habitat of familiar animals.

1 Ask the students to suggest a local bird that they know. Ask them what the bird needs for food, shelter and to have babies (e.g. the Wedge-tailed Eagle eats kangaroos and goannas, perches on trees, has a nest to have babies, and finds other Wedge-tailed Eagles to breed with).

2 Add this to a table (see Activity 1) as the bird's habitat. Continue with any other familiar animals. If students don't know an answer, make a note to ask an Aboriginal expert.

3 Give students the habitat template (see template at the end of the 'Animals' topic) to write or draw examples of animals and their habitat.

Add any new words to the word wall in Language and in Standard Australian English.

Activity 3: Field trip preparation

Aboriginal experts visit the classroom to talk to students about the chosen animal and introduce Aboriginal Language.

Teacher:

- Focus the Learning on Country.
 - Connect, question and predict—ask students:
 - What do you know about the animal and the place where it lives?
 - What does it eat?
 - Does it live in a burrow or nest?
 - Where does it have babies?
 - What is the animal doing now?
- Prepare equipment and go through the field trip plan.
- Introduce the task—you are the animal. What do you need to eat, shelter and breed?

Example: Does it live in a burrow or nest? What does it eat? Why is this animal important to people?

Where does it breed?

Photograph nests, burrows or shelter.



What does the animal eat?

Collect samples of seeds, scats, bones etc.



What can you hear?

Make a recording.



Animal habitat: Learning on Country

1. Learn about an animal from an Aboriginal expert.

- Record stories.
- Write down Language names.
- Take photos.

2. Ask students: 'You are the animal. What do you need to survive?' (Food, shelter, breeding).

3. Collect data and samples to take back to the classroom.

Equipment

iPad/Camera, microphone and recorder, journals, pencils, buckets, containers and lids.

Photos by David Broun, CSIRO.

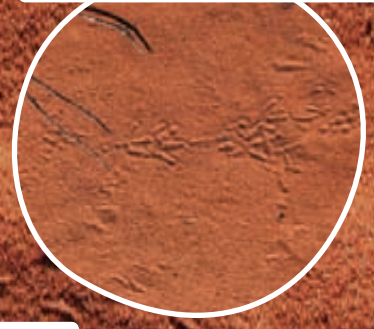
What bugs can you find?

Photograph or draw them.



What other animals live here?

Photograph or draw tracks, scats or burrows.



What is this country called (e.g. sandplain, rocky country)? What plants grow here?

Take cuttings, collect flowers and seeds, collect litter from the ground under the plants, collect materials to make a nest.



Animal habitat: Learning in class (follow-up)

Activity 4: Recounting the learning

Aboriginal person and teacher together: reflect, recount and write about the field trip.

- Listen to/view any photographs, recordings and videos.
- What did we learn from Elders about the animal?
- Add new words in English and Language to the class word wall.

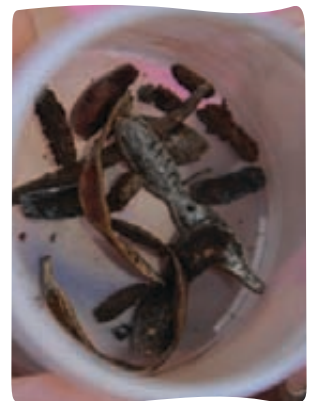
Activity 5: Sorting litter

Use samples the students collected for sorting, classifying, ordering activities, e.g. sort and classify the litter into groups.

- 1 Find examples of the leaves of the different plants. Label them in Language and Standard Australian English.



- 2 Look for seeds and insects in the litter. Sort them. Who eats this food?



Photos by David Broun, CSIRO.

3 Look at the seeds and insects under the microscope.



Grass seeds from an investigation into Zebra Finch habitat. Photos by David Broun, CSIRO.



A small spider and spider exoskeleton found in leaf litter. Photos by David Broun, CSIRO.



4 Identify what students find.

- Take a photograph using the microscope.
- Identify what you find. If you don't know, take an educated guess and research or ask an expert later.
- Record as a class or in a Two-way Science journal.

Activity 6: Investigate scats

Scats can provide information about animal diet. Some scats will show the food an animal has eaten clearly. Take a photo of the scat in the field or collect a dry sample. Use a stick or tweezers to break up the scat. Look carefully with a magnifying glass or microscope to find evidence of the animal's diet. Collect only dried scats, use gloves, avoid direct handling and wash hands afterwards.



Students found evidence of diet in the form of prey remains under a Wedge-tailed Eagle nest. Photo by David Broun, CSIRO.



Raptors such as eagles, hawks and owls disgorge pellets containing undigested food. This can give clues to their diet. Here kangaroo fur and a reptile skin and bones are clearly visible in a Wedge-tailed Eagle pellet. Photo by David Broun, CSIRO.



Animal scats can give information about their diet. These pictures of Emu scat show seeds in one scat and an insect shell in another. Photos by David Broun, CSIRO.

Activity 7: Making nests/models

Use the collected materials and the knowledge learnt on country to build models of the nest the animal makes, or the place that it lives.



In Wiluna, students learnt about the Nganamarra (Malleefowl) and its mound nest from Elder Rita Cutter. The teacher asked the students: 'You are the Malleefowl, what do you need to make your nest?' Students used the litter they had collected to make a nest with Rita. This strengthened the students' understanding of Malleefowl habitat. Students learnt that the Malleefowl keeps its eggs warm in cold weather by using the heat produced by decomposing litter, and cool in warm weather by using the insulation properties of the same litter. Clever birds! Photos by David Broun, CSIRO.



Leonora students made Nyii Nyii (Zebra Finch) nests using grass collected on a Learning on Country field trip. Photos by David Broun, CSIRO.

Activity 8: Create a mural

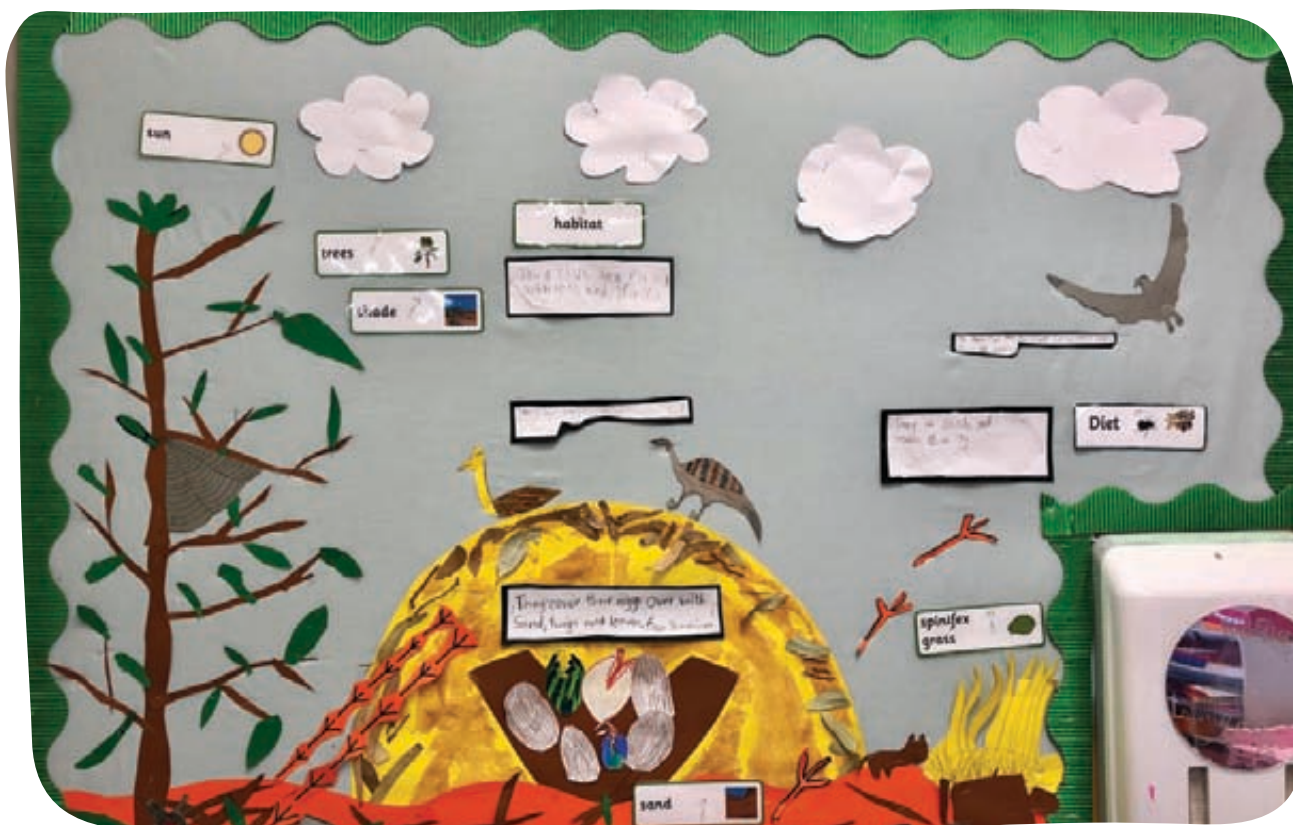
Using the collected specimens from the field trip, and any other art supplies (e.g. paint, crayons, pastels), create a mural representing the country students visited during the field trip. The mural can be started low on a wall, on the ground, or on top of desks to make it interactive and accessible for students. Move the mural to display when it is finished. Try to make it as accurate as possible by positioning plants and animals where students found them (e.g. under litter, in the sky, between rocks, in sandy areas).

This is a way of recording, representing and communicating data.

Encourage students to use scientific drawing and painting.

- Only include what they found or learnt on the field trip.
- Pay attention to the colours, e.g. different shades of green, brown and grey.
Encourage students to mix paint to make different colours.
- Pay attention to the textures, e.g. shiny, dull, smooth and rough surfaces. Explore various techniques to represent these.

- 1 Sketch out the background.
- 2 Add plants. Place in the large trees, then add other plants.
- 3 Attach animals and insects so that they can be moved in later activities.
- 4 Label the mural in Standard Australian English and Language.
- 5 Add stories and other information.



(above): Mural showing data collected during a Two-way Science investigation into the Malleefowl in Wiluna. Photo by David Broun, CSIRO.

(opposite): Early Years student diagram of life around a tree.

Activity 9: Habitats of local animals

With assistance from an Aboriginal person, students record what an animal needs for food, shelter and reproduction. Use the animals of the class mural. Students can use this to reflect on where they placed the animals and insects in their mural.

Activity 10: Flip book

Students can create a 'flip book' showing what each different animal eats.

For example: 'I am an echidna. I eat ... termites.' 'I am a Spinifex Hopping Mouse. I eat ... seeds and small insects.'

This can also be done in Language, and/or with the focus of shelter.

For example: 'I am a termite. I live inside logs.'

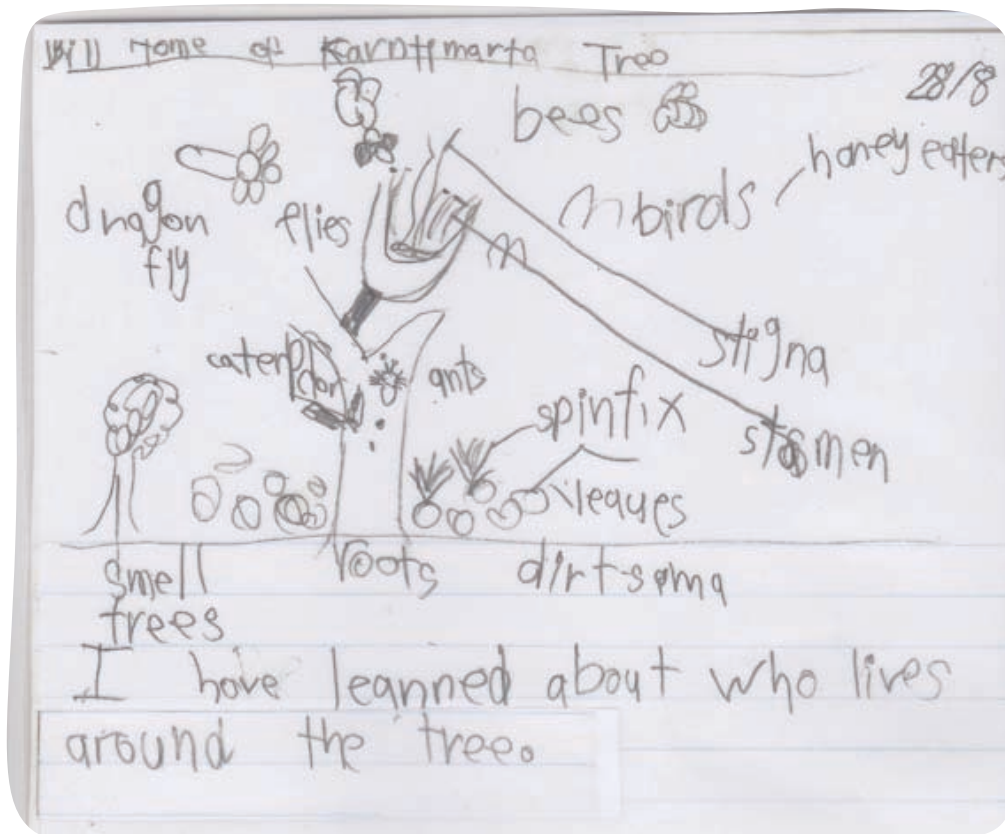


Photo by Cameron Hugh, CSIRO.

Food webs and ecosystems

In these activities students use their mural to illustrate a food web or ecosystem. They represent visually how animals and plants are dependent on each other for food to survive. They use the food web to explore the impact of changes to the ecosystem when the food web is disrupted by a feral animal or the disappearance of a part of the food web (extinction). The food web is an interactive, moving and evolving representation of the students' knowledge of the place where the animal lives. It provides an engaging hands-on approach to studying the desert environment as an ecosystem.

BACKGROUND

Animals and plants depend for each other on survival and exist together in an ecosystem. For example, in an arid zone ecosystem, small marsupials rely on native grasses and invertebrates for their food. They turn over the soil and fertilise this with their scats, which helps create the conditions to grow more grass. These animals are eaten by predators such as eagles. Ecosystems are delicately balanced and can be disrupted by invasive species such as feral cats, which can reduce the populations of marsupials and birds, further impacting on the animals that rely on them for survival. The predator-prey relationships can be shown as a food web.

Activity 11: Food web

Use the large class mural created in the animal habitat activity. Use lengths of string or wool to make connections between each animal and its food.

For example, a length of wool would connect an antlion and ants; a Dingo would link to kangaroos and rabbits; a honeyeater with nectar from flowers; Rainbow Bee Eater with insects; echidna with termites; a Malleefowl to seeds and insects, etc.



The mural from page 124 with arrows to indicate the connections between the animals, food and shelter; and the origin of the shelter, e.g. fallen leaves and twigs. Photo by David Broun, CSIRO.

Activity 12: Changes to the food web

Remove a single species at a time from the food web, talking about how the removal impacts the other plants and animals that it was connected to.

Choose an animal or plant in the food web, and ask students:

- What would happen if this plant/animal was removed?
- What will happen if there are more of this animal or plant

For example:

- What happens when we remove the ants? The antlion will have no food.
- What happens when we remove the echidna? There might be more termites.
- What happens when we remove the cats? There will be more birds, Bilbies, lizards, house mice, etc.

Activity 13: Record and share the learning about the food web

Students can write their findings in their Two-way Science journal. They can invite parents, other classes or rangers into the class to show them what they have learnt.



The male Western Bowerbird builds elaborate bowers where it performs dances to attract a mate. He decorates the bower with colour-themed found objects. In recent times this includes human-made items, a reflection of its changing habitat. Photo by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning that animal habitats include the elements of food, shelter and reproduction.	• F Living things live in different places where their needs are met (ACSSU211). • Y1 Living things have a variety of external features (ACSSU017). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
Investigating the habitat of an animal during a field trip. Collecting evidence of animal diet, and shelter. Making a model of an animal shelter.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning about the impact of feral animals on foodwebs and ecosystems.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y3/4 Science knowledge helps people to understand the effects of their actions (ACSHE051, ACSHE062). • Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061).
ACTIVITY	SCIENCE INQUIRY SKILLS
Recording animal habitat using the habitat template. Making a mural showing animal habitat. Creating a mural showing connections in an ecosystem.	• Y1/2 Use a range of methods to sort information, including drawings and providing tables through discussion, compare observations with predictions (ACSI027, ACSI040). • Y1/2 Compare observations with those of others (ACSI0213). • Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110).

Animal habitat

Food

Shelter

Reproduction

Unit 4: Feral animals and threatened species

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

In this unit students will learn about feral animals and threatened species, and the work that Indigenous rangers are doing to manage the impact of feral animals on the environment and threatened species.

BACKGROUND: NATIVE, FERAL AND THREATENED SPECIES

Australia is home to unique wildlife with each species adapted to living in the extremes of this landscape. Unfortunately Australia has the unenviable record of having the worst mammal extinction rate in the world. Almost all of the medium-sized mammals that once lived in the outback are now extinct, or have disappeared from mainland Australia but survive only on off-shore islands or in predator-free enclosures. Other species are hanging on in pockets of their former range on the mainland. The primary cause of these alarming declines is the introduction of feral animals, particularly cats. Australia's native animals are vulnerable to predation by feral cats because they did not evolve with feline predators and therefore haven't developed effective predator avoidance instincts. In the Western and Central Desert regions, cats, camels, foxes and large wildfires have a high impact on the environment and are the focus of management efforts by Indigenous rangers and scientists.

CATS

Cats are not native to Australia. They were introduced, arriving as pets with the first fleet. Since then cats have become wild (feral) and are now present in 99.8% of the Australian continent from the harshest deserts to the snow covered Alps.



(left): Feral cat image from a motion sensor camera. Photo by DBCA MKK IPA research.



(right): The remains of a bird killed by a feral cat. Photo by David Broun, CSIRO.

CAMELS

Camels were brought to Australia in the 1840s where they were used for exploration and development in arid areas in favour of horses. Camels are adapted to arid environments and this has led to Australia having the largest wild camel population in the world. Camels cause significant damage to Australia's environment. One of the biggest impacts is their ability to empty and pollute rockholes that contain precious water. A single camel can drink up to 200 litres of water in one go. A herd of camels can easily empty a waterhole, leaving little or no water for native animals. Camels are able to consume a wide variety of native plants and overgrazing is a problem in some areas.



Feral camels seek relief from the heat in a once pristine waterhole. Photo by Pat Hodgens and Jayne Brim-Box.

Feral animals and threatened species: Planning

Meet with local rangers to plan the unit. Go through the unit together and ask them:

- What feral animals and threatened species are you working with at the moment?
- Go through the animal cards to look for examples of local native animals, feral animals and threatened species. Discuss how these cards can be used in an activity with students.
- What do you think the students should learn about these animals and the work rangers are doing?
- Where should students visit to learn about the work you do with these animals?
- Who is the best person to take the students on a field trip to this place?
- Arrange a visit by rangers to the class.

Feral animals and threatened species: Learning in class (preparation)

Students learn the language and concept of native animals, feral animals and threatened species by seeing examples, sorting known animals into groups and learning about the work of Indigenous rangers. All of these activities can be conducted with the support of local Aboriginal people, rangers or scientists.

Activity 1: Native animals, feral animals and threatened species

BACKGROUND

Native animals have been in Australia for thousands of years.

Feral animals are animals that have been brought to Australia and have now gone wild. Feral animals cause problems for native animals and plants.

Threatened species are any species of animal or plant which might soon become extinct.

- 1 Add the words 'native animal', 'feral animal', 'threatened species' and 'extinct' to the class word wall.
- 2 Explain the concept of native animals, feral animals and threatened species using animal cards or photos of examples such as kangaroos, goannas, cats, camels and Bilbies. Put these animals under headings in groups.
- 3 Explain to students where these animals came from and how they got here.
- 4 Use animal cards (see planning above) to sort local animals into groups—native animals, feral animals and threatened species. Discuss with students why these animals are in this category.



Animal cards sorted into feral and native. Photo by David Broun, CSIRO.

Activity 2: Where is the Bilby?

1 Watch the film 'Wanyja Mankarr? (Where is the Bilby?)' (available online).

Ask questions and discuss:

- What animals did the students see? Make a list.
- Which animals visited the burrow most?
- Why does the Bilby live in a burrow? (answers might be: 'shelter from hot and cold', 'place to have babies', 'protection from predators')
- What are the different animals doing? (answers might be 'cats looking for food', 'camels passing through')
- What threats are there for the Bilby or its babies? (e.g. cats eating Bilbies, goannas eating Bilbies, camels trampling on Bilby burrows or eating their feed, Dingos eating Bilbies, fire making them exposed to predators)
- What method do the KJ Martu rangers use to find out about the Bilby? (motion sensor cameras, tracking)

2 Data collection.

- Use a tracking data sheet to record the number of days each animal visits the burrow.
- Make a tally mark for each day the animal (including people) appears.
- Total the number of days each animal is seen.
- Answer these questions:
 1. Which animals visited the burrow the most?
 2. Which animal visited the burrow the least?
 3. Which feral animals visited the burrow the most?
 4. Which feral animal visited the burrow the least?
 5. Which native animal visited the burrow the most?
 6. Which native animal visited the burrow the least?
- Graph the information.
- Make a list of the animals in order from visiting most often to least often. The terms 'frequency', 'frequent' and 'infrequent' could be introduced depending on the age and numeracy levels of the students.

3 Discuss the question 'Wanyja Mankarr?' (Where is the Bilby?).

Where is the Bilby now? What might have happened to it?

Note: In the absence of this video, this activity can be conducted using a set of motion sensor camera photos taken by the school, or provided by a local Indigenous ranger group or scientific organisation.



Stills from the video 'Wanyja Mankarr? (Where is the Bilby?)', Kanyirninpa Jukurrpa 2014.'

Activity 3: Where is the Bilby? Acting out

In this activity students act as the animals in the video.

In the classroom or playground:

- Pick one person to be each of the seven animals (Sand Goanna, Camel, Cat, Button Quail, Dingo, person, Bilby).
- Make an area that is the Bilby burrow.
- Each person acts out their role as the animal that is visiting the burrow.
- Act how that animal moves, how it behaves, etc.
- Then act out what they think the interactions are between the different animals.

What is the role of the rangers in relation to these interactions?

Students can make a play about the impact of feral animals and present it at a school assembly.

Activity 4: Ranger class visit

Rangers talk to students about the work they are doing with feral animals or threatened species.



Photo by Mac Jensen.

Rangers/Elders may talk to students about:

- Animals the rangers see when they are out bush.
- A story from when the old people first saw a camel, horse, cattle, etc.
- Work they do looking after threatened species such as the Bilby.
- Work that they do with other ranger groups to look after native animals or control feral species (e.g. the Bilby Festival <https://www.youtube.com/watch?v=cOk7bZX8lQc>).
- Animals that are almost 'finished up' (extinct).
- Camels drinking all the water and making the rockholes dirty.

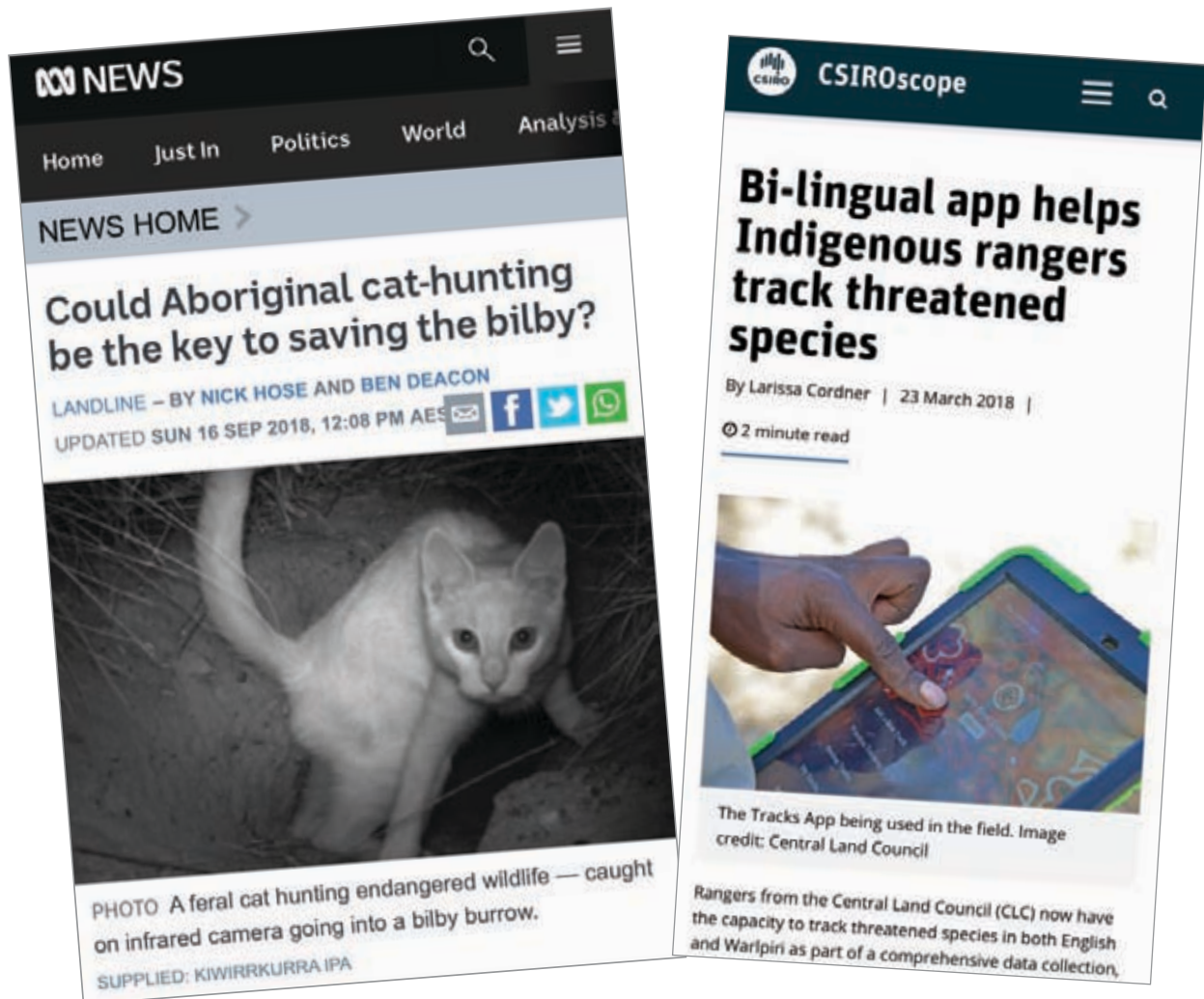
Most ranger groups will have photos of their work in these areas and these would make a great starting point. They can show the students some of the equipment that they use in this work such as motion sensor cameras, GPS units, iTrackers and other data-recording devices. Following the ranger visit, students recount what they learnt and use this in literacy activities.

Activity 5: Write a report about a threatened species or feral animal

Tell students that they will go on country with rangers to learn about a threatened species or feral animal. They will use this information to write a report about the animals that rangers work with, and how rangers and scientists look after or control them.

Early Years students' report can be a drawing and a sentence about ranger work.

Find simple examples of videos, books or news reports about rangers managing threatened species and feral animals. Use these as examples and prepare students for the report that they will write.



Ask the students:

- What do students need to find out for their report?
 - See the Learning on Country activity on the next page.
 - Make a set of questions with the class relevant to the field trip and go through these.
 - What do we already know some answers to? What else do we need to find out?
 - Assign questions to particular students to ask the rangers.

Who?

Who are the rangers that come here to work with the threatened species?

Who else comes here to work with the threatened species?

What?

What threatened species live here?

What are the threats to this species?

Where?

Where are we?

What is the name of this place?

Feral animals and threatened species: Learning on Country

1. Learn about threatened species conservation from a local Aboriginal ranger group.

- Ask questions and record answers (with permission).
- Write down Language names.
- Take photos.

2. Students will be writing a report about the work that the rangers do. Make sure to get answers to all of the questions to use later in class.

Equipment

iPad/ camera, journals, report planner.

When?

When do people come here?

When do animals come here?

How?

How do the rangers look after the threatened species?

How do the rangers use special equipment to find out about the animal?

Why?

Why is it important to look after the threatened species?

Feral animals and threatened species: Learning in class (follow-up)

Activity 6: Recount the learning

Reflect, recount and write.

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in Standard Australian English and Language to the class word wall.

Activity 7: Write a report

Use a reporting template to structure a report on the work of rangers and the threatened species that students learnt about.

- 1 Go through the questions for the report and list student learning under report headings.
- 2 List any questions that students want to find out more about.
They can guide further research or activities below.

This report can be made as a video using the recordings of rangers answering student questions, and photos and videos from the field trip. See the 'How to make a video story' section.

Other follow-up activities

Activity 8: Cat research project

Students write a report giving an overview of cats and the damage they do. This can be linked to a food web with and without cats and investigation into the adaptations of cats that makes them effective predators in the arid zone.

Activity 9: Write a story about a threatened species

Students write a first person narrative about the life of a threatened species such as the Bilby, and the challenges it needs to overcome to survive.



The Greater Bilby once lived across Australia. Now a threatened species due to habitat loss and feral cat predation, the largest Bilby populations are on Aboriginal managed lands. Photo courtesy of Save the Bilby Fund.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Watching the ‘Wanyja Mankarr?’ film. Learning about threats to the Bilby. Learning why animals visit the burrow.	• F Living things have basic needs including food and water. • Y1 Living things live in different places where their needs are met (ACSSU211). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
Counting and classifying native and feral animals.	• Y1 Living things have a variety of external features (ACSSU017). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning about feral animals and the impact that they have on native species. Learning how Indigenous rangers manage threatened species and feral animals. Writing a report on a threatened species and the impact of feral cats.	• Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050 ACSHE061). • Y3/4 Science knowledge helps people to understand the effects of their actions (ACSHE051, ACSHE062). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Counting the number of times animals visit the burrow in motion sensor camera data in the ‘Wanyja Mankarr?’ film. Graphing data showing the frequency of burrow visits. Writing a report on a threatened species and the impact of feral cats.	• Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (ACSI055, ACSI066). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110).

Unit 5: Invertebrates

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Invertebrates provide excellent subjects to explore biological and ecological components of the curriculum. Students connect their knowledge of culturally important invertebrates such as the Witchetty grub or Honeyant to a scientific investigation of invertebrates. They also use the opportunities of seasonal change with rains to investigate the explosion of invertebrate life in the desert. Some invertebrates such as antlions (the larval stage of the adult lacewing fly) are suitable to capture, study and observe in class.

In this unit, Aboriginal people will teach students about invertebrates. They will lead a field trip to find Witchetty grubs, and share knowledge about how to locate, use and prepare them for food or other purposes. This activity can be adapted to suit other culturally important invertebrates such as the Honeyant. Students will connect this learning to investigations into the life cycles, anatomy and habitat of invertebrates.

In some states, invertebrates do not require a permit or ethics approval to study for educational purposes. Check your local education department policy to make sure.

BACKGROUND: WHAT ARE 'INVERTEBRATES'?

Scientists divide animals into two groups based on their skeletons—those with a backbone, and those without. Animals without backbones such as worms, insects and spiders are called invertebrates. Animals with backbones are called vertebrates. These include mammals (such as kangaroos and humans), reptiles, birds, amphibians and fish. More than 96% of the world's animal species are invertebrates.

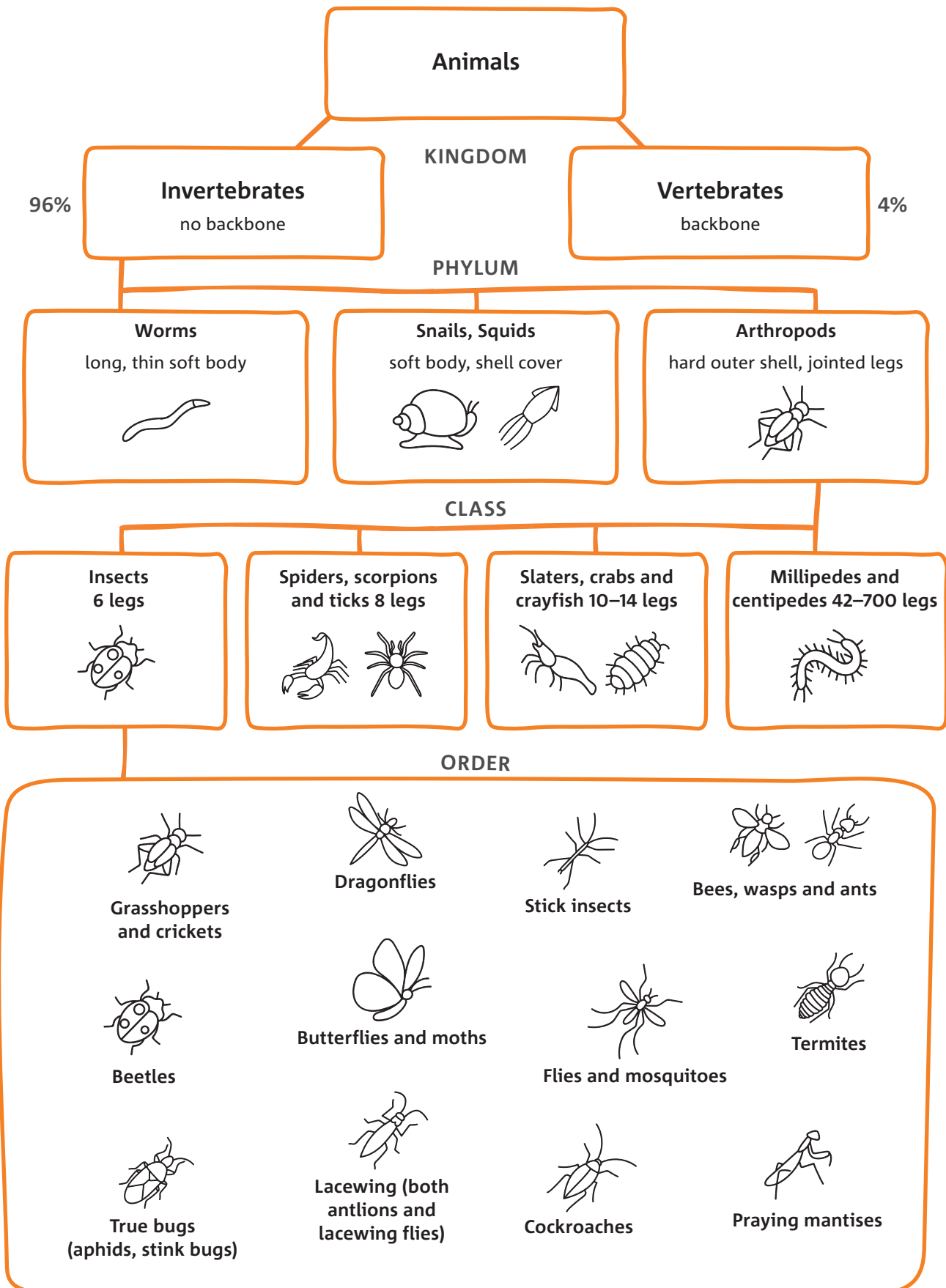


(top row): 'Invertebrates' is the term used to describe all animals without backbones. Some invertebrates have 'exoskeletons' or hard external body coverings instead of internal skeletons. Invertebrates include insects, spiders, scorpions, worms and crustaceans. Photos by David Broun, CSIRO.

(bottom left): Scorpion. Photo by Stella Gray Broun.

(bottom right): Lacewing fly. Photo by Sally Deslandes.

Invertebrate classification



Invertebrates have been important to Aboriginal people from the desert in different ways. For example, the appearance of an insect can be an indicator for seasonal change. ‘Sugarbag’ is the honey of the native bee. Witchetty grubs live in the roots of certain trees and are an important food source containing large amounts of protein. Honeyants are skillfully excavated after rain for their delicious ‘honey’.



Digging for Honeyants near Leonora in WA. Honeyants collect the sugary nectar made by aphids living on the sap of the mulga tree. The nectar is often called honeydew. Honeyants also collect nectar from mulga and other flowers. The energy from the sugars in the nectar is processed and stored as a sweet liquid in the expanded abdomen of certain ants in the colony. Locating and excavating these ants requires a complex knowledge of seasons, habitat and the structure of the Honeyant colony. Photos by David Broun, CSIRO.

Most invertebrates (except for those like worms and slugs) have a hard protective shell, called an ‘exoskeleton’. The exoskeleton must break open to allow the adult to grow. All invertebrates have juvenile and adult stages of growth, with each stage having a particular function.

Winged invertebrates, such as moths, may change through several different body forms, or morphs. This process is called metamorphosis. First, the eggs hatch. Moth eggs hatch into larvae, often called caterpillars. After feeding for some time, the larva secretes a cocoon around itself. Inside the cocoon, the larva changes, or pupates, into a ‘pupa’ to develop the body parts of the adult such as wings. It changes into an adult moth with legs, wings and body segments, and then it emerges from its cocoon as an adult.



(left): The case moth caterpillar builds structures of sticks for protection. The caterpillar (larva) moves around with the case like it is a suit of armour. Once the caterpillar is ready to pupate, it spins a cocoon inside and changes to its adult form. Some cases are also used to lay and protect eggs. Photo by David Broun, CSIRO.

(middle): Insect larvae inside a plant stem found during a student invertebrate investigation. Photo by David Broun, CSIRO.

(right): Witchetty grub pupa case after the adult cossid moth has emerged and flown away. Photo by David Broun, CSIRO.

One group of invertebrates are insects. They have six legs, a head, abdomen and thorax and one or two pairs of wings. Insects have important biological roles such as pollination (butterflies, wasps and ants), aerating soil (ants), breaking down nutrients for plants (termites) and in the distribution of seeds (ants).



(left): Image of an ant taken with a magnifying lens clipped to a mobile device during a student investigation. Can you see the head, thorax and abdomen? Photo by David Broun, CSIRO.

(right): Scorpion exoskeletons glow under ultraviolet light. They can be located at night in the bush with a UV torch. Photo by David Broun, CSIRO.

DIGGING FOR WITCHETTY GRUBS

In this activity Aboriginal experts will lead a field trip to find, catch and prepare Witchetty grubs to eat. Students will learn about the seasonal indicators of the Witchetty grub life cycle, the plants in which they are found and the habits of the larvae that allow them to be caught and eaten. This will be connected to an investigation and description of the Witchetty grub life cycle.

This activity can be adapted to suit other important invertebrates such as Honeyants.

Witchetty grubs: Planning

Aboriginal people and teacher plan the unit together and arrange for a Learning on Country field trip to dig for Witchetty grubs.

Questions for Aboriginal people:

- What are the Language names for Witchetty grubs in your area?
- When is the best time to collect Witchetty grubs?
- What do you think the students should learn about finding and eating Witchetty grubs? What Language should they learn?
- Where can we go to on a field trip to find Witchetty grubs?
- Who is the best person to lead the students on a field trip?
- What other plants and animals live at this place?



The Witchetty grub is the larval form of the adult cossid moth. Witchetty grubs create hollows in roots and feed from the sap produced by the plant. They are a staple in the diets of many desert communities. Other similar edible larvae live in tree branches and under bark. Photo by David Broun, CSIRO.

Witchetty grubs: Learning in class (preparation)

Activity 1: Introduction to Witchetty grubs

Traditional Owner: talk to students about the Witchetty grubs and introduce Aboriginal Language.

Teacher:

- Focus the Learning on Country.
 - Connect, question and predict:
 - What do you know about Witchetty grubs?
 - Do you hunt Witchetty grubs with your family?
 - Where do you find them?
 - What season do you hunt for them?
 - How do you dig them out?
- Prepare equipment and go through the field trip plan.
- Introduce the task of writing a procedure about finding and digging for Witchetty grubs.
Learning from Elders how to find, collect, prepare and eat the Witchetty grub.



Pupa cases of the emerging adult cossid moth are an indicator of Witchetty grubs. Photos by Fiona Walsh.

Where is the Witchetty grub found? What country does it grow in?



What does the Witchetty grub eat?

Witchetty grubs: Learning on Country

- 1. Learn about digging for Witchetty grubs from Elders.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
- 2. Take photos of each stage to use back in class as students will be writing a procedure: How to collect, prepare, cook and eat Witchetty grubs.**

Equipment

iPad/camera, journals, digging equipment.

Photo by David Broun, CSIRO.

How do you cook it?

How do you collect it?

How do you find it?

Witchetty grubs: Learning in class (follow-up)

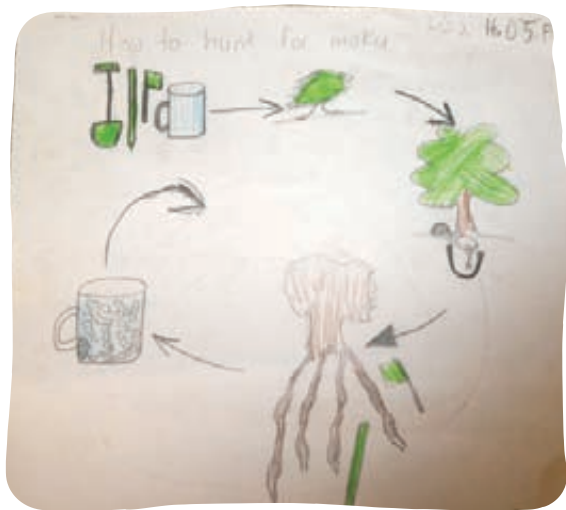
Activity 2: Recount the learning

Reflect, recount and write.

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in Standard Australian English and Language to the class word wall.

Activity 3: Procedure: Digging for Witchetty grubs

Use photographs from the field trip to develop a procedure. Students can sequence pictures, develop writing, make an eBook or a movie to record their learning. See the 'How to make a video story' topic.



Early Years procedure showing how to hunt Maku or Witchetty grub. Photo by Chris Deslandes, CSIRO.



On Martu lands, the shrub Lungkun (*Acacia dictyophleba*) is a favoured source of Lunki (Witchetty grubs). The plant has bright green growing tips. Noreena Williams, the artist, has shown exoskeletons of the larvae at the soil surface near the stem. These indicate to the hunter that there are likely to be Lunki (caterpillars) in the roots of that plant. Photo by Fiona Walsh.



1. Lunki hunter with crowbar (digging stick).



2. Sign to indicate Lunki might be in the shrub.



3. Excavating into roots where grub may be.



4. Thickened root indicates a Lunki might be inside.



5. Splitting open a root to remove the Lunki.



6. Several Lunki found in the same bush.



7. Whole Lunki cooked carefully on hot ashes.



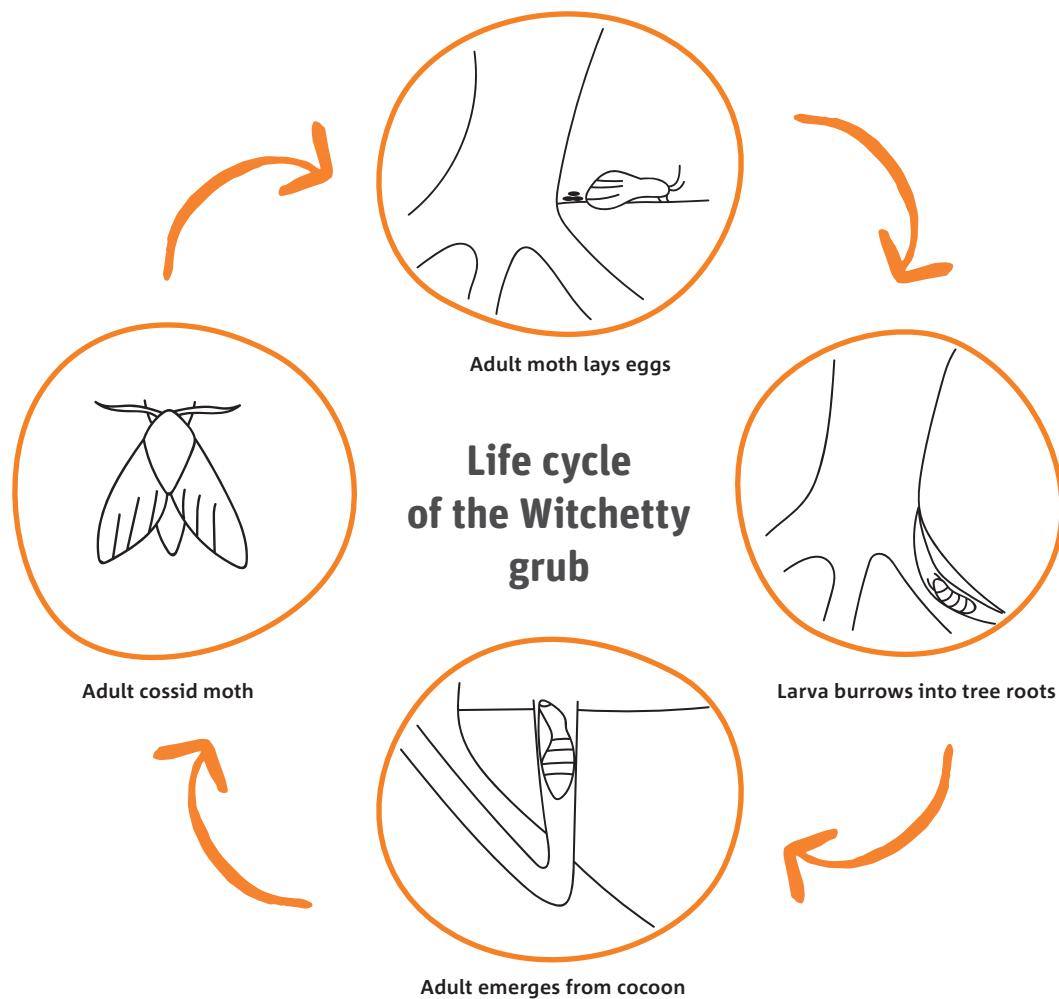
8. Giving Lunki to your grandmother as a mark of generosity.

Above are some stills from the video 'Lunki' produced by a Wiluna School student featuring her mother and grandmother in a procedure finding and cooking Lunki (Martu Wangka for Witchetty grub). These images could be used as a sequencing exercise before or after a field trip, or to explain the elements of a procedure for either a writing or film activity.

Activity 4: Life cycle

Students make a diagram of the life cycle of the Witchetty grub. This can be labelled in Standard Australian English and Language. Students can look for examples of the different stages of the life cycle when on country with Elders and use photographs of these to illustrate the diagram.

Use a diagram of the life cycle cut into pieces. Students reconstruct the life cycle diagram from its parts and label each stage in Language and Standard Australian English. It's good to get students to match the labels and the pictures for the life cycle. These can be a word or a phrase for Early Years students and a short sentence for older students. You can print the life cycle labels, out of order, on a separate page. Younger students can cut out the labels, and paste in the appropriate place, older ones can write them. It's good to get a Language speaker to translate/write the labels in Language before the class. The students can do the whole activity in Language and again, maybe the next day, in English.



Activity 5: Compare invertebrates with vertebrates

Students learn the terms ‘invertebrate’ and ‘vertebrate’ by comparing their own anatomy and that of other animals to common invertebrates.

BACKGROUND

What is an invertebrate?

Animals without backbones such as worms, caterpillars, moths, spiders, beetles and other insects are invertebrates.

What is a vertebrate?

Animals with backbones are vertebrates. These include mammals (such as kangaroos and humans), reptiles, birds, amphibians (frogs) and fish.

Show students images or real life examples of both invertebrates and vertebrates and discuss their differences. Where are the soft bits found? Where are the hard bits found? Where are the bones? Ask students to feel where their own bones are—are they a vertebrate or an invertebrate?

Classify and sort pictures of vertebrates and invertebrates.

What are the advantages and disadvantages of each type of skeleton?

Activity 6: Examine skeletal remains

Find the clean and dried bones of a vertebrate animal. Students can use them to explore bones, anatomy and the structure of their own bodies compared to other animals. Find pictures of the skeletons of different animals. Discuss how the muscles join to the bones, and how they move. What would an animal look like if it didn't have a skeleton?



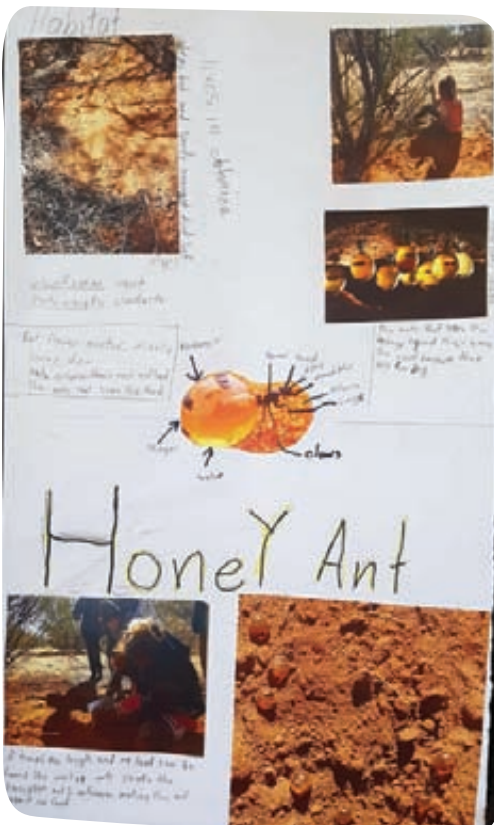
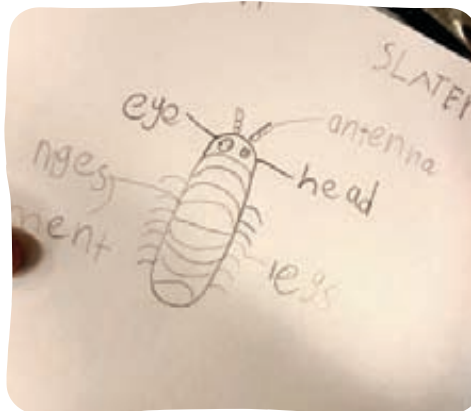
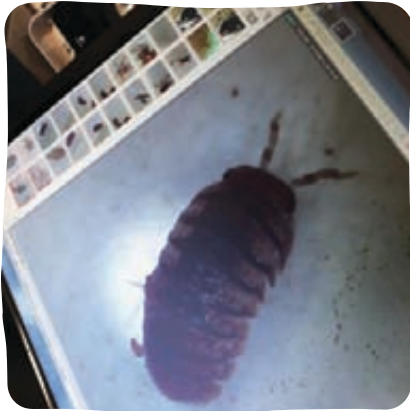
Early Years students collected bones on a field trip and used these to explore vertebrates and anatomy. Photos by David Broun, CSIRO.

Activity 7: Body parts

Look at the invertebrate under a microscope. Draw a detailed diagram of what you see. Label its body parts (e.g. head, abdomen, thorax, antenna). This can be compared to some common invertebrates (e.g. spider, ant, fly). What do other invertebrates have in common with your focus invertebrate? What are the differences?

Younger students could:

- Compare body parts of an insect with themselves, a dog or other animal.
- Make a book about body parts that is divided into three sections that shows the head/body/legs, each in a different section that can be flipped.
- Make a model of an invertebrate showing the different body parts.



(top left and top right): A student uses a digital microscope to investigate slater anatomy. Photos by David Broun, CSIRO.

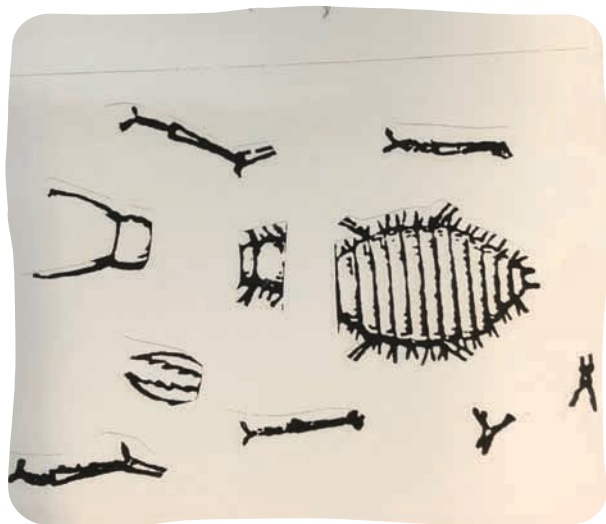
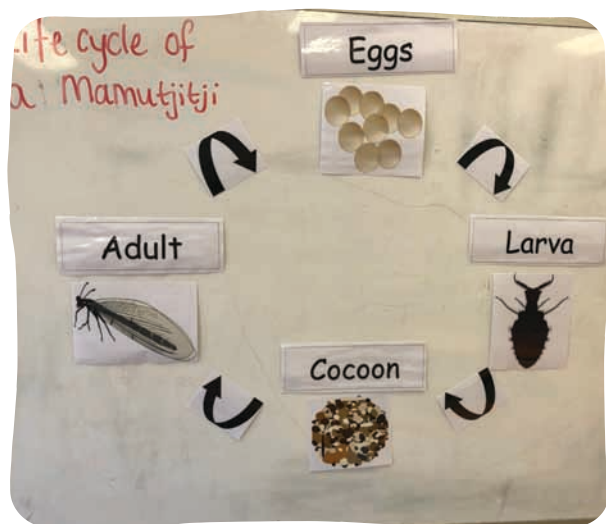
(bottom right): Early Years model of a Honeyant. Photo by David Broun, CSIRO.

(bottom left): Honeyant poster. Photo by Mandy Doust.

Activity 8: Antlions

Antlions are the larval stage of the lacewing. The antlion larva possibly develops the ultimate protection for the pupa. It uses grains of sand (tiny rocks!) to encase it while it morphs into the delicate lacewing.

Antlions have cultural importance for some Aboriginal groups as well as other cultures across the world. Antlions make their own pit traps to capture prey. They can easily be caught and studied in the classroom: see <https://www.antlionpit.com> for more information.



In Ngalia Language antlions are called 'Mamutjitji'. Students in Leonora learnt the Dreamtime story of the Mamutjitji then collected and kept antlions in their class. They fed them ants and watched them change through the stages of their life cycle. They connected this to a study of invertebrates and anatomy. Photos by David Broun, CSIRO.

Activity 9: Science investigation: invertebrate survey (Early Years)

In this activity students will explore an outdoor location such as a school yard to find and classify invertebrates. This exercise can be used with Early Years students. It can also be adapted to suit older students with increasing levels of complexity in classification and language based on their literacy levels. The term 'bugs' is loosely used to describe invertebrates. Teachers can persist with this or teach further vocabulary as required.

This activity should be supervised by local Aboriginal people and teachers to ensure that students aren't exposed to venomous invertebrates such as spiders. Students shouldn't handle any invertebrates with their hands. Use tweezers, sticks or a pooter as described below.

EQUIPMENT

- Magnifying glass.
- Tweezers.
- Small sticks.
- Small containers with lids.
- Invertebrate classification chart (see guide at the beginning of this unit).

QUESTION AND PREDICT

- What bugs will we find in the school yard?
- How many ... might we see?

PLAN AND CONDUCT

1. Students find bugs and put them in small containers using tweezers, pop sticks or an insect 'pooter'.
A pooter safely sucks bugs into a container through a straw. Instructions can be found online.
2. Use a magnifying glass to count the legs and look at other details.
3. Name the bugs in Language with an Aboriginal expert.
4. Identify the bugs using a class chart.

The teacher can choose some of the bugs to look at using a digital microscope connected to a large screen. Discuss anatomy and classification using simple terms such as 'insect' or 'spider' with students.

ANALYSE THE DATA

1. Look at the bugs in the jars and record their names in Standard Australian English and Language on the whiteboard. Use the invertebrate identification chart at the beginning of this unit for reference.
2. Count how many different types of bugs there are.
3. Make a list of the different bugs in English and Language.

SHARE

- Each student to draw and colour/paint a picture of one of the bugs using the class chart to help them include some details.
- Draw a mud map of the school yard on a big piece of paper.
Students stick their bug on the map according to where it was found.
- Write labels to go with each bug.
- Display the map in the classroom or somewhere else in the school.



Different invertebrates found in an investigation. How are they similar or different? Try to classify them using the invertebrate classification chart. Look at the ants. How many types of ants are there? What are the differences? It is OK not to have all the answers in these activities with students. Let students develop language and skills in classification. An educated guess is fine. The process is more important than the result. Photos by David Broun, CSIRO.

Activity 10: Science investigation: Pit trap invertebrate survey (Primary)

In this investigation students will trap, identify and count invertebrates. They then use this data to create simple graphs, and share what they find with the school and others.

This investigation can take on higher complexity by repeating at another site, or at the same site in a different season. Results can be compared and contrasted, and links can be made to habitats, influence of seasons, etc.

BACKGROUND: WHAT IS A PIT TRAP?

Scientists and Aboriginal rangers identify and count the number of different small mammals, reptiles and invertebrates in an area. This is a measure of biodiversity. High biodiversity can indicate a healthy environment. Monitoring biodiversity is an important part of conservation and land management. To catch small marsupials, reptiles and invertebrates scientists and rangers use 'pit traps'. Pit traps are containers buried at ground level that trap animals when they fall into the container. Animals can't climb out of a pit trap because of the smooth sides. Scientists can compare data from different sites because they use the same traps and method, making it a 'fair test'.

SELECT A SITE

Choose a suitable site to set the traps. The site needs to limit student access so they don't interfere with invertebrates in the traps. At the site, look for places with different ground surfaces and vegetation to set the traps, such as under a tree, open ground, leafy, by fallen logs, near a termite nest, or in moist soil. Spreading the pits through different conditions will trap a greater number of different invertebrates. Ask students: What food do the invertebrates need? Where do they live? Where do they shelter from the weather? Where do they shelter from other animals that eat them?

EQUIPMENT

- Pit traps—collect glass jars with lids for pitfall traps. Glass is preferable to plastic because it is smoother, reducing chance of escape. The opening of the jar should be a minimum 10 cm in diameter and the jar should be at least 10 cm in height. It is important for traps to be the same.
- Small garden spades—one for every 4–6 students.
- Popsticks or forceps—for moving invertebrates.
- Magnifying glasses.
- Camera or iPad.
- Digital microscope.
- Inquiry planner or Two-way Science journal.
- Invertebrate identification guide (at the beginning of this unit). Other guides are available such as a flip guide for ground-dwelling invertebrates that classifies by the number of legs, and the CSIRO website at http://www.ento.csiro.au/education/key/couplet_01.html.
- 1 cm graph paper for photography.
- Tray for each small group of students.



(above): A ranger checks a pit trap during a small mammal and reptile biodiversity survey. Photo by David Broun, CSIRO.

(below): A small marsupial caught in a pit trap during a biodiversity survey. Photo by David Broun, CSIRO.

SCIENCE INVESTIGATION PROCESS

Question and predict

What invertebrates will we find? How many invertebrates will we find?

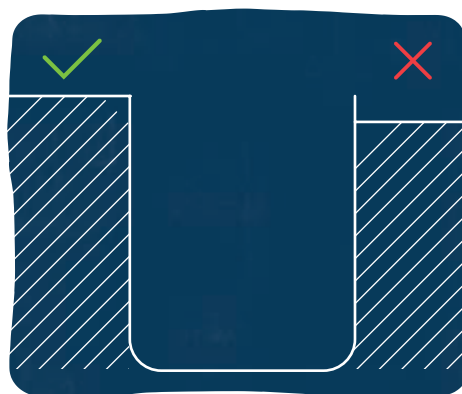
How many different types of invertebrate will we find?

Plan and conduct

Practice setting and inspecting the traps before the activity so that students are familiar with the process.

1 Install the pit traps.

- Label each pit trap and a popstick with the student or group name.
- Arrange the pit traps at each site in a line or grid approximately 4 m apart.
Having a long piece of string with a knot or ribbon every 4 m will help arrange the traps.
- Choose locations at each site that give a range of different habitats (e.g. near an old log, in the open, by a bush, near some rocks). It is OK to put pit traps a little way off the line or grid to make sure a range of habitats are covered.
- Dig a hole for each pit deep enough for the jar. Make sure each jar is installed with the rim flush with the ground so that small crawling animals will fall inside.
- Push the labelled popstick into the ground next to the trap.
- Take a picture of each labelled trap and the surrounding habitat.



- Draw a map of where the pit traps are located.

2 Monitor the pit traps.

- Leave the pit traps in place for enough time to capture insects but no longer than 5 days. Check them just once daily to:
 - Keep the traps dry. The trap lids should be put on if rain is forecast so that animals don't drown.
 - Remove lizards. Monitor the traps daily. If small lizards are found they can be photographed and removed immediately, though not by the tail, as some will shed it.
 - Remove twigs or leaves. Check for fallen twigs or leaves that provide an escape route. Make sure that leaves or twigs are free of a clinging invertebrate when discarded!

Collect and record data

Safety check!

- Don't pick up or handle the animals.
- Before students remove the trap, inspect and safely remove any potentially harmful invertebrates, such as scorpions.
- Students must use a wooden probe, or popstick, when observing the animals in their traps. Alternatively, use tweezers to remove them.

Place the lid on the jar, remove it and take the jar back to class. Observe any fast moving invertebrates while they are still in the jar. Count them if possible. Tip the contents into the tray, but beware of escaping invertebrates!



Checking pit traps. Photo by David Broun, CSIRO.

1 Photograph.

Photograph each type of invertebrate with a camera or digital microscope. Use the photos for further identification, for follow-up activities in class and to share the results of student work.



Native silverfish found in a pit trap. Watch out—they jump! Photo by David Broun, CSIRO.

2 Observe and describe.

Observe and describe the shape and anatomy of the animals.

Are some soft? Do any have wings? Do some have a hard, outer covering? Is the body one shape or is it divided up into sections? How many legs do the other animals have? Can students count them? Are their legs jointed?

Students can draw an invertebrate in their journal or inquiry planner. See Invertebrates Activity 7: Body parts.

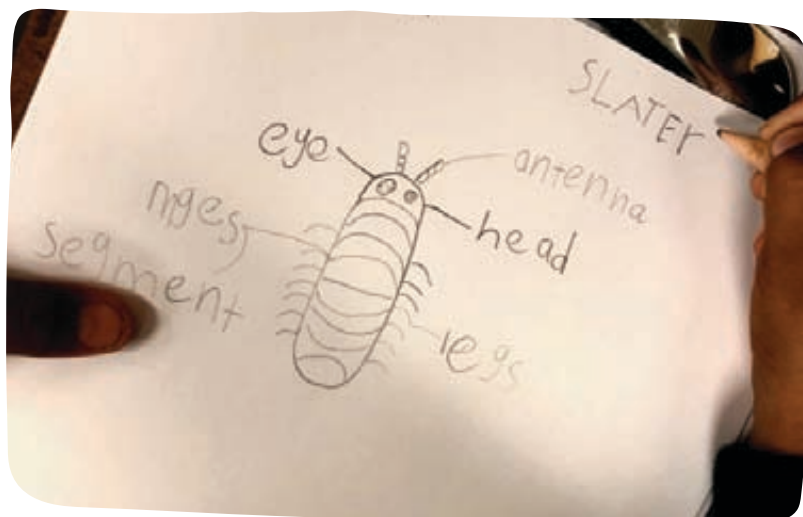
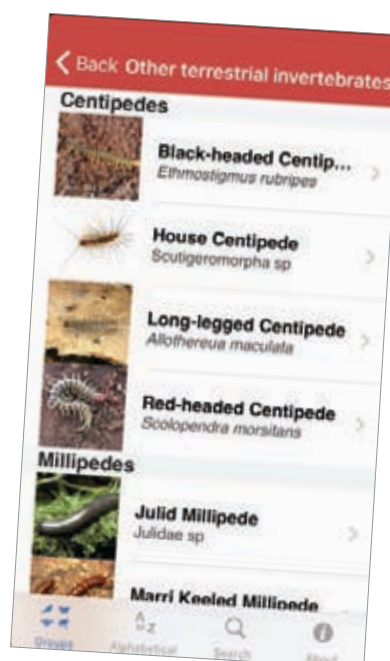


Photo by David Broun, CSIRO.

3 Identify.

Students identify each invertebrate with the help of a guide.



(left): Invertebrate ID Flip Guide (Kinnear 1994). Photo by David Broun, CSIRO.

(right): WA Museum 'WA Field Guide' app, Western Australian Museum.

4 Count.

Students count how many of each type of invertebrate.
Record in a pit trap data sheet. Use tally counting if preferred.

Pit trap data sheet

Name: _____ Site: 2

Date: _____ Trap number: 3

INVERTEBRATE NAME	TALLY	COUNT
Ant		12
Slater		1
Springtail		1
Spider		1

Photo by David Broun, CSIRO.

5 Return invertebrates to the site whether alive or dead.

This practice emphasises the importance of invertebrates, alive or dead, as part of an ecosystem.

*Note that in Western Australia at the time of writing, an animal ethics permit is not needed for projects with invertebrates in an educational setting. Please check requirements in other jurisdictions. While all care should be taken not to harm invertebrates in the activities, it can be expected that some mortality will occur.



A wolf spider opens its hinged web trapdoor and emerges from its burrow.
Photo by David Broun, CSIRO.

Analyse the data

1 Master table.

Use the data from each trap to construct a table to show the type, number and total of all invertebrates trapped. This should have a column for each invertebrate type, and a row for each student or group. Ask each student/group to enter their count of each invertebrate into the master table. Help students to count the total number of each invertebrate type if required. Use tally counting if preferred.

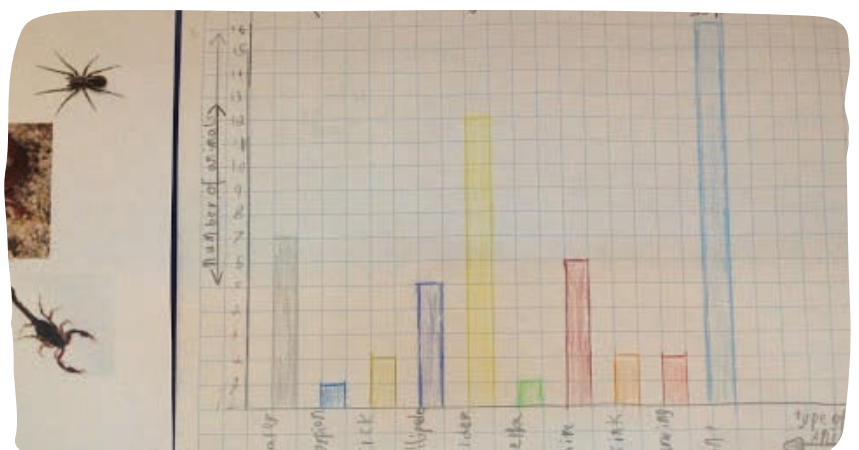
Site 1: Rawa Spring

Name	beetle	spider	ant	millipede	earthworm	centipede	scorpion	lizard	snail	TOTAL
Alex		1	8	2			3			14
Sally	2				1					3
Myaparu			10				2			12
David	1		6							7
Cam	3							1		4
Chris	5					1				6
Jo	2		7			2				11
Ben		2					4			6
Caro	8							1		9
Felicity			12	1	1					14
Glenda	4		8							12
Dylan	1	1		2						4
Total	26	4	51	5	2	3	9	2		102

Photo by Joanna Griffith, CSIRO.

2 Graph the results.

Students use the table (above) to construct a column graph for each site. This task can be designed to suit the literacy and numeracy levels of the students. It can be done using 1 cm square graph paper or simpler techniques such as pictographs. Display these later in the classroom.



Photos by Felicity Bradshaw.

3 Interpret the data.

Students look at the data and answer the questions for each site:

- What is the total number of invertebrates we found?
- How many different types of invertebrates did we find?
- What is the most common invertebrate?
- Which trap had the most invertebrates?
- What else did you find out?

4 Find answers.

Ask students to compare the results with their predictions:

- Did they find the invertebrates that they thought they would?
- Did they find anything they didn't expect?
- Help students to summarise their data and make some statements about what they found. For example:
 - 'We found 37 invertebrates.'
 - 'Ants were the most common.'
 - 'There were two different spiders.'
 - 'Centipedes were only trapped near the log.'
- Discuss possible reasons for their results, e.g. is there more of one type in a particular trap? Did they notice anything particular about the area surrounding that trap? (Near fallen timber? In thick litter? Under a mulga? etc.). Use photos of the installed pit traps to refer to for these questions.

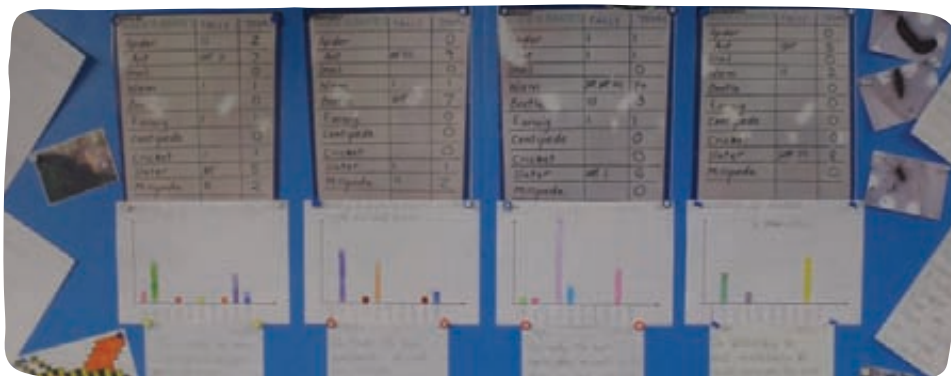
Reflect

Students reflect on the equipment and process of the investigation. Guiding questions:

- What went well? What could we do better?
- Did the equipment work properly?
- Was there anything we missed?
- Did we do things in the right order?

Share

Students share their results and learning. Make a book or eBook about the invertebrates found at the site. Include drawings, photos, location maps and information about each invertebrate you found and where you found it. Share this with another class at school, and any Aboriginal people who were involved in the process.



Student display showing pit trap data and results. Photo by Felicity Bradshaw.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning from an Aboriginal expert how to locate, collect, process and eat (for example) Witchetty grubs or Honeyants, and the seasonal conditions for this to occur.	• PP Living things have basic needs, including food and water (ACSSU002). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y2 Living things depend on each other and the environment to survive (ACSSU073). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by physical conditions of their environment (ACSSU094).
Comparing invertebrates and vertebrates. Looking at external features of invertebrates.	• Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Undertaking invertebrate surveys. Learning how Aboriginal people manage and harvest invertebrates.	• Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y3/4 Science knowledge helps people to understand the effects of their actions (ACSHE051, ACSHE062). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).

Science curriculum links

ACTIVITY	SCIENCE INQUIRY SKILLS
Taking photos and using digital microscopes to investigate invertebrates. Recording pit trap data in tables and representing the data in graphs. Using pit traps to compare different sites as part of a 'fair test'. Reflecting, evaluating and sharing the results of invertebrate surveys.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029, AC SIS042). • Y1/2 Use a range of methods to sort information, including drawings and provided tables through discussion, compare observations with predictions (AC SIS027, AC SIS040). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS060, AC SIS071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (AC SIS093, AC SIS110). • Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (AC SIS055, AC SIS066). • Y3/4 Reflect on investigations, including whether a test was fair or not (AC SIS058, AC SIS069). • Y1/2 Compare observations with those of others (AC SIS213, AC SIS041). • Y3/4 Reflect on investigations, including whether a test was fair or not (AC SIS058, AC SIS069). • Y5/6 Reflect on and suggest improvements to scientific investigations (AC SIS091, AC SIS108).

Pit trap data sheet

Name: Site:

Date: Trap number:

INVERTEBRATE NAME	TALLY	TOTAL

Unit 6: Reptiles

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

In this unit students will learn from Aboriginal people about reptiles. They will learn about reptile life cycles and behaviour in different seasons. An expert will take students on country to hunt and cook goannas. Students will make a book or movie about hunting for goannas and this will be connected to investigations about reptiles and heat.



Yellow-spotted Monitor (*Varanus panoptes*). Photo by David Broun, CSIRO.

BACKGROUND

Reptiles are important to Aboriginal people in the desert regions of Australia. They are a source of food and are the subjects of important Dreaming stories and cultural knowledge. The term 'reptile' is a Western scientific term. Aboriginal people have different names and classifications for reptiles that fit within traditional knowledge systems. There are many stories involving reptiles; some are sacred but others can be shared, while others may be the student's own experiences with reptiles.

Reptiles are a group of animals including lizards, snakes, turtles and crocodiles. Unlike birds and mammals, reptiles do not maintain a constant internal body temperature. Without fur or feathers for insulation, they cannot stay warm on a cold day, and without sweat glands or the ability to pant, they cannot cool off on a hot one. Instead, they move into the Sun or into the shade as needed. During cooler parts of the year they become inactive. Because of their slow metabolism and heat-seeking behavior, reptiles are considered cold-blooded. Most reptiles lay their eggs in a nest or burrow, leaving them to hatch on their own.

Australia is home to many unique species of reptile that have adapted to live in extremes of hot and cold in the arid zones of Australia.



(left): The Thorny Devil has special adaptations to drink water. It has thin grooves between its spines. Water collects on its body on a dewy night and is channelled along the grooves to its mouth. This process is called capillary action. The Thorny Devil stands in puddles of water after rain and drinks in the same way. Photo by David Broun, CSIRO.

(right): The Gidgee Skink. When threatened this lizard will take cover in a hollow log, under bark or between rocks. If harassed further it will inhale air, making its body swell up—this increased size, combined with the spiky keeled scales, makes it difficult for a predator to dislodge the lizard from its hiding place. Photo by David Broun, CSIRO.

HUNTING GOANNAS

In this activity students will learn about goanna behaviour, life cycle and adaptations through a hunting trip on country. Aboriginal people hunt goannas using traditional knowledge in communities today and this is an important cultural skill for future generations.

Hunting goannas: Planning

Teachers and Aboriginal experts plan the unit together. Aboriginal experts will have extensive knowledge about (for example) the goanna's life cycle, habitat, anatomy both internal and external, and impact of temperature on behaviour. There may be strict protocols around who can hunt for goannas, which parts of a goanna are eaten, and how the parts of the goanna are distributed to family and Elders. These are important cultural considerations. Teachers should learn respectfully about this and allow experts autonomy in how to teach this to students.

Various state and Commonwealth legislation protects the right of Aboriginal people to hunt for food. This activity should only be undertaken by Aboriginal people in accordance with customary practices.

Example questions for Aboriginal experts:

- When are goannas fat and good to hunt?
- What time of year do they breed, hibernate and wake up?
- What should students learn about hunting and cooking goanna?
- Who is the best person to lead a trip to hunt goanna?

Talk together about how to maximise the learning for students and connect all parts of the process to follow-up activities. Look at the example activities in this unit and discuss which ones are appropriate and how they can be used in the learning program.



Preparing goanna, Warralong, WA. Photo by Cameron Hugh.



(left): Goanna fat lining the stomach cavity is a prized delicacy. Photo by Fiona Walsh.



(right): At least four species of goanna are hunted for food. Here two species lie side by side after a successful hunting trip: the Sand Goanna and Ridge-tailed Monitor. Photo by Fiona Walsh.

Hunting goannas: Learning in class (preparation)

Activity 1: What is a reptile?

Students identify familiar reptiles and look for common features. They will add to their knowledge as they do further activities in this unit.

- 1 Go through animal cards and identify local reptiles.
- 2 Make a list of local reptiles and their Language names.
- 3 Connect this to pictures of other reptiles from around the world.
- 4 What features do they have in common?
- 5 What else do you know about reptiles?



Photo by David Broun, CSIRO.

Activity 2: Learning about goannas

Aboriginal expert:

- Speak to students about the different types of reptiles and their tracks using hand imprints in the sand.
- Talk about past hunting trips for goannas and share knowledge and stories if appropriate.
- Use pictures or drawings of the goanna found locally to teach the Language names for the parts of the goanna.
- Teach students about (for example) burrows, goanna behaviour and life cycle.

Teacher:

- Focus the Learning on Country.
 - Connect, question and predict:
 - What do you know about hunting for goanna?
 - Tell me about a time you went hunting goanna with your family?
 - How did you find the goanna?
 - How did you catch it?
 - How did you cook it?
 - How does hunting goanna make you feel?
 - Where will we find goanna?
 - Will they be in their burrows or walking around?
- Prepare equipment and go through the field trip plan.
- Introduce the task:
 - Students are writing a procedure showing how to catch and cook a goanna. Learn from Elders how to find, catch, prepare and eat a goanna.
 - Students will draw and label the parts on the outside and inside of a goanna. Learn from Elders about the different parts of the goanna.

Goanna anatomy

This activity should be directed by an Aboriginal expert. Watch as the goanna is gutted and prepared. Take photos to use in class later.

- First identify the external body parts.
- Identify male or female body parts.
- Gut the animal and look at the shape of the gullet, stomach, intestine, reproductive organs, etc.
- Identify fat deposits and learn how this relates to animal condition.
- Look in the stomach to see what the goanna has been eating.

Hunting goannas: Learning on Country

1. Learn about hunting goanna from an expert.

- a. Record stories.
- b. Write down Language names.
- c. Take photos.

Students will be writing a procedure about hunting goanna, and making a diagram of goanna body parts. Take photos or video of each stage to use back in class.

Equipment

iPad/camera, journals, hunting and cooking equipment.

Make a video story

Make one or more five-shot sequences (see the 'How to make a video story' section) showing the steps for:

1. finding the goanna
2. catching the goanna
3. preparing the goanna (gutting)
4. cooking and sharing the goanna.

Hunting goannas: Learning in class (follow-up)

Activity 3: Recounting the learning

Reflect, recount and write.

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in Standard Australian English and Language to the class word wall.

Activity 4: Make a big book

Early Years students can use photographs to make a class big book based on their recount about hunting and cooking goannas.

Activity 5: Make a movie

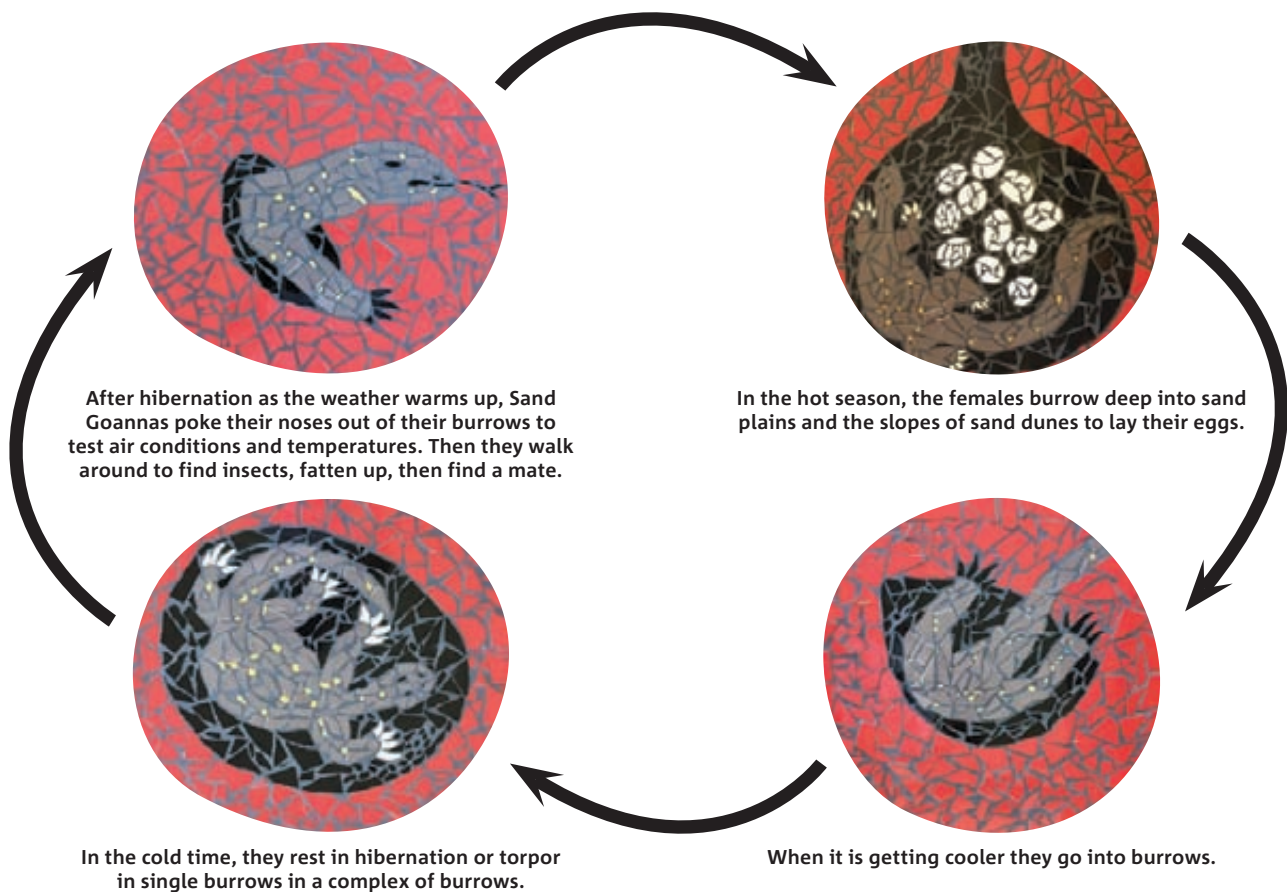
Use the five-shot sequence taken on country to edit a movie.

Students can record a narration or interview each other about hunting goannas.

Details on this process can be found in the 'How to make a video story' section.

Activity 6: Life cycle and behaviour

Students write, paint or draw the life cycle of the goanna that they learnt about. Ask students to describe each stage and add information to a diagram in their journal or class poster.



Wiluna school mosaics showing key stages of the goanna life cycle and behaviour with seasonal change. Photos by David Broun, CSIRO.

Activity 7: Goanna anatomy

Students record their knowledge of goanna anatomy learnt on country.

- Draw an outline of the goanna from a photo.
- Add detail and label the external features in Language then Standard Australian English.
- Draw another outline of the goanna.
- Draw the internal anatomy in the outline like an X-ray.
- Label it in Language and Standard Australian English.

Activity 8: Physical adaptations

Students look at pictures of the goanna and answer the question: What special parts of the goanna's body help it to survive, catch food, avoid predators and find shelter?

Goanna claws help it to dig burrows and climb trees. The colour of its skin provides camouflage to avoid predators and hunt prey.

For example:



Photos by David Broun, CSIRO.

(below): Sand Goanna (*Varanus gouldii*). Photo by David Broun, CSIRO.



Warming up and cooling down in the desert

Students investigate the relationship between heat and reptile behaviour using observations in the field of the Central or Western Netted Dragon. They will learn how reptiles change their behaviour to heat up or cool down, and investigate how the colour of a surface such as reptile skin can change the way it absorbs heat. They use thermometers to record the difference in temperature inside a goanna burrow compared to the outside temperature. This will connect to further learning about physical and behavioural adaptations of reptiles.

BACKGROUND

Reptiles use the Sun to warm up and become active. Mammals, like humans, keep themselves at the same temperature all the time. This uses lots of energy which mammals get from their food.

Despite being called 'cold blooded', some reptiles aim to maintain a body temperature of around 37 degrees Celsius, much the same as a human. There are other reptiles, geckos for example, that maintain their body temperature at around 21 degrees Celsius. This allows geckos to be active at night. In order to warm up, reptiles use the warmth of the Sun to get heat energy. If it is too hot or cold, the reptile changes its behaviour and the Central Netted Dragon is able to change its skin colour to regulate its body temperature. These adaptations allows reptiles to survive with much less energy than humans, and consequently they need less food in a desert environment where resources can be scarce.

This section will focus on the Central Netted Dragon to illustrate ways that the behaviour and skin colour of the dragon are used to cool down and warm up in the desert.



Species of dragon such as the Central Netted Dragon are common in the desert regions and familiar to students in remote community schools. Photo by David Broun, CSIRO.

Behaviour and heat

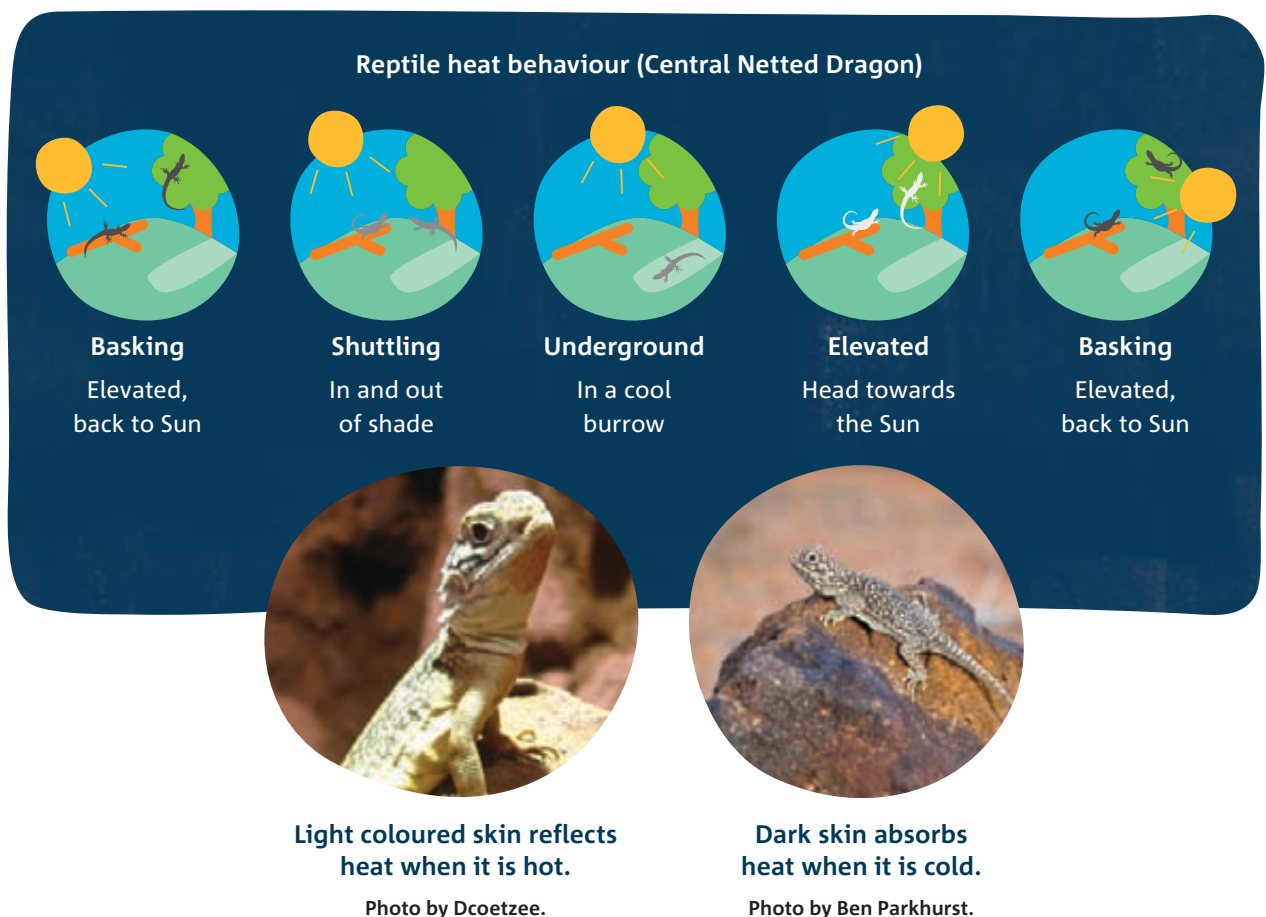
Dragon lizards may be noticed in the open when they are either warming up or cooling down. The Central Netted Dragon lizard controls its body temperature to about 37 degrees Celcius by four basic actions:

Basking: body is perched on a rock or small bush, with its back to the Sun, skin is dark. When getting warmer, will lift its head up and become active.

Shuttling: moves in and out of shade to cool down when getting too hot. Skin colour is grey.

Elevated: high up off the ground in order to maintain body temperature. Head is towards the Sun and body is pale.

Underground: lizards retreat into their burrow when air temperature is higher than 43 degrees Celsius, re-emerging when air temperature falls. The lizard also stays in the burrow, during the night, when its body temperature falls to that in the burrow.



Colour and heat

The Central Netted Dragon lizard tries to maintain its body temperature at 37 degrees Celsius. In addition to changing its behaviour, the dragon has the ability to reflect the rays of the Sun if it gets too hot. The lizard lightens its colour by restricting blood flow to the skin.

When it is cold, the dragon's skin is darker. Dark colours like black and red absorb more heat using more of the Sun's energy to warm the lizard. When the weather gets hot, the dragon's skin becomes lighter. Lighter colours reflect heat, reducing the amount of energy absorbed from the Sun. Other reptiles such as the Thorny Devil have similar adaptations.

Activity 9: Science investigation: Reptile behaviour and heat

Students observe the behaviour of the Central Netted Dragon and relate this to changing heat conditions. Older students can measure the temperature at which different behaviours are observed.

This investigation should take place during the warmer time of the year when the dragon is out of its burrow and active. Dragons are common and often seen around the school yard in remote community schools. Early Years students can complete this investigation without measuring the temperature. Students can observe the dragon's behaviour at different times of the day in organised activities or incidentally as suits the class.

EQUIPMENT

- Thermometer (older students) and binoculars (optional).

QUESTION AND PREDICT

Discuss that students' body temperature is very similar to each other because they are 'warm-blooded'. Reptiles are different and use the heat of the Sun to try and heat or cool their bodies to the same temperature as humans.

Ask students:

- What is the Language name for the Central Netted Dragon?
- What does the dragon lizard do during the day when it is hot?
- What does a dragon lizard do during the day when it is cold?
- Have you ever watched a dragon lizard during the day?
- What do you think we will see?

PLAN AND CONDUCT

Students should observe what the lizard does at different times of the day, then record what the lizard is doing on a timeline. Include:

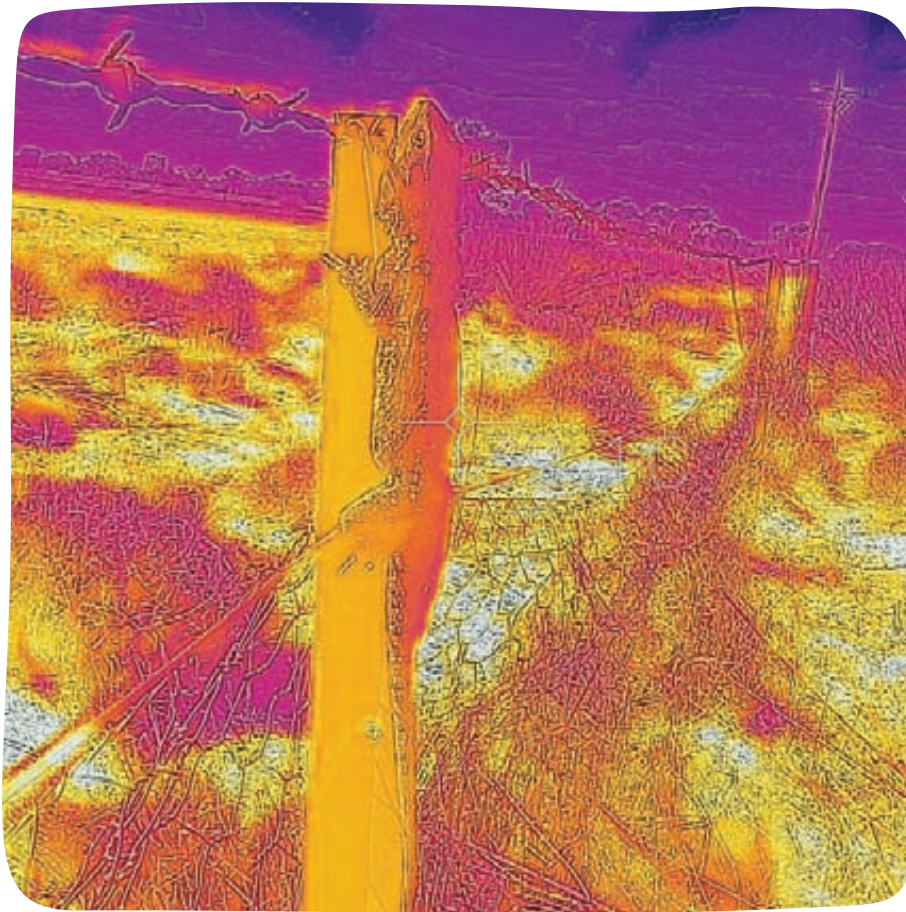
- A drawing of the lizard.
- A label that describes its behaviour (introduce the English words 'basking', 'shuttling', 'elevated', 'underground', but also ask the students to tell you in Language what the lizard is doing).
- A clock face showing what time it is.
- Temperature; this can be described as warm, hot or very hot, or measured using a thermometer by older students (see below).

Using a thermometer

Students should practise using the thermometer and reading temperature on the scale. Before undertaking the investigation, students should use a glass thermometer under supervision to measure the temperature of:

- ice water
- hot water
- their own bodies.

The results can be noted in a table to record air temperature. The temperature probe is held 1 m above the ground and in the shade. If there is no shade nearby, the student uses the shade of their body.



An Eastern Bearded Dragon (*Pogona barbata*) escapes the hot ground to cool down on a fence post. This thermal image shows the hottest areas in white or yellow and cooler areas in orange and purple. Photo by Jonathan Howard.

ANALYSE THE DATA

Students discuss the results.

- What dragon behaviour did they notice?
- What did the dragon do when it was cool, warm, hot and very hot?
- Older students can discuss the temperature at which the behaviours were observed.
- Did their findings match their predictions?

SHARE

- Display the timeline in the classroom or somewhere in the community.
- Act the different types of dragon behaviour. Make a play to share with the class, school or community.

Activity 10: Heat walk

Students investigate the way that different colours absorb heat.

Walk around the school looking for objects or surfaces in the sunlight. Try touching different areas of the ground, parts of a building or different coloured cars. Make a list of the things that are warmer and cooler. What colours are warmer? What colours are cooler? What is the warmest colour? What is the coolest colour?

This activity should be supervised—some surfaces can get hot enough to burn in direct sunlight.

Activity 11: Science investigation: Reflecting and absorbing heat

In this investigation students will test the heat absorption of black and white surfaces. They will cover glasses of water with white and black paper and measure the temperature at 15 minute intervals. They will graph their results and make conclusions about the data they collect. This can be related to the adaptation of dragon lizards to make their skin lighter to reflect heat on hot days.

EQUIPMENT

- Two identical drinking glasses or jars.
- Water.
- Thermometer.
- Two elastic bands or some tape.
- White paper.
- Black paper.



QUESTION AND PREDICT

Discuss with students: Will the water in the glass heat up differently under white paper or black paper? Which colour will heat up more? Why?

PLAN AND CONDUCT

- Wrap the white paper around one of the glasses using an elastic band or tape to hold it on.
- Do the same with the black paper and the other glass.
- Fill the glasses with the exact same amount of water.
- Make a small hole in the paper to insert the thermometer.
- Measure the temperature every 15 minutes.
- Record your results in a table.

TIME	BLACK PAPER—WATER TEMPERATURE	WHITE PAPER—WATER TEMPERATURE
10:00		
10:15		
10:30		
10:45		
11:00		
11:15		
11:30		
11:45		
12:00		

Sample table.

ANALYSE THE DATA

Graph the results. When the 2 hours are up, create a line graph to track the temperature change in each glass. Temperature should be your Y-axis and time should be your X-axis.

- Did one glass heat up faster than the other?
- Did they both reach the same temperature at the end?

Have students describe the results of the experiment. How does this relate to the colour of the dragon's skin?

REFLECT

- What worked well and what didn't?
- Did the temperature change as expected?
- Could there be other reasons for your results?
- What other questions does this make you think of?

Dark surfaces such as black paper absorb more light and heat than the lighter ones such as white paper. The glass with the black paper around it should heat up quicker and be hotter than the other. Lighter surfaces reflect more light. The dragon lizard has adapted to make its skin lighter in hot conditions to reflect heat so it doesn't warm up as quickly.

This experiment could be adapted to test other coloured paper or reflective materials such as Alfoil.

Central Netted Dragon. Photo by Simon Cherriman.



Activity 12: Science investigation: Temperatures in a lizard burrow

Students compare the temperature inside a lizard burrow with the temperature outside the burrow, and on the ground at three times during one day. This should be done at warmer times of the year when reptiles are active.

Note: To avoid injury to themselves or fauna, at no times should students put any part of their body in a reptile burrow during this activity.

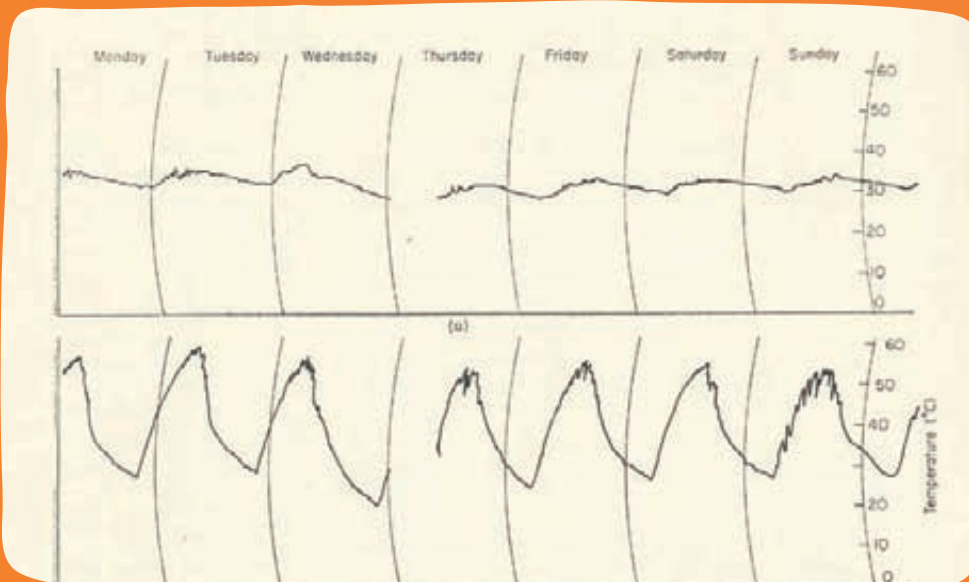
BACKGROUND

Burrows are used by reptiles for protection from predators, to lay eggs and to escape extremes of temperature in both hotter and colder times of the year. This investigation will take place at the warmer time of the year when reptiles escape the extremes of heat to maintain a more even body temperature. This diagram from research conducted on reptiles in the Shark Bay region of Western Australia shows the difference between temperatures in and out of the burrow over a week-long period. Students will create a simpler graph over the period of a day comparing burrow, air and ground temperature.

Controlling heat

Burrow Temperature

Ground Temperature



Source: Bradshaw and Main (1968).

EQUIPMENT

- Digital thermometer.
- Stick.
- Tape.

QUESTION AND PREDICT

Will the temperature be the same or different inside the burrow, outside the burrow and on the ground at different times of the day? Which will be cooler? Which will be hotter?

PLAN AND CONDUCT

- Measure the temperature inside a lizard burrow using a digital thermometer.
The thermometer can be taped to a stick so that no parts of the body are placed in the burrow. The thermometer should be placed at least 10 cm into the burrow or further if this can be done easily and without damaging the burrow or impacting on its occupant.
- Measure the temperature of the ground near the burrow. The probe can be placed against, but not under, the soil surface for this reading.
- Measure the temperature outside the burrow in the shade. To record air temperature.
The temperature probe is held 1 m above the ground and in the shade. If there is no shade nearby, the student can use the shade of their body.
- Record temperatures in a table. Temperature can be measured more often than the times shown in the table if possible.

TIME	AIR TEMPERATURE	GROUND TEMPERATURE	BURROW TEMPERATURE
08:00 am			
11:00 am			
2:00 pm			

ANALYSE THE DATA

Graph the results, with time of day along the X-axis, and temperature along the Y-axis. There should be three lines to show temperature of the ground surface, temperature in the air and temperature in the burrow.

Discuss the results. Where was the hottest temperature recorded?

Where was the coldest temperature recorded? Which changed the most? Why?

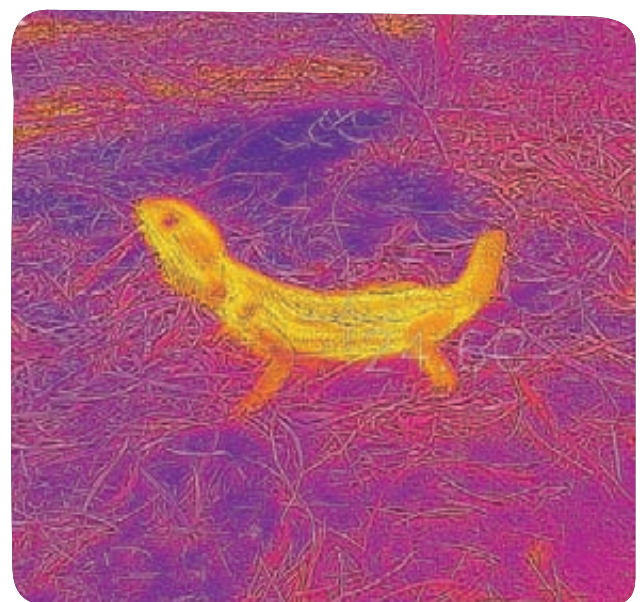
REFLECT

Did the equipment work?

What worked well and what didn't?

What would you do differently next time?

Ground surface should have the greatest variation in temperature, followed by the air temperature. The burrow temperature should be fairly uniform (if the probe was placed far enough into the burrow). The soil surface and air temperature have the greatest variation in temperature compared to the burrow because the soil under the ground and away from the Sun absorbs less energy and takes longer to heat up and cool down.



Infra-red cameras that attach to mobile devices illustrate heat and temperature difference visually. This Central Bearded Dragon (*Pogona vitticeps*) is visibly warmer than the background. Photo by Jonathon Howard.

Adaptations

Adaptations are an important part of the science curriculum and synthesise understanding about an animal and its relationship with the habitat and ecosystem in which it lives.

There are many educational resources around adaptations that can be applied or adapted to suit the context of Aboriginal students in remote community schools.

Activity 13: Recount lizard adaptations

Adaptations can be behavioural and physical. Students have explored both behavioural and physical adaptations of the Central Netted Dragon lizard in this unit. After students have completed the activities in this section, ask them to list the behavioural and physical adaptations that the Central Netted Dragon has to be able to live in a desert (doesn't eat much, protected in a burrow, controls its temperature by turning pale, long sharp claws for climbing and digging, camouflage skin colour, etc.).

Activity 14: Investigate adaptations of other animals

Use the understanding gained from Activity 11 to investigate other animals both local and beyond.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Hunting goanna—learning about the seasonal availability, location and behaviour of the goanna.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y2 Living things depend on each other and the environment to survive (ACSSU073). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by physical conditions of their environment (ACSSU094).
Observing Central Netted Dragon behaviour in response to temperature.	• F The way an object moves depends on a variety of factors, including their size and shape. • Y4 Living things depend on each other and the environment to survive (ACSSU073).
Learning about adaptations of the goanna and Central Netted Dragon.	• Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things depend on each other and the environment to survive (ACSSU073). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043).

ACTIVITY	PHYSICAL SCIENCES
Learning how the Central Netted Dragon changes skin colour and behaviour in response to heat.	• Y3 Heat can be produced in different ways and move from one object to another (ACSSU049). • Y5 Light travels in straight paths, forms shadows, and can be absorbed, reflected and refracted (ACSSU080).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Hunting goanna—learning about the seasonal availability, location, behaviour of the goanna.	• Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y3/4 Science knowledge helps people to understand the effects of their actions (ACSHE051, ACSHE062). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Investigating heat transfer and temperature. Taking photos and using digital microscopes to investigate invertebrates. Recording data in tables and representing the data in graphs. Representing temperature change in a graph. Reflecting on the investigation process.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029, ACSI042). • Y1/2 Use a range of methods to sort information, including drawings and provided tables through discussion, compare observations with predictions (ACSI027, ACSI040). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110). • Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (ACSI055, ACSI066). • Y1/2 Compare observations with those of others (ACSI213, ACSI041). • Y3/4 Reflect on investigations, including whether a test was fair or not (ACSI058, ACSI069). • Y5/6 Reflect on and suggest improvements to scientific investigations (ACSI091, ACSI108).



In Leonora they call it yurrarn. It is the sweet honeydew made by the larvae of psyllid bugs living on the mulga tree. The honeydew crystallises to form orange protective cocoons but before that happens, people can lick the delicious syrup from the branch. Honeyants also collect the honeydew to make a sugary fluid stored in the abdomens of special ants as food for the colony in leaner times. Photo by David Broun, CSIRO.

(opposite): Warmula, the Martu name for Bush Tomato (*Solanum diversiflorum*), found near Punmu showing the bitter seeds that should be discarded before eating. Photo by Grace Atwell.

Plants



Background

Indigenous Australians have relied on, and used, plants in order to live healthy, prosperous lives for tens of thousands of years. Aboriginal people managed vast areas of Australia before colonisation and these practices are still in place today in parts of the Western Desert region. For example, fire is used as a tool to increase the productivity of bush foods and bush medicines, and seeds are stored and scattered close to wetlands for future harvest.

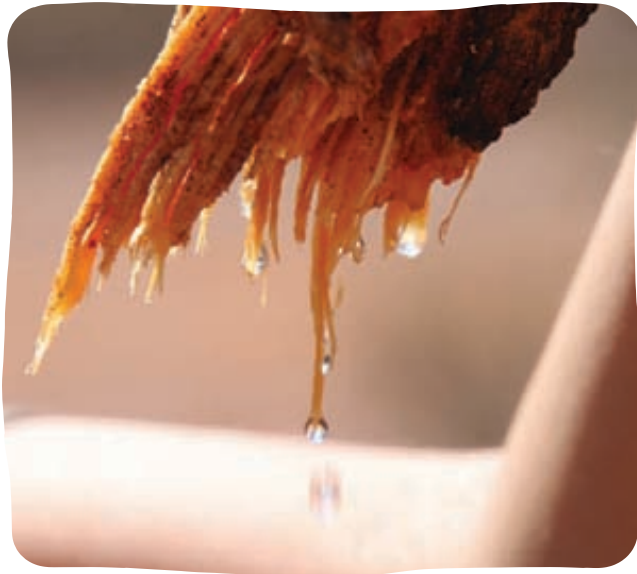
Aboriginal people have detailed knowledge of hundreds of plants. This includes not just their names and uses but also where and when they grow, how to promote their growth, how to prepare them for eating or medicine, when to gather them and how to gather them. Tools and weapons were made from plants including hardwood, softwood and spinifex glue. These were an essential part of daily life, and each tool could be used in different practical ways.

Rainfall in desert regions varies from year to year. Indigenous knowledge holders know where to find water and what sources of food and medicine are available during drought and times of rain. Travelling long distances without carrying food and water was possible because people managed the country and knew where to find food as they went. Water supplies could be found in the roots of certain trees if waterholes were dry.

Modern Western medicine is now acknowledging the effectiveness of many traditional medicines, and some traditional bush foods are making their way into Western restaurants and kitchens. Passing on knowledge and practices to the next generation is essential if this knowledge is to be maintained, explored and used.



Martu on country collecting Warmula (Bush Tomato—*Solanum diversiflorum*). Photo by Chris Deslandes, CSIRO.



(clockwise from top left): Certain plants can provide water from their roots (photo by David Broun, CSIRO). Edible fruits of Silky Pear grow on vines after rain (photo by Fiona Walsh). Bush Carrot (*Calandrinia polyandra*) (photo by Fifi Harris). Seeds from a native grass (photo by David Broun, CSIRO). A grindstone with its pestle or top stone for grinding seeds to make seed cakes (photo by David Broun, CSIRO). Passionberry (*Solanum cleistogamum*) (photo by David Broun, CSIRO).

Unit 1: Classifying plants

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students’ capabilities and current learning.

Students collect and sort plants on country. Aboriginal experts teach students different ways to classify plants according to Aboriginal knowledge systems. Students document their learning through a class book on plant names and classification, and relate this to Western or scientific classification.

BACKGROUND

There are thousands of plant species in the bush. In the old days, Aboriginal people could name hundreds of these plants, especially the ones that were important to them. Scientists have names for each plant too. There are too many different plants for most people to know the names of each plant so we group them to learn, describe and recognise plants. Desert Aboriginal people and scientists both have ways to group or classify these plants. These groups are based on relatedness. The relationships or plant family groups that people see vary between desert Aboriginal people and scientists. Even amongst desert people and scientists there are different ways to see relationships.

The study of relationships is called taxonomy or ethnotaxonomy as we recognise Aboriginal people have their own systems of classification. In general, desert Aboriginal people classify plants by their uses and scientists name and classify plants by the Linnaean system of genetic relatedness.

Table 1: Examples of common and other ways to classify plants showing primary and one secondary classification level.

DESERT ABORIGINAL WAYS TO GROUP OR CLASSIFY PLANTS	SCIENTISTS WAYS TO GROUP OR CLASSIFY PLANTS
By ‘use’ groups i.e. food, medicine, tools, tobacco	By Linnaean taxonomy from physical and genetic characters that show relatedness
Within food groups i.e. seed plants, root plants, nectar plants	Phylum, class, family, genus, species
Within seed groups i.e. seeds to make damper, seeds to make edible paste	By food groups i.e. fruit, vegetables, seeds and grains, pulses
By plant form or habit	By plant form or habit i.e. trees, shrubs, grasses, creepers
People connections—by skin and kin relationships from Jukurrpa or Dreaming	By timber types i.e. hard woods, soft woods

Classifying plants: Planning

Questions for an Aboriginal expert:

- What are some different types of plants?
- What are different plants used for?
- How do you sort plants into groups?

This can be done on country with plant samples, with samples of different plants brought to school and/or with the plant cards. Choose the way that suits people and context.

Plan a field trip to a place where students can collect and sort different plants.

Classifying plants: Learning in class

Activity 1: Grouping plants using Indigenous ecological knowledge

Aboriginal expert: talk to students about the ways to group plants.

Introduce Aboriginal Language. Use plant cards or plant samples.

Teacher and Aboriginal expert:

- Focus the Learning on Country.
 - Connect, question and predict (use plant cards or samples to discuss).
 - Are all plants the same? Or are they different?
 - What plants can you eat? What plants are medicine plants? What plants are used to make tools? What are their names?
 - Tell me about a time that you went bush with your family to collect bush foods, medicines or make tools.
 - How do we know they are different?
 - How many different plants are there on your country?
 - How do you learn the names of different plants?
 - How can we group those plants?
 - Do some plants have only one use or lots of uses?
 - What plants will we find?
 - What is in season now?
- Prepare equipment and go through the field trip plan.
- Introduce the task.
 - You are going on country to find out about the different types of plants from Elders.
 - Cut small pieces of different plants and learn how to sort them into groups.
- Talk to students about showing respect for plants, walk quietly, break them neatly and don't pull them up by the roots.



Martu plant classification including Mirrka (food) plants, Wama (nectar) and bush medicine categories. Photos courtesy of Kanyirninpa Jukurrpa.

Classifying plants: Learning on Country

1. Learn from Elders.

- a. Record stories.
- b. Write down Language names.
- c. Take photos.

2. Collect plant samples.

- a. Collect 30 cm samples of different plants in student pairs (15 minutes).
- b. Include flowers, fruit and seeds from each plant if possible.
- c. Come back together and put the plants on a large tarpaulin.
- d. Sort them into groups of the same plant like the game 'Snap!'.
- e. Select one specimen of each plant and label it with masking tape on the stem.
- f. Group them in different ways with Aboriginal experts (e.g. food, tools, medicine). Write the group name on a large card.
- g. Sort each group into smaller groups (e.g. food plants could be sorted into seed plants, nectar plants or root plants). Label these with cards.
- h. Regroup the plants in different ways and write more large labels. Use multiple plant samples if necessary.
- i. Take a specimen of each plant back to school in a bag. Spray the plants with water to keep them fresh.

Equipment

Secateurs (if students are allowed to use them), tarpaulin, 30 cm ruler, masking tape, black textas, large plastic bags (rubbish bags or chook food bags), water to spray plants, plant identification books.

Classifying plants: Learning in class (follow-up)

Activity 2: Reflect, recount and write

Listen to/view any photographs, recordings and videos.

- Recount important pieces of information.
- Add new words in Standard Australian English and Language to the class word wall.

Activity 3: Making a class plant book

Students work as a class or in smaller groups to make a class book or books about the plant groups.

- Repeat the classification activity using one of the groupings (e.g. food, medicine, tools—use local Language terms where possible).
- Each student pair could select one of the groups learnt on country. They then find good samples of plants for that group.
- To make the book students could (for example) photograph each plant and print, lay samples of related plants onto a photocopier and copy them, make botanical drawings or draw around each plant.
- Students could make a booklet about the related plants, e.g. 'Our Food Plants' arranged by traditional food groups.
- Show parents, guardians and community the booklets made by students.



Mosaics from Wiluna Remote Community School.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Classifying plants into groups according to Indigenous Ecological Knowledge.	- F Living things have basic needs, including food and water (ACSSU002). - Y1 Living things live in different places where their needs are met (ACSSU211). - Y1 Living things have a variety of external features (ACSSU017). - Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Aboriginal experts teaching students which plants are edible/non-edible and where to find them.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Collecting and classifying plant samples during the Learning on Country trip. Making a class book about plants found during the Learning on Country trip.	- F Engage in discussions about observations and represent ideas (ACIS0233). - F Share observations and ideas (ACIS012). - Y1/2 Represent and communicate observations and ideas in a variety of ways (ACIS029, ACIS042). - Y1/2 Participate in guided investigations to explore and answer questions (ACIS025, ACIS038). - Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACIS026, ACIS039). - Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACIS060, ACIS071). - Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACIS060, ACIS071). - Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACIS093, ACIS110).

Unit 2: Bushfood

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn about a bushfood from Aboriginal experts. They learn where it is found, how to collect, prepare and cook the bushfood. They write a procedure (recipe) about this process. Students learn how to press a plant specimen and record information about a plant.

BACKGROUND

Plants provide staple food for Aboriginal people of the desert. Aboriginal experts know where plants grow, what season they grow in, and how to collect, harvest and process foods. Some plant parts are not suitable for consumption or are poisonous to people without the correct method of processing. Aboriginal people have managed the landscape for productivity using fire to promote new growth and advantage certain species of plants. Aboriginal people are acknowledged as the first bakers of bread using seeds and grains that were farmed, harvested and collected in Australia. Food from plants has many forms including fruits, seeds, bulbs, tubers and sap.



(clockwise from top left and middle): Seeds are used to make nutritious seed cakes (photos by David Broun, CSIRO). Bush Tomato (*Solanum diversiflorum*) (photo by Grace Atwell). Silky Pear (*Marsdenia australis*) (photo by David Broun, CSIRO). Bush Onions (*Cyperus bulbosus*) (photo by David Broun, CSIRO). Quandong (*Santalum acuminatum*) (photo by John Moss).



Students watch Martu Elder Nyamuru Bidu winnowing seed to make flour and damper. Photo courtesy of Kanyirrinpa Jukurrpa.

Bushfood: Planning

Aboriginal experts and teacher plan the unit together and arrange for a Learning on Country field trip to collect a bush food.

Questions for Aboriginal experts:

- What bush food do you want students to learn about?
- Where is it found?
- When is it in season?
- How do you find it?
- How do you collect it?
- How do you prepare or cook it?
- What are the Language names of the bush food?
- Where can we go to on a field trip to learn about it?
- Who is the best person to teach the students on the field trip?

Bushfood: Learning in class (preparation)

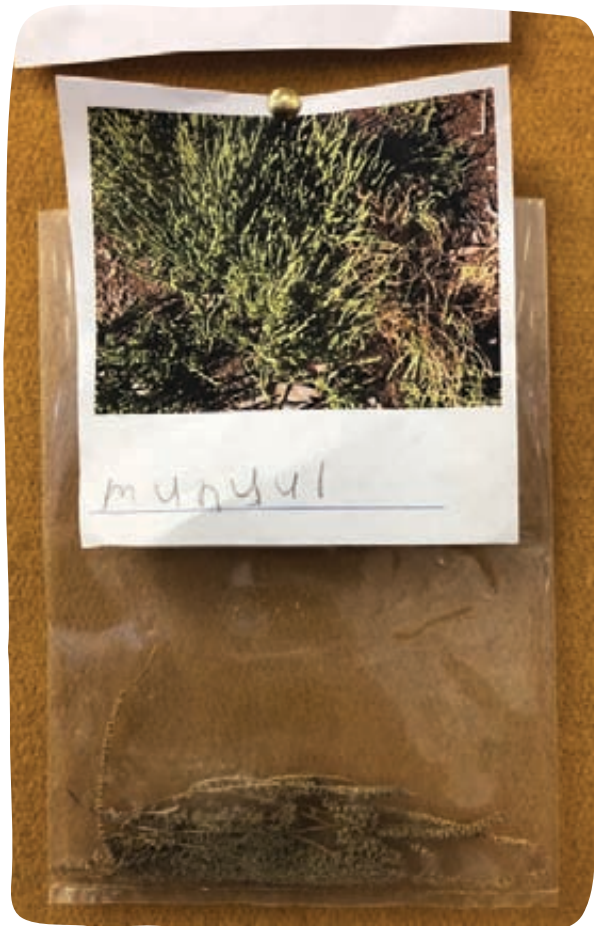
Activity 1: Introduction to bush foods

Aboriginal expert:

Talk to students about the bush food and introduce its Aboriginal Language names. Explain the place that everyone is going, how to find and collect the bushfood. Tell stories about a time that you collected this food when you were young or how people used this food in the old days.

Teacher and Aboriginal expert:

- Focus the Learning on Country.
 - Connect, question and predict:
 - What do you know about the bushfood?
 - Have you eaten this?
 - Tell me about when you have collected this with your family.
 - What do you think we will find on country?
 - How will we collect it?
- Prepare equipment and go through the field trip plan.
- Introduce the task—students will write a recipe about the bush food.
Learn from Elders how to find, collect, prepare and cook the bush food.



Munyul or Rats Tail (*Dysphania kalpari*) from near Wiluna. This plant enjoys disturbed soil and can be abundant on the road side. It provides prolific seed in season. Photos by David Broun, CSIRO.



What is the bush food?

When it is in season?
When does it grow?

What country does it grow in?

Bushfood: Learning on Country

- 1. Learn about a bush food from Aboriginal experts.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
- 2. Students will write a recipe: How do you collect, prepare, cook and eat the bush food?**
- 3. Collect bush food and plant samples and take back to class.**

Equipment

iPad/camera, journals, buckets, secateurs or scissors, containers and lids.

Top photos and bottom right photo by David Broun, CSIRO. Bottom left photo by Grace Atwell.

How do you find it?

How do you prepare or cook it?

How do you collect it?



Bushfood: Learning in class (follow-up)

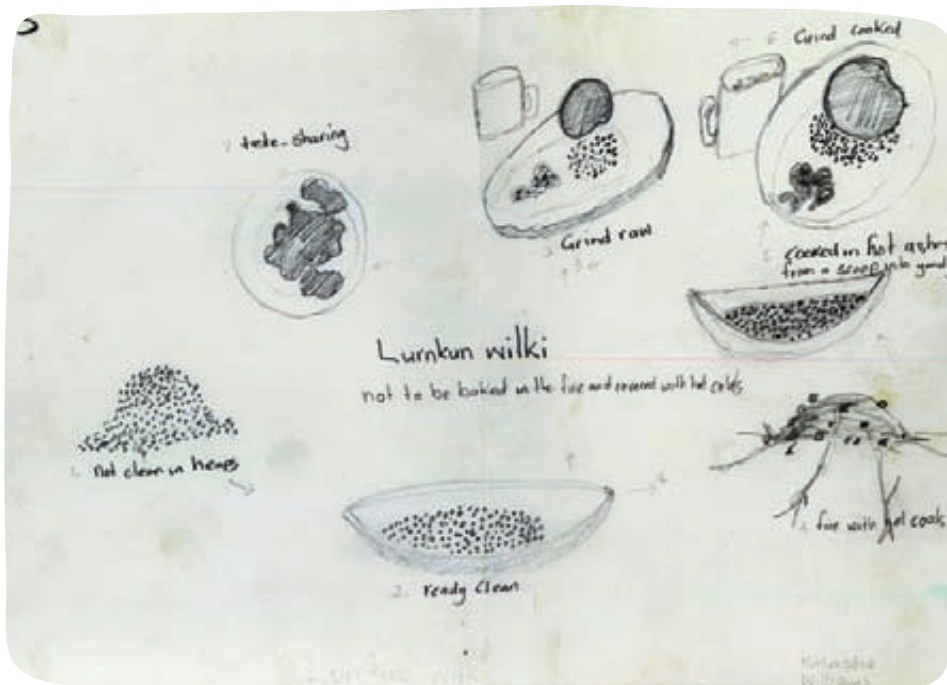
Activity 2: Reflect, recount and write

Listen to/view any photographs, recordings and videos.

- Recount important pieces of information.
- Add new words in Standard Australian English and Language to the class word wall.

Activity 3: Write a recipe (procedure)

- 1 Use photos to recount with the class how to find, collect, prepare and eat the bush food.
- 2 Students can use pictures and/or words to write a procedure explaining step by step how old people used to prepare the plant to eat.
- 3 This could be done in Language with an Aboriginal expert.
- 4 Share the procedure or recipe with others. Put recipes together in a class bush food recipe book.



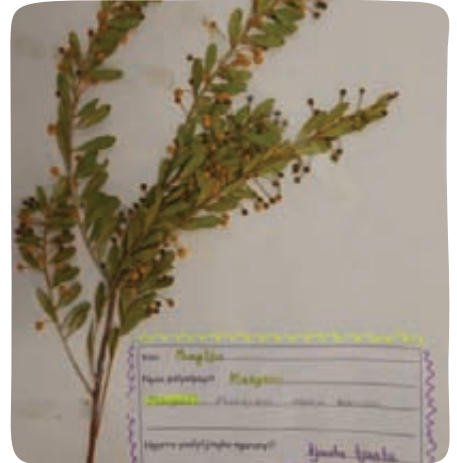
(left) Procedure showing how to make damper using Wilki (seeds). Drawing by Natasha Williams from Parnngurr. Photo by Fiona Walsh.

(below): Martu winnowing and grinding seeds to make damper. Photos courtesy of Kanyirninpa Jukurrpa.



Activity 4: Record plant information

Record information about the plant with help from the Aboriginal expert, using pre-printed labels (see page 198). Attach each plant sample to A3 paper or card with the information on the label.



Pressing and mounting plant samples with their labels. Photos by Meg Mooney.

These can be displayed in the classroom, made into a class big book and added to after other field trips.

PLANT LABEL

Print name in Language:

Wanganu

Plant name in English:

Woolybutt grass

Name (who found it):

Nyapuru

Date:

24/4/2019

Location:

Wanilla

Habitat (e.g. sandhill, claypan, rocky hills, etc.):

Rocky ground near waterhole

Type of plant (grass/shrub/vine/tree):

Grass

Uses (e.g. medicine, food, shelter, tools, animal home):

Food

Notes (e.g. how is it prepared and used?):

Seeds were collected and de-husked in a wooden dish before being ground up with a grinding stone to make flour. This was mixed with water and then cooked in coals to make bush damper.

Activity 5: Pressing plant samples to keep

- 1 Record plant information first (reference plant information activity).
- 2 Place each plant sample between two sheets of paper.
- 3 Place the sample between pages of a heavy book.
- 4 Press all of the plants under a heavy weight, e.g. a pile of books.
- 5 Leave them for a week.



(above): Plant press used by rangers in the field. Photos by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about bushfoods, where they are found and how to prepare them for consumption.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—CHEMICAL SCIENCES
Locating particular plant species to extract the seeds, which are then ground down to make flour for damper.	• F Objects are made of materials that have observable properties (ACSSU003). • Y1 Everyday materials can be physically changed in a variety of ways (ACSSU018). • Y2 Different materials can be combined, including by mixing, for a particular purpose (ACSSU031). • Y3 A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046). • Y4 Natural and processed materials have a range of physical properties that can influence their use (ACSSU074). • Y6 Changes to materials can be reversible or irreversible (ACSSU095).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning on Country trip with Aboriginal experts teaching students about edible plants. Aboriginal knowledge holders teaching students about how fire is used to change the landscape.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y3/4 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). • Y3/4 Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).

Science curriculum links

ACTIVITY	SCIENCE INQUIRY SKILLS
Recording plant information. Pressing plant samples. Using photos, tables and drawings to record and represent information.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029, AC SIS042). • Y1/2 Participate in guided investigations to explore and answer questions (AC SIS025). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (AC SIS026, AC SIS039). • Y1/2 Use a range of methods to sort information, including drawings and provided tables through discussion, compare observations with predictions (AC SIS027, AC SIS040). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS060, AC SIS071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (AC SIS093, AC SIS110).

Plant label

Print name in Language:	Plant name in English:
Name (who found it):	Date:
Location:	Habitat (e.g. sandhill, claypan, rocky hills):
Type of plant (grass/shrub/vine/tree):	
Uses (e.g. medicine, food, shelter, tools, animal home):	
Notes (e.g. how is it prepared and used?):	

Unit 3: What do plants need to grow?

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn about the growth of plants from a Western science perspective.

They learn about plant anatomy and investigate how light and water are essential for plants to grow.

In this unit students learn the anatomy of plants. They locate and label plants in English.

This can be used to describe plants in subsequent activities.



Quandong tree mosaic, Wiluna Remote Community School, Western Australia. Quandong trees are parasitic. They attach to the roots of other plants to source water and nutrients. Photo by David Broun, CSIRO.

BACKGROUND

These are the key parts of all plants:

Seeds: The seeds develop from the ovule (female part of the plant) after fertilisation by pollen (male part of the plant) and, in the right conditions, grow into a new plant.

Flower: The flower is the part of the plant where seeds are made. Flowers have petals that attract animal pollinators; they may also be pollinated by wind.

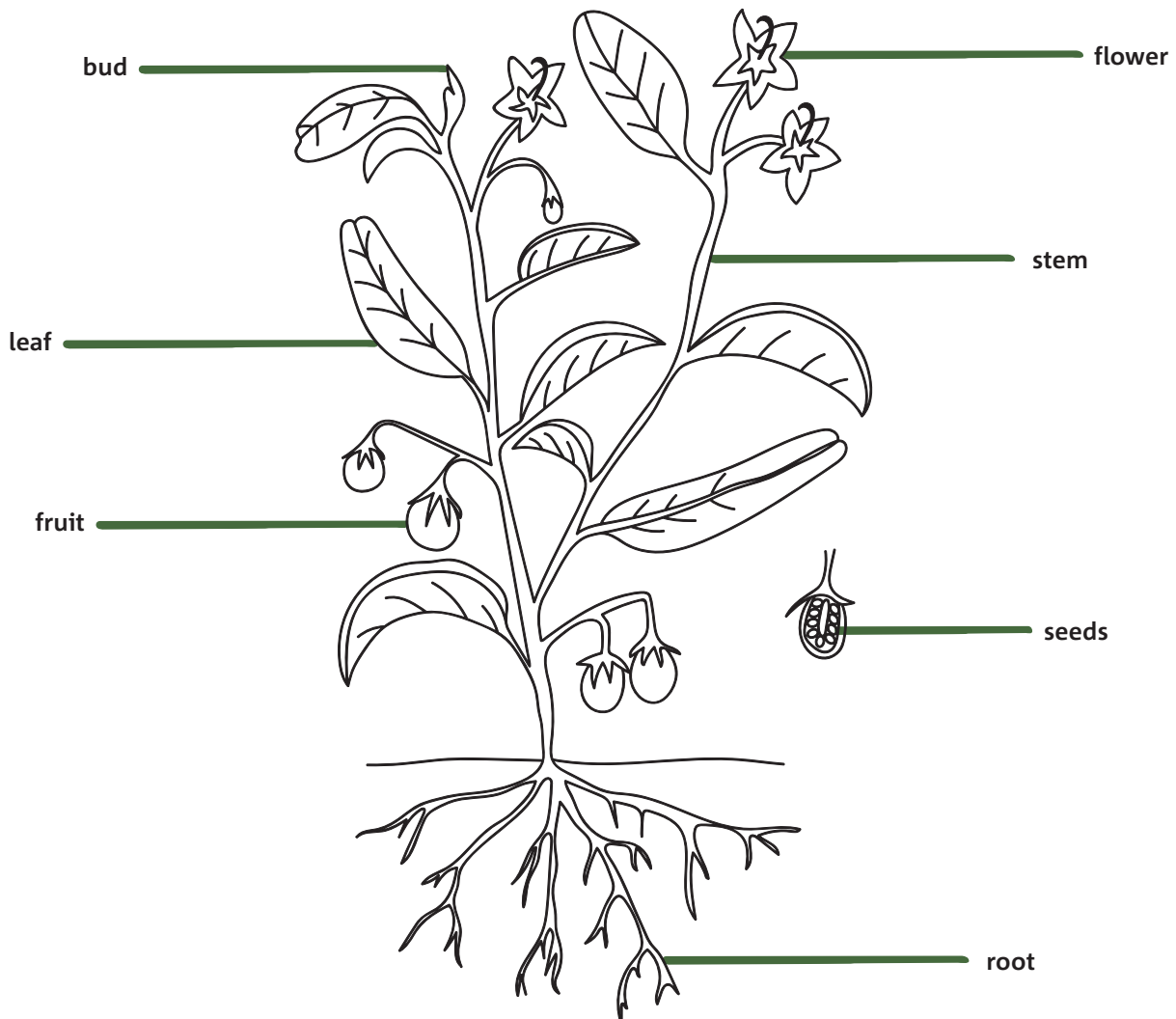
Bud: A bud is an immature shoot. It can be a leaf bud or a flower bud.

Stem: The stem holds the flowers and leaves above the ground so they can get the most light. The stem is also the transport system of the plant. Water and mineral salts are transported from the roots to the leaves through the stem.

Leaf: The leaf is joined to the stem by a stalk. The transport system in the stem continues from the stalk to the veins in the leaf. The leaf is where photosynthesis happens. Photosynthesis is when the plant makes its own food using sunlight and carbon dioxide which the plant absorbs from the air.

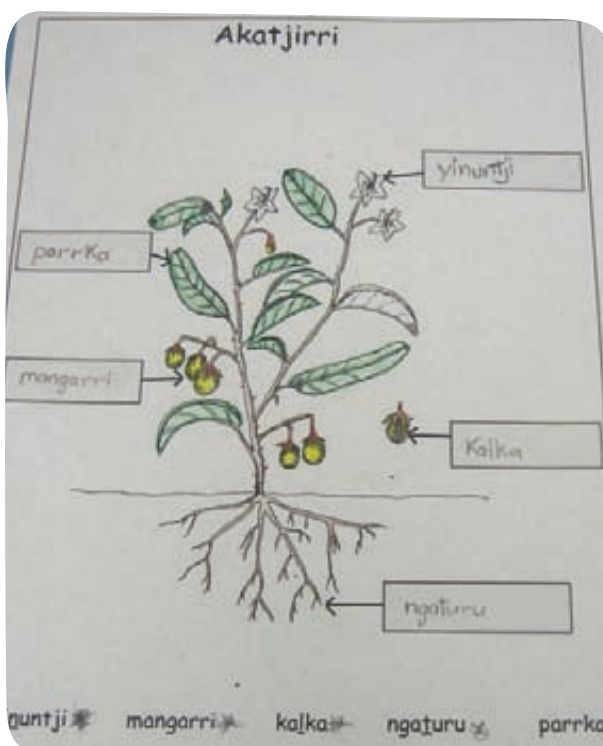
Roots: The roots hold the plant in the soil. They take up water and minerals to help the plant grow.

Parts of a plant: Desert Raisin



Activity 1: Label parts of a plant

- 1 Ask students to brainstorm the different parts of plants that they eat. (e.g. roots: yams/bush onion, fruit: bush tomato/berries, flower: woma).
- 2 Write down the different edible parts of the plant in Language and English.
- 3 Show a picture of a plant. Use a general image or a picture of a familiar desert plant.
- 4 Discuss with students what they know about the parts of a plant.
- 5 Label the plant together. These should include: roots, stem, leaf, flower, fruit and bud.
- 6 Record Language terms with the help of an Aboriginal education worker or Aboriginal expert.
- 7 Walk in the school yard and find some examples of small plants or weeds. Pull them up, being careful to keep the roots intact.
- 8 Students draw and label the plants. Talk about the differences and similarities between the different plants.



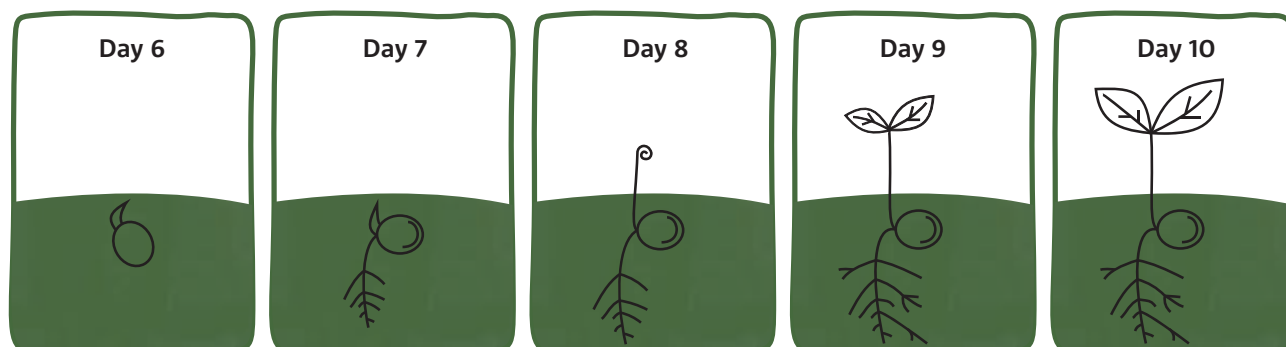
(above left): Desert Raisin from Martu country. Photo by Fiona Walsh.

(above right): Warmula (Bush Tomato). Illustration by Noreena Williams.

(left): Akatjirri (Desert Raisin) labelled in Pintupi Luritja, Papunya school. Photo by Meg Mooney.

Activity 2: Seed germination

- 1 Each student plants bean seeds in four clear jars filled with soil. The containers and the soil must be the same.
- 2 Water the seeds and record/draw their growth daily.



DATE	HEIGHT OF THE PLANT	NUMBER OF LEAVES SEEN	ANY OTHER CHANGE
10th October	1 cm	2	No
11th October	1.5 cm	3	No
12th October	2.5 cm	4	Stem became thicker
13th October	4 cm	6	Stem became even thicker

Activity 3: Investigation: Plants and water

Students conduct an investigation to see if plants can survive without water.

First: Look at pictures or walk along a local creek line with large River Red Gum trees.

Ask students: Why are the trees larger here? Have students travelled to places where the trees are larger? Discuss the relationship between plants and water based on student observations.

Ask an Aboriginal expert which plants indicate that water is under the ground.



Photo by David Broun, CSIRO.

- 1 Once students' beans in Activity 2 have grown to at least 4–5 cm tall, label one 'with water', and one 'without water', and ensure they are receiving some sunlight (filtered is OK).
- 2 Make predictions about what might happen over time.
- 3 Over time, have students record the changes they see.
- 4 After 1–2 weeks, discuss results with students:
 - What happened to the plant with water?
 - What happened to the plant without water?
 - What does this tell us about plants? (Plants need water to grow.)

Use the format below as a class, or in a Two-way Science journal, to conduct the investigation.

QUESTION AND PREDICT

Will a plant grow without water? What will happen to the plant without water?

PLAN AND CONDUCT

Grow some plants.

1. Water one plant every day, but leave the other plant alone.
2. Record what happens.

Note: Make sure that it is a fair test: the plants must be in the same sized and shaped container, with the same amount of soil and in the same light.

ANALYSE THE DATA

What happened to each plant?

SHARE

Make a poster showing the results.

Activity 4: Investigation: Plants and light

Students learn that plants need light from the Sun to survive.

Explain that you are doing a science investigation to see if plants need light to grow. You need to have one plant in the dark and the other in the light. Explain that everything else must be exactly the same for each plant except for one variable—the light. One plant will stay in the light, the other will stay in the dark.

The teacher can model this or students can write up the experiment in their Two-way Science journal, using headings below.

EQUIPMENT

- Two pots with germinated seeds (same size, pots and soil).
- A cardboard box or dark room.
- Water.

Note: Each plant must be the same size, grown in the same amount of soil and given the same amount of water every day. This will make the test a ‘fair test’.

QUESTION AND PREDICT

Do leaves need light energy from the Sun in order to grow? What will happen to the plant without light?

PLAN AND CONDUCT

1. Put one plant near the window and one under a box or dark cupboard nearby.
2. Water the plants daily with the same amount of water.
3. Record observations in a table in a Two-way Science journal.

ANALYSE DATA

What happened? Do plants need light to grow?



Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Germinating seeds and recording observations. Labeling the parts of a plant. Investigating plant water and light living requirements.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y2 Living things grow, change and have offspring similar to themselves (ACSSU030). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things have life cycles (ACSSU072). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Investigating plant water and light living requirements.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y3/4 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). • Y5/6 Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081, ACSHE098).

Science curriculum links

ACTIVITY	SCIENCE INQUIRY SKILLS
Discussing with students about what makes the investigations a 'fair test'.	Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029, AC SIS042).
Using photos, tables and drawings to record and represent information.	Y1/2 Participate in guided investigations to explore and answer questions (AC SIS025).
Evaluating and reflecting on both investigations.	- Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (AC SIS026, AC SIS039). - Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS060, AC SIS071). - Y3/4 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (AC SIS054, AC SIS065). - Y3/4 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (AC SIS055, AC SIS066). - Y3/4 Compare results with predictions, suggesting possible reasons for findings (AC SIS215, AC SIS216). - Y5/6 With guidance, pose clarifying questions and make predictions about scientific investigations (AC SIS231, AC SIS232). - Y5/6 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (AC SIS086, AC SIS103). - Y5/6 Decide variables to be changed and measured in fair tests, and observe, measure and record data with accuracy using digital technologies as appropriate (AC SIS087, AC SIS104). - Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (AC SIS093, AC SIS110).

Unit 4: Bush medicine

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students will learn about a bush medicine from Aboriginal experts. They will learn where it is found, how to collect, prepare and use it. They will write a procedure (recipe) about the bush medicine.

BACKGROUND

Historically plant substances have been the major source of medications all over the world. While Western medicines are now made in laboratories it was often plants that were the original source of compounds needed for many medicines. Today, many Aboriginal people still use traditional plant medicines. The plants that are used range from tall trees to small ground covers to roots. Few of the medicines used are swallowed; they are more often in the form of a paste or wash that is applied to the skin. The use of smoke made by placing plants on the coals of a fire, or the placement of plant resin on an affected area, are two other ways that medicine is administered. The complex processes of preparing specific medicines requires a knowledge not just of what plant for what ailment but also knowing where the plant grows, when the plant can be collected, and how it is to be prepared. This might involve pounding, soaking, mixing the plant ash with fat, smoking, crushing or binding part of the plant to the skin. Although making and using bush medicine is a skilled adult activity, students can learn about the use of bush medicine and observe the collection and preparation of some bush medicines that Aboriginal people are happy to show the students.



(above left): Samples of bush medicines collected for a classification exercise. Bush medicine plants have been separated from food plants. Photo by Kanyirninpa Jukurrpa.

(above right): Bush medicines are classified into medicines for different purposes. Here are the rubbing medicines with cards showing the plants from which they're sourced. Labelling helps those who don't recognise the plants. Photo by Fiona Walsh.

(left): Maroon Bush from Leonora pictured in a classroom display. Photo by David Broun, CSIRO.

Bush medicine: Planning

Questions for Aboriginal experts:

- What bush medicine do you want students to learn about?
- Where is it found?
- How do you collect it?
- How do you prepare it?
- What are the Language names of the bush medicine?
- Where can we go to on a field trip to learn about it?
- Who is the best person to teach the students on the field trip?

Bush medicine: Learning in class (preparation)

Activity 1: Introduction to bush medicine

Aboriginal expert: talk to students about the bush medicine and introduce or consolidate Aboriginal Language.

- Focus the Learning on Country.
- Connect, question and predict.
 - What bush medicines does your family use?
 - Where is it found?
 - How do they make it?
 - How is it used?
- Prepare equipment and go through the field trip plan.
- Introduce the task of students writing a procedure about the bush medicine after learning from Elders how to find, collect, prepare and use the bush medicine.



The sap or kino from Desert Bloodwood is used as a medicine by many desert people. Quantities of the crystals are collected, dissolved in water, then applied as a solution to dry wounds. Preparation of bush medicines gives students experience or examples of plant collection, transport, solutions, crystal to liquid ratios and the effectiveness of remedies. Photo by Fiona Walsh.

What is the plant called?
Collect samples of the
medicine plant.

Where is it found?

What country does
it grow in?

Bush medicine: Learning on Country

- 1. Learn about a bush medicine from Aboriginal experts.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos.
- 2. Students write a procedure: How do you collect, prepare and use the bush medicine?**
- 3. Collect bush medicine samples and take back to class.**

Equipment

iPad/camera, journals, buckets, envelopes, secateurs/scissors.

How do you collect it?

How do you prepare
or cook it?

Bush medicine: Learning in class (follow-up)

Activity 2: Reflect, recount and write

Listen to/view any photographs, recordings and videos.

- Recount important pieces of information.
- Add new words in Standard Australian English and Language to the class word wall.

Activity 3: Record plant information

Record information about the plant with help from the Aboriginal expert, using pre-printed labels (see page 213). Attach each plant sample to A3 paper or card with the information on the label. These can be displayed in the classroom, made into a class big book and added to after other field trips.

PLANT LABEL

Print name in Language:

Yirmangka-yirmangka

Plant name in English:

Emu bush / poverty bush

Name (who found it):

Nyapuru

Date:

24/4/2019

Location:

Leonora

Habitat (e.g. sandhill, claypan, rocky hills):

Widespread

Type of plant (grass/shrub/vine/tree):

Shrub

Uses (e.g. medicine, food, shelter, tools, animal home):

Medicine

Notes (e.g. how is it prepared and used?):

Burn branches and tap wax onto the skin as a rub (nyitilpa). Now we make it into a cream. Branches can be heated over the fire and used as a vapour like Vics Vaporub. For cold sick.



Yirmangka-yirmangka. Photo by David Broun, CSIRO.

Activity 4: Pressing plant samples

- 1 Record plant information.
- 2 Place each plant sample between two sheets of paper.
- 3 Place the sample between pages of a heavy book.
- 4 Press all of the plants under a heavy weight, e.g. a pile of books.
- 5 Leave them for a week.
- 6 Mount with plant information.



Plant press used by rangers in the field. Photos by David Broun, CSIRO.

Activity 5: Write a procedure

- 1 Use photos to recount with the class how to find, collect, prepare and eat the bush medicine.
- 2 Students can use pictures and/or words to write a procedure explaining how to find, collect, prepare and eat the chosen bush medicine.
- 3 This can be done in Language with an Aboriginal expert.
- 4 Share the procedure with others. Put recipes together in a big book.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about plant species that can be used as medicine. Recording the features and habitat of plant species that are used as medicine.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—CHEMICAL SCIENCES
Using heat or water to change the state of matter when preparing a bush medicine. For example, using heat to produce a vapour.	• F Objects are made of materials that have observable properties (ACSSU003). • Y1 Everyday materials can be physically changed in a variety of ways (ACSSU018). • Y2 Different materials can be combined, including by mixing, for a particular purpose (ACSSU031). • Y3 A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046). • Y4 Natural and processed materials have a range of physical properties that can influence their use (ACSSU074). • Y6 Changes to materials can be reversible or irreversible (ACSSU095).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning on Country trip with Aboriginal knowledge holders teaching students about bush medicine.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y2/3 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Writing a procedural text on the process of making bush medicine. Using photos, tables and drawings to record and represent information.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029, ACSI042). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026, ACSI039). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110).

Plant label

Print name in Language:

Plant name in English:

Name (who found it):

Date:

Location:

Habitat (e.g. sandhill, claypan, rocky hills):

Type of plant (grass/shrub/vine/tree):

Uses (e.g. medicine, food, shelter, tools, animal home):

Notes (e.g. how is it prepared and used?):

Unit 5: Flowers and pollination

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students will learn about the parts of a flower and their functions.

They will learn how plants and animals work together to pollinate certain plants.

BACKGROUND

Flowers are the breeding parts of plants. Flowers attract pollinators such as birds, bees and ants with bright colours and sweet nectar to share genetic material between the male and female parts of the flower. This in turn creates fruit and seeds used by the plant to distribute and grow other plants, with both people and animals benefiting from the food provided. Bees use the nectar from flowers to create honey. Aboriginal people also eat the sweet nectar from certain grevillea species. After rain the desert explodes into colour providing wonderful educational opportunities for students to examine flower structure, function and the unique processes of pollination.



Photo by Fiona Walsh.

POLLINATION

Flowers serve an important role in the plant's life cycle. The flower is the part of the plant where seeds are made. The scent, colour and nectar produced by many flowers, attracts **pollinating** animals. Pollinating animals, such as a bee, bird or ant, visit the flower to eat or collect nectar. As the animal accesses the nectar, **pollen** (a fine powder that contains the plant's sperm cells) is brushed onto its body. When the animal visits another flower, some of the pollen brushes onto the sticky top of the flower's female part, the **stigma**. This process is called **pollination**, and it allows new seeds to be made in the plant's **ovary**. So, the plants help feed the animal with pollen and nectar and, in return, the animal helps the plant by moving pollen from flower to flower.

Some plants are self-pollinated. On other plants, pollen is carried on the wind.



(left): A wasp collects nectar from a melaleuca flower. Photo by Sally Deslandes.



(right): A bee collects pollen and nectar from a eucalyptus flower. Photo by Sally Deslandes.



Spinifex is a grass that is pollinated by the wind. Photos by David Broun, CSIRO.

About half of Australia's plants are pollinated by animals (such as small mammals, birds, bees, wasps, ants). Flowering plants have evolved ways to get their pollen to the ovule of the same type of plant:

- growing coloured petals surrounding the stamens to attract pollinators
- producing nectar to attract a pollinator.



(left): (left) *Solanum* plants including the Bush Tomato have brightly coloured petals to attract pollinators. Photo by David Broun, CSIRO.

(right): (right): Attracted by nectar, a moth walks up the flower of plants from this *Ptilotus* sp. (Mulla Mulla) collecting pollen on the way. Photo by Rob Davis.

Many plants indicate where to find the nectar with a 'map' for animals.

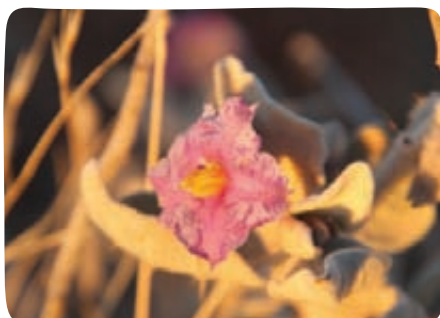
Other plants have 'flight paths' on their petals. These are petal sections of a different colour that lead to the nectar and are only visible to animals, such as a bee, with ultraviolet vision.



(left): Sturt's Desert Pea has large, bright red petals with a darker circle showing where the beak of a bird will find the nectar. Photo by David Broun, CSIRO.

(right): Ultraviolet light shows the 'flight path' for a pollinator. Photo by plantsurfer.

Some flowers are designed to be pollinated by a particular animal. Tomato plants (*Solanum* sp.) are buzz pollinated by bees. The stamens in these flowers are enclosed in a tube-like structure, with a tiny hole at the end. When a bee vibrates its flight muscles, the anther dislodges its pollen through the hole. It is usually species of solitary bees that are buzz-pollinators.



(left): *Solanum* flower. Note the tube structures adapted for buzz pollination. Photo by David Broun, CSIRO.

(right): Blue Banded Bees are common buzz pollinators in Australia. Photo by Chiswick Chap.

Activity 1: Seeds up close

Look at seeds from fruit collected on a field trip or from the shop.

Use a digital microscope. Peel/cut/open up the seeds and look again. What do you see?

Compare different seeds under the microscope. Record and label photos and drawings.



(left): Everlasting seeds ready to be blown away by the wind. Photo by Fiona Walsh.

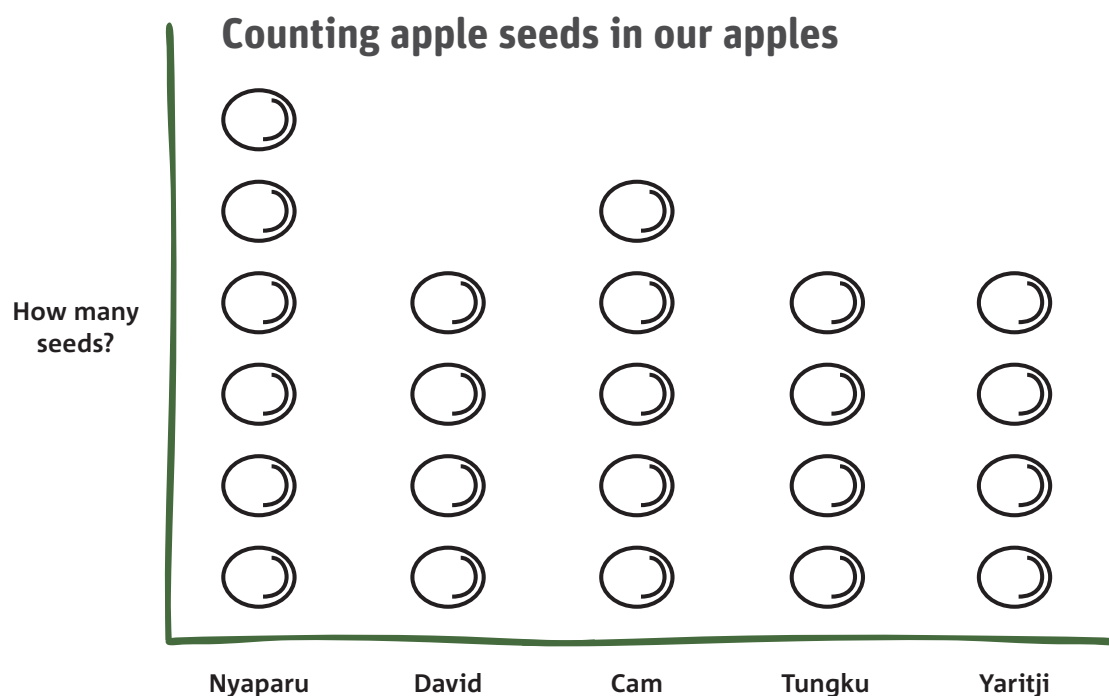
(middle): Quandong seeds in the litter at the base of the tree. Photo by Fiona Walsh.

(right): The Bean Tree seed. Photo by Fiona Walsh.

Activity 2: Counting and comparing seeds

Count/sort/compare seeds in different fruits or grasses:

- Give each student their own piece of fruit for them to count the number of seeds it has. Graph the results. Find the average for that fruit.



- What fruit has the most seeds?
 - Compare fruits from the shop (e.g. apples, oranges) and local bush foods.
 - Graph the number of seeds in each fruit. Which fruit has the most? Why do you think?



Warmula (*Solanum diveriflorum*) from Martu country. The black seeds of this Bush Tomato are very bitter so should be handled with gloves on, then discarded. Photo by Grace Atwell.

Activity 3: Parts of a flower

BACKGROUND

There are many different types of flowers and each type has its own structure. Some features are common to most flowers.

Common features of flowers:

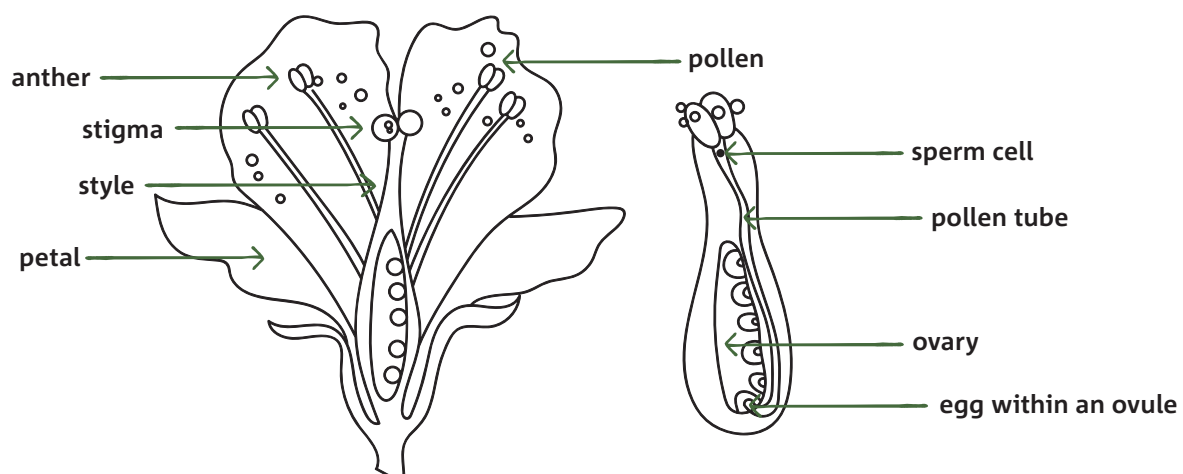
Petals: attract pollinating animals with their scent or colour.

Stamen: the male part of the flower that produces pollen.

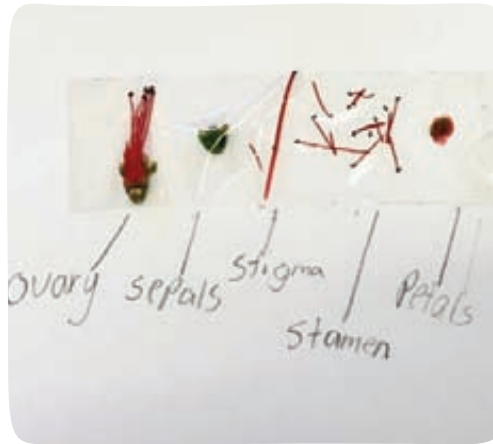
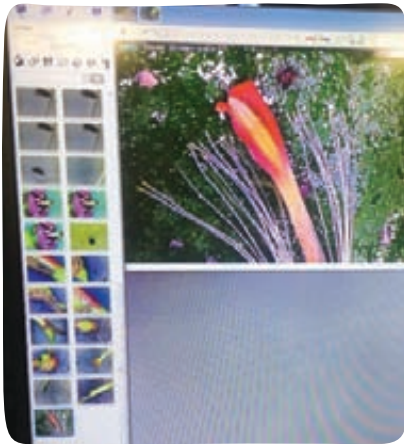
Ovary: produces fruit after fertilisation occurs.

Stigma: the sticky, female part of the flower where fertilisation happens.

Sepals: the covering of the flower bud.



- Show the students a diagram of the parts of a flower.
- Show the students a real flower. Use a digital microscope or a close-up photo to point out the different parts and ask the students to name each part.



(left): An image of a flower under a digital microscope displayed on the class smartboard. Photo by David Broun, CSIRO.

(middle): Dissected and labelled *Callistemon* sp. flower. Photo by David Broun, CSIRO.

(right): *Eremophila* sp. flower from near Leonora. Photo by David Broun, CSIRO.

- Explain that the students will each be dissecting a flower.
- Demonstrate dissecting a flower with tweezers and placing each flower part on double sided sticky tape on a card:
 1. Start at the base of the flower. Carefully remove one sepal at a time and place it on the left hand side of the sticky tape. Allow about 1 cm between each sepal.
 2. Next remove the petals one at a time and stick those on the tape.
 3. Repeat this process with the stigma, stamens, and lastly the ovary.
 4. Place a piece of sticky tape carefully over the top of the flower parts to protect them.
 5. Write the names of the flower parts under the different parts.
- Give each student a flower, some tweezers, a piece of card and a piece of two-sided sticky tape. Ideally it would be good for there to be a variety of flowers so students can compare the numbers of sepals, petals and stamens with each other.

Encourage the students to work slowly and carefully!

Activity 4: Pollination

Discuss what animal students may have seen visiting a flower—a bird, a lizard, a bee or an ant? Do they know why the animal was visiting? Look around the school yard or go on another field trip to look for examples of flowers being pollinated by insects or birds.

Explain that pollination helps the plant to make seeds that grow into new plants.

Watch videos and look at pictures of bees and birds pollinating flowers.



(above left): A honeyeater eating nectar from a flower caught the eye of students in Wiluna. A teacher used this observation to start a pollination investigation with students. Photo by David Broun, CSIRO.

(above right): Look carefully. How many pollinators can you see? Photo by Sally Deslandes.

(bottom left): A wasp pollinates this bitter pea flower. Photo by Sally Deslandes.

Activity 5: Nectar

Nectar is the sweet, sugary liquid made by the flowers of plants. Plants make nectar to attract pollinating animals like birds, ants and bees. Insects are attracted to flowers having a very sweet nectar. Vertebrates, such as birds, are attracted to a less sweet nectar.

Ask students if they have tasted nectar from flowers. Which flowers have sweet nectar? Why do plants have nectar?

What plants that the students collected had nectar? Taste nectar from sweet flowers identified by Aboriginal people.

What birds and insects did students see eating the nectar?

Activity 6: Bee pathways

Students look for flight paths on petals by examining flowers under ultraviolet light, using a UV torch. Do this in a dark room or cupboard.



A comparison between visible and ultraviolet light. Note the bee pathway shown in ultraviolet light by the dark central area around the stigma and stamen. Photo by David Kennard.

Activity 7: Who is the pollinator?

Students photograph/draw and label the parts of the flower and draw conclusions about ‘Who is the pollinator?’.

There are clues in every flower that help to identify the pollinator—students can learn the clues, connect them to their observations, then use them to predict ‘Who is the pollinator?’.

- For example, does the flower have a bee flight path under UV light?
- What animal did you see on the flower? Look carefully! This could be a bird or an insect.

Research if necessary.



An ant pollinating an *Eremophila* flower. Photo by Sally Deslandes.

Activity 8: Role-playing pollination

Students demonstrate their understanding of the pollination process by acting out a pollinator carrying pollen from one flower to another. They can pretend to be the different parts of the flower and a pollinator. They can use flour instead of pollen, then turn into a seed and grow into a plant. Show this to another class, to family or at a school assembly.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about plant anatomy and reproduction. Learning about the anatomy of flowers and the process of pollination. Dissecting parts of a flower.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y2 Living things grow, change and have offspring similar to themselves (ACSSU030). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y4 Living things have life cycles (ACSSU072). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE INQUIRY SKILLS
Acting out the process of pollination. Using drawings to illustrate the anatomy of a flower and the process of pollination.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACIS029 ACIS042). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACIS060, ACIS071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACIS093, ACIS110).

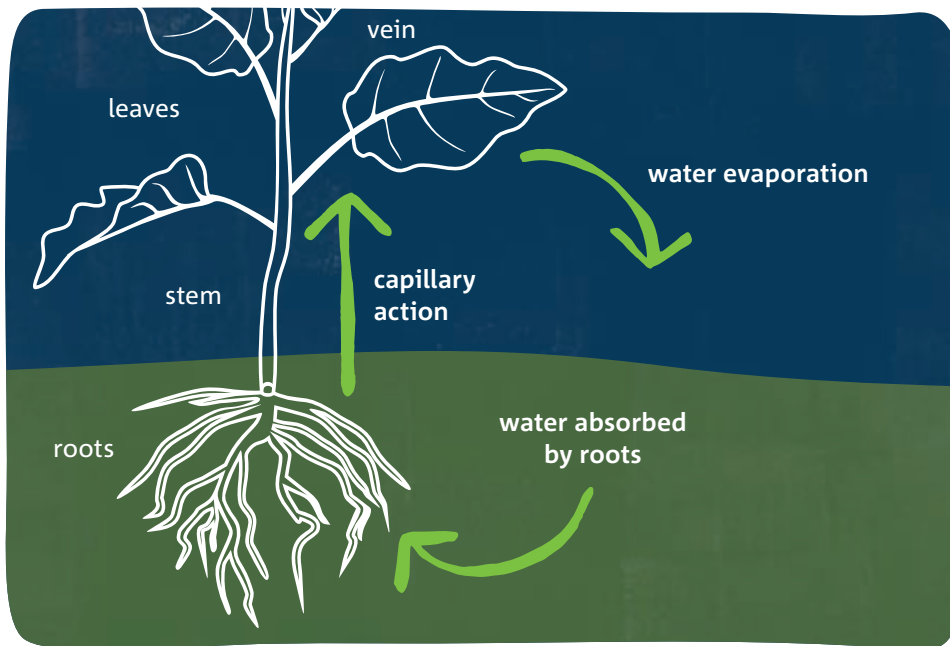
Unit 6: Leaves, roots, water and adaptations

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students will learn how plants move water through roots, stems and leaves through transpiration and capillary action. They will explore desert plant leaf adaptations to life in a dry climate.

BACKGROUND

Plants use water to move nutrients from the roots to the rest of the plant, and for photosynthesis to make food from the Sun. Water is moved from roots, through stems to the leaves in veins helped by capillary action. Capillary action is a physical process where water is drawn against gravity because it is attracted to the walls of narrow tubes. Some water exits the leaves in the form of gas (water vapour). This is called transpiration. Desert plants live in an environment with limited water. They have developed special adaptations to survive by storing water and reducing water loss through evaporation.



Kado Muir from Leonora shows how water can be found in the root of the Kapi tree. This provided reliable drinking water in between water sources. Photos by Reggie Carson.

Activity 1: Evaporation

Students learn that water can move from liquid into the air through evaporation. Introduce evaporation—when do students notice water ‘drying up’? What happens to salt lakes and wetlands when the rains stop? Where does the water go? Demonstrate several examples of evaporation.

- Paint water on concrete and watch it disappear.
- Put water on a saucer and observe over 24 hours.

Explain that the water changes from liquid to gas and is held in the air. Connect this to activities involving clouds and condensation at an appropriate level for students.

Activity 2: Collect and sort leaves

Students collect, observe, sort and classify leaves.

Teacher and Aboriginal expert together:

- Ask students about the things that leaves can be used for.
- Elders and expert knowledge holders could share stories or uses about different leaves.
During a field trip or around the school, collect leaves of different sizes and shapes.
- Students sort their collection of leaves. This might be according to traditional uses, their shape (flat/rolled), size (large/small), colour (dark/light), texture (hairy/smooth) (waxy/sticky/not waxy), etc.

Ask students: Why are the leaves are different?



Leaves are a common source of bush medicine. Photo by Fiona Walsh.

Activity 3: Compare leaves from different environments

Students compare pictures of a desert environment with another part of the world. They compare examples of local leaves with those from elsewhere, for example from a vegetable garden.

- 1 Show a picture of rainforest next to a picture of desert country.
What do students notice about the difference in the leaves and plants between the two pictures?
Ask students to compare the size, shape and colour of the leaves.
Find a range of close up and wide images of rainforest and arid zone plants



(left): Photo by Dukeabruzzi (Wikimedia).



(right): Photo by Fiona Walsh.

- 2 Collect leaves from the school vegetable garden or shop, like a lettuce or spinach leaf (big round and dark green), and a leaves from a desert plant (thin, lighter in colour, hard/waxy).
- 3 Feel and describe them. What is different? What is the same? Compare colour, shape, size and texture.
- 4 Put the leaves on a plate in the classroom, and leave them there overnight.
Look at the leaves again the next day, discuss what has changed.

Activity 4: Leaf rubbings

- 1 Collect eucalyptus leaves or similar broad leaves from around the school grounds.
Place the leaves under a piece of paper, and rub a crayon or oil pastel over the leaf to make a leaf rubbing.
- 2 Point out and label the veins in the leaf.
These work similarly to human veins—they carry water and nutrients around the plant.
- 3 Compare leaves from the vegetable garden to those found locally.
- 4 How do the textures and shapes of the leaves from the desert compare to the vegetable garden?



Photo by Emma Craig.

Activity 5: Capillary action

Students learn about the transport of water through a plant using capillary action.

- 1 Review with the students the different parts of the plant and what they do.
- 2 Demonstrate how a celery plant uses its stem to transport food and water by placing several sticks of celery in a jar of water that has red or blue food colour added to it.



Photo by Katrina Lane.

- 3 Ask the students to predict what will happen after 30 minutes, 60 minutes and 90 minutes.
- 4 Observe the celery carefully over 90 minutes to see what changes occur.
- 5 After half an hour ask a student to cut one stick of the celery into thirds.
- 6 What is visible in each section? (You should be able to see coloured dots on the end of one section. These are the cross-section of the tiny tubes in the stem, veins, that are carrying the water to the leaves.)



Photo by Katrina Lane.

- 7 After 60 minutes repeat this with a second piece of celery and again after 90 minutes with a third piece.
 - What is visible now?
 - What changed over time?

Activity 6: Transpiration

BACKGROUND

Students will tie a bag over leaves to capture water released by the leaves. Water on the inside of the bag shows that the leaf has released water as a gas—a process called transpiration. The gas has condensed in the bag, and changed from a gas to a liquid.

Demonstrate that plants release water from their leaves.

- 1 Place a plastic bag over some leaves on a tree (near the classroom) and tie firmly around the main stem to the leaves with an elastic band. Ask students to make predictions about what they might see.
- 2 Check the bag every hour. Do you notice any changes? Does the bag get bigger? Why do you think?
- 3 The following day, remove the bag and look inside. What do students observe? Is there any water inside the bag? Where did it come from?



This experiment compared the transpiration of different plant species. The Australian cypress transpired the most water. This collected over a few hours from a small branch. Photo by David Broun, CSIRO.

Activity 7: Leaf adaptations

Students investigate the different adaptations of leaves from desert plants. Show students the guide on leaf adaptations on page 228 and discuss, asking students to identify examples from the plants they have collected with each adaptation that helps a plant to reduce water loss.

Students investigate the adaptations of desert plants to reduce water loss.

- 1 Show students the leaf guide on page 228 and discuss the different adaptations.
- 2 Collect different leaves, or use the collection of leaves from Activity 2, and identify examples of different adaptations.
- 3 Repeat the transpiration experiment to see which plants transpire the most.
- 4 Look at the different leaves under the microscope to examine their adaptations.

LEAF GUIDE: DESERT PLANTS HAVE SPECIAL ADAPTATIONS TO REDUCE WATER LOSS



Shape: Short or narrow leaves reduce evaporation because less surface area of leaves are exposed to the Sun.



Size: Small leaves lose less water.



Texture: Hard and spiny plants like spinifex contain silica which is found in quartz rocks and sand.



Colour: Pale colours reflect the Sun's rays.



Thickness: Thick plants store water in their leaves.



Surface: A thick waxy outer layer reduces evaporation.



Surface: Tiny white hairs on leaves and flowers slow down dry air passing over the surface of the leaf, reducing evaporation.

Photos by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning how plants from arid environments have adaptations to reduce water loss. Comparing the leaves from plants from different environments.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y5 Living things have structural features and adaptations that help them to survive in their environment (ACSSU043). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—CHEMICAL SCIENCES
Learning about transpiration/ evaporation and how desert plants are adapted to conserve water. Placing a plastic bag over leaves to observe water formed by transpiration.	• Y3 A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046). • Y4 Natural and processed materials have a range of physical properties that can influence their use (ACSSU074). • Y5 Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077). • Y6 Changes to materials can be reversible or irreversible (ACSSU095).
ACTIVITY	SCIENCE INQUIRY SKILLS
Investigating capillary action and transpiration. Using photos, tables and drawings to record and represent information.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029, ACSI042). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026, ACSI039). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110).

Unit 7: Plants as tools and shelter

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students will go on a field trip led by an Aboriginal expert to learn about using plants for tools and shelter. Students will learn about the tool, its traditional uses, how to find the plant, prepare, make and use it.

BACKGROUND

Plants have been used in many additional ways, other than as food and medicine sources. These include native tobacco that is dried, broken up and mixed with ash from one of several specific trees before being chewed. Some plant roots can be a source of water, the bark of some trees can be used to make sandals, resin prepared from spinifex is used as a strong glue for making implements, plant poisons have been used in waterholes to stun animals being hunted and the wood from many different plants has been used to make implements such as digging sticks, spears, spear throwers, shields, bowls and boomerangs. Branches are used to make shelters and windbreaks as well as a mat on the ground to keep food dirt free. Plant materials have been used to make a type of cushion that is placed on the head when carrying a heavy object, branches are used to cover small rock holes to slow down evaporation, and grasses can be used as a filter when drinking from a waterhole.



(left): This Jara Putal or Beefwood *Grevillea* bears the scar where its strong bark was cut to make ceremonial shields or Coolamon for carrying food and water. Photo by David Broun, CSIRO.

(above): Coolamon being used to process seeds. Photo by Kanyirninpa Jukurrpa.

Plants as tools: Planning

Meet with an Aboriginal expert to plan the unit together.

Arrange for a Learning on Country field trip to learn about making a traditional tool (e.g. spear).

Questions for Aboriginal experts:

- What traditional tool do you want students to learn about?
- What plants are suitable for making the tool?
- How is it collected/prepared/made and used?
- What are the Language names of the materials required and the processes used?
- Where can we go to on a field trip to learn about this tool?
- Who is the best person to lead the students on a field trip to that place?

Plants as tools: Learning in class (preparation)

Activity 1: Introduction to using plants for tool making

Aboriginal expert:

Talk to students about the tool and introduce or consolidate

Aboriginal Language. Use the questions above as a guide.

Teacher:

- Focus the Learning on Country.
 - Connect, question, predict:
 - What tools made from plants (wood, etc.) have you used?
 - What do you know about the tool?
 - Have you used the tool?
 - Have you made the tool?
 - What is the tool made of?
- Prepare equipment and go through the field trip plan.
- Introduce the task of students writing a procedure showing how to make the tool after learning from Elders how to find the plant, collect material, prepare and make the tool.



Look carefully—can you see the remains of a Puri (shelter)? This one was built by adapting traditional methods and had uprights with a frame to stretch a tarp over. All that is left are the Mulga uprights (warta). It takes a trained eye to spot them now. Photo by David Broun, CSIRO.

Who can make and use the tool?

When is it best to collect it?

What is the tool?
Collect samples or take photos of the plant leaves and flowers.

What country does it grow in?

Plants as tools: Learning on Country

- 1. Learn from Aboriginal experts about a tool made from a plant.**
 - a. Record stories.
 - b. Write down Language names.
 - c. Take photos of each stage.
- 2. Students learn how to find materials and make the tool.**
- 3. Collect plant samples and take them back to class.**

Equipment

iPad/camera, journals, tools.

How do you collect it?

How do you make the tool step by step?

How do you use it?

Who can make it?



Nancy Donegan and Kathleen Donegan taught students from Tjuntjuntjara school to dig the roots of the Western Myall (Kartaya) and the Quandong (Wayanu) trees. They showed the students how to locate underground roots by noticing cracks in the earth under the bushes, and then use a crowbar or rod to find the root before digging it out. The students prepared the roots to make wooden tools or artefacts (punu) by removing the outer layer. They used the roots to make tapping sticks. The punu roots are softer and easier to work with than the trunks and branches of the trees. Photos by Monika Klein.

Plants as tools: Learning in class (follow-up)

Activity 2: Reflect, recount and write

Listen to/view any recordings, photographs and videos.

- Recount important pieces of information.
- Add new words in Standard Australian English and Language to the class word wall.

Activity 3: Procedure

Students use the photos taken on country to create a step by step procedure. This should include information about who can make and use the tools and any other cultural protocols learnt from Elders.

Plants as shelter and tools activities

The following activities are examples that could be used in a Two-way Science program. Local Aboriginal experts should determine which shelter or tool making activities are appropriate in the local area and how students are taught.



Bruce Thomas from Strelley shows students how to make a shelter using paperbark branches. See how he cut strong straighter branches with many sticks and leaves on the end. The ends were dug into the sand. Then the sticks were interwoven and balanced against each other to stabilise them. Then additional leafy twigs were added to make the shade darker. Photos by Anne Westerink.

Activity 4: Making shelter

Aboriginal people made a variety of types of shelters from different plants to protect from the Sun, wind and rain.

Activity 5: Bark sandals



(left): Photo by Annette Ruzicka.



(right): Jakapiri (*Crotalaria cunninghamii*, Green Bird Flower). Photo by Fiona Walsh.

Aboriginal people in some desert areas made sandals from bark stripped from the *Crotalaria cunninghamii* (Green Bird Flower). The bark is woven to protect their feet from the hot sand or when walking on gravelly areas.

An Aboriginal expert can show students how to collect, process and weave the sandals. Connect this to Design and Technologies curriculum outcomes. Material substitutes could include: hemp, jute string or leather thonging.

Activity 6: Creating fire

Aboriginal people made fire using friction between soft and hard timber.



(left): Hand saw fire tools from Punmu in Western Australia. The hardwood saw is rubbed across the softwood to create friction, heat and burning embers that ignite the flammable material in the wedged groove. Photo by Fiona Walsh.



(right): Corkybark (*Gyrostemon ramulosus*) is a desert plant used as softwood to make fire. Photo by Fiona Walsh.

In desert Australia the hand saw method was most common for fire starting. A hardwood ‘saw’ is rubbed over softwood to produce heat through friction. Another common method was the hand drill method. This method required two pieces of wood—a drill stick and hearth (or base) stick.

Plan with an Aboriginal expert to teach students how to make fire or replicate the materials and process of creating fire. Methods vary from place to place. It is important that this is done using the local method.

Activity 7: Making glue

Aboriginal people used spinifex resin and other plants to create a glue used to make tools.

Plan for an Aboriginal expert to show students how to find and make glue using the local method. Teachers can connect this to Chemical Sciences curriculum outcomes around reversible and irreversible change.



(above): A block of spinifex resin. The resin is used with binding, to attach the peg of the spear thrower. Photos by Fiona Walsh.

(below): The species of spinifex *Triodia pungens* is used to make resin in the desert. Note the abundant resin on the stalk in the close-up photo. Photos by Fiona Walsh and Mark Marathon.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about plant species that can be utilised as tools.	- F Living things have basic needs, including food and water (ACSSU002). - Y1 Living things have a variety of external features (ACSSU017). - Y1 Living things live in different places where their needs are met (ACSSU211). - Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). - Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—CHEMICAL SCIENCES
Making fire from friction between a hardwood and a softwood. Making glue from spinifex resin.	- F Objects are made of materials that have observable properties (ACSSU003). - Y1 Everyday materials can be physically changed in a variety of ways (ACSSU018). - Y2 Different materials can be combined, including by mixing, for a particular purpose (ACSSU031). - Y3 A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046). - Y4 Natural and processed materials have a range of physical properties that can influence their use (ACSSU074). - Y6 Changes to materials can be reversible or irreversible (ACSSU095).
ACTIVITY	SCIENCE UNDERSTANDING—PHYSICAL SCIENCES
Making fire from friction between a hardwood and a softwood.	Y3 Heat can be produced in many ways and can move from one object to another (ACSSU049).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Making bark sandals. Constructing a shelter.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). - Y2/3 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035).

Science curriculum links

ACTIVITY	SCIENCE INQUIRY SKILLS
Using photos to write a step-by-step procedure on how to build a shelter.	- Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029, AC SIS042). - Y1/2 Participate in guided investigations to explore and answer questions (AC SIS025). - Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (AC SIS026, AC SIS039). - Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS060, AC SIS071). - Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (AC SIS093, AC SIS110).

Plant label

Print name in Language:	Plant name in English:
Name (who found it):	Date:
Location:	Habitat (e.g. sandhill, claypan, rocky hills):
Type of plant (grass/shrub/vine/tree):	
Uses (e.g. medicine, food, shelter, tools, animal home):	
Notes (e.g. how is it prepared and used?):	

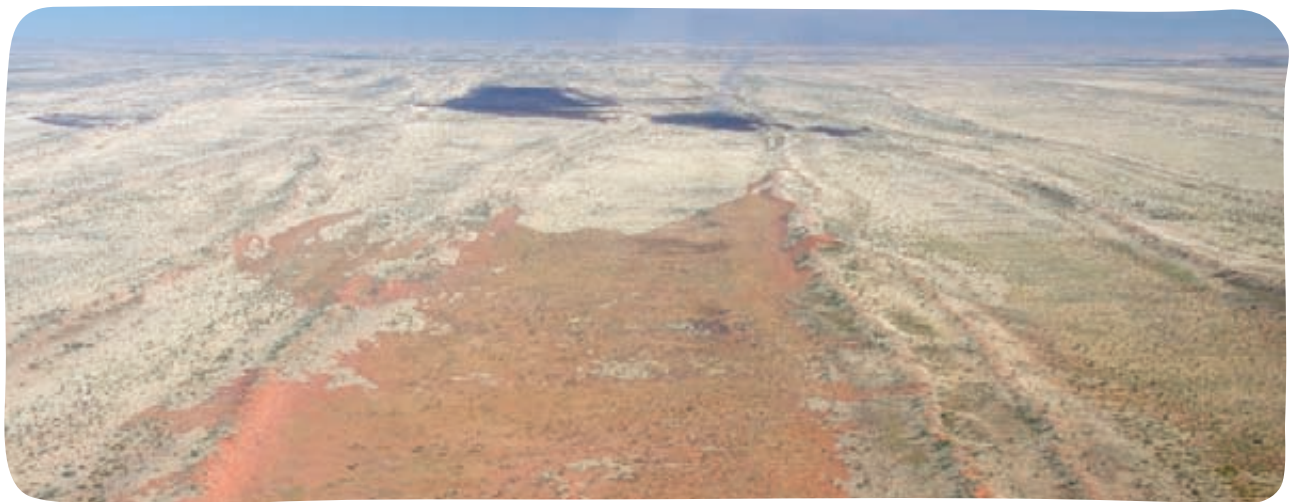
Unit 8: Plants and fire

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

An Aboriginal expert will show students how the use of fire relates to plants. Students will learn about reasons for burning and plant regrowth after a fire. They will identify and survey plants in burnt and unburnt areas and record their data in a graph. They will demonstrate their understanding through a painting of country.

BACKGROUND

Country is burnt by Aboriginal people for many reasons. Fire is used purposefully. After a fire, plants appear as if they are dead, then come to life with bright green shoots. Different stages of regrowth give food for people and animals. Some plants such as Bush Tomato grow after a fire. Aboriginal rangers manage huge areas of land by adapting traditional burning practices. Traditional patchwork or mosaic burning early in the season creates fire breaks to slow the progress of hot late-season fires. These practices reduce the impact of fire on native animals, allowing them to escape to safe ground. Fire breaks also reduce the amount of carbon released into the atmosphere in large-scale wildfires. Landscape burns are used in this way as a strategy to slow global warming.



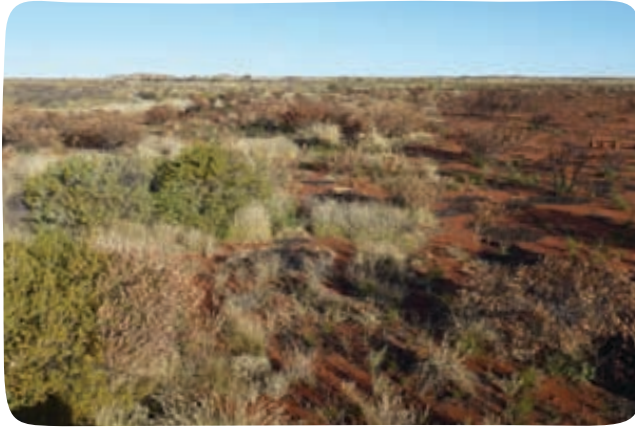
(above): A fire scar between sand dunes on Martu country. Can you tell the burnt from unburnt country? How long ago do you think this was burnt? Martu burn the landscape to regenerate plants to produce food for people and animals. This fire was lit in the cool season, creating a diverse patchwork of burnt and unburnt country. Photo by Kanyirninpa Jukurrpa.

(bottom left): A Martu woman walks in bare areas cleared by her fire. She searches for Parnajarpa (Sand Goanna, *Varanus gouldii*) burrows exposed by the fire. When a burrow is found she uses her long digging stick to dig out the goanna. The burn makes it easier to walk, see and dig so increases hunting efficiency. Photo by Fiona Walsh.

(bottom right): Spinifex regenerates after burns and rainfall. This creates different stages of regrowth with different habitats for different animals. Photo by David Broun, CSIRO.

Plants and fire: Planning

Teacher and Aboriginal experts meet to plan the unit together. Arrange for a Learning on Country field trip to learn about fire and plants on country that has been burnt recently, and country of the same type that hasn't been burnt for a while, or has regrown after a fire. Plan a field trip so that students can compare the different country.



(left): Longer unburnt sandplain (on left) with standing spinifex and shrubs and recently burnt sandplain (on right). Photo by Matthew Patterson, Kanyirninpa Jukurrpa.

(right): Spinifex regenerating after fire (foreground) and longer unburnt spinifex (background). Note the fire in the background. Photo by Fiona Walsh.

Questions for Aboriginal experts:

- What do you want students to learn about fire and plants?
- Why do people burn country?
- How is fire used to look after country?
- What useful plants like different bushfoods grow after country is burnt?
- What animals can be found on country after it is burnt? After 1 year, 2 years?
- How was fire used to look after country in the old days? How is fire used today?
- What are fire related Language words for different burn stages that students should learn?
- Where can we go to on a field trip to learn about plants?
- Who is the best person to lead the students on a field trip to that place?
- What local paintings show burnt and unburnt country?



Bush Tomato (*Solanum diversiflorum*) growth is encouraged by fire. Photo by Fiona Walsh.

Plants and fire: Learning in class (preparation)

Aboriginal expert: explain how fire is used to burn country, and how the country changes in the years after it is burnt. Use and teach Aboriginal Language. If possible, show students a painting of local country that has been burnt and the stages of regrowth.

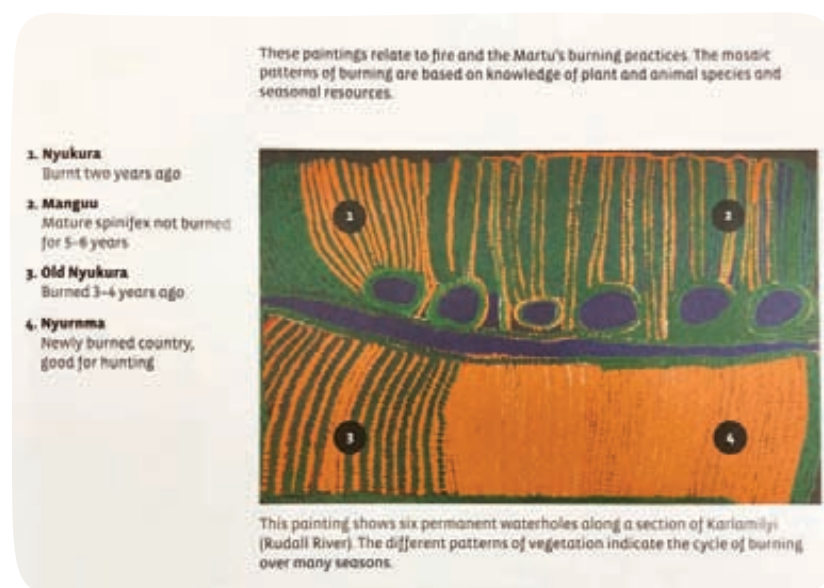
Activity 1: Watch a film about fire

- 1 Watch a film such as 'Waru' (Fire) by Kanyirninpa Jukurrpa about Waru, kuka, mirrka wankarringu-lampaju (burning, bush foods and bio-diversity) (<https://www.youtube.com/watch?v=nKLD9LrySeU> or 'The Art of Fire' <https://www.youtube.com/watch?v=ZQ2Zjaa1wAE>) which is also available as a book with English translation.
- 2 After watching the film invite a ranger to talk to the students in Language about their work using fire.
- 3 Students design a labelled poster that illustrates why it is important for people to burn country in the right way, and the benefits to plants, animals and people.

Activity 2: Art and fire

Visit a local art centre, gallery or painting shed. Talk to artists about fire in their paintings.

Ask the artist to explain how they show burning of country and the foods and animals that come after the fire.



(left): A painting showing Martu burning practices and stages of regrowth. From 'We Don't Need a Map Education Resource'.

(right): View of different fire ages and patches of plants in dunes near Pungarli, West Mackay Range. Photo by Matthew Patterson Kanyirninpa Jukurrpa.

Activity 3: Before going on country

Focus the Learning on Country.

- Connect, question and predict:
 - What is a good fire and a bad fire?
 - Does your family burn country? Why?
 - What plants and animals will we find in burnt country?
 - What plants and animals will we find in unburnt country?
- Prepare equipment and go through the field trip plan.
- Introduce the task—after you have been on country, you will paint a picture to show how country changes after it is burnt, and the plants and animals that live there.

What type of country
has been burnt?

When was this
country burnt?
Write this down.

What plants did you
find on burnt country?
What plants did you find
on unburnt country?
Make a list of the main
plants in each place.

What animals tracks
can you see on burnt
country? On unburnt
country? Record animal
tracks at each place.

Plants and fire: Learning on Country

- 1. Learn from Aboriginal experts about plants that grow before and after a fire.**
 - a. Visit country at different stages after burning.
 - b. Record stories.
 - c. Write down Language names.
 - d. Take photos.
- 2. Discuss with students what will be in their painting to show burnt and unburnt country.**
- 3. Collect plant and bushfood samples and take back to class.**
- 4. Record tracks using a tracking data sheet.**

Equipment

iPad/camera, journals, tracking data sheets, buckets and paper envelopes for plant samples.

Photos by CSIRO and Fiona Walsh.

Collect samples
of the different
plants on burnt and
unburnt country.



Plants and fire: Learning in class (follow-up)

Activity 4: Reflect, recount and write

Listen to/view any photographs, recordings and videos.

- Recount important pieces of information.
- Add new words in Standard Australian English and Language to the class word wall.

Activity 5: Record observations

Look at the photos taken on burnt and unburnt country.

Ask students to describe what they saw in each place. What do you see? For example:

In burnt country:

- 'Black sticks'.
- 'Plants have no leaves'.
- 'New leaves are bright green'.
- 'Lots of sand'.
- 'Goanna tracks'.

In unburnt country:

- 'Plants are bigger'.
- 'There are leaves on the ground'.
- 'Places for animals to hide'.
- 'Animal diggings'.
- 'Bush tomatoes'.

Students can write their observations in their Two-way Science journal or a class Two-way Science journal.

Activity 6: Record data

Students make a list of the plants and animals they found on burnt country, and on country that has grown after fire.

Plants in burnt and regrown country:

- 1 Look at the photos taken on burnt and regrown country.
- 2 Use pictures of the plants or words to make a list of the plants that students found on burnt and regrown country.
- 3 Aboriginal people help students to label them in Language.
- 4 Ask students: What is the difference between the two places? Why?

Animals in burnt and regrown country:

- 1 Look at the tracking data sheets.
- 2 Make a list of animal tracks and scats found in burnt country and a list on animals found in country that has regrown.
- 3 Aboriginal people help students to label them in Language.
- 4 Ask students: What is the difference between the two places? Why?

Activity 7: Plants and fire painting

Use the data about plants and animals found on burnt and regrown country to make a painting about how country changes after it is burnt. Students should pay attention to the colours and shapes of the plants in their design.

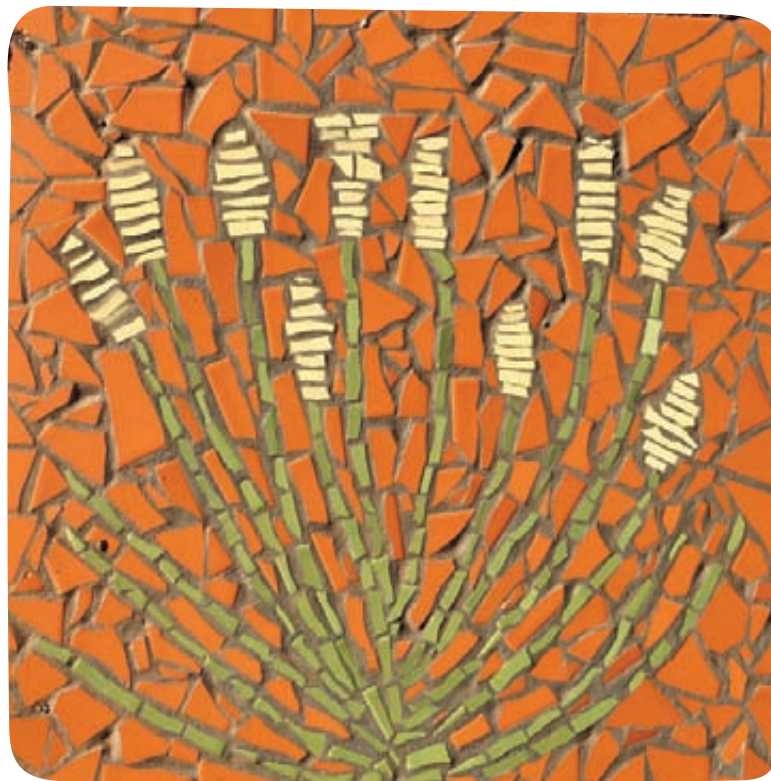
Make a video of students explaining what is in their painting, the difference between the burnt and regrown country and why it is important to burn country the right way.



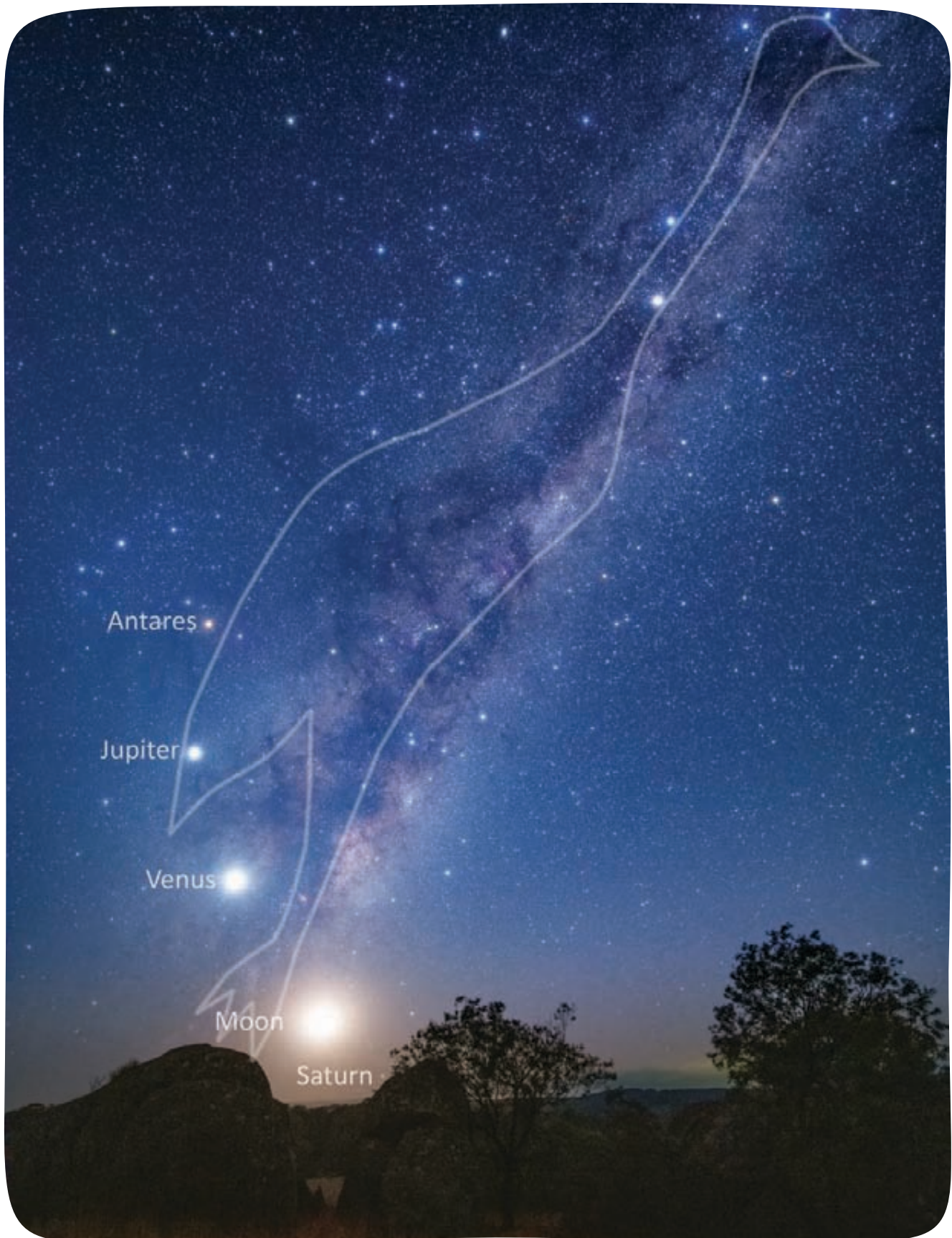
Desert Raisin (*Solanum centrale*) shrub mosaic, Wiluna Remote Community School, Western Australia. Desert Raisin is a food plant that grows back after rainfall and burns on sandplains. Photo by David Broun, CSIRO.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Identifying and recording animal tracks during the Learning on Country trip. Observing plants regenerating after fire. Describing the differences of burnt/unburnt country in regards to animals and plants.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things have a variety of external features (ACSSU017). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y3 Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Learning on Country trip where Aboriginal knowledge holders teach students about burning country and the effect it has on plants and animals.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y1/2 People use science in their daily lives, including when caring for their environment and living things (ACSHE022, ACSHE035). • Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y3/4 Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062). • Y5/6 Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081, ACSHE098). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Using photos, tables and drawings to record and represent the differences between burnt/unburnt country. Using art to demonstrate how country changes after fire.	• Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029, ACSI042). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026, ACSI039). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071). • Y5/6 Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSI093, ACSI110).



Tjanpi (spinifex). Mosaics from Wiluna Remote Community School.



An early morning alignment of the planets against the Dark Emu constellation on February 2nd, 2019. Photo by Alex Cherney.

(opposite) The Dark Emu has featured in Indigenous storytelling for thousands of years. Compare the labeled diagram above to the image opposite. The Emu shape is defined by the dark areas in the Milky Way. Photo by Alex Cherney.

Seasons, weather and astronomy



Background

Indigenous Australians have developed unique systems of time and seasons. This has enabled them to explain and predict what is happening around them. This includes astronomical knowledge as well as the relationships between plants, animals, climate and all aspects of the environment.

The extreme variability of daily and seasonal temperatures and the changing rainfall from year to year shape the availability over time of food, medicine and water in the arid regions of Australia. In desert regions, there are not well-defined periods when many foods are available. Desert concepts of time and seasons differ to tropical concepts and are dramatically different to European-derived concepts. In deserts, rainfall and fire are the main drivers of food production. The foods available in good seasons vary from those available in poor seasons. Surface water that is abundant after heavy rain is less reliable than water from well-known sheltered rockholes or roots of certain trees.

In tropical and temperate regions, Indigenous Australian seasons can vary in number from two to 13. The names of the seasons usually reflect each

season's chief characteristic, such as food abundance or dominating weather such as strong winds. Desert people had concepts of time and season embedded in astronomical features and changes in temperature.

Students will deepen their understanding and knowledge of seasons in a Two-way Science context by learning from Aboriginal people throughout the year, and recording and analysing what is learnt back in the classroom.

Weather and climate

Weather is the day-to-day meteorological events in the atmosphere. Patterns of weather accumulate to be described as climate. Climate is measured by different variables like average maximum temperature, average minimum temperature, numbers of days over 40 degrees Celsius, etc.

Scientific data shows unequivocal evidence for trends of change that accelerate from the 1970s. These trends show human-induced climate change. These changes affect the reliability and stability of seasons. Variability in desert regions has increased.



An ephemeral lake (non-permanent) after a big desert rain.
Photo by David Broun, CSIRO.



Sturt's Desert Pea. Wiluna School mosaic.
Photo by David Broun, CSIRO.

Unit 1: Seasonal calendar

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students will learn about seasonal change from Aboriginal experts. They will observe and record seasonal change on country using the bush planner, and repeat this at different times of the year to develop a seasonal calendar.

A Two-way Science education program reflects seasonal change in the planning and design of education activities. Aboriginal people use prompts from the environment in the current season to begin the development of a learning program: Where in the night sky are the Seven Sisters? What bushfood is fruiting? Are goannas waking up? Are the waterholes full or empty? What animals are fat? What is the weather doing? Is it the right time to burn? This knowledge can also be shared with students when learning about seasons and change.

The Learning on Country trip in this unit is suited to times of seasonal change—after a big rain, during the build up to stormy weather, after the rain has stopped and things are drying up, when rains have led to flowers and fruit. There is high value in repeated visits to the same place at different times of the year to note and record seasonal change.

BACKGROUND

The climate in the Australian desert does not reflect the four European seasons of Summer/Autumn/Winter/Spring. All parts of Australia are different depending on the local climate—some areas have six seasons, others have three. In the arid zone rainfall at any time of the year can trigger flowering and fruiting of particular plants, the appearance of amphibians and insects, and the breeding of certain animals. Indigenous knowledge of seasons will be local to the area, and will include indicators of seasonal change, rather than specific dates. For example, Wiluna Martu describe the Parnka (goanna) waking up with the thunder.

Seasonal calendar: Planning

Teacher and Aboriginal experts plan the unit together. Look at the example of the season poster in this unit. Discuss how to record observations with students and arrange for a Learning on Country field trip to observe the signs of the current season.

Questions for Aboriginal expert:

- What do you want students to learn about the current season?
- What is the Language name of the season(s)?
- What is happening currently with animals/plants/waterholes/weather? For example:
 - What plants are flowering?
 - What animal tracks are visible?
 - What bush food and bush medicine is around?
 - What is good to hunt at the moment?
 - Is it the right time to burn?
 - What is the weather doing?
- Choose some animal and plant cards to use in activities about the current season.
- Are there stories about this season or the weather that are appropriate to share with the class?
- Where can we go to on a Learning on Country field trip to learn about this season?
- Who is the best person to lead the students to that place?

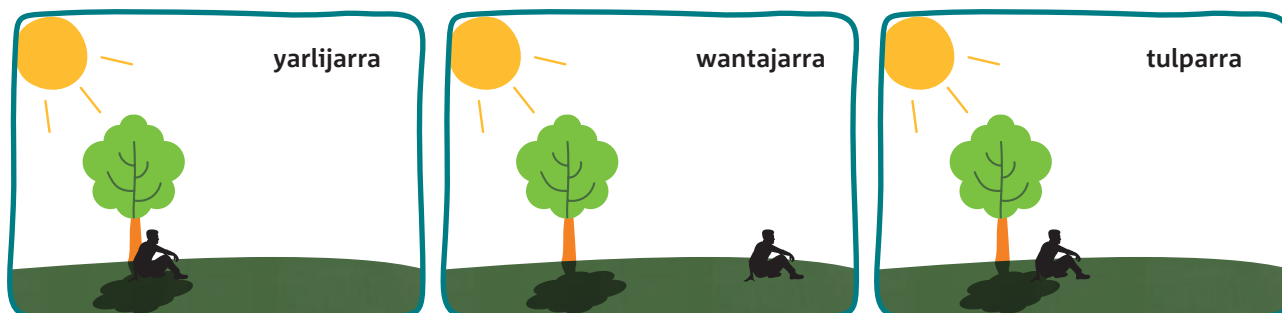
Seasonal calendar: Learning in class (preparation)

Activity 1: Introduction to seasons

This activity should be done with an Aboriginal expert. Students will learn about the names and weather words for the different local seasons. They will record this information as a mobile or on a poster. Note that this is an introductory activity. The concepts and language around weather will be developed further in 'Unit 2: Seasons and weather'.

Discuss the names of the seasons for your particular community or Language group. For each season, discuss and record on the whiteboard:

- What do people do in that season?
- What clothes do you wear?
- What is the weather like in each season? Use weather words describe the season such as hot, cold, windy, warm, sunny, cloudy, rain. Make sure that both Aboriginal Language and Standard Australian words are noted where possible.
- In the evening sky before children go to bed, where is the constellation Seven Sisters or the Pleiades?

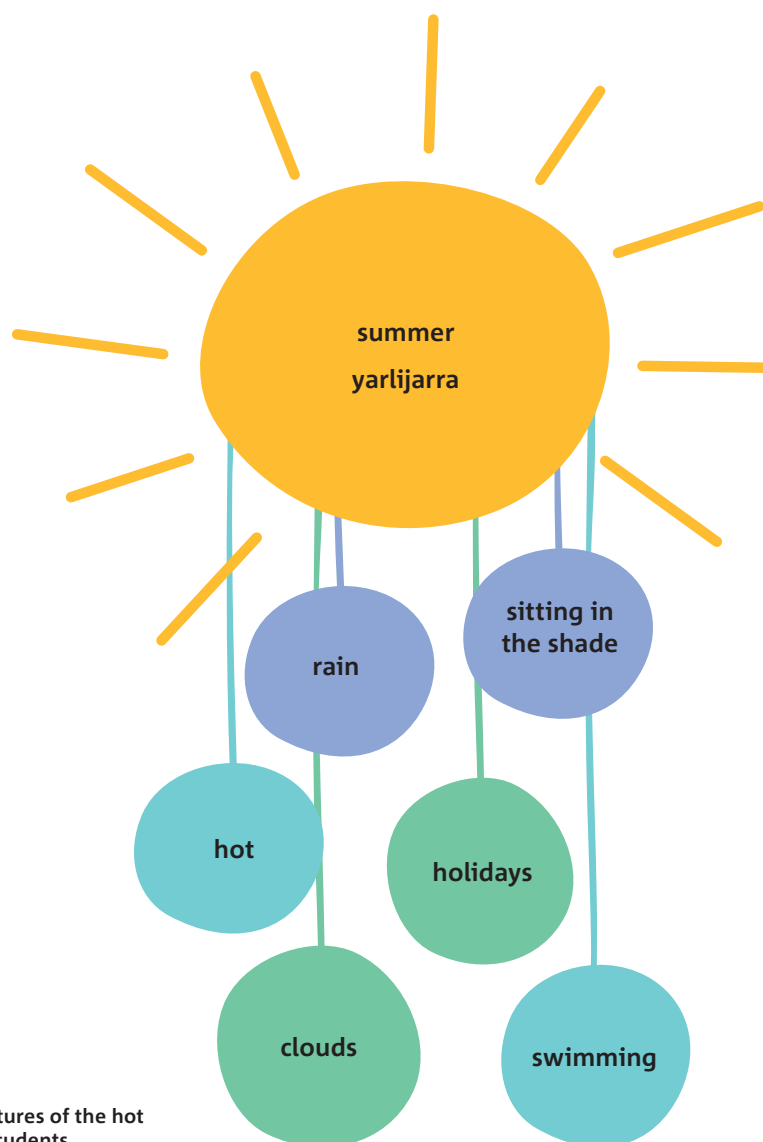


YARLIJARRA	WANTAJARRA
hot rain clouds holiday swimming lightning sitting in the shade	cold dry warm clothes football emu egg hunting cold wind sitting in the Sun

Examples from a Martu community. Language and seasons will vary across different Language groups.

Suggestions for students to record their learning:

- Create mobiles using pictures that represent the seasons. Hang words that describe the season or activities enjoyed during the season.
- Use the language on the word wall to write a description or poem about the different seasons.
- Make a poster with drawings to show the weather and people in each season.



A mobile showing features of the hot season identified by students.

Activity 2: Animals, plants and seasons

This activity should be done with an Aboriginal expert. Students will learn about plants and animals that are active or important in the current season.

The Aboriginal expert should select animal and plant cards relevant to the current season. Use these to talk about what is happening in the current season. For example—goannas are in their burrows or silky pears have grown after rain. Discuss what bush foods or animals students might find when they go out on country. Students can add this knowledge to the season poster (Activity 3).

Activity 3: Season poster

This activity should be done with an Aboriginal expert. Students record information about plants, animals, weather and waterholes in the current season. This can be done in pairs or as a class group. Students can use drawings, photographs, Aboriginal Language or Standard Australian English to complete this task. Students should start this activity in the classroom with the teacher and Aboriginal expert, then complete it after a Learning on Country field trip.

1 Explain that students will undertake this activity in two stages:

- Stage 1 in the classroom (what they know).
- Stage 2 after a Learning on Country field trip (what they observe and learn).

2 Brainstorm 'What is happening on country this term?'

3 Complete each section in turn:

- What are the plants doing?
- What are the animals doing?
- What are the rivers, lakes and waterholes doing?
- What is the weather doing?
- Is there burning happening on country at the moment?

Encourage students to use the language and knowledge from the

'Introduction to seasons' and 'Animal and plant cards' activities on pages 251 and 252.



A seasons poster from an upper primary class in Parnngurr community. This was completed with Aboriginal education worker Darlene Richards and Elders in class. Note the use of photos and Martu Language. Photo by Michelle McRae.



What are the animals doing?



What is the weather doing?

Seasonal calendar: Learning on Country

1. Learn about the current season from Elders.

- Record stories.
- Write down Language names.
- Take photos.

2. Students observe the weather, plants, animals and water on country.

3. Record information about the season to add to the bush planner.

Equipment

iPad/camera, journals.

Top photos and bottom right photo by David Broun, CSIRO.
Bottom left photo by Fiona Walsh.



What are the plants doing?

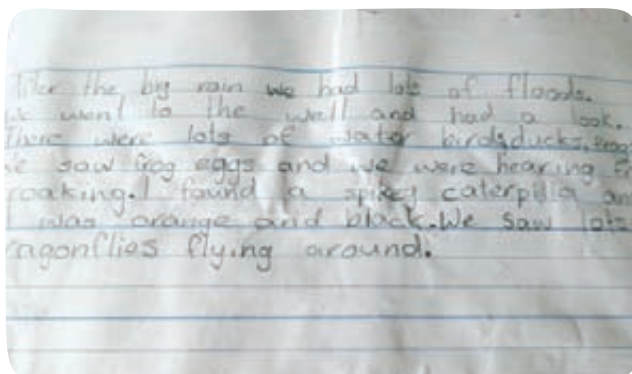


What are the rivers, lakes
and waterholes doing?

Seasonal calendar: Learning in class (follow-up)

Activity 4: Reflect, recount and write

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in English and Language to the class word wall.



(left): Observations and events recorded during a trip to the old Kunawarritji soakage also called Well 33. Photo by Chris Deslandes, CSIRO.

(right): Early Years students' drawing and writing about what they found on country. Photo by David Broun, CSIRO.

Activity 5: Season poster (follow-up)

This activity should be conducted with an Aboriginal expert. Students add material they learnt about the current season on country and complete the poster. This can include photos, drawings, collected samples, Language and stories from Elders. Student knowledge can be combined to create one record of the current season for the class. This activity can be repeated in following seasons to create an 'active calendar' that combines students understanding of plants, animals, burning practices and the weather as they learn.

The season poster can be used as a way of developing further learning activities based on student interest.

Activity 6: Seasonal calendar

This activity should be conducted with an Aboriginal expert. Look at examples of Indigenous seasonal calendars such as those developed by the CSIRO. Find examples that are horizontal (timeline) as well as circular (see <http://jalilands.com.au> Ngunya Jargoan Cultural Calendar—JALI Local Aboriginal Land Council). Look for examples that are from the arid zone with a variable climate, as well as those from the tropics and the south where the weather is more reliable. Some Indigenous groups are developing digital versions of their calendars that can be found online.



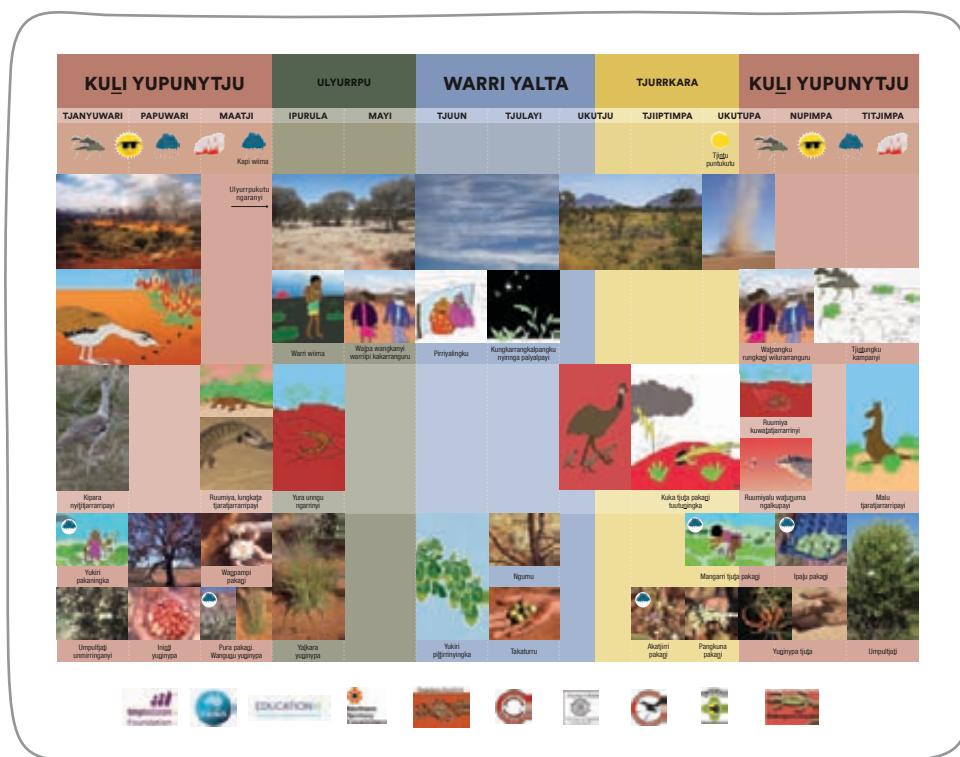
Discuss the content of the different calendars—do students notice anything similar to their own observations? Discuss similarities and differences between the calendars from different Indigenous nations.

Explain that students will be making their own calendar across the year. They will collect information and add to this as they learn about different seasons through the year.

Students will use a horizontal format to create their calendar. They may choose to create a circular calendar using their information at a later date. However using a horizontal timeline format is the best way to organise information.

(above): Circular format calendar from the CSIRO website (<https://www.csiro.au/en/Research/Environment/Land-management/Indigenous/Indigenous-calendars>).

(opposite): Horizontal format calendar from the Northern Territory in Pintupi Luritja. Reproduced courtesy of Tangentyere Council, Haasts Bluff School and Areyonga School.



Find a space in the classroom and lay out a long piece of butchers paper, at least 2 m long. Divide the butchers paper into horizontal strips labelled with the following categories:

1. seasons (local Aboriginal seasons)
2. stars
3. shadows
4. weather
5. fire
6. animals
7. plants
8. waterholes.

Write the calendar months across the top of the calendar, and the names of the Indigenous seasons prominently across the top.

MONTHS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Season	[insert local seasons here]											
Stars												
Shadows												
Weather												
Fire												
Animals												
Plants												
Waterholes												

Begin by inputting information from student activities during the Two-way Science program. Use student drawings, photographs and writing. Samples of seeds and dried plant cuttings can be added. Don't be worried about leaving blank space—this will be required as student knowledge and observations develop through the year. Student observations make the learning the deepest here—they can connect this to learning from Elders and others rather than complete information quickly based on existing material or research.



Wiluna Martu seasonal calendar after a workshop with community. Photos by David Broun, CSIRO.

A NOTE ON SEASONS IN THE ARID ZONE

Many cycles of plants and animals are dependent on rain.

Rain in any season can lead to an explosion of life as plants and animals adapted to making the most of scarce water commence a rapid cycle of breeding and flowering. For example, frogs will emerge from the sand to breed in puddles, silky pear will sprout from seeds lying in wait and plants will flower and seed quickly. Rain in the desert is sporadic and unreliable. Animals and plant behaviour with the rain can be indicated on the calendar with a symbol such as cloud with rain.



(left): Seasonal samples and observations by students after Learning on Country. Photo by Phoebe Stoneman.

(right): A seasonal calendar developed as part of a cooking and gardening program. Photo by David Broun, CSIRO.

Activity 7: Seasons around the world

Students compare their own seasons with seasons in other parts of the world. Look for a diverse range of examples including other Indigenous cultures.

- 1 Find and read story books or view films that feature different seasons in different parts of the world.
- 2 Discuss the names and characteristics of the different seasons as you view them.
- 3 Find the places that feature in the films or books on a map of the world or a globe.
- 4 Students choose a season, and a place they would like to visit and illustrate themselves in that place during that season. This will include:
 - doing an activity
 - wearing appropriate clothing
 - a title for their picture.

A workshop to develop a Wiluna Martu seasonal calendar. Photo by Phoebe Stoneman.



Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning how the seasons affect and influence plants and animals. Constructing a poster or calendar that describes the influence seasons have on the surrounding environment.	• F Living things have basic needs, including food and water (ACSSU002). • Y1 Living things live in different places where their needs are met (ACSSU211). • Y6 The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094).
ACTIVITY	SCIENCE UNDERSTANDING—EARTH AND SPACE SCIENCES
Learning about seasons, including the names and characteristics for each. Learning about seasons in other parts of the world.	• F Daily and seasonal changes in our environment affect everyday life (ACSSU004). • Y1 Observable changes occur in the sky and landscape (ACSSU019). • Y3 Earth's rotation on its axis causes regular changes, including night and day (ACSSU048). • Y5 The Earth is part of a system of planets orbiting around a star (the Sun) (ACSSU078).
ACTIVITY	SCIENCE INQUIRY SKILLS
Learning how the seasons affect and influence plants, animals and people.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y1/2 Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021, ACSHE034). • Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE100).

Unit 2: Seasons and weather

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to be able to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn to observe and describe the weather from both Aboriginal and Western science perspectives. This can include language and concepts about wind, clouds, rain and temperature.



Lightning strikes in an early hot season storm near Wiluna. See how there is localised rain near the lightning strike which comes from the cloud above. These isolated 'convictional' storms can be a feature of the early hot season. Photo by David Broun, CSIRO.

Seasons and weather: Planning

Teachers and Aboriginal experts plan the unit together. Discuss ways of teaching students about the weather: What words describe weather? Discuss the different types of wind, clouds and rain that come at different times of the year. Use pictures as prompts for discussion. Are there traditional stories that are OK to share with everyone about the weather? What are the best ways to teach students about the weather? Who is the best person to lead the learning on country?

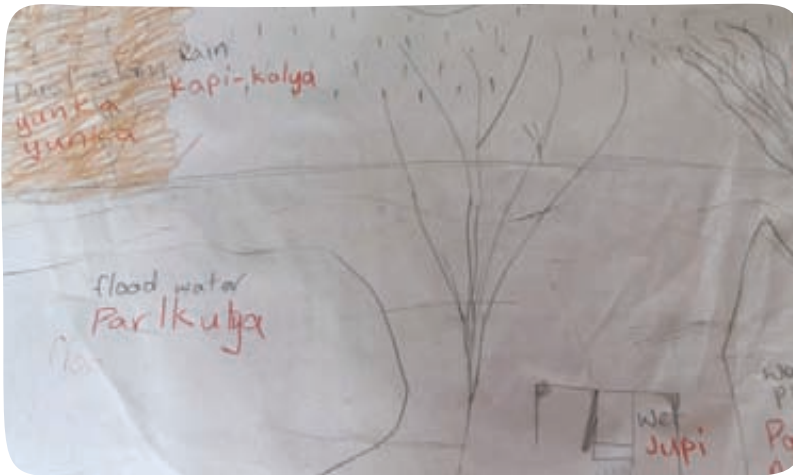
Plan to teach students about the weather in the current season. This should take place at a time when the weather is suitable to teach the concepts identified in planning. For example, teaching about clouds is difficult on a clear day! This may require flexibility in timing to take advantage of weather conditions.

Seasons and weather: Activities

Students learn words to describe the weather in their local Language and then in Standard Australian English. Add these words to a word wall. The weather in Language activity should be taught with an Aboriginal expert. It may be more appropriate to do this activity outside the classroom so that the current weather can be discussed.

Activity 1: Weather in Language

What words do we use to describe weather in the local Language?
Here are some suggestions for topics and activities.



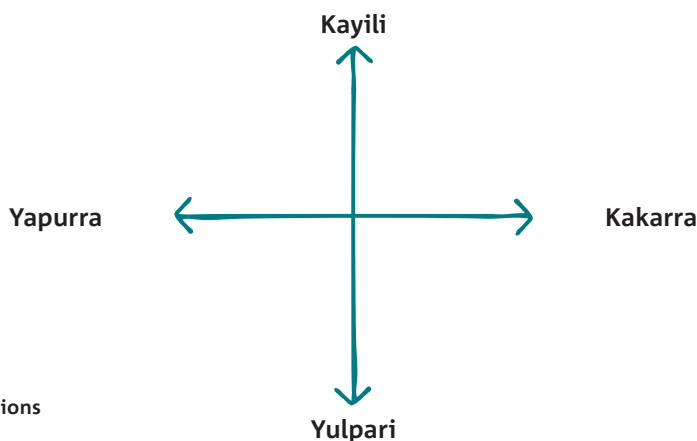
Detail of student weather observations from Rawa school in Punmu community.
Photo by Chris Deslandes, CSIRO.

WIND

Students learn or consolidate their learning of the words for wind in their local Language.
Students can learn the name for the different winds that blow now or at different times of the year.

DIRECTION

Aboriginal people can teach the words for north, east, west and south. Draw and label a compass rose using the local Language names. Apply this to the description of wind that blows in the current season. What direction is the wind coming from? See 'Places, maps and country, Unit 1: Sunrise, sunset and compass points' for activities to teach direction.



Martu Wangka directions
on a compass rose.

CLOUDS AND RAIN

Students learn or consolidate their learning of the words for clouds, rain, thunder and lightning. They can learn to identify clouds and understand the weather that the different clouds bring. Locate pictures online of different clouds. Aboriginal people can teach the words for clouds and the weather that they bring. Go outside the classroom when the opportunity arises and talk about the clouds the students can see. Students can draw or photograph the clouds and label them.



Clouds at Matuwa Kurrara Kurrara Indigenous Protected Area. What weather do they indicate? Photos by David Broun, CSIRO.

TEMPERATURE

Students learn or consolidate their learning of the local Language words for hot, cold, humid, etc. Use this to talk about the weather.

Activity 2: Weather in English

- 1 Repeat the activities above in Standard Australian English.
- 2 Add weather words to the word wall.
- 3 Write sentences using the weather words to describe the weather each day.



A word wall with key words for seasons and weather in local Language. Photo by Chris Deslandes, CSIRO.

Activity 3: Weather poster

Make a poster about the weather in the current season in Standard Australian English or the local Language. Add new language and information about weather in the current season to the seasonal calendar that was created in Unit 1.

Activity 4: Measuring the weather

Weather is recorded and communicated by Western science using standard units of measurement. Temperature is in degrees Celsius, wind is measured in knots or kilometres per hour and rainfall in millimetres. Weather measurement is important in the daily lives of people everywhere and a key skill for rangers and scientists. Students should be provided with opportunities to use equipment such as thermometers, wind meters and rain gauges. These activities need to take into account students' prior knowledge and experience, and may require scaffolding in numeracy skill development including counting, reading scales and estimation. There are plenty of good activities to teach weather recording skills and knowledge available in existing education resources. Teachers can build practice of these skills into daily routines at school. For instance:

- Use a thermometer to record temperature at different times of the day.
- Make a line graph using temperature readings at intervals during the day.
- Estimate and measure temperature in different places, e.g. in a car, in the shade, a cup of tea, a cold drink, or out in the hot Sun. Who can make the closest guess?
- Make an anemometer from paper cups to measure wind speed.
- Set up a rain gauge at the school. Make a habit of checking this at 9 am every day and record the reading in a class science journal or seasons calendar.
- Keep a daily weather record in the classroom. Students take it in turns to use equipment to record the weather and update a chart. This can be read out over the PA system.
- Some communities have weather stations. Make a time to tour the station and students can find out how it works.



(left): Using a ribbon to indicate wind strength. Photo by David Broun, CSIRO.



(right): Measuring wind speed using an anemometer. Photo by David Broun, CSIRO.

Activity 5: Television weather report

Students make a simple television weather report using an iPad. This can be done in Language or in English using the words and concepts learnt in earlier weather activities. Use a green screen application to put photos of country and weather in the background.



Students using a green-screen mobile app to make a video weather report. Photos by Wiluna Remote Community School.



Two types of clouds are visible in this image. High level cirrus clouds are formed of ice crystals. Lower level cumulus clouds indicate fine weather but can build into rain clouds. What are these clouds called in your community? How do people read clouds to forecast the weather? Photo by David Broun, CSIRO.

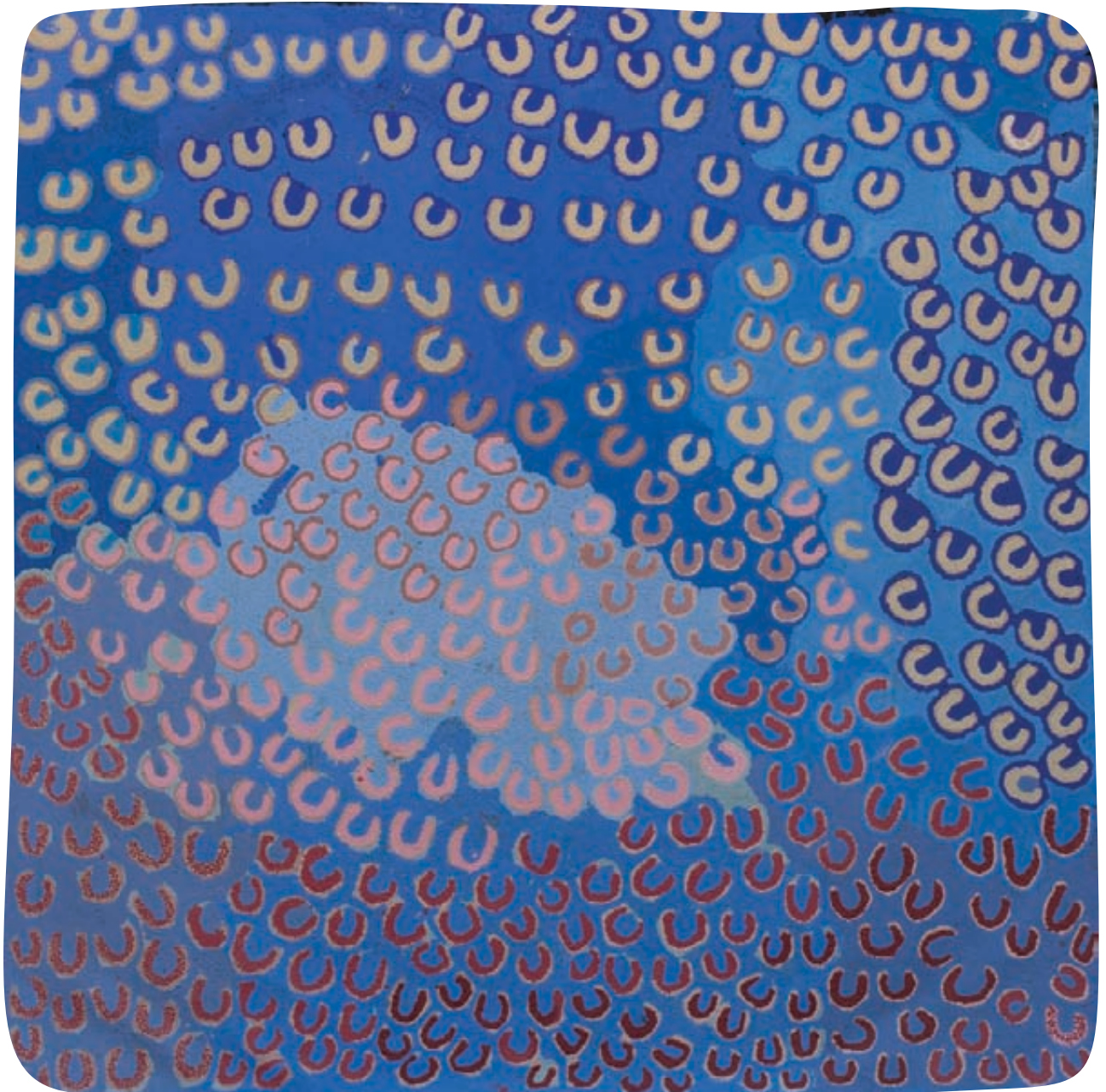
Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—BIOLOGICAL SCIENCES
Learning about weather, climate and seasonal changes from both an Aboriginal and Western science perspective. Recording the weather (temperature, wind, rain).	• F Daily and seasonal changes in our environment affect everyday life (ACSSU004). • Y1 Observable changes occur in the sky and landscape (ACSSU019). • Y3 Earth's rotation on its axis causes regular changes, including night and day (ACSSU048). • Y4 Earth's surface changes over time as a result of natural processes and human activity (ACSSU075). • Y5 The Earth is part of a system of planets orbiting around a star (the Sun) (ACSSU078)
ACTIVITY	SCIENCE UNDERSTANDING—PHYSICAL SCIENCES
Recording the weather (temperature, wind, rain). Observing and recording temperatures in different locations and at different times throughout the day.	• Y1 Light and sound are produced by a range of sources and can be sensed (ACSSU020). • Y3 Heat can be produced in many ways and can move from one object to another (ACSSU049). • Y5 Light travels in straight paths; forms shadows and can be absorbed, reflected and refracted (ACSSU080).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Describing weather, climate and seasonal changes from an Aboriginal and Western science perspective. Observing and recording the weather (temperature, wind, rain). Producing a weather report.	• F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). • Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061). • Y5/6 Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE 100).
ACTIVITY	SCIENCE INQUIRY SKILLS
Observing and describing the weather (temperature, wind, rain). Producing a weather report.	• F Engage in discussions about observations and represent ideas (ACSI233). • F Share observations and ideas (ACSI012). • Y1/2 Participate in guided investigations to explore and answer questions (ACSI025, ACSI038). • Y1/2 Represent and communicate observations and ideas in a variety of ways (ACSI029, ACSI042). • Y1/2 Use informal measurements in the collection and recording of observations, using digital technologies as appropriate (ACSI026, ACSI039). • Y3/4 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (ACSI053, ACSI064). • Y3/4 Represent and communicate observations, ideas and findings using formal and informal representations (ACSI060, ACSI071).

Unit 3: Seasons and the stars

The activities in these resources are suggestions and examples. At all times it is important for Aboriginal people to be able to lead the cultural learning by choosing what they want the students to learn. Suggestions for science, literacy or numeracy activities need to be contextualised to the students' capabilities and current learning.

Students learn from Aboriginal experts about the relationship between stars and the seasons. They learn about the changing light from the Sun at different times of the year and how this is caused by the position of the Earth as it rotates around the Sun. Students go on an overnight camp to learn from Aboriginal experts and use telescopes to view the night sky.



Martu and other Aboriginal people often paint the Seven Sisters and other constellations. Paintings can portray the stars in the night sky, the geographic sites where the stars 'touched down' in their earthly travels or the human body paintings symbolic of the stars. This Minyipuru (Seven Sisters) painting by Kumpaya Girgirba (Martumili Artists) shows the Pleiades constellation amongst many other stars and the texture of a night sky.

BACKGROUND

Desert Aboriginal people use the stars to navigate. They also use the Sun, the Moon and the stars to tell the time. Seasonal change can be indicated by the presence or position of stars in the night sky. Some Aboriginal groups know that when Orion first appears in the night sky, dingo puppies are about to be born. When Scorpius appears, the Yolngu know that the Macassan fisherman will soon arrive to fish for sea cucumber and bring goods to trade. For the Pitjantjatjara, the rising of the Pleiades at dawn (in May) marks the start of the cool season, when some animals in the desert go into hibernation. The night sky is also inscribed with Dreamtime stories that are used to transfer important cultural knowledge about people and country. The stars can also be a map charting songlines across the surface of the Earth. Some of the information in the stars is sacred and only used for ceremony and lore business. Other information can be shared as part of an education program. It is important to respect this during the planning and discussion of the night sky with Aboriginal people.

Seasons and the stars: Planning

Aboriginal experts and teachers plan the unit together and arrange for a Learning on Country overnight camp to look at the night sky. If you are using the camp to observe the night sky with a telescope and applications on mobile devices, you will need to make sure that there is dedicated time for the teaching of Aboriginal knowledge. This is an opportunity for students, teachers and Aboriginal people from the community to teach and learn together.

Questions for Aboriginal expert:

- What do you want students to learn about the stars?
- Are there stories that are OK to tell students on camp?
- How are stars used to navigate across country?
- What can stars tell us about the changing season?
- What are the Language names of stars that are OK to talk about?
- Where can we go to on a camp to learn about the stars?
- Who is the best person to teach the students about the stars?

Teachers:

Does your school have a 6" or 8" Dobsonian telescope or can you borrow one? Use the opportunity of an overnight camp to explore astronomy. Use star apps on mobile devices to learn about the positions of stars, the Moon and other features of the night sky students could observe. Set up the telescope at home and practice focussing and viewing the stars and Moon. The rings of Saturn and the moons of Jupiter are visible through the telescope. Some supernovas are visible.



A Dobsonian telescope at Wiluna School waiting for dark. Photo by David Broun, CSIRO.

Seasons and the stars: Learning in class (preparation)

Aboriginal experts:

Talk to students about the Sun, Moon and stars and introduce or consolidate Aboriginal Language.

Teacher:

- Focus the Learning on Country.
 - Connect, question and predict
 - What do you know about the Sun, Moon and stars?
 - How does the Sun tell us what time it is?
 - How does the Moon change each month?
 - What do the stars tell us about the seasons?
 - What stars tell us when to hunt goanna?
 - What stars tell us when emu eggs hatch?
 - Do you know the names of any stars?
 - How can people look closely at the stars?
 - What is a telescope and how does it work?
- Prepare equipment and go through the field trip plan.
- Introduce the task—you are drawing pictures of the stars to add to the seasonal calendar. Learn from Elders the names of important stars, and what they tell us about the seasons.

Activity 1: Draw and paint the stars

Students learn about important stars and other objects in the night sky from an Aboriginal expert. This could be done with an artist from the art centre or gallery. Students draw or paint the shapes that they are shown.

What is happening
with the stars tonight?

What are the names of
the important stars?

What do the stars
tell us about the
season, plants
and animals?

Seasons and the stars: Learning on Country

1. Learn about the stars and seasons from Elders.

- a. Record stories.
- b. Write down Language names.
- c. Take photos.

2. What are the important stars in the sky? How can they tell us about the seasons?

Equipment

iPad/camera with star apps, Dobsonian telescope, journals.



Photo by Alex Cherney.

Seasons and the stars: Learning in class (follow-up)

Activity 2: Reflect, recount and write

- Listen to/view any photographs, recordings and videos.
 - Recount important pieces of information.
 - Add new words in English and Language to the class word wall.

Activity 3: Add to the seasonal calendar

Add pictures and words about stars and seasons to the seasonal calendar. Students can focus on the use of stars as indicators for changes in the environment by local Aboriginal people. For example, the Emu constellation indicates when Emu lays its eggs for some groups.



Photo by David Broun, CSIRO.

Western science and astronomy

THE EARTH TURNING

These are a series of hands on activities designed to be part of further study about the planets and the solar system. Use these to help students to experience the Earth turning in different ways and then move into some of the many excellent astronomy resources available. Note that there are lots of Aboriginal words for different times of the day. Work with an Aboriginal expert to incorporate these into the activities below.

Activity 4: Imagine the Earth turning

In this activity the students visualise the Earth spinning. Ask students to go outside and lie on the ground on their backs in the shade with their feet facing east. Then they should close their eyes. Ask them to imagine that they are lying on a giant ball spinning toward their feet. The ball they are on is the Earth. As the Earth spins, the Sun stays still. They should imagine seeing the Sun going past their feet, over their heads and back behind them, then around the ball they are on until it is seen near their feet again.

Activity 5: Google Earth

Use Google Earth to show students a picture of the globe. Find the place they live, drop a marker and zoom all the way in and out. Turn on the night and day function. Rotate the Earth back and forth and show students how the place they live goes in and out of sunlight as the Earth spins. Introduce language such as 'axis' 'poles' and 'equator'.



Google Earth 2015.

Activity 6: Ball and torch

Use a torch and a basketball in a dark room to illustrate the Earth turning. Make a mark on the basketball and say that is the place they live. Shine the torch on the basketball and spin the basketball to show the mark going in and out of daylight as the Earth spins. When the Earth spins all the way around, this is one day.

Activity 7: Changing shadows

Ask students to stand in an area of open sandy ground. In pairs, draw a shape around each other's shadow. Discuss how the Sun shines down and makes a shadow. Then place a pole in an open space or use an existing pole such as a flag pole or goal post. Look at the shadow of the post that the Sun makes on the ground. Make a mark where the shadow is on the ground. Come back to the pole every hour and make another mark. Discuss how the position of the shadow is changing because the Earth is spinning and the Sun is staying still. See 'Sunrise, sunset and compass points' in the 'Places, maps and country' topic.



Photo by Fiona Walsh.

Activity 8: Timelapse video

Use an iPad to take a timelapse video over a day or part of a day. Set the iPad up in a classroom filming out of the window so it can stay connected to power. Watch the video and talk about the changing shadows.

Science curriculum links

ACTIVITY	SCIENCE UNDERSTANDING—EARTH AND SPACE SCIENCES
Observing and drawing stars. Using a torch and a ball to illustrate how the rotation of the Earth around the Sun results in night and day. Observing and recording the movement of shadows over the day.	- Y1 Observable changes occur in the sky and landscape (ACSSU019). - Y3 Earth's rotation on its axis causes regular changes, including night and day (ACSSU048). - Y5 The Earth is part of a system of planets orbiting around a star (the Sun) (ACSSU078).
ACTIVITY	SCIENCE UNDERSTANDING—PHYSICAL SCIENCES
Using a torch and a ball to illustrate how the rotation of the Earth around the Sun results in night and day. Observing and recording the movement of shadows over the day.	- Y1 Light and sound are produced by a range of sources and can be sensed (ACSSU020). - Y5 Light travels in straight paths; forms shadows and can be absorbed, reflected and refracted (ACSSU080).
ACTIVITY	SCIENCE AS HUMAN ENDEAVOUR
Using Google Earth to represent and describe the movement of the Earth.	- F Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013). - Y3/4 Science involves making predictions and describing patterns and relationships (ACSHE050, ACSHE061).
ACTIVITY	SCIENCE INQUIRY SKILLS
Observing and recording the movement of shadows over the day.	- F Engage in discussions about observations and represent ideas (AC SIS233). - F Share observations and ideas (AC SIS012). - Y1/2 Represent and communicate observations and ideas in a variety of ways (AC SIS029, AC SIS042). - Y1/2 Participate in guided investigations to explore and answer questions (AC SIS025, AC SIS038).

How to make a video story



Students from Wiluna school making a video story about digging for Lunki (Witchetty grub). Note the positions of the videographers and the different camera angles that they have chosen. Note also that the videographers are shooting with the Sun behind them to show faces and actions clearly.

Video and photography are powerful storytelling tools. Students can develop visual literacy in a variety of text structures including reports, narrative and procedures which are transferable to written and oral language development. The visual medium can also express Aboriginal cultural storytelling. It is important to make the purpose of the video story clear so that the conventions of that form can be taught explicitly. For instance, a report needs to show who, what, where, when, why and how. A procedure shows how something is done step by step. Two-way Science provides many opportunities to make video stories and the tools are at students fingertips with every mobile device now a video and editing tool.

Five-shot sequence

This activity teaches students to make a short photo story using five photographs and a voice over. By using

only still photography instead of moving images, and a voice over instead of live sound, students can concentrate on learning key conventions of movie making and produce a pleasing result quickly and simply. The skills and knowledge developed here can then be applied in more complex projects.

Activity for five-shot sequence

The 'five-shot sequence' is a film convention that shows the audience what a person is doing. The activity and people are revealed in photos taken from close up to further away. In this activity students will take many photographs then choose five. They then record an interview with their subject to be put with the pictures. This can be compiled in a simple video editing application such as iMovie or in other applications such as Book Creator. The final five-shot sequence should be 30 seconds in duration. For a longer interview, join two or more five-shot sequences together.

A 'five-shot sequence' to show what a person or a group is doing



1. Close up of the hands.

What is the person doing?
A bit of mystery is OK.
The hands should fill half the frame.



2. Close up of the face.

Who is doing it? How do they feel?
It is OK to cut off the top of their head
but show two eyes and chin.



3. Wide shot.

Where are they? Who are they with?
Show the people and place.



4. Over shoulder.

What are they doing? What are they looking at?
Show their hands and what they are holding.

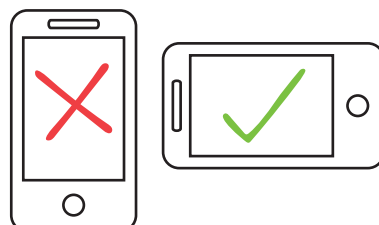


5. Unusual or quirky.

Shoot from a different angle. Lie low and
look up or stand high and look down.
Change what is in front or behind.

Tips:

- Move to take your shots. Move left, right, up, down to change angles.
- Take about three photos of each shot so you can choose the best one later.
- Hold the camera in landscape not portrait.
- Hold the camera still when you take the shot.
- Keep your fingers off the lens and keep the lens clean!



Record an interview or voice over

Record an interview to put over the five-shot sequence. An interview is a series of questions that one person asks another person. The interviewer is the person asking the questions, the subject is the person answering the questions.

- Sit down somewhere quiet and out of the wind with your subject.
- Practise asking questions with the camera or device to make your subject feel comfortable.
- Ask them to say their name, chat and check the sound is recording properly.
- The more relaxed the interviewer is, the more relaxed your subject will be.
- Ask questions that help the subject tell their story.
 - Who—What is your name and where are you from?
 - Where—Where are we now? How did we get here?
 - What—What are you doing?
 - Why—Why are you here? Why are you doing it? Why do you like doing this?
 - How—How do you do it? What are the steps?
 - When—When do you come here?

Interview tips:

- Hold the device close to the subject or use an external microphone on the camera.
- Sit out of the wind, a car is a good place to record an interview if it's not too hot.
- Ask lots of open or 'why?' questions—they get the best answers.
- Try not to ask closed questions that can be answered with a yes or no.
- Don't interrupt the subject or make any noise while they are talking.
- Nod and smile but don't make any sound while the subject is talking.



Nakisha interviewed Simon Cherriman 'the Eagle Man'

Some of the questions Nakisha asked Simon included 'Why do you like Eagles? Do you wish you were an Eagle? How high do Eagles fly? How many Eagles are there in Australia? Why do the mummy Eagles leave their eggs? What shows you that Eagles are smart?'

If your subject is talking about a plant you might ask them: What are the names of this plant? How did the old people use this plant? How do you feel when you see this plant? What does the plant make you remember? Why is this plant important to you?

Video or audio record a short interview (less than four minutes) with your subject. Using a video editor on a mobile device or computer, choose the important parts of the interview that tell the story and edit that down to 30 seconds with the images in your five-shot sequence.

References

Introduction

Page 5, Quote. KJ (2016) 'Kanyirninpa Jukurrpa Annual Report 2015–16.' (Kanyirninpa Jukurrpa, Newman) Available at URL <http://www.kj.org.au/annual-reports> [Verified 10 March 2019]

Page 6, Quote. ACARA (2019) 'Two-way Science at Leonora District High School: the Mamutjitji (antlion) and other invertebrates.' (ACARA: Australia) Available at URL <https://www.australiancurriculum.edu.au/resources/aboriginal-and-torres-strait-islander-histories-and-cultures/illustrations-of-practice/> [Verified 10 March 2019]

Page 11, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Places, maps and country

Page 12, Painting. Janice Nixon Juwali, *Jitiri* [acrylic on canvas], Martumili Artists, Newman, Western Australia

Page 12, Painting. Rita Muni Simpson, *Mukurtu* [acrylic on canvas], Martumili Artists, Newman, Western Australia

Page 13, Karlamilyi satellite image, extracted by Nat Raisbeck-Brown. Landsat high-level products courtesy of the U.S. Geological Survey Earth Resources Observation and Science Center.

Page 14, Mahood K (2014) 'We Don't Need a Map Education Resource' developed by Ilsa Bennion (Education Officer Art On The Move) with assistance from Fremantle Arts Centre, Kanyirninpa Jukurrpa and Martumili Artists

Page 14, Walsh FJ, Chewings V, Raisbeck-Brown N, Kanyirninpa Jukurrpa (2009) 'Martu lands atlas version 1: Maps for natural and cultural heritage management', CSIRO and Kanyirninpa Jukurrpa

Page 16, Mural by Samantha Wortelhock, Breakaway Art (2015).

Page 23, Quote from <https://www.kj.org.au/cultural-programs-1> under the 'Helicopter mapping' section [Verified 28 July 2019]

Page 23, Photos from Walsh FJ, Mitchell P (Eds) (2002) 'Planning for country: cross-cultural approaches to decision making on Aboriginal lands', Jukurrpa Books/IAD Press, Alice Springs

Page 32, Quote. KJ (2016) 'Kanyirninpa Jukurrpa Annual report 2015–16.' (Kanyirninpa Jukurrpa, Newman) Available at URL <http://www.kj.org.au/annual-reports> [Verified 10 March 2019]

Page 32, Text adapted from website Kanyirninpa Jukurrpa (2019) available at URL <http://www.kj.org.au> [Verified 10 March 2019]

Page 40, Painting. Rita Muni Simpson (2008) *Rawa* (with body paint design) [acrylic on canvas], Martumili Artists, Newman. Mahood K (2012) in Bennion I 'We Don't Need a Map Education Resource' Art on the Move.

Page 40, Satellite image. Google Earth (2019) from CNES and DigitalGlobe Imagery, date 10/8/2005, 22°06'42.02" S 123°11'15.36", elevation 274 m, eye altitude 42.19 km, viewed 14/03/2019 <https://www.google.com/maps/@-22.11167,123.1876,50081m/data=!3m1!1e3>

Page 39 and 41, Martu terms for sand dunes and salt lakes from Hill C, Turk A (2016) 'Manyjilyjarra—English Pictorial Dictionary of Landscape Terms.' Kanyirninpa Jukurrpa, Newman, Western Australia. [prepared for Kanyirninpa Jukurrpa by Clair Hill and Andrew Turk with assistance from Martu Language speakers: Gladys Bidu; Jakayu Biljabu; Nancy Chapman; Mulyatingki Marney; Minyawu Miller; Reena Rogers; Bugai Whyoulter; Rose Williams; Nora Wompi; Majorie Yates]

Page 42, Satellite image. Google Earth (2019) from CNES/ Airbus imagery and Maxar Technologies imagery, date 6/19/2005, 26 degrees 36.598'S 120 degrees 27.297'E, elevation, 0 m, eye altitude 24.93 km, viewed 28/7/2019.

Page 48, Photos. Morton S, Martin M, Mahood K, Carty J (2013) 'Desert Lake: Art, Science and Stories from Paruku', CSIRO Publishing.

Page 50, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Water

Page 55, Painting. Wiluna Artists, *Wati Kutjara* [acrylic on canvas], Tjukurba Gallery, Wiluna, Western Australia

Page 84, image ice cube tray with waterbugs, see 'logo and imagery' section on this web page:
<https://www.waterbugblitz.org.au/Resources>

Page 85, Agreed Level Taxonomic Order Key adapted from Gooderham J (2017) ALT KEYS v1.5, the Waterbug Company Pty Ltd, <https://www.waterbugblitz.org.au/Resources> [verified 18th September 2019]

Page 89, Photo Water Strider, Katja Shultz, viewed 25th June 2019, [https://commons.wikimedia.org/wiki/File:Water_Strider_on_Lily_Lake_\(15058406212\).jpg](https://commons.wikimedia.org/wiki/File:Water_Strider_on_Lily_Lake_(15058406212).jpg)

Animals

Page 96, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 101, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 104, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 107, Mooney M *et al.* (2007) Land and Learning, Tangentyere Landcare.

Page 107, Walpari Rangers, North Tanami Rangers and the Bilby Blitz Project 2018 'Training in Tracking' Central Land Council.

Page 108, Photo Australian Bustard, Castro T, viewed 18th March 2019, https://en.wikipedia.org/wiki/Australian_bustard#/media/File:Australian_Bustard_3.jpg (CC BY-SA 4.0)

Page 108, Photo Red Kangaroo, Rileypie, viewed 18th March 2019, <https://commons.wikimedia.org/wiki/File:RedRoo.JPG>

Page 108, Photo Dingo of Fraser Island (2017) viewed at https://commons.wikimedia.org/wiki/Category:Canis_lupus_dingo#/media/File:Dingo_of_Fraser_Island-20170215-092336.jpg (CC BY-SA 4.0)

Page 109, Photo child drawing tracks, Reid C. Reproduced with permission Central Land Council 2019

Page 117, Photo Malleefowl *Leipoa ocellata butupa* (2010), viewed 27th March 2019 at https://commons.wikimedia.org/wiki/File:Leipoa_ocellata_-Ongerup,_Western_Australia,_Australia-8.jpg (CC 2.0)

Page 117, Photo Greater Bilby, Dupont B (2000), viewed 27th March 2019 at [https://en.wikipedia.org/wiki/File:Greater_Bilby_\(Macrotis_lagotis\)_9996143106.jpg](https://en.wikipedia.org/wiki/File:Greater_Bilby_(Macrotis_lagotis)_9996143106.jpg) (CC 2.0)

Page 131, Photo of camels in a waterhole, Hodgens, P and Brim Box, J

Page 133, Stills from video King Z, Walsh F, Wanyja Mankarr? (Where is the Bilby?), Kanyirninpa Jukurrpa, Newman, Western Australia. Viewed <https://www.kj.org.au/mediaandfilms/wanyja-mankarr>

Page 137, Photo Bilby (2013) Save the Bilby Fund www.savethebilbyfund.org

Page 145, Drawing Lunki by Noreena Williams in Martu women and Walsh F (2018) Paarninpa-laju mayinga ngarranyungkuraku, We make these foods to share, Internal report for Martu and Kanyirninpa Jukurrpa, Newman.

Page 150, Information on antlions is available at <https://www.antlionpit.com>

Page 153, A key to invertebrates is available at www.ento.csiro.au/education/key/couplet_01.html

Page 157, Kinnear A (1994) 'A flip guide to animals of the soil and leaf litter' Edith Cowan University

Page 171, Dcoetzee, (2007) Photo Central Netted Dragon closeup at Sydney Wildlife World, viewed 18th March 2019 at https://commons.wikimedia.org/wiki/File:Central_Netted_Dragon_closeup_at_Sydney_Wildlife_World.jpg

Page 171, Reptiles heat diagram adapted from: Bradshaw SD, Main AR (1968) Behavioural attitudes and regulation of temperature in *Amphibolurus* lizards. *Journal of Zoology (London)* 154, 193–221.

Page 176, Line graph from Bradshaw SD, Main AR (1968) Behavioural attitudes and regulation of temperature in *Amphibolurus* lizards. *Journal of Zoology (London)* 154, 193–221.

Plants

Page 188, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 190, Photo Quandong *Santalum acuminatum* fruit, Moss J (2008), viewed 19th March 2019 https://en.wikipedia.org/wiki/Santalum_acuminatum#/media/File:Santalum_acuminatum_fruit1.JPG

Page 194, Drawing Lurnkun Wilki procedure by Natasha Williams in Martu women and Walsh F (2018) Paarninpa-laju mayinga ngarranypunkuraku, We make these foods to share, Internal report for Martu and Kanyirninpa Jukurrpa, Newman.

Page 200, Plant diagram adapted from Mooney M *et al.* (2007) *Land and Learning: A Central Australian Environmental Education Program for Aboriginal Schools and Others*, Tangentyere Landcare

Page 201, Drawing by Noreena Williams in Martu women and Fiona Walsh (2018) Paarninpa-laju mayinga ngarranypunkuraku, We make these foods to share, Internal report for Martu and Kanyirninpa Jukurrpa, Newman.

Page 216, Photo *Mimulus*_nectar_guide_UV_VIS by plantsurfer (1999), viewed 19th March 2019 at https://commons.wikimedia.org/wiki/File:Mimulus_nectar_guide_UV_VIS.jpg (CC Attribution Sharealike 2.0)

Page 216, Photo Long-tongued *Amegilla cingulata* bee on long tube of *Acanthus ilicifolius* flower by Chiswick Chap (2013), viewed 19th March at https://commons.wikimedia.org/wiki/File:Amegilla_cingulata_on_long_tube_of_Acanthus_ilicifolius_flower.jpg (CC Attribution Sharealike 4.0)

Page 221, Photo *Ranunculus acris* (Meadow buttercup) Vis UV IR comparison by David Kennard / www.davidkennardphotography.com (2015), viewed 19th March at [https://commons.wikimedia.org/wiki/File:Ranunculus_acris_\(Meadow_buttercup\)_Vis_UV_IR_comparison.jpg#/media/File:Ranunculus_acris_\(Meadow_buttercup\)_Vis_UV_IR_comparison.jpg](https://commons.wikimedia.org/wiki/File:Ranunculus_acris_(Meadow_buttercup)_Vis_UV_IR_comparison.jpg#/media/File:Ranunculus_acris_(Meadow_buttercup)_Vis_UV_IR_comparison.jpg) (CC Attribution Sharealike 4.0)

Page 225, Photo Rainforest in Kinabalu Park, Borneo by Dukeabruzzi (2014), viewed 19th March at https://commons.wikimedia.org/wiki/File:Borneo_rainforest.jpg (CC Attribution Sharealike 4.0)

Page 225, Photo Leaf rubbing by Emma Craig (2013), viewed 19th March 2019 at <https://www.flickr.com/photos/98925031@N08/9768223775> (CC BY 2.0)

Page 235, Photo Spinifex resin on stalk Mark Marathon (2015), viewed March 19th 2019 at https://en.wikipedia.org/wiki/File:Triodia_resin.jpg (CC Attribution Sharealike 4.0)

Page 240, Films 'Waru' (Fire) by Kanyirninpa Jukurrpa (<https://www.youtube.com/watch?v=nKLD9LrySeU>) and 'The Art of Fire' (<https://www.youtube.com/watch?v=ZQ2Zjaa1wAE>)

Page 240, Bennion I. *We Don't Need a Map Education Resource* developed by Art On The Move with assistance from Fremantle Arts Centre, Kanyirninpa Jukurrpa and Martumili Artists.

Page 241, Photo Goanna by CSIRO Science Image, viewed March 19th 2019 at <https://www.scienceimage.csiro.au/image/334/a-goanna/> (CC BY 3.0)

Page 243, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 245, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Seasons, weather and astronomy

Page 249, Mosaics were created by Wiluna Martu students and community with technical support and guidance from artist Jane Byrne as part of a program delivered by Indigenous Community Volunteers Australia

Page 256, Indigenous seasonal calendar <http://jalilands.com.au> Ngunya Jarqoon Cultural Calendar—JALI Local Aboriginal Land Council

Page 267, Painting. Kumpaya Girgirba, *Minyipuru* [acrylic on canvas], Martumili Artists, Newman, Western Australia

Page 272, Satellite image. Google Earth (2019) from Landsat/ Copernicus Imagery, date 12/14/2015, lat -17.8711412 lon 115.274751, eye altitude 20107.2 km, viewed 19 March 2019 at <https://www.google.com/maps/@-17.87141,115.27475,30508711m/data=!3m1!1e3>

Index to topics

Places, maps and country	13
Background	15
Places, maps and country: Planning.....	16
Unit 1: Sunrise, sunset and compass points.....	17
Background	17
Sunrise, sunset and compass points: Planning.....	19
<i>Activity 1: Compass points.....</i>	19
<i>Activity 2: Shadows and direction</i>	20
<i>Equipment.....</i>	20
<i>Activity 3: Estimating direction.....</i>	21
Science curriculum links.....	22
Unit 2: Maps and mapping	23
Background	23
Maps and mapping: Planning	24
Maps and mapping: Learning in class (preparation).....	24
<i>Activity 1: Making a ground map.....</i>	24
<i>Equipment.....</i>	25
<i>Procedure.....</i>	26
<i>Activity 2: Draw the ground map on paper.....</i>	28
<i>Activity 3: Maps of the community.....</i>	28
Maps and mapping: Visit Aboriginal rangers to learn about maps.....	29
<i>Background.....</i>	29
<i>Equipment.....</i>	29
<i>At the ranger office or base.....</i>	29
Maps and mapping: Learning in class (follow-up)	30
<i>Activity 4: Reflect and recount.....</i>	30
Science curriculum links.....	31
Unit 3: Mapping country.....	32
Background	32
Mapping country: Planning	33
Mapping country: Learning in class (preparation)	34
<i>Activity 1: Introduction to mapping country.....</i>	34
<i>Activity 2: Sketch map</i>	34
Mapping country: Learning on Country.....	35
Mapping country: Learning in class (follow-up).....	36
<i>Activity 3: Make a map of country.....</i>	36
<i>Activity 4: Reflect and share maps</i>	37
Science curriculum links.....	38
Unit 4: Landforms and country types	39
Background	39
Landforms and country types: Planning	42
Landforms and country types: Learning in class (preparation).....	43
<i>Activity 1: Introduction to landforms and country types</i>	43
<i>Activity 2: Satellite images of country types</i>	43
Landforms and country types: Learning on Country.....	44
Landforms and country types: Learning in class (follow-up).....	45
<i>Activity 3: Draw or paint a country type</i>	45
<i>Activity 4: Label landforms on a map.....</i>	45
<i>Activity 5: Making a class scale map of the landforms.....</i>	45
<i>Activity 6: Make a school map of the region</i>	46
<i>Map making at Mulan School</i>	47
<i>April Pengart Campbell talks about making the Ti Tree school map.....</i>	49
Science curriculum links.....	50

Water	51
Background	52
Unit 1: Life around the waterhole	54
Life around the waterhole: Planning.....	56
Life around the waterhole: Learning in class (preparation)	56
<i>Activity 1: Introduction: What do we know about water?</i>	56
<i>Activity 2: Look at paintings featuring waterholes</i>	57
<i>Activity 3: Prepare for Learning on Country</i>	57
<i>Background: Artefacts around waterholes</i>	58
Life around the waterhole: Learning on Country	59
Life around the waterhole: Learning in class (follow-up)	60
<i>Activity 4: Recounting the learning</i>	60
<i>Activity 5: Painting of a waterhole</i>	61
<i>Activity 6: Class big book</i>	62
<i>Activity 7: Science investigation: Motion sensor camera survey</i>	62
<i>Motion sensor cameras</i>	62
<i>Planning</i>	64
<i>Introduction</i>	64
<i>Map the waterhole</i>	64
<i>Using the motion sensor cameras</i>	65
<i>Using the motion sensor camera data sheet</i>	65
<i>Question and predict</i>	66
<i>Equipment</i>	66
<i>Plan and conduct</i>	66
<i>Analyse data</i>	66
<i>Reflect</i>	67
<i>Share</i>	67
<i>Activity 8: Follow-up inquiry: Compare in another season</i>	67
<i>Activity 9: Bird survey</i>	68
<i>Background: Animals that appear after the rain</i>	70
<i>Background: Frogs</i>	71
<i>Activity 10: Frog life cycle</i>	72
<i>Record the life cycle of the frogs</i>	73
<i>Make a calendar of frog events</i>	73
Science curriculum links.....	74
Motion sensor camera survey data sheet	75
Unit 2: Water health	76
Background: Water quality	76
Water health: Planning.....	77
Water health: Learning in class (preparation)	77
<i>Activity 1: Describing water using five senses</i>	77
<i>Activity 2: Preparing for Learning on Country</i>	78
Water health: Learning on Country	79
Water health: Learning in class (follow-up)	80
<i>Activity 3: Five senses report</i>	80
<i>Activity 4: Under the microscope</i>	80
<i>Activity 5: Write a report</i>	80
<i>Activity 6: Develop another investigation</i>	80
<i>Activity 7: Science investigation: Waterbug survey</i>	81
<i>Background: Waterbugs and water quality</i>	81
<i>What is a waterbug?</i>	81
<i>Equipment</i>	83
<i>Question and predict</i>	83
<i>Plan and conduct</i>	84
<i>Waterbug identification key</i>	85
<i>Analyse data</i>	86
<i>Observe and sort</i>	86
<i>Identify waterbugs</i>	86

<i>Assess biodiversity</i>	86
<i>Reflect</i>	87
<i>Share</i>	87
Follow-up activities	88
<i>Activity 8: Science investigation: Grow your own waterbugs</i>	88
<i>Activity 9: Science investigation: Compare data in another season</i>	89
<i>Activity 10: Waterbug life cycle</i>	89
<i>Activity 11: Research a waterbug</i>	89
<i>Activity 12: Adopt a waterhole</i>	91
Science curriculum links	92
Water health data sheet	94
Animals	97
Background	98
Unit 1: My special animal	100
Background	100
Equipment	100
My special animal: Planning	101
My special animal: Learning in class (preparation)	102
<i>Activity 1: What do we already know about animals?</i>	102
My special animal: Learning on Country	103
My special animal: Learning in class (follow-up)	104
<i>Activity 2: Record the learning</i>	104
<i>Activity 3: Share the learning</i>	104
Science curriculum links	105
Unit 2: Tracking	106
Background	106
Tracking: Planning	107
Tracking: Learning in class (preparation)	107
<i>Activity 1: What do we already know about tracks?</i>	107
<i>Activity 2: Talk about animals and their tracks</i>	108
<i>Activity 3: Draw animal tracks</i>	109
<i>Activity 4: Game: What animal are you?</i>	109
<i>Activity 5: Plaster casts of tracks</i>	109
Tracking: Learning on Country	110
<i>Activity 6: Recording tracks</i>	111
Tracking: Learning in class (follow-up)	112
<i>Activity 7: Data sheet</i>	112
<i>Activity 8: Recount</i>	112
<i>Activity 9: Tracks, scats and burrows</i>	113
<i>Activity 10: Compare tracking sites</i>	113
<i>Activity 11: Nocturnal animal tracks</i>	113
<i>Activity 12: Track symbols hunt</i>	113
<i>Activity 13: Trackplot monitoring with a ranger group</i>	113
Looking for tracks	114
Tracking data sheet	115
Science curriculum links	116
Unit 3: Animal habitat	117
Background	117
Animal habitat: Planning	118
Animal habitat: Learning in class (preparation)	118
<i>Background: What is a habitat?</i>	118
<i>Activity 1: What is my habitat?</i>	119
<i>Activity 2: Habitats of other animals</i>	119
<i>Activity 3: Field trip preparation</i>	119
Animal habitat: Learning on Country	120
Animal habitat: Learning in class (follow-up)	121
<i>Activity 4: Recounting the learning</i>	121

Activity 5: Sorting litter	121
Activity 6: Investigate scats.....	122
Activity 7: Making nests/models.....	123
Activity 8: Create a mural.....	124
Activity 9: Habitats of local animals.....	125
Activity 10: Flip book	125
Food webs and ecosystems.....	126
Background.....	126
Activity 11: Food web.....	127
Activity 12: Changes to the food web.....	127
Activity 13: Record and share the learning about the food web	127
Science curriculum links.....	128
Animal habitat.....	129
Unit 4: Feral animals and threatened species.....	130
Background: Native, feral and threatened species	130
Cats.....	130
Camels.....	131
Feral animals and threatened species: Planning.....	131
Feral animals and threatened species: Learning in class (preparation)	132
Activity 1: Native animals, feral animals and threatened species	132
Background.....	132
Activity 2: Where is the Bilby?.....	133
Activity 3: Where is the Bilby? Acting out	134
Activity 4: Ranger class visit.....	134
Activity 5: Writing a report about a threatened species or feral animal	135
Feral animals and threatened species: Learning on Country	136
Feral animals and threatened species: Learning in class (follow-up)	137
Activity 6: Recount the learning	137
Activity 7: Write a report.....	137
Other follow-up activities	137
Activity 8: Cat research project.....	137
Activity 9: Write a story about a threatened species.....	137
Science curriculum links.....	138
Unit 5: Invertebrates	139
Background: What are 'invertebrates'?.....	139
Invertebrate classification.....	140
Digging for Witchetty grubs	142
Witchetty grubs: Planning	142
Witchetty grubs: Learning in class (preparation).....	143
Activity 1: Introduction to Witchetty grubs.....	143
Witchetty grubs: Learning on Country.....	144
Witchetty grubs: Learning in class (follow-up).....	145
Activity 2: Recount the learning.....	145
Activity 3: Procedure: Digging for Witchetty grubs	145
Activity 4: Life cycle	147
Activity 5: Compare invertebrates with vertebrates	148
Background.....	148
What is an invertebrate?	148
What is a vertebrate?.....	148
Activity 6: Examine skeletal remains.....	148
Activity 7: Body parts.....	149
Activity 8: Antlions.....	150
Activity 9: Science investigation: Invertebrate survey (Early Years)	151
Equipment.....	151
Question and predict.....	151
Plan and conduct.....	151
Analyse the data	151
Share what I find	151

Activity 10: Science investigation: Pit trap invertebrate survey (Primary)	153
Background: What is a pit trap?	153
Select a site	153
Equipment	153
Science investigation process	155
Question and predict	155
Plan and conduct	155
Collect and record data	156
Analyse the data	159
Reflect	160
Share	160
Science curriculum links	161
Pit trap data sheet	163
Unit 6: Reptiles	164
Background	164
Hunting goannas	165
Hunting goannas: Planning	165
Hunting goannas: Learning in class (preparation)	166
Activity 1: What is a reptile?	166
Activity 2: Learning about goannas	166
Hunting goannas: Learning on Country	167
Hunting goannas: Learning in class (follow-up)	168
Activity 3: Recounting the learning	168
Activity 4: Make a big book	168
Activity 5: Make a movie	168
Activity 6: Life cycle and behaviour	168
Activity 7: Goanna anatomy	169
Activity 8: Physical adaptations	169
Warming up and cooling down in the desert	170
Background	170
Behaviour and heat	171
Colour and heat	171
Activity 9: Science investigation: Reptile behaviour and heat	172
Equipment	172
Question and predict	172
Plan and conduct	172
Analyse the data	173
Share	173
Activity 10: Heat walk	173
Activity 11: Science investigation: Reflecting and absorbing heat	174
Equipment	174
Question and predict	174
Plan and conduct	174
Analyse the data	175
Reflect	175
Activity 12: Science investigation: Temperatures in a lizard burrow	176
Background	176
Equipment	176
Question and predict	176
Plan and conduct	177
Analyse the data	177
Reflect	177
Adaptations	178
Activity 13: Recount lizard adaptations	178
Activity 14: Investigate adaptations by other animals	178
Science curriculum links	178

Plants	181
Background	182
Unit 1: Classifying plants.....	184
Background	184
Classifying plants: Planning	185
Classifying plants: Learning in class	185
<i>Activity 1: Grouping plants using Indigenous ecological knowledge.....</i>	185
Classifying plants: Learning on Country	187
Classify plants: Learning in class (follow-up)	188
<i>Activity 2: Reflect, recount and write</i>	188
<i>Activity 3: Making a class plant book.....</i>	188
Science curriculum links.....	189
Unit 2: Bushfood.....	190
Background	190
Bushfood: Planning.....	191
Bushfood: Learning in class (preparation)	192
<i>Activity 1: Introduction to bush foods.....</i>	192
Bushfood: Learning on Country	193
Bushfood: Learning in class (follow-up)	194
<i>Activity 2: Reflect, recount and write</i>	194
<i>Activity 3: Write a recipe (procedure).....</i>	194
<i>Activity 4: Record plant information</i>	195
<i>Activity 5: Pressing plant samples to keep</i>	196
Science curriculum links.....	197
Plant label.....	198
Unit 3: What do plants need to grow?	199
Background	200
<i>Parts of a plant: Desert Raisin.....</i>	200
<i>Activity 1: Label parts of a plant</i>	201
<i>Activity 2: Seed germination</i>	202
<i>Activity 3: Investigation: Plants and water.....</i>	203
<i>Question and predict.....</i>	203
<i>Plan and conduct.....</i>	203
<i>Analyse the data</i>	203
<i>Share</i>	203
<i>Activity 4: Investigation: Plants and light</i>	204
<i>Equipment.....</i>	204
<i>Question and predict.....</i>	204
<i>Plan and conduct.....</i>	204
<i>Analyse data</i>	204
Science curriculum links.....	205
Unit 4: Bush medicine.....	207
Background	207
Bush medicine: Planning	208
Bush medicine: Learning in class (preparation)	208
<i>Activity 1: Introduction to bush medicine</i>	208
Bush medicine: Learning on Country	209
Bush medicine: Learning in class (follow-up)	210
<i>Activity 2: Reflect, recount and write</i>	210
<i>Activity 3: Record plant information</i>	210
<i>Activity 4: Pressing plant samples</i>	211
<i>Activity 5: Write a procedure</i>	211
Science curriculum links.....	212
Plant label.....	213

Unit 5: Flowers and pollination.....	214
Background	214
Pollination	215
Activity 1: <i>Seeds up close</i>	217
Activity 2: <i>Counting and comparing seeds</i>	217
Activity 3: <i>Parts of a flower</i>	218
Background.....	218
Activity 4: <i>Pollination</i>	220
Activity 5: <i>Nectar</i>	220
Activity 6: <i>Bee pathways</i>	221
Activity 7: <i>Who is the pollinator?</i>	221
Activity 8: <i>Role-playing pollination</i>	222
Science curriculum links.....	222
Unit 6: Leaves, roots, water and adaptations	223
Background	223
Activity 1: <i>Evaporation</i>	224
Activity 2: <i>Collect and sort leaves</i>	224
Activity 3: <i>Compare leaves from different environments</i>	225
Activity 4: <i>Leaf rubbings</i>	225
Activity 5: <i>Capillary action</i>	226
Activity 6: <i>Transpiration</i>	227
Background.....	227
Activity 7: <i>Leaf adaptations</i>	227
<i>Leaf guide: Desert plants have special adaptations to reduce water loss</i>	228
Science curriculum links.....	229
Unit 7: Plants as tools and shelter.....	230
Background	230
Plants as tools: Planning	231
Plants as tools: Learning in class (preparation).....	231
Activity 1: <i>Introduction to using plants for tool making</i>	231
Plants as tools: Learning on Country.....	232
Plants as tools: Learning in class (follow-up).....	233
Activity 2: <i>Reflect, recount and write</i>	233
Activity 3: <i>Procedure</i>	233
Plants as shelter and tools activities	233
Activity 4: <i>Making shelter</i>	234
Activity 5: <i>Bark sandals</i>	234
Activity 6: <i>Creating fire</i>	234
Activity 7: <i>Making glue</i>	235
Science curriculum links.....	236
Plant label.....	237
Unit 8: Plants and fire	238
Background	238
Plants and fire: Planning	239
Plants and fire: Learning in class (preparation).....	240
Activity 1: <i>Watch a film about fire</i>	240
Activity 2: <i>Art and fire</i>	240
Activity 3: <i>Before going on country</i>	240
Plants and fire: Learning on Country.....	241
Plants and fire: Learning in class (follow-up).....	242
Activity 4: <i>Reflect, recount and write</i>	242
Activity 5: <i>Record observations</i>	242
Activity 6: <i>Record data</i>	242
Activity 7: <i>Plants and fire painting</i>	243
Science curriculum links.....	244

Seasons, weather and astronomy	247
Background	248
<i>Weather and climate</i>	248
Unit 1: Seasonal calendar	250
Background	250
Seasonal calendar: Planning	250
Seasonal calendar: Learning in class (preparation)	251
<i>Activity 1: Introduction to seasons</i>	251
<i>Activity 2: Animals, plants and seasons</i>	252
<i>Activity 3: Season poster</i>	253
Seasonal calendar: Learning on Country	254
Seasonal calendar: Learning in class (follow-up)	255
<i>Activity 4: Reflect, recount and write</i>	255
<i>Activity 5: Season poster (follow-up)</i>	255
<i>Activity 6: Seasonal calendar</i>	256
<i>A note on seasons in the arid zone</i>	258
<i>Activity 7: Seasons around the world</i>	259
Science curriculum links	260
Unit 2: Seasons and weather	261
Seasons and weather: Planning	261
Seasons and weather: Activities	262
<i>Activity 1: Weather in Language</i>	262
<i>Wind</i>	262
<i>Direction</i>	262
<i>Clouds and rain</i>	263
<i>Temperature</i>	263
<i>Activity 2: Weather in English</i>	263
<i>Activity 3: Weather poster</i>	264
<i>Activity 4: Measuring the weather</i>	264
<i>Activity 5: Television weather report</i>	265
Science curriculum links	266
Unit 3: Seasons and the stars	267
Background	268
Seasons and the stars: Planning	268
Seasons and the stars: Learning in class (preparation)	269
<i>Activity 1: Draw and paint the stars</i>	269
Seasons and the stars: Learning on Country	270
Seasons and the stars: Learning in class (follow-up)	271
<i>Activity 2: Reflect, recount and write</i>	271
<i>Activity 3: Add to the seasonal calendar</i>	271
Western science and astronomy	271
<i>The Earth turning</i>	271
<i>Activity 4: Imagine the Earth turning</i>	271
<i>Activity 5: Google Earth</i>	272
<i>Activity 6: Ball and torch</i>	272
<i>Activity 7: Changing shadows</i>	272
<i>Activity 8: Timelapse video</i>	273
Science curriculum links	273
How to make a video story	274
Five-shot sequence	274
<i>Activity for five-shot sequence</i>	274
Record an interview or voice over	276