



Australian Curriculum: Science Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority

Content elaborations and teacher
background information for Foundation to Year 6



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Introduction

This document showcases the 95 new content elaborations for the Australian Curriculum: Science (Foundation to Year 10) that address the Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority. It also provides the accompanying teacher background information for each of the elaborations from Foundation to Year 6 to support primary teachers in planning and teaching the science curriculum.

The Australian Curriculum has a three-dimensional structure encompassing disciplinary knowledge, skills and understandings; general capabilities; and cross-curriculum priorities. It is designed to meet the needs of students by delivering a relevant, contemporary and engaging curriculum that builds on the educational goals of the Melbourne Declaration. The Melbourne Declaration identifies Aboriginal and Torres Strait Islander cultures as a key area to be addressed for the benefit of both individuals and Australia as a whole. As such, Aboriginal and Torres Strait Islander histories and cultures have been included as a cross-curriculum priority in the Australian Curriculum and are intended to enrich the curriculum through the development of considered and focused content that fits naturally within learning areas. This cross-curriculum priority enables teachers to deliver the learning area content at the same time as students develop knowledge, understandings and skills relating to Aboriginal and Torres Strait Islander histories and cultures.

ACARA has developed 95 new elaborations for the Australian Curriculum: Science (F-10) that demonstrate the connections between Aboriginal and Torres Strait Islander histories and cultures and core science concepts in the Australian Curriculum. The elaborations acknowledge that Aboriginal Peoples and Torres Strait Islander Peoples have worked scientifically for millennia and continue to contribute to contemporary science. These elaborations have the potential to make learning more relevant for Aboriginal and Torres Strait Islander students and, as a result, help increase their participation in STEM subjects. They also provide the opportunity to embed a uniquely Australian perspective into the Science curriculum.

Each of the new elaborations is supported by teacher background information that is intended to assist teachers in preparing culturally appropriate and scientifically rigorous classroom materials. The teacher background information includes a list of published works that were consulted in the preparation of the information.

Background

The Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority recognises two distinct needs in the Australian Curriculum:

- *Aboriginal and Torres Strait Islander students can see themselves, their identities and their cultures reflected in the curriculum of each of the learning areas, can fully participate in the curriculum and can build their self-esteem.*
- *The Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority is designed for all students to engage in reconciliation, respect and recognition of the world's oldest continuous living cultures.¹*

Since the publication of the Australian Curriculum, ACARA has received and collated feedback regarding this cross curriculum priority from stakeholders, including Aboriginal and Torres Strait Islander communities and educators in schools. This feedback suggested the desire for more opportunities to incorporate Aboriginal and Torres Strait Islander Histories and Cultures in the Australian Curriculum and the need for more coherent alignment between the learning areas and the cross curriculum priority to support implementation.

ACARA's Aboriginal and Torres Strait Islander Advisory Group reflected on this feedback and provided advice to ACARA and its Board, resulting in the project to develop the new content elaborations and teacher background information for the Australian Curriculum: Science provided in this document.



¹ Sourced from the 'Cross-curriculum priorities' section of the Australian Curriculum website: <https://www.australiancurriculum.edu.au/f-10-curriculum/cross-curriculum-priorities/aboriginal-and-torres-strait-islander-histories-and-cultures/>

Process for developing the elaborations

The process to develop new elaborations and supporting information for the Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority in the Australian Curriculum: Science ensured both cultural and scientific integrity. It involved the following steps:

1. Appointment of a writing team consisting of an Aboriginal and Torres Strait Islander science education expert from the Queensland Department of Education and ACARA curriculum specialists, supported by a reference group comprised of nationally recognised Aboriginal and Torres Strait Islander education experts.
2. Researching of Aboriginal and Torres Strait Islander histories and cultures, sourced from materials published by recognised research institutions, universities, museums, government and Aboriginal and Torres Strait Islander community organisations and media publications.
3. External editing of all materials to ensure the materials' cultural integrity.
4. Ongoing consultation with, and endorsement by, ACARA's Aboriginal and Torres Strait Islander Advisory Group.





How the elaborations strengthen the Australian Curriculum: Science

The Australian Curriculum: Science (F-10) contains content descriptions that define what is to be taught and what students are expected to learn. The content descriptions of the three Science strands – Science understanding (SU), Science as a human endeavour (SHE) and Science inquiry skills (SIS) – are accompanied by content elaborations. These elaborations are non-mandatory components of the curriculum, provided to suggest contexts through which to explore the core science content in both depth and breadth.

The new elaborations promote an integrated approach to teaching the three interrelated strands of the Australian Curriculum: Science.

- Elaborations within the Science understanding and Science as a human endeavour strands are organised into topics and embedded in a progression of learning. Some topics are included in several year levels to accommodate increasingly sophisticated aspects or understandings.
- Elaborations within the Science inquiry skills strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander histories and cultures, in particular:
 - acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
 - consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
 - collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.
- Wherever possible, the focus of each elaboration has been chosen to facilitate the integration of closely related content from two or more strands at the same year level or two-year band. Such opportunities are referred to as ‘cross-strand linkages’ and are provided in the teacher background information.
- All elaborations reference the appropriate Organising Ideas of the Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority framework.
- Many elaborations offer opportunities for students to also develop the general capabilities of the Australian Curriculum, such as Personal and Social Capability, Critical and Creative Thinking, Ethical Understanding and Intercultural Understanding.

Through the cross-curriculum priority dimension of the Australian Curriculum, carefully selected aspects of Aboriginal and Torres Strait Islander histories and cultures relevant to the core science content are woven into the F–10 Science curriculum. These aspects, ranging from times before European colonisation to modern-day society, broadly pertain to Aboriginal and Torres Strait Islander knowledges, technologies, processes, contributions to science and ethical considerations that overlap the content of the F-10 Science curriculum. They provide non-mandatory contexts that can be used to engage the learning of core science concepts, for example:

- **Knowledges** relating to chemistry, physics, geology, botany, zoology, physiology, genetics, meteorology, astronomy, nutrition, hydrology, ecology are covered.
- **Technologies** such as the development of machines, specialised tools, weaponry, architecture, clothing, blankets, torches, nets, traps and domestic utensils (baskets, knives, chisels, sieves) are explored.
- **Processes**, both physical and chemical, are investigated. These include; lithic heat treatment, detoxification, stone knapping, skin tanning, use of acids and alkalis, use of poisons, production of medicines, medicine delivery, cooking methods, production of pigments and dyes, production of adhesives, fire lighting methods, fibre, string and rope production.
- **Contributions** to medicine, mining, ecology, archaeology, anthropology, exploration, zoology, botany, agriculture, bio-security, nutrition, fire management, ecological restoration, water management, sustainability, reduction of atmospheric pollution and bio-geography are revealed.
- **Ethical considerations** regarding the treatment of cultural heritage sites and the respect of intellectual property rights are investigated as they relate to 21st century scientists.

The elaborations are generic in nature and aim to assist educators in opening a dialogue with local communities that could engage and collaborate in the teaching of these curriculum aspects. If a local community does not have the capacity in this space, the elaborations still provide a rich example of how the curriculum content is relevant to Aboriginal and/or Torres Strait Islander Peoples.



The Australian Curriculum: Science content elaborations linked to the Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority

The following tables list all of the elaborations linked to the Aboriginal and Torres Strait Islander Histories and Cultures cross-curriculum priority by year level, including the Science strand – Science Understanding (SU), Science as a Human Endeavour (SHE), or Science Inquiry Skills (SIS) – the relevant sub-strand, and the content description from the F–10 Australian Curriculum: Science. The 95 new elaborations are highlighted in blue font.



Foundation

In Foundation Science, students observe and describe the behaviours and properties of everyday objects, materials and living things. They explore change in the world around them, including changes that impact on them, such as the weather, and changes they can affect, such as making things move or change shape. They learn that seeking answers to questions they pose and making observations are a core part of science and use their senses to gather different types of information.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Living things have basic needs, including food and water (ACSSU002)	<ul style="list-style-type: none"> recognising how Aboriginal and Torres Strait Islander Peoples care for living things
SU Physical sciences	The way objects move depends on a variety of factors, including their size and shape (ACSSU005)	<ul style="list-style-type: none"> exploring how the size and shape of traditional instructive toys used by Aboriginal and Torres Strait Islander Peoples influence their movement
SU Earth and space sciences	Daily and seasonal changes in our environment affect everyday life (ACSSU004)	<ul style="list-style-type: none"> learning how Aboriginal and Torres Strait Islander Peoples' concepts of time and weather patterns explain how things happen in the world around them
SHE Nature and development of science	Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE013)	<ul style="list-style-type: none"> recognising how Aboriginal and Torres Strait Islander Peoples gain knowledge about the land and its vital resources, such as water and food, through observation





Year 1

In Year 1 Science, students infer simple cause-and-effect relationships from their observations and experiences, and begin to link events and phenomena with observable effects and to ask questions. They observe changes that can be large or small and happen quickly or slowly. They explore the properties of familiar objects and phenomena, identifying similarities and differences. Students begin to value counting as a means of comparing observations, and are introduced to ways of organising their observations.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Living things have a variety of external features (ACSSU017)	<ul style="list-style-type: none"> exploring how Aboriginal and Torres Strait Islander Peoples' observations of the external features of living things are mimicked and replicated in traditional dance
SU Chemical sciences	Everyday materials can be physically changed in a variety of ways (ACSSU018)	<ul style="list-style-type: none"> exploring how Aboriginal and Torres Strait Islander Peoples apply physical changes to natural materials to render them useful for particular purposes
SU Earth and space sciences	Observable changes occur in the sky and landscape (ACSSU019)	<ul style="list-style-type: none"> recognising the extensive knowledge of daily and seasonal changes in weather patterns and landscape held by Aboriginal and Torres Strait Islander Peoples
SU Physical sciences	Light and sound are produced by a range of sources and can be sensed (ACSSU020)	<ul style="list-style-type: none"> exploring how traditional musical instruments used by Aboriginal and Torres Strait Islander Peoples produce their characteristic sounds
SHE Nature and development of science	Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE021)	<ul style="list-style-type: none"> recognising how Aboriginal and Torres Strait Islander Peoples use changes in the landscape and the sky to answer questions about when to gather certain resources
SHE Use and influence of science	People use science in their daily lives, including when caring for their environment and living things (ACSHE022)	<ul style="list-style-type: none"> considering that technologies used by Aboriginal and Torres Strait Islander Peoples require an understanding of how materials can be sustainably sourced to make tools and weapons, musical instruments, clothing, cosmetics and artworks
SIS Communicating	Represent and communicate observations and ideas in a variety of ways (AC SIS029)	<ul style="list-style-type: none"> acknowledging and learning about Aboriginal and Torres Strait Islander Peoples' ways of representing and sharing observations
SIS Evaluating	Compare observations with those of others (AC SIS213)	<ul style="list-style-type: none"> consulting with Aboriginal and Torres Strait Islander Peoples to compare observations and evaluate identifications of animal tracks

Year 2

In Year 2 Science, students describe the components of simple systems, such as stationary objects subjected to pushes or pulls, or combinations of materials, and show how objects and materials interact through direct manipulation. They observe patterns of growth and change in living things, and describe patterns and make predictions. They explore the use of resources from the earth and are introduced to the idea of the flow of matter when considering how water is used. They use counting and informal measurements to make and compare observations and begin to recognise that organising these observations in tables makes it easier to show patterns.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Chemical sciences	Different materials can be combined for a particular purpose (ACSSU031)	<ul style="list-style-type: none"> investigating the ways in which Aboriginal and Torres Strait Islander Peoples combine different materials to produce utensils (hafting, weaving, sewing and glueing)
SU Earth and space sciences	Earth’s resources are used in a variety of ways (ACSSU032)	<ul style="list-style-type: none"> considering how Aboriginal and Torres Strait Islander Peoples live in regions with scarce resources or in sensitive environments
SU Physical sciences	A push or a pull affects how an object moves or changes shape (ACSSU033)	<ul style="list-style-type: none"> investigating the push and pull movements of traditional Aboriginal and Torres Strait Islander children’s instructive toys
SHE Nature and development of science	Science involves observing, asking questions about, and describing changes in, objects and events (ACSHE034)	<ul style="list-style-type: none"> recognising how Aboriginal and Torres Strait Islander Peoples observe and describe developmental changes in living organisms and answer questions about when to harvest certain resources
SHE Use and influence of science	People use science in their daily lives, including when caring for their environment and living things (ACSHE035)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples use science to meet their needs, such as food supply





Year 3

In Year 3 Science, students observe heat and its effects on solids and liquids and begin to develop an understanding of energy flows through simple systems. In observing day and night, they develop an appreciation of regular and predictable cycles. Students order their observations by grouping and classifying; in classifying things as living or non-living they begin to recognise that classifications are not always easy to define or apply. They begin to quantify their observations to enable comparison, and learn more sophisticated ways of identifying and representing relationships, including the use of tables and graphs to identify trends. They use their understanding of relationships between components of simple systems to make predictions.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' systems of classifying living things and how these systems differ from those used by contemporary science
SU Biological sciences	Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)	<ul style="list-style-type: none"> recognising Aboriginal and Torres Strait Islander Peoples' use of observable features to group living things
SU Chemical sciences	A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)	<ul style="list-style-type: none"> investigating how changes of state in materials used by Aboriginal and Torres Strait Islander Peoples, such as beeswax or resins, are important for their use
SU Earth and space sciences	Earth's rotation on its axis causes regular changes, including night and day (ACSSU048)	<ul style="list-style-type: none"> exploring how cultural stories of Aboriginal and Torres Strait Islander Peoples explain the cyclic phenomena involving sun, moon and stars and how those explanations differ from contemporary science understanding
SU Physical sciences	Heat can be produced in many ways and can move from one object to another (ACSSU049)	<ul style="list-style-type: none"> investigating the production and transfer of heat in Aboriginal and Torres Strait Islander Peoples' methods of cooking, such as the use of ground ovens
SHE Nature and development of science	Science involves making predictions and describing patterns and relationships (ACSHE050)	<ul style="list-style-type: none"> researching how knowledge of astronomy has been used by some Aboriginal and Torres Strait Islander Peoples
SHE Use and influence of science	Science knowledge helps people to understand the effect of their actions (ACSHE051)	<ul style="list-style-type: none"> researching Aboriginal and Torres Strait Islander Peoples' knowledge of the local natural environment, such as the characteristics of plants and animals
SIS Communicating	Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS060)	<ul style="list-style-type: none"> consulting Aboriginal and Torres Strait Islander Peoples' representations of living things as evidenced and communicated through formal and informal sharing of information
SIS Communicating	Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS060)	<ul style="list-style-type: none"> acknowledging and exploring Aboriginal and Torres Strait Islander Peoples' ways of communicating information about anatomical features of organisms
SIS Planning and conducting	With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS054)	<ul style="list-style-type: none"> consulting with Aboriginal and Torres Strait Islander Peoples to guide the planning of scientific investigations, including safety considerations for field investigations
SIS Questioning and predicting	With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (ACSIS053)	<ul style="list-style-type: none"> consulting with and using existing knowledge held by Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions regarding invasive species



Year 4

In Year 4 Science, students broaden their understanding of classification and form and function through an exploration of the properties of natural and processed materials. They learn that forces include non-contact forces and begin to appreciate that some interactions result from phenomena that can't be seen with the naked eye. They begin to appreciate that current systems, such as Earth's surface, have characteristics that have resulted from past changes and that living things form part of systems. They understand that some systems change in predictable ways, such as through cycles. They apply their knowledge to make predictions based on interactions within systems, including those involving the actions of humans.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Living things have life cycles (ACSSU072)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples understand and utilise the lifecycles of certain species
SU Biological sciences	Living things depend on each other and the environment to survive (ACSSU073)	<ul style="list-style-type: none"> recognising how Aboriginal and Torres Strait Islander Peoples perceive themselves as being an integral part of the environment
SU Chemical sciences	Natural and processed materials have a range of physical properties that can influence their use (ACSSU074)	<ul style="list-style-type: none"> considering how Aboriginal and Torres Strait Islander Peoples use natural and processed materials for different purposes, such as tools, clothing and shelter, based on their properties
SU Chemical sciences	Natural and processed materials have a range of physical properties that can influence their use (ACSSU074)	<ul style="list-style-type: none"> considering how Aboriginal and Torres Strait Islander Peoples' knowledge of natural and processed materials informs the preparation of effective, vibrant and long-lasting paints
SU Earth and space sciences	Earth's surface changes over time as a result of natural processes and human activity (ACSSU075)	<ul style="list-style-type: none"> considering how Aboriginal and Torres Strait Islander Peoples' fire management practices over tens of thousands of years have changed the distribution of flora and fauna in most regions of Australia
SU Physical sciences	Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076)	<ul style="list-style-type: none"> investigating the effect of contact and non-contact forces on the movement of objects in traditional Aboriginal and Torres Strait Islander children's instructive toys and games
SHE Nature and development of science	Science involves making predictions and describing patterns and relationships (ACSHE061)	<ul style="list-style-type: none"> considering how scientific practices such as sorting, classification and estimation are used by Aboriginal and Torres Strait Islander Peoples in everyday life
SIS Questioning and predicting	With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (ACSIS064)	<ul style="list-style-type: none"> acknowledging and using information from Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions regarding life cycles



Year 5

In Year 5 Science, students are introduced to cause and effect relationships through an exploration of adaptations of living things and how this links to form and function. They explore observable phenomena associated with light and begin to appreciate that phenomena have sets of characteristic behaviours. They broaden their classification of matter to include gases and begin to see how matter structures the world around them. Students consider Earth as a component within a solar system and use models for investigating systems at astronomical scales. Students begin to identify stable and dynamic aspects of systems, and learn how to look for patterns and relationships between components of systems. They develop explanations for the patterns they observe.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' knowledge of the adaptations of certain species and how those adaptations can be exploited
SU Chemical sciences	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)	<ul style="list-style-type: none"> recognising Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of evaporation and how the effect of evaporation can be reduced to conserve water, such as by covering surfaces
SU Chemical sciences	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)	<ul style="list-style-type: none"> recognising Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of solids, liquids and gases
SU Earth and space sciences	The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)	<ul style="list-style-type: none"> researching Aboriginal and Torres Strait Islander Peoples' understanding of the night sky and its use for timekeeping purposes as evidenced in oral cultural records, petroglyphs, paintings and stone arrangements
SU Physical sciences	Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)	<ul style="list-style-type: none"> recognising Aboriginal and Torres Strait Islander Peoples' understanding of refraction as experienced in spear fishing and in shimmering body paint, and of absorption and reflection as evidenced by material selected for construction of housing
SHE Use and influence of science	Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples' traditional ecological and zoological knowledge informs sustainable harvesting practices of certain species, such as dugongs and turtles
SHE Use and influence of science	Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)	<ul style="list-style-type: none"> investigating how Torres Strait Islander Peoples and Aboriginal Peoples of arid regions of Australia use scientific knowledge to manage precious water resources
SHE Nature and development of science	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)	<ul style="list-style-type: none"> learning how Aboriginal and Torres Strait Islander Peoples use observation of the night sky to assist with navigation
SIS Planning and conducting	Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)	<ul style="list-style-type: none"> consulting with Aboriginal and Torres Strait Islander Peoples to guide the planning of scientific investigations, considering potential risks for field investigations
SIS Communicating	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)	<ul style="list-style-type: none"> acknowledging and exploring Aboriginal and Torres Strait Islander Peoples' ways of representing and communicating information about anatomical features, including structural adaptations
SIS Questioning and predicting	With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)	<ul style="list-style-type: none"> acknowledging and using information from Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions about adaptations



Year 6

In Year 6 Science, students explore how changes can be classified in different ways. They learn about transfer and transformations of electricity, and continue to develop an understanding of energy flows through systems. They link their experiences of electric circuits as a system at one scale to generation of electricity from a variety of sources at another scale and begin to see links between these systems. They develop a view of Earth as a dynamic system, in which changes in one aspect of the system impact on other aspects; similarly, they see that the growth and survival of living things are dependent on matter and energy flows within a larger system. Students begin to see the role of variables in measuring changes and the value of accuracy in these measurements. They learn how to look for patterns and to use these to identify and explain relationships by drawing on evidence.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of the physical conditions necessary for the survival of certain plants and animals in the environment
SU Chemical sciences	Changes to materials can be reversible or irreversible (ACSSU095)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' knowledge of reversible processes, such as the application of adhesives, and of irreversible processes, such as the use of fuels for torches
SU Earth and space sciences	Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096)	<ul style="list-style-type: none"> researching Aboriginal and Torres Strait Islander Peoples' cultural stories that provide evidence of geological events
SHE Nature and development of science	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples test predictions and gather data in the development of technologies and processes
SHE Use and influence of science	Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)	<ul style="list-style-type: none"> discussing how modern approaches to fire ecology in Australia are being informed by Aboriginal and Torres Strait Islander Peoples' traditional ecological knowledge and fire management practices
SHE Nature and development of science	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)	<ul style="list-style-type: none"> learning how Aboriginal and Torres Strait Islander Peoples' knowledge, such as the medicinal and nutritional properties of Australian plants, is being used as part of the evidence base for scientific advances
SIS Questioning and predicting	With guidance, pose clarifying questions and make predictions about scientific investigations (AC SIS232)	<ul style="list-style-type: none"> consulting with Aboriginal and Torres Strait Islander Peoples to clarify investigable questions based upon their traditional ecological knowledge, such as predictions regarding the impact of invasive species



Year 7

In Year 7 Science, students explore the diversity of life on Earth and continue to develop their understanding of the role of classification in ordering and organising information. They use and develop models such as food chains, food webs and the water cycle to represent and analyse the flow of energy and matter through ecosystems and explore the impact of changing components within these systems. They consider the interaction between multiple forces when explaining changes in an object's motion. They explore the notion of renewable and non-renewable resources and consider how this classification depends on the timescale considered. They investigate relationships in the Earth-sun-moon system and use models to predict and explain events. Students make accurate measurements and control variables to analyse relationships between system components. They explore and explain these relationships through appropriate representations and consider the role of science in decision making processes.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Classification helps organise the diverse group of organisms (ACSSU111)	<ul style="list-style-type: none"> investigating classification systems used by Aboriginal and Torres Strait Islander Peoples and how they differ with respect to approach and purpose from those used by contemporary science
SU Biological sciences	Interactions between organisms, including the effects of human activities can be represented by food chains and food webs (ACSSU112)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' responses to the disruptive interactions of invasive species and their effect on important food webs that many communities are a part of, and depend on, for produce and medicine
SU Chemical sciences	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)	<ul style="list-style-type: none"> investigating separation techniques used by Aboriginal and Torres Strait Islander Peoples, such as hand picking, sieving, winnowing, yandying, filtering, cold pressing and steam distilling
SU Earth and space sciences	Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)	<ul style="list-style-type: none"> researching Aboriginal and Torres Strait Islander Peoples' oral traditions and cultural recordings of solar and lunar eclipses and investigating similarities and differences with contemporary understandings of such phenomena
SU Earth and space sciences	Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)	<ul style="list-style-type: none"> researching knowledges held by Aboriginal and Torres Strait Islander Peoples regarding the phases of the moon and the connection between the lunar cycle and ocean tides
SU Earth and space sciences	Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' calendars and how they are used to predict seasonal changes
SU Earth and space sciences	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable (ACSSU116)	<ul style="list-style-type: none"> exploring Aboriginal and Torres Strait Islander Peoples' connections with, and valuing of, water and water resource management
SU Physical sciences	Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)	<ul style="list-style-type: none"> investigating the effect of forces through the application of simple machines, such as the bow and arrows used by Torres Strait Islander Peoples or the spear throwers used by Aboriginal Peoples

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SHE Nature and development of science	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119)	<ul style="list-style-type: none"> investigating the contributions of Aboriginal and Torres Strait Islander Peoples' knowledge in the identification of medicinal and endemic plants
SHE Use and influence of science	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)	<ul style="list-style-type: none"> researching the development of commercial products that are founded on the traditional knowledge and practices of Aboriginal and Torres Strait Islander Peoples and discussing related ethical considerations associated with bio-piracy and intellectual property rights
SHE Nature and development of science	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223)	<ul style="list-style-type: none"> investigating how land management practices of Aboriginal and Torres Strait Islander Peoples informs contemporary management of the environment to protect biodiversity
SHE Use and influence of science	People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)	<ul style="list-style-type: none"> investigating how the knowledge and experience of Aboriginal and Torres Strait Islander Peoples are being used to inform scientific decisions, such as the care of Country/Place
SIS Planning and conducting	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander Peoples in planning scientific investigations, and seeking guidance regarding culturally sensitive locations during fieldwork
SIS Planning and conducting	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)	<ul style="list-style-type: none"> consulting with Aboriginal and Torres Strait Islander land councils in planning scientific investigations, and seeking guidance regarding land access rights
SIS Planning and conducting	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander communities and organisations to conduct research investigations about ecosystems, ensuring mutually beneficial outcomes
SIS Processing and analysing data and information	Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)	<ul style="list-style-type: none"> acknowledging, analysing and interpreting data and information from Aboriginal and Torres Strait Islander Peoples' understandings of Earth's systems and cycles
SIS Processing and analysing data and information	Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander Peoples in the production of calendars that demonstrate seasonal patterns and relationships using digital technologies



Year 8

In Year 8 Science, students are introduced to cells as microscopic structures that explain macroscopic properties of living systems. They link form and function at a cellular level and explore the organisation of body systems in terms of flows of matter between interdependent organs. Similarly, they explore changes in matter at a particle level, and distinguish between chemical and physical change. They begin to classify different forms of energy, and describe the role of energy in causing change in systems, including the role of heat and kinetic energy in the rock cycle. Students use experimentation to isolate relationships between components in systems and explain these relationships through increasingly complex representations. They make predictions and propose explanations, drawing on evidence to support their views while considering other points of view.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Chemical sciences	Chemical change involves substances reacting to form new substances (ACSSU225)	<ul style="list-style-type: none"> investigating chemical reactions employed by Aboriginal and Torres Strait Islander Peoples in the production of substances such as quicklime, plaster, pigments, acids, salts and ethanol
SU Earth and space sciences	Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)	<ul style="list-style-type: none"> exploring the traditional geological knowledge of Aboriginal and Torres Strait Islander Peoples that is used in the selection of different rock types for different purposes
SU Physical sciences	Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems (ACSSU155)	<ul style="list-style-type: none"> investigating traditional fire-starting methods used by Aboriginal and Torres Strait Islander Peoples and their understanding of the transformation of energy
SHE Nature and development of science	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE226)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples connect knowledge from the disciplines of physics, chemistry, biology and geology in the development of material culture
SHE Nature and development of science	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE226)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples employ knowledge from the disciplines of chemistry, biology, physics and geology in their development of pigments and dyes
SHE Use and influence of science	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)	<ul style="list-style-type: none"> investigating use of sustainable technologies to deliver basic services in remote Aboriginal and Torres Strait Islander communities and considering ethical implications of these
SHE Use and influence of science	People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples used scientific understandings of complex ecological relationships to develop specific fire-based agricultural practices
SIS Planning and conducting	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (AC SIS140)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander Peoples in the planning of scientific investigations, including considerations of heritage sites and artefacts



Year 9

In Year 9 Science, students consider the operation of systems at a range of scales. They explore ways in which the human body as a system responds to its external environment and the interdependencies between biotic and abiotic components of ecosystems. They are introduced to the notion of the atom as a system of protons, electrons and neutrons, and how this system can change through nuclear decay. They learn that matter can be rearranged through chemical change and that these changes play an important role in many systems. They are introduced to the concept of the conservation of matter and begin to develop a more sophisticated view of energy transfer. They begin to apply their understanding of energy and forces to global systems such as continental movement.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)	<ul style="list-style-type: none"> investigating the interdependence of communities and the role of Aboriginal and Torres Strait Islander Peoples in maintaining their environment
SU Chemical sciences	All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177)	<ul style="list-style-type: none"> investigating how radiocarbon and other dating methods have been used to establish that Aboriginal Peoples have been present on the Australian continent for more than 60,000 years
SU Chemical sciences	Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (ACSSU179)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples use fire-mediated chemical reactions to facilitate energy and nutrient transfer in ecosystems through the practice of firestick farming
SU Physical sciences	Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)	<ul style="list-style-type: none"> investigating the impact of material selection on the transfer of sound energy in Aboriginal and Torres Strait Islander Peoples' traditional musical, hunting and communication instruments
SU Physical sciences	Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)	<ul style="list-style-type: none"> investigating aspects of heat transfer and conservation in the design of Aboriginal and Torres Strait Islander Peoples' bedding and clothing in the various climatic regions of Australia
SHE Nature and development of science	Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE157)	<ul style="list-style-type: none"> investigating how fire research has evaluated the effects of traditional Aboriginal and Torres Strait Islander Peoples fire regimes and how these findings have influenced fire management policy throughout Australia
SHE Nature and development of science	Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158)	<ul style="list-style-type: none"> researching how technological advances in monitoring greenhouse gas emissions and other environmental factors have contributed to the reinstatement of traditional fire management practices as a strategy to reduce atmospheric pollution
SHE Use and influence of science	People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE160)	<ul style="list-style-type: none"> considering how the traditional ecological knowledge of Aboriginal and Torres Strait Islander Peoples is being reaffirmed by modern science and how this is generating new career opportunities in the field of restorative ecology



STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SHE Use and influence of science	Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)	<ul style="list-style-type: none"> researching how Torres Strait Islander Peoples are at the forefront of the development of scientific measures to prevent the transfer of certain infectious diseases and pests to the Australian continent
SIS Processing and analysing data and information	Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)	<ul style="list-style-type: none"> consulting Aboriginal and Torres Strait Islander Peoples' histories and cultures that reveal scientific information about the past
SIS Communicating	Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)	<ul style="list-style-type: none"> acknowledging and exploring Aboriginal and Torres Strait Islander Peoples' ways of communicating their understanding of the internal systems of organisms
SIS Planning and conducting	Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)	<ul style="list-style-type: none"> acknowledging cultural heritage protection Acts as they relate to Aboriginal and Torres Strait Islander Peoples in planning field investigations
SIS Processing and analysing data and information	Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)	<ul style="list-style-type: none"> acknowledging and identifying the relationship between First Peoples' knowledges and contemporary science and the co-contributions in arriving at shared understanding when working "both-ways"
SIS Questioning and predicting	Formulate questions or hypotheses that can be investigated scientifically (ACSIS164)	<ul style="list-style-type: none"> acknowledging and using information from Aboriginal and Torres Strait Islander Peoples to hypothesise about fauna or flora distributions
SIS Questioning and predicting	Formulate questions or hypotheses that can be investigated scientifically (ACSIS164)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander Peoples to formulate questions and hypotheses that can be investigated scientifically regarding disrupted ecosystems



Year 10

In Year 10 Science, students explore systems at different scales and connect microscopic and macroscopic properties to explain phenomena. Students explore the biological, chemical, geological and physical evidence for different theories, such as the theories of natural selection and the Big Bang. Students develop their understanding of atomic theory to understand relationships within the periodic table. They understand that motion and forces are related by applying physical laws. They learn about the relationships between aspects of the living, physical and chemical world that are applied to systems on a local and global scale and this enables them to predict how changes will affect equilibrium within these systems.

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SU Biological sciences	Transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)	<ul style="list-style-type: none"> investigating Aboriginal and Torres Strait Islander Peoples' knowledge of heredity as evidenced by the strict adherence to kinship and family structures, especially marriage laws
SU Biological sciences	The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)	<ul style="list-style-type: none"> investigating some of the structural and physiological adaptations of Aboriginal and Torres Strait Islander Peoples to the Australian environment
SU Chemical sciences	Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187)	<ul style="list-style-type: none"> investigating some of the chemical reactions and methods employed by Aboriginal and Torres Strait Islander Peoples to convert toxic plants into edible food products
SU Earth and space sciences	The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (ACSSU188)	<ul style="list-style-type: none"> researching Aboriginal and Torres Strait Islander Peoples' knowledge of celestial bodies and explanations of the origin of the universe
SU Earth and space sciences	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere (ACSSU189)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples are reducing Australia's greenhouse gas emissions through the reinstatement of traditional fire management regimes
SU Physical sciences	The motion of objects can be described and predicted using the laws of physics (ACSSU229)	<ul style="list-style-type: none"> investigating how Aboriginal and Torres Strait Islander Peoples achieve an increase in velocity and subsequent impact force through the use of spear throwers and bows
SHE Use and influence of science	Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)	<ul style="list-style-type: none"> researching how the values of 19th and early 20th century Australian society, combined with scientific misconceptions about heredity and evolution, influenced policies and attitudes towards Aboriginal and Torres Strait Islander Peoples
SHE Nature and development of science	Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE191)	<ul style="list-style-type: none"> investigating how prior to germ theory Aboriginal and Torres Strait Islander Peoples used their scientific observations to develop traditional medicines to treat wounds and infections of the skin



Year 10

STRAND – SUB-STRAND	CONTENT DESCRIPTION	CROSS-CURRICULUM PRIORITY ELABORATION (NEW ELABORATIONS IN BLUE)
SHE Nature and development of science	Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries (ACSHE192)	<ul style="list-style-type: none"> researching how technological advances in dating methods of Aboriginal Peoples’ material culture are contributing to our understanding of the changing climatic conditions and human interaction with Australian megafauna
SHE Use and influence of science	People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities (ACSHE194)	<ul style="list-style-type: none"> considering how ecological sciences are recognising the efficacy of traditional ecological practices of Aboriginal and Torres Strait Islander Peoples and how restorative programs based on these practices are generating new career opportunities
SHE Use and influence of science	Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)	<ul style="list-style-type: none"> investigating how disease outbreaks and the emergence of drug-resistant infections have focused scientific research into Aboriginal and Torres Strait Islander Peoples’ traditional medicines to identify effective therapeutic compounds for the use in pharmaceuticals
SIS Planning and conducting	Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199)	<ul style="list-style-type: none"> collaborating with Aboriginal and Torres Strait Islander Peoples to explore the development of a commercial product based upon traditional ecological knowledge while addressing ethical issues
SIS Evaluating	Critically analyse the validity of information in primary and secondary sources, and evaluate the approaches used to solve problems (ACSIS206)	<ul style="list-style-type: none"> acknowledging the need to critically analyse scientific literature for potential cultural bias towards Aboriginal and Torres Strait Islander Peoples

**Foundation
to Year 6**



TEACHER BACKGROUND INFORMATION FOR FOUNDATION TO YEAR 6

Teacher background information

The teacher background information is provided to assist teachers in preparing culturally appropriate and scientifically rigorous classroom materials relevant to the topics suggested in the elaborations.

There is a teacher background information document for each elaboration. Each document contains a short paragraph that explains how the topic suggested by the elaboration connects to the curriculum content and how it emphasises the cross-curriculum priority. The subsequent section describes in detail the cultural significance of the topic and outlines the scientific concepts addressed in it. Each document finishes with a brief paragraph that summarises what students gain from studying the core science content using the context suggested by the elaboration. Each teacher background information also contains a list of consulted works that provides valuable additional information and deeper insights for the educator. Please note that some historical sources listed in the consulted works may contain language that is culturally offensive or inappropriate. These sources are not suitable to be used as classroom resources.

It should be emphasised that all the topics explored in the teacher background information documents focus only on those aspects of Aboriginal and Torres Strait Islander histories and cultures that overlap with the content of the Australian Curriculum: Science. As such, the given information is not meant to provide a complete review of the historical and cultural context of the topic investigated and may only be referring to one component or concept of a highly complex topic. A more complete understanding of the topic may be found through community consultation and further research.

The following section contains the teacher background information documents for Foundation to Year 6.



Foundation

Teacher background information



ACSSU002	Caring for Country
ACSSU005	Traditional instructive toys – teaching how movement is related to shape and size
ACSSU004	Seasonal indicators
ACSHE013	Observation skills used to gain resources

ACSSU002

Caring for Country

CONTENT DESCRIPTION

Living things have basic needs, including food and water.

CONTENT ELABORATION FOR CCP (OI.2, OI.3)

- ▶ recognising how Aboriginal and Torres Strait Islander Peoples care for living things



Transport and propagation of important plant species require understanding of how to care for living things

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long held understandings of the needs of living things, including the provision of vital resources such as food and water. For millennia, Aboriginal and Torres Strait Islander Peoples have sensitively cared for the living things in their Country or Place and have implemented sustainable practices to maintain environmental balance. Country and Place have immense spiritual and cultural significance for Aboriginal and Torres Strait Islander Peoples, and the plants and animals within the environment have long been tended to as part of Caring for Country responsibilities. This elaboration provides students with the opportunity to recognise that Aboriginal and Torres Strait Islander Peoples understand the basic needs of plants and animals and have long cared for the living things in their environment.

DETAIL

As the First Peoples of Australia, Aboriginal and Torres Strait Islander Peoples have established and maintained a shared living culture with their environment since time immemorial. Across Australia there exists a diverse range of climate and environmental conditions that influence the living things that are present in a particular Country or Place. Aboriginal and Torres Strait Islander Peoples' deep knowledges and understandings about the natural environment have been developed through astute observation over millennia, and environmental management practices ensure ecological balances are maintained. Intrinsic to this balance is an understanding of the basic needs and physical requirements of living things, including access to water and food that provides living things with vital nutrients.

Many plant and animal species are of crucial significance to Aboriginal and Torres Strait Islander Peoples, and they are cared for and protected to ensure they continue to thrive. Across Australia, there are locations of cultural and spiritual significance where Aboriginal and Torres Strait Islander communities gather at certain times; such places are immensely important for the Aboriginal and Torres Strait Islander Peoples connected with that Country. One such region is *Booburrgan Ngmmunge*, a traditional language name used by many Aboriginal Peoples to describe the Bunya Mountains region in southern Queensland. This place is of immeasurable cultural significance to the Wakka Wakka, Jarowair, Djaku-nde and Barrungam Peoples whose Country encompasses this area. *Booburrgan Ngmmunge* is also significant to many neighbouring Aboriginal Peoples from southern Queensland and northern New South Wales for whom the region holds important associations. The *bonye* (traditional Aboriginal name for the Bunya pine; *Araucaria bidwillii*) dominates the landscape in this region and is endemic to Queensland. The *bonye* is an example of a plant that has particular significance to the Aboriginal Peoples of *Booburrgan Ngmmunge*. The trees are treated with great respect, cared for and protected by customary and cultural protocols, to ensure that they continue to thrive. Some of the *bonye* trees belong to particular family or clan groups who have the responsibility to protect the resources and environment. The *bonye* produces large ovoid-shaped

cones that can weigh up to ten kilograms; each cone contains 60 or more highly nutritious seeds, rich in oils and carbohydrates. The cones ripen in an annual seasonal cycle, with bumper crops occurring approximately every three years. In anticipation of the three-year cycle that brings an abundance of seeds, special envoys sent by the custodians of the *bonye* carry message sticks to neighbouring communities to invite particular groups to attend the seasonal gathering. This is timed for when the seeds ripen and are ready for harvest. Thousands of Aboriginal Peoples travel great distances to attend the Bunya Gathering, trade goods and knowledges, share stories, songs and dances, conduct business, attend to personal matters, and feast on the abundant *bonye* seeds.

Aboriginal Peoples have long intentionally transported and nurtured plants to propagate new areas and increase their range and abundance. The *bonye* is only found abundantly in one other geographical region in northern Queensland. It has been suggested that this population was purposefully propagated by the Atherton rainforest Peoples. Current research is endeavouring to determine, through genetic analysis, whether the *boyne* nuts were carefully transported and planted 1500 kilometres north. If proven, the successful establishment of the population in north Queensland would only have occurred through deep understanding of the basic growing requirements of the *bonye*. Over millennia, the cultural responsibility held by Traditional Custodians of the *bonye* has ensured that the trees and the surrounding environment are cared for and continue to thrive.

There are many animal species that are of significance to Aboriginal and Torres Strait Islander Peoples. For many thousands of years, native animals such as dingoes, kangaroos, lizards, and emu and cassowary chicks have been tamed; their basic needs, including specific food requirements and living conditions, are well understood and provided for by the community. Dingoes have long been tamed and cared for by a community in a manner similar to dogs being kept as family pets today. Aboriginal Peoples acquired dingo pups from dens during whelping season and they were hand reared by the community. The Yankunytjatjara Peoples of north-west South Australia and the Ngukurr Peoples of south-eastern Arnhem Land bestow names on many of the tamed dingoes and incorporate the animals into kinship systems. Tamed animals are cared for by ensuring basic needs are met, such as the provision of food, water and shelter. It has been reported that dingoes were also kept by some Peoples of the Torres Strait Islands.

Tamed dingoes served many purposes for a community. The dingoes tamed by the Warlpiri Peoples of the Northern Territory accompanied hunting parties to aid in tracking and capturing animals. As territorial animals, dingoes also served as protectors for a community, patrolling the perimeter of a place of residence and alerting their owners of approaching visitors. Prior to colonisation, tamed dingoes also provided warmth to assist in maintaining body temperature in cool climates. For animals to provide warmth they were required to be raised from pups to ensure the absence of fear and aggression. Tamed dingoes were sometimes carried around a person's neck for warmth and were described by early colonists as walking blankets or living shawls. The animals also often slept with their owners, sharing shelters or a place by a fire to provide warmth through body heat. The taming of dingoes for many purposes, paralleled in some ways by contemporary pet ownership,

demonstrates Aboriginal Peoples' deep care for living things and an understanding of the basic needs of animals, including food, water, shelter and warmth.

Many living things including particular plants and animals have immense cultural significance to Aboriginal and Torres Strait Islander Peoples, and have been cared for over millennia. Living things have basic needs, such as food and water, and Aboriginal and Torres Strait Islander Peoples have long ensured the basic needs of living things are met, for continuation of the organism. This elaboration provides students with the opportunity to recognise that Aboriginal and Torres Strait Islander Peoples have long cared for the living things in their environment, including culturally significant species such as the *bonye* (Bunya pine) and the dingo.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU005

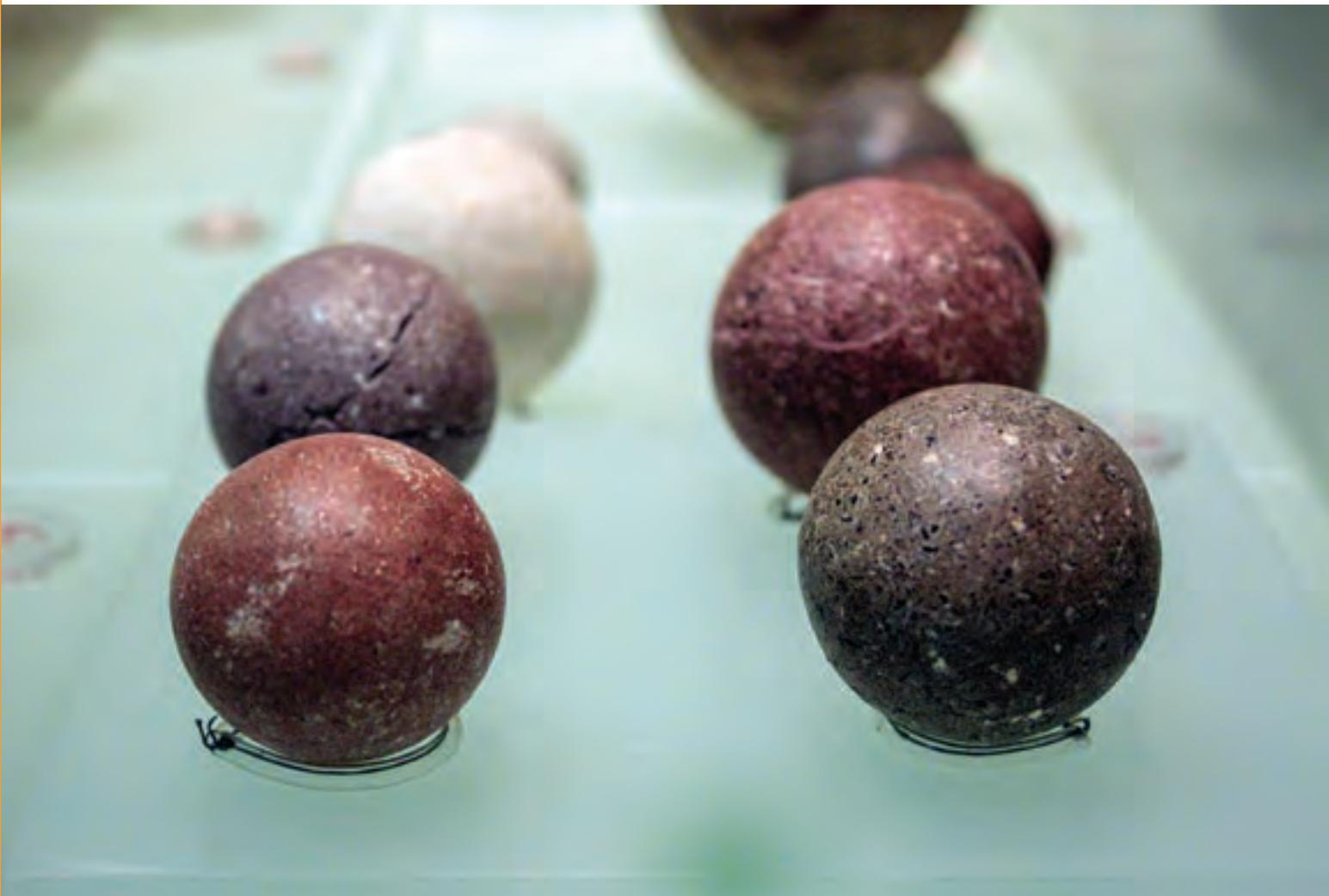
Traditional instructive toys – teaching how movement is related to shape and size

CONTENT DESCRIPTION

The way objects move depends on a variety of factors, including their size and shape.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ exploring how the size and shape of traditional instructive toys used by Aboriginal and Torres Strait Islander Peoples influence their movement



Toys have long been manufactured to teach many lessons, including how size and shape influence movement

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long used instructional devices and models as play-based learning objects. Instructive toys are objects of play, mostly designed for children, that stimulate learning by promoting the development of a specific skill or providing play experiences to learn about a particular subject. Instructional toys may be simplified or miniaturised versions of objects used by adults or model the activities and practices of adults. Aboriginal and Torres Strait Islander Peoples have long manufactured and utilised instructive toys to teach children about how movement is influenced by size and shape. This elaboration provides students with the opportunity to explore how the size and shape of instructive toys, constructed and used by Aboriginal and Torres Strait Islander Peoples, can influence their movement.

DETAIL

For millennia, Aboriginal and Torres Strait Islander Peoples have used instructive toys and games as educational devices and models to stimulate and achieve learning in young people. Children's games and activities have long provided a context for acquiring knowledge, understanding, and the development of skills required in later life. The size and shape of instructive toys impacts the way the object moves; this has long been understood and considered by Aboriginal and Torres Strait Islander Peoples in the design and construction of instructive toys. In the construction of objects such as balls, size and shape are critical in achieving the desired rolling or sliding movements. Size and shape have long been a consideration in the construction of objects such as miniaturised spears and boomerangs, as these factors affect their movement. The size and shape of instructive toys may be modified as a child develops a particular skill, to make a game more challenging and ensure that the skill continues to develop.

The game *juluhya* (Bundjalung Language; that translates to “to go down” in English) is a rolling game; it is played by Bundjalung children of the coastal region on the border of Queensland and New South Wales. A long, cylindrical tube is crafted from sheets of bark. The game involves rolling small, round pebbles, previously collected by the children, through the tube. The winner of the game is the owner of the stone that rolls fastest through the tube, appearing first at the opposite end. The shape, size and weight of a pebble must be carefully considered; a rounded pebble rolls faster, and the size and weight of a pebble impact its speed through the tube.

A variety of Aboriginal and Torres Strait Islander Peoples' games are designed to develop skills such as aim and coordination; spears and a target are manufactured to suit the child's size and ability. The Pitjantjatjara Peoples of the central desert are known to manufacture toy spears from the long stems of bushes and a target from bark. The beginner's disc is circular in shape, as this rolls smoothly along the ground. The players divide into two groups and the disc is rolled between the groups; as the disc passes, each group in turn tries to spear the moving target. Variations in the size and shape of the disc are made in many regions of Australia to make the game more challenging. A disc carved in an

irregular shape causes it to wobble and roll less predictably, thus requiring greater skill to accurately hit the moving target. The Ngarinjin Peoples of the Kimberley region in Western Australia carved discs as small as 11 centimetres in diameter to challenge more skilful spear throwers. A further element of difficulty is added to the game by using an elliptical shaped target that bounces or hops as it rolls along the ground.

The Meriam Peoples of Mer Island in the Torres Strait construct *kolap*, a spinning top made from volcanic tuff, for competitions to determine which top can spin for the longest time. The spinning tops are carefully manufactured and take a considerable amount of time to complete. First, the selected stone is chipped into a roughly circular shape using another piece of stone, and then the surface is ground down until smooth. Shaping continues until the upper surface of the top is flat, the underneath is slightly convex, and a sharp central edge is achieved. The shape of the spinning top is vital to maintain balance when spinning, as an unevenly crafted disc will only spin a few revolutions before it comes to a standstill. The shape of stones is also important in skimming games where stones are thrown in a manner that makes them skip across the surface of a body of water. Aboriginal and Torres Strait Islander children have long selected flattened stones for skimming games, as these are more easily thrown to skip across a smooth water surface. The importance of the shape of an object for skimming games is well understood, as evidenced by the Bandjin and Djiru children of Dunk Island in north Queensland who use the flat bone of the *krooghar* (cuttlefish) for this game. The *krooghar* can skim a great distance across the surface of the water due to its regular elongated, oval shape.

Many Aboriginal and Torres Strait Islander Peoples' instructional games and objects involve airborne toys that whirl or fly in the air. Size and shape affect the aerodynamic qualities of manufactured objects such as boomerangs and propellers, and of natural forms such as leaves. Leaf casting, where leaves float on the hot air currents from a fire, has been recorded in many parts of central Australia, Queensland and New South Wales. The Jangga Peoples of the central Queensland region play a game called *bindjhera* using leaves from the *Acacia* tree folded into boomerang shapes. The leaves are set into motion over the rising air current from a fire, and once the leaves are beyond air current, the folded shape causes the leaves to spin and spiral back to the ground. The Gamilaraay Peoples of northern New South Wales and southern Queensland play a leaf casting game by the fireside known as *wimberoo*. A dry leaf from the coolabah tree (*Eucalyptus coolabah*) is selected and warmed so that it can be slightly bent. The aim of the game is to set the leaves airborne over the hot air currents of a fire and determine whose leaf will go the highest. The curved shape of the leaf is important in such games as it affects the movement of the leaves in the air current.

Other propeller devices are constructed to whirl or travel through the air. The Biyaygiri and Djiru Peoples of the north Queensland coastal region construct propeller and aeroplane devices from the leaves of *Pandanus* spp. palms. The shape of the propeller whirled in the air either at the end of a spindle, like a windmill, or set in motion by dropping from a height so that it spirals to the ground.

A *piar-piar* is carefully constructed by folding and interlocking four strips of *Pandanus* spp. leaf into a Z-shape. When thrown, the shape of this aerodynamic instructional toy travels through the air in a pattern similar to a returning boomerang. Miniaturised wooden boomerangs are used by children in games to develop aim and accuracy when setting the implement in motion. The shape of the instructive device, and the way it is set in motion, determines the path the object takes through the air. Curved toy boomerangs travel on an elliptical path; the degree of the central angle of the boomerang affects the flight path of the object. The Gulngai Peoples of the Tully River region in Queensland constructed cross-shaped toy boomerangs that travelled in a more circular flight path. Young children constructed an imitation cross-shaped boomerang from thick swamp grass that is tied or plaited together. Thrown into the air with a flick of the wrist, it spirals through the air and back to the owner.

For many thousands of years, instructive toys and games have been an essential means to develop the skills that children will need in adult life. The size and shape of the objects used for these purposes has long been carefully considered in their construction. Many devices, such as the spinning tops of the Torres Strait Islander Peoples, require painstaking precision for optimal movement. From an early age, Aboriginal and Torres Strait Islander children consider the size and shape of objects, such as balls and stones, in educational game play; the size and shape of the object will impact its motion. This elaboration provides students with the opportunity to explore how the size and shape of instructive toys used by Aboriginal and Torres Strait Islander Peoples affects movement.

CONSULTED WORKS

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ACSSU004

Seasonal indicators

CONTENT DESCRIPTION

Daily and seasonal changes in our environment affect everyday life.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ learning how Aboriginal and Torres Strait Islander Peoples' concepts of time and weather patterns explain how things happen in the world around them



The Gundejihmi Peoples knew the arrival of afternoon storms signalled the time to move to stone Country for shelter

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have observed the daily and seasonal weather patterns in the world around them for millennia and used these phenomena to inform aspects of daily life. Many thousands of years of unbroken meteorological observations have resulted in a deep understanding of environmental changes that form a predictable annual cycle. Weather patterns have an impact on everyday life activities; daily and seasonal changes affect when and where to travel, clothing choices and the type of shelter required. This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples have long used meteorological events such as temperature, precipitation, wind and humidity, to explain the world around them and inform aspects of daily life.

DETAIL

The geographical vastness of Australia means that daily and seasonal changes can vary significantly across the Australian continent and seasonal cycles differ substantially depending on location. The diversity of seasons and seasonal indicators such as weather events is evidenced in the ecological (seasonal) calendars of many Aboriginal and Torres Strait Islander Language Groups. For example, the seasonal calendar of the Miriwoong Peoples whose Country encompasses the east Kimberley region of Western Australia and extends into the Northern Territory comprises three seasons, whereas the seasonal calendar of the D'harawal Peoples of the region north of Sydney encompasses six seasons. Aboriginal and Torres Strait Islander Peoples have a deep scientific understanding of the complexities and interrelationships between seasonal, meteorological and astronomical changes and have long used observations of these changes to inform life in a particular Country or Place. These changes contain important information that influences when to travel to particular locations to access and harvest resources and the times to prepare clothing and shelters appropriate for impending weather or seasonal change.

Weather indicators have long been used by Aboriginal and Torres Strait Islander Peoples as signs of resource availability. Often, travel to a particular geographical region for a period of time was necessary to access a resource while it was abundant. The Djab Wurrung and the Jardwadjali Peoples of the Grampians region in Victoria know that hot, dry weather indicates *kooyang*, the time of the eel season. Prior to colonisation, stone huts were occupied during eel harvest time to provide relief from the heat of the sun. The Nyangumarta People of the north-western coast of Western Australia understand that the cold south-east winds indicate the time that threadfin are running. The Erubam Le Peoples of Erub Island in the Torres Strait observe the sky for the rapid appearance and disappearance of *lid lid* (small clouds); these clouds indicate the end of the monsoon season, the time when turtles and frigate birds are plentiful, and sorbi (*Syzygium branderhorstii*) and mangos are ready for harvest. The 'morning glory' cloud is a rare meteorological phenomenon that occurs at predictable times; it only appears in the Gulf of Carpentaria due to the configuration of land and

sea. This cloud pattern, observed by Aboriginal Peoples of the region for millennia, is associated with seasonal changes. The Yanyuwa Peoples of the Sir Edward Pellew Group of Islands in the Gulf of Carpentaria know that the morning glory clouds indicate the beginning of the wet season. They also mark the arrival of flying foxes, the Torres Strait pigeon, various species of parrots, and the time when seagulls and sea turtles lay their eggs in the sand. The Kaiadilt Peoples of the South Wellesley Islands in north-west Queensland know that *kambudanda*, the north wind, indicates that the Pandanus fruit is ripe and will fall with the onset of the winds.

Weather indicators also provide information about the type of shelter that will be required or when to time movement to a particular part of the Country due to impending seasonal conditions. The Wardaman Peoples of the Katherine region in the Northern Territory know that *yijilg* (wet season, December–January) brings heavy rainfall. Prior to colonisation, the Wardaman Peoples constructed rain shelters that were covered with *wolon* (spear grass; *Heteropogon contortus*), to provide protection from rainfall. The Masigalgal Peoples of Masig (known as Yorke Island in English) in the Torres Strait know that *naigai*, the season of hot dry weather and calm winds, is the time for house maintenance in readiness for the coming wet season. At this time, knowing that rainfall is coming, gardens are also prepared by burning plant litter and fertilizing the soil with the ashes. The Peoples of the Gundjeihmi Language Group in the Kakadu region of the Northern Territory look to the late afternoon storm clouds during *gunumeleng* to know when to move from the floodplains to the stone country, to shelter from the coming monsoon.

Prior to colonisation, clothing was manufactured to suit environmental conditions; consequently, it varied greatly across the Australian continent. The daily and seasonal temperature and precipitation level informed the wearer of the most suitable clothing for that time of year. The Kurna Peoples of the Adelaide Plains region of South Australia know that *pukarra* (north-west winds) and *kudmu* (dew on the ground) indicates the time to prepare skin rugs and seaweed cloaks for the impending cold weather season. In wet weather, the Wiradjuri Peoples of central New South Wales wore animal furs with the fur side facing outwards, as this orientation protected the wearer from rainwater. In cool, dry weather the Gunditjmara Peoples of western Victoria wore possum furs with the fur side facing inwards, as this orientation provided thermal insulation through warm air trapped between the fibres. The Noongar Peoples of south-west Western Australia manufactured *buka*, kangaroo skin cloaks; in *makaru*, the coldest and wettest time of the year, these were also worn with the fur side facing inwards for warmth. The D'harawal Peoples of the southern Sydney region know at the time of *marrai'gang*, the cool, wet weather, it is time to make or repair cloaks for warmth, and to begin the travel to the coastal areas.

For millennia, Aboriginal and Torres Strait Islander Peoples have used weather patterns associated with daily and seasonal changes to inform aspects of daily life. Knowing when rainfall is imminent or cold weather is approaching provides information about the type of shelter required or the clothing that needs to be worn or manufactured. Such weather indicators, including wind and cloud presence, have long been monitored by Aboriginal and Torres Strait Islander Peoples so that appropriate

preparations can be made. Annual weather patterns indicated by meteorological phenomena such as the strength and direction of wind, the type of cloud, and temperature, have long been correlated with seasonal events. Seasonal patterns, and the important environmental changes that accompany these events, inform many aspects of everyday life, including when and where resources can be accessed. This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples' knowledge of weather patterns in daily and seasonal cycles has long been used to understand changes in the environment and inform aspects of daily life.

CONSULTED WORKS

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ACSHE013

Observation skills used to gain resources

CONTENT DESCRIPTION

Science involves observing, asking questions about, and describing changes in, objects and events.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ recognising how Aboriginal and Torres Strait Islander Peoples gain knowledge about the land and its vital resources, such as water and food, through observation



Important resources such as turtle eggs are located through astute observation

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have worked scientifically for millennia to gain knowledge about the land and vital resources, such as water and food. The wealth of environmental knowledge held by Aboriginal and Torres Strait Islander Peoples is a result of continuous observations of the environment, noticing changes that have occurred, asking questions, and documenting and preserving knowledges and understandings. These knowledges and understandings have long informed how to access and sustainably manage important natural resources. Astute observations of the environment provide important information: the location of water sources, particularly in times of drought or in arid parts of Australia when water is limited, and the availability of natural resources that provide food, medicines and matter for material culture. This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples have vast knowledges about the land and its vital resources that have developed through many thousands of years of observations.

DETAIL

Aboriginal and Torres Strait Islander Peoples have made detailed observations of their Country or Place for many thousands of years, resulting in a wealth of knowledge and understanding about the intricate interrelationships within the environment. Observations of changes within the environment lead to scientific questioning to understand the reason and impact for the change. Accessing vital resources, such as water and food, requires careful observation of the environment to notice when changes occur; some changes have special significance as they may indicate when particular resources become available. As well as obvious waterbodies in an environment, there are many other signs that can indicate the presence of water, such as the presence of particular plant and animal life, behaviours of animals that can lead to a water source, discolouration of bark on trees, bulging of tree trunks or roots, and the colour and texture of soil. Careful observation of the often subtle changes in an environment can also indicate the availability of important food resources; changes in fruit colour can indicate ripeness, animal size can indicate suitability for consumption, and tracks and prints can indicate the presence of a particular organism. Aboriginal and Torres Strait Islander Peoples have observed the environment for millennia, making detailed records and questioning changes, to build a deep understanding of when and how to access vital resources.

Fresh water is a necessity for human life and knowing how and where to find water is crucial to survival. In times of drought, in arid parts of Australia or while travelling in unfamiliar environments, water can be a scarce resource. Over millennia, Aboriginal and Torres Strait Islander Peoples' astute observations have resulted in a deep understanding of indicators of the presence of water. The presence of specific plants has long indicated the likely presence of a nearby water source. The Gugadja Peoples of the eastern Great Sandy Desert region in Western Australia know that the presence of *yiliyili* (Queensland bluebush; *Chenopodium auricomum*) can indicate the nearby

presence of drinking water. *Yiliyili* is a low growing shrub that grows on swamp floors, in clay pans or at the fringe of lakes, hence its presence is often localised with an ephemeral water source. The Kaiadilt Peoples of the South Wellesley Islands in the Gulf of Carpentaria in Queensland use the presence of recurring groups of sheoak trees (*Casuarina* spp.), along the coast of Bentinck Island, to identify the location where small seeps of fresh water come out of the sand near the tide margin. It has also been recorded that in the vicinity of Mapoon on the western Cape York Peninsula of Queensland, clumps of *Pandanus* spp. have been used as an indicator of underground water. An excavation of the ground where *Pandanus* spp. is plentiful is used to confirm the presence of an underground water source.

Changes to the usual appearance of particular plants can also indicate a water source, and such observations and knowledges have long been used by Aboriginal and Torres Strait Islander Peoples to locate drinking water. For example, many Aboriginal Peoples of the far north Queensland region carefully observe the tea trees (*Melaleuca* spp.) for changes on the trunk that can indicate water under the bark. The circumference of the trunk of the tea tree usually appears to be roughly circular; however, at times lateral bulges in the trunk can be observed. Girramay Elder Claude Beeron, of Far North Queensland, explained that the distended swellings are a known water source that can be accessed when needed, such as during dry weather and when travelling. The Whadjuk Peoples of south-west Western Australia can locate water in *Eucalyptus* spp. trees by observing the trunk discoloration that appears when water is present in a hollow under the bark. Water is tapped from the tree by creating a small hole that is closed again once the water has been accessed.

The roots of some species of tree are also reliable sources of water; careful observation of plants can identify the correct species and examination of the ground can reveal where to dig. The Ngarkat Peoples, east of the Murray River region in South Australia, accessed water from the roots of mallee (*Eucalyptus* spp.) while in the semi-arid region of southern Australia water can be obtained from the roots of both *Eucalyptus* spp. and *Hakea leucoptera*. To obtain water from roots the ground is carefully observed for cracks or bulges in the earth. At these points the roots are excavated from the ground, broken off near the trunk of the tree, and the water is either sucked directly from the root or drained into a container.

Careful observation can also reveal tree hollows where rainfall and dew can collect, another source of drinking water. Across the dry desert regions of the Northern Territory, South Australia and Western Australia, the desert sheoak (*Allocasuarina decaisneana*) is a plant known to often have a cavity, with a small opening, in a fork of the tree. Water trickles down the branches to the fork, through the hole and gathers in the cavity. The small opening through which the water drains makes the water inaccessible to birds and other wildlife, meaning that it is a clean source of fresh water. Aboriginal Peoples of the central desert regions carefully observe the desert sheoak trees to locate the small openings under which a volume of water may be stored. The knowledge that water can gather and be stored in tree hollows was exploited by the Darumbal Peoples of the Rockhampton region in central-east Queensland. It has been reported that the Darumbal Peoples carved hollows in bottle

trees (*Brachychiton rupestris*) to create artificial reservoirs so that an abundant supply of water was available when required.

Aboriginal and Torres Strait Islander Peoples carefully observed the presence and behaviour of animal species within a region as a means of identifying water sources. Birds such as the zebra finch and some species of pigeons are known to be never far from a fresh water source. Careful observation of these birds, in parts of Australia where water is scarce, can assist in determining whether water is present and in locating the source. The behaviour of ants moving in lines up and down the trunk of a tree can indicate a hidden store of water in the tree. Aboriginal Peoples have been reported to use this ant behaviour to locate stores of fresh water; water is recovered for human consumption by syphoning it from the hollow.

Aboriginal and Torres Strait Islander Peoples' astute observations and knowledge also inform the availability of food and the optimum time for harvest. In the Torres Strait Islands, careful observation of turtle tracks on sand banks and low islets indicates the location of turtle nests from which eggs can be collected. A female turtle emerges from the sea and trails up the sand to dig a nest in which her eggs are laid; she returns to the water taking a different route. Torres Strait Islander Peoples are experts in tracking turtles; the nest is located by the convergence of the tracks, and incoming or outgoing tracks can be determined by the sand direction when pushed by the turtle's flippers.

The fruit of Kangaroo Apple plant (*Solanum laciniatum*) is poisonous when unripe, but it is a nutritious food source once ripened. Many Aboriginal Peoples whose Country encompasses south-eastern parts of Australia, where the plant is found, know to observe the plant carefully and not harvest the fruit until they change from a yellow-green colour to a bright blood-orange colour. The Peoples of the Gundjeihmi Language Group in the Kakadu region of the Northern Territory know when the berries of *andjurrugumarlba* (native black currant) turn black that they are ripe and delicious.

Aboriginal Peoples whose Country encompasses the desert environments where honey ants can be found, including the Arrernte, Luritja and Pitjantjatjara Peoples, have long observed the environment to understand the relationship of the ants with trees and lerp insects. Such knowledge informs the accurate identification and location of the honey ant nests. The trees under which the honey ants nest can be identified by the characteristic lerps that form on the branches, and the nests are usually found on the shady side of the tree. Aboriginal Peoples who have observed and understand the behaviour of the honey ants know not to dig directly down from the top of the nest. Instead, digging from the side provides access to the underground chambers where the storage caste ants reside, and the ants can be harvested for their honey filled abdomens. Larvae of several native moth species are a highly nutritious food source that have long been sought after by Aboriginal Peoples. The Noongar Peoples of south-west Western Australia carefully observe the environment for the holes that the larvae bore in particular species of wattle or eucalyptus and the frass (fine, powdery saw dust) that collects underneath the hole. When the holes are located, the larvae can be collected for consumption. Similarly, the Pitta Pitta Peoples of the Boullia region in Queensland carefully observe

the environment for the presence of *kalorangoro* (large grubs) in trees that are collected and roasted on a fire before consumption.

This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples have made astute observations about the environment for millennia, asking questions and describing changes to build a wealth of knowledge and understanding about a Country or Place. This knowledge is crucial in knowing when, where and how to access vital resources including food and water. Detailed observations of the environment and changes that may occur have long been connected with particular events, such as where water sources may be located or when important food resources are ready for harvesting and safe for consumption. Students can learn how Aboriginal and Torres Strait Islander Peoples' continual observations of objects and events over many thousands of years have resulted in vast knowledges about the land and its vital resources.

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Year 1

Teacher background information



ACSSU017	Dance and other cultural practices that depict animals and their identifiable external features
ACSSU018	Science of everyday material changes – bending and twisting
ACSSU019	Knowledge of seasons – changes in weather and landscape
ACSSU020	Traditional musical instruments
ACSHE021	Knowledge of seasons – when to harvest
ACSHE022	Science of everyday material changes – sustainably sourcing materials
AC SIS029	Acknowledging local knowledge – whose tracks are whose?
AC SIS213	Consulting local knowledge – what made this track? Native or pest?

ACSSU017

Dance and other cultural practices that depict animals and their identifiable external features

CONTENT DESCRIPTION

Living things have a variety of external features.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ exploring how Aboriginal and Torres Strait Islander Peoples' observations of external features of living things are mimicked and replicated in traditional dance



The Urab dancers (Puruma Island, Torres Strait) represent the splaying crest of the sulphur-crested cockatoo

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For millennia Aboriginal and Torres Strait Islander Peoples have used story telling through song, dance, painting and music to preserve and transfer knowledges. Many Aboriginal and Torres Strait Islander Peoples' dances incorporate imitations of certain animals that communicate important information about its external features, characteristics and behaviours. Observations about living things in an environment provide important knowledges that facilitate the sustainable management of the environment including the animals and plants of a particular Country or Place. This elaboration provides students with the opportunity to explore how Aboriginal and Torres Strait Islander Peoples' observations of the external features of living things are mimicked and replicated in dance. Through these dances, the intended audience receives important scientific information about living things in the environment.

DETAIL

An important aspect of science is the recognition that living things have external features and some of these features may be distinctive or unique to a particular organism. Science uses these features for specific purposes, such as classification systems and the hierarchal organisation of organisms. Aboriginal and Torres Strait Islander Peoples have observed living organisms in their environment for millennia, particularly noting the external features of the organisms. Stories, songs, dances and paintings have long been a way in which Aboriginal and Torres Strait Islander Peoples document, preserve and communicate knowledges. Often, dance contains knowledges and information about the environment and the living things of that Country or Place, including important marine and terrestrial animals. Incorporating the external features, characteristics and behaviours of significant animals in Aboriginal and Torres Strait Islander Peoples' dance communicates and preserves the scientific knowledges and understandings about the organisms within an environment. These knowledges can be of vital importance to the community; many organisms can have highly dangerous external features while others provide important materials, such as for the construction of domestic implements.

The external features of birds and other winged organisms are depicted in the dance of Aboriginal and Torres Strait Islander Peoples. The brolga, whose name in English is derived from *burruga*, the Gamilaraay language term for the bird, is a large wetland crane, with a featherless red head, grey crown and long legs. It is an important cultural species to many Aboriginal and Torres Strait Islander Peoples whose Countries encompass brolga habitats, including tropical northern Australia, central Australia and along the east coast into south-west Victoria. Many Aboriginal Peoples, including the Numbulwar Peoples of the Nunggubuyu Language Group in the Gulf of Carpentaria in the Northern Territory, have documented the external features of the brolga in dance. The performers may be painted with grey and white ochres or wear costumes to mimic the feather colours of the brolga. A bright red stripe painted across the forehead or red fabric tied around the head is used to represent

the distinctive red head of the bird. Dance movements also mimic other external features of the brolga. The dancers communicate that the bird has long legs by stretching and elongating their legs as they perform the dance; they simulate the movement of the brolga as it places each long limb as it walks. The wings of the brolga are mimicked in the arm movements of the dancers. Arms are held behind a dancer's body with their wrists and hands touching the lower back to replicate the position of the wings as the brolga walks. Dancers extend their arms and use rhythmic movements up and down to indicate the extension of the brolga's wings in flight or during mating rituals.

External features of other winged organisms are mimicked in specific choreography of Aboriginal and Torres Strait Islander Peoples. The *watji* dance of the Noongar Peoples of south-west Western Australia mimics the external features of the emu. Dancers use an arm extended in front of the face to represent the long neck of the emu and the beak is mimicked with the dancer's fingers closed to the thumb and pointed forwards. The Wagana Aboriginal Dancers who come together on the lands of the Darug, Gundungurra and Wiradjuri Peoples in New South Wales mimic external features of the cockatoo in dance. The characteristic crest is represented by the dancer's hand on top of the head and fingers spread apart in the same manner as a raised cockatoo crest. The Urab dancers of Puruma Island in the Torres Strait perform a dance featuring sulphur-crested cockatoos in which each dancer wears a mechanised apparatus on their head which splays open to mimic the cockatoo raising its crest. The contemporary Australian dance theatre company, Bangarra, incorporates external features of organisms in the productions that depict animals. In the production "Bush", the emergence of a moth from a cocoon is represented by arm movements that transition from arms closely folded into the body to outstretched arms that mimic the wings of the emerging moth. A dance of the Guugu Yimithirr Peoples of far north Queensland mimics the features and behaviour of the flying fox; dancers hang upside down by their legs from tree branches and fold their arms into their chest.

The external features of many marine organisms are also represented in Aboriginal and Torres Strait Islander Peoples' dance. The Muralag Peoples of Muralag Island in the Torres Strait represent and communicate external features of the sawfish in a dance in which the performers wear masks. The masks are constructed to represent the distinctive features of the sawfish, including the long series of teeth along the snout, the dorsal fins and heterocercal tail. The dance involves slow movement of the mask from side to side, imitating the motion of the sawfish as it moves through water. On Mabuig Island in the Torres Strait, dancers perform *tadu kap* (that translates to crab dance in English). The performer crouches down with the upper arms positioned horizontally and the forearms vertically, as a representation of the nipping claws of the crab. Guugu Yimithirr Peoples of the Hopevale region of far north Queensland have been reported to represent and communicate important information about dangerous organisms using songs, dances and models of animals. The potential danger of the venomous stonefish is communicated through a cultural dance, with a warning about the consequences of treading on the stonefish spines. A beeswax model of the stonefish includes anatomical details of the spines; the model is used to represent its structural features and communicate the dangers of the organism.

Aboriginal and Torres Strait Islander dancers also use movements and costumes to represent native land animals. The kangaroo is depicted in the dance of many cultural groups across Australia. A dancer will frequently adopt a staunch, powerful stance with shoulders held back and a protruding chest, to represent the upright posture, muscular shoulders and elongated torso of the kangaroo. The kangaroo has large, pointed ears that can twist independently of each other, and in dance this feature is often mimicked using two fingers pointing upwards from the sides of the performer's head. The tripod stance of a kangaroo, when the kangaroo stands on powerful hind legs balanced by its tail, is mimicked when dancers squat on their haunches. The dancers hold their arms close into their chest to mimic the position and size of the kangaroo's front paws. Aboriginal dancers use arms and legs in succession to imitate the pentapedal locomotion of a kangaroo; that is, the placement of the front legs, tail then hind legs in sequence.

This elaboration provides students with the opportunity to explore how Aboriginal and Torres Strait Islander Peoples represent the external features of living things in dance. Aboriginal and Torres Strait Islander Peoples have long represented and communicated knowledge of the observable features of organisms through cultural practices, including dance. The movement, choreography and costumes incorporated into dance reflect observations of the living things within an environment and have been a means of preserving and communicating such knowledge for thousands of years. Through observing Aboriginal and Torres Strait Islander Peoples' dance, students have the opportunity to understand scientific details about the external features of living things that are represented in the performance.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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ACSSU018

Science of everyday material changes – bending and twisting

CONTENT DESCRIPTION

Everyday materials can be physically changed in a variety of ways.

CONTENT ELABORATION FOR CCP (OI.2, OI.5)

- ▶ exploring how Aboriginal and Torres Strait Islander Peoples apply physical changes to natural materials to render them useful for particular purposes



First Nations Peoples have long employed specialised techniques to twist natural fibres to make string

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long sourced materials from the environment for a range of purposes including the construction of watercraft, shelters, tools and other implements. Natural materials often require physical changes to render them useful for a particular purpose. Aboriginal and Torres Strait Islander Peoples have scientific knowledges and understandings of the processes to physically change natural materials and apply these knowledges in the construction of items. Physical processes, such as bending and twisting, are methods that can be applied to change natural materials and make them fit for purpose. This elaboration provides students with the opportunity to explore how Aboriginal and Torres Strait Islander Peoples apply physical changes to natural materials in order to construct or manufacture items for specific purposes.

DETAIL

Prior to European arrival in Australia, there were more than 500 distinct Aboriginal and Torres Strait Islander Nations, each occupying a specific geographical territory. The region occupied by a specific Aboriginal or Torres Strait Islander People determined the resources that were available to them. Aboriginal and Torres Strait Islander Peoples have sourced natural materials from the environment for millennia to use in the construction of a wide range of items, including tools, watercraft and shelters. Often these natural materials require physical changes to make them suitable for the desired purpose. Aboriginal and Torres Strait Islander Peoples have a scientific understanding of the properties of natural materials and the processes that can be applied to physically change the materials. Bending and twisting materials are processes that confer physical changes to natural materials and these processes have long been used by Aboriginal and Torres Strait Islander Peoples in the manufacture of items for particular purposes. The ongoing cultural practices of Aboriginal and Torres Strait Islander communities throughout Australia continue to utilise material science knowledge and understanding in the manufacture of many items.

Aboriginal and Torres Strait Islander Peoples process fibre by twisting and twining to manufacture items such as nets, baskets, bags, belts, mats and other woven or netted items. These items are used for fishing and to catch game, to process and prepare food resources, to carry items and for other domestic uses. A variety of natural resources are used to prepare fibre for string and cordage; these differ according to each geographical region and the desired purpose of the finished product. For example, the Gunai Peoples of the Gippsland region in Victoria have long prepared kangaroo grass to manufacture string for nets, while the Mabuag Peoples of Mabuag Island in the Torres Strait process coconut husk to manufacture string. Fibres are prepared through processes that may involve a combination of steaming, soaking, splitting, scraping, chewing, stripping, washing, pounding and drying. These processes are carried out to improve the flexibility, strength and durability of the fibre. Animal materials are also used in the manufacture of string, including sinew or tendon and hair. Once the string is prepared it can then be physically changed through twisting, twining, plaiting or knotting to manufacture items for a desired purpose.

In many parts of Australia, the initial physical change to string involves twisting a strand on itself to become uniform, often achieved by rolling the strand with an open palm along the outer thigh. This increases the strength of the strand and removes any irregularities. The direction of the twist in the string is designated 'S' or 'Z' by contemporary definitions, depending on the direction of the twist (anti-clockwise or clockwise respectively). The Guugu Yimithirr Peoples of far north Queensland form two-ply string using two strands of string, both prepared with an S-twist and twining the strands together with a Z-twist. This process of reversing the direction of the twist results in a strong, even product. The two-ply string is then further manipulated into the desired item, including bags, fishing nets, nets for the capture of large game and baskets. The Wirramayo Peoples of Ngadjuri Country in the mid-north of South Australia knot together lengths of two-ply string to manufacture nets up to 12 metres in length to capture kangaroo and emu. Expert net makers knot the string together, judging the size of the mesh required with their thumb and fingers; the regularity and uniformity of the gauge of the net determined by the targeted animal. It has been estimated that a net approximately 18 metres in length and 12 metres breadth, requires up to 9,000 metres of string and 90,000 netting knots.

The Yolŋu Peoples of north eastern Arnhem Land in the Northern Territory manufacture three-ply rope for use with dugong and turtle harpoons. The rope is prepared by three people sitting together, each with a stick on to which S-twisted string is wound. The process to prepare three-ply rope involves each person twisting their stick to twine the strand and passing it to the person next to them, twining the three strands together. The Wik and Wik Way Peoples of north-eastern Australia manufacture string bags using a pattern of looping and knotting. Loops may be made using a range of techniques including a figure-of-eight pattern, loop and twist form or a cross-knit style. The length of the looped mesh determines the diameter of the bag and when the desired length has been achieved, the string is knotted to hold the bag in place.

On many of the Torres Strait Islands mats are constructed for a range of purposes, including to sit and sleep on, to wrap items and as canoe sails. Materials to construct the mats including coconut leaf, pandanus or the bark of tea tree, are made supple by scraping. Many techniques are used to manufacture the mats. However, the material is commonly plaited or woven together in a regular pattern and finished off by bending over and interlacing the ends. The physical process of bending to manipulate plant fibres in the manufacture of string, rope and domestic items has long been understood and employed by Aboriginal and Torres Strait Islander Peoples. The physical change to natural material renders it useful for particular purposes, including the manufacture of nets, bags and mats.

Bending is a physical change that can be applied to other natural materials to make them useful for specific purposes. For example, the construction of shelters, watercraft and items such as bicornuate-shaped baskets, all require natural materials to be bent into shape during the manufacturing process. Steam bending is a technique whereby heat and moisture are applied to wood or bark to enable the material to be moulded into a desired form. Steam bending has long been

used, and continues to be used, by Aboriginal and Torres Strait Islander Peoples to treat wood and bark for a variety of applications. Other methods to bend wood include: using flexible, green timber; soaking wood in water; burying wood in hot, dry sand; and bending and fastening wood in place with twine or sinew.

Prior to European colonisation, some Tasmanian Aboriginal people, particularly in the west-north-west, constructed unique beehive-shaped shelters. The dome-shaped shelters were constructed using wooden structural supports that had been steamed by fire to facilitate bending. The Bama Peoples of the rainforest region in far north Queensland construct arched shelters from saplings that are stuck into the ground, bent towards each other and fastened in place by tying with lawyer cane or vines. The Kaurareg Peoples of Murulag Island in the Torres Strait construct dome shelters for protection during the wet season. The shelters are constructed with an arched framework of flexible sticks and overlaid with tea tree cladding to prevent water from penetrating the shelter.

The Gunaikurnai Peoples of the Gippsland region of Victoria steamed sheets of stringybark over a fire to improve pliability for the construction of canoes. Once steamed, the bark could then be shaped by bending up the sides and folding the edges together to construct a watertight vessel with the capacity to carry multiple passengers. The Ngarrindjeri Peoples of the lower Murray River region in South Australia have long manufactured large bark canoes from various species of *Eucalyptus*, bent and carved into the desired shape. To bend the bark to the required shape a hollow is dug in the ground in the shape of the desired canoe. The bark is then placed over the hollow, weighted with mud and clay, and left to bend into shape. The Wik Mungkan Peoples of the Cape York Peninsula region in Queensland construct bark canoes from the bark of the messmate tree harvested during the wet season. The bark is held over a fire until it can be bent into shape. Initially, the bark sheet is folded in half and then it is bent up and the ends are fastened to form the prow and stern.

The Dyrirbal Peoples of far north Queensland physically change lawyer cane in the construction of frames for animal nets and traps. *Bala warrany* (that translates to turkey net in English) and *bala mugarru* (that translates to butterfly net in English, due to its winged shape) require a frame on which the net is woven. *Bala warrany* is a turkey trap that is constructed by setting several lengths of lawyer cane into the ground and bending the cane over into a semi-circular shape. The netting is then placed over the top of the frame and drawn to a close at one end to capture the turkey. *Bala mugarru* is a folded fishing net that is shaped like the wings of a butterfly, giving the net its name. It is constructed from two lengths of lawyer cane that are bent into a curved shape; netting is knotted along each length of cane, from one end to the other. The net is used to catch fish, turtles, eels and other aquatic animals. It is held ajar on either side and carried through the water so that fish and other organisms swim into the net. The two wings of the net are then brought together to close the net, entrapping the catch.

In the north Queensland region, lawyer cane is physically changed in the construction of other items, including the distinctive *jawun* (bicornuate basket) that is unique to the region. The bicornuate

basket is used in the detoxification of cycads; water is used in a process to leech toxins from the nut. Girramay Elder, Abe Muriata of rainforest Country in far north Queensland, is an expert *jawun* craftsman who shares some of the knowledges to make bicornuate baskets. The basket is constructed with several lengths of stripped lawyer cane that are bent into a bow shape over a fire to make the frame. Fine fibre is then twined across the bent cane frame. Then, to strengthen the basket, rings of bent cane are added to the interior at regular intervals. Handles to assist carrying the basket are added by attaching bent strips of lawyer cane to the mouth of the basket.

This elaboration provides students with the opportunity to explore how Aboriginal and Torres Strait Islander Peoples apply physical changes to natural materials to make them useful for specific purposes. Students can learn that everyday materials can be physically changed in a variety of ways, including bending and twisting. For millennia Aboriginal and Torres Strait Islander Peoples have sourced natural materials from their environment and manipulated the materials in the construction of shelters, fishing nets, baskets, domestic implements and watercraft, such as canoes. The ongoing cultural practices of Aboriginal and Torres Strait Islander Peoples ensure the knowledges of applying physical changes to natural materials for particular purposes continue.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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ACSSU019

Knowledge of seasons – changes in weather and landscape

CONTENT DESCRIPTION

Observable changes occur in the sky and landscape.

CONTENT ELABORATION FOR CCP (OI.2, OI.3, OI.5)

- recognising the extensive knowledge of daily and seasonal changes in weather patterns and landscape held by Aboriginal and Torres Strait Islander Peoples



Morning fog is indicative of good fishing for the Ngan'gi Peoples of the Northern Territory

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have made observations of the sky and landscape for millennia; noting, recording and communicating changes in these environments, and connecting them with other events in the environment. Observable changes in the sky such as cloud formations, the appearance and movement of celestial bodies including the sun, moon, planets and stars, and the colour of the sky at sunrise and sunset, have long informed connections between daily and seasonal changes within an environment. Landscape changes including changes in the observable features of plant life such as flowers, fruit or foliage colour changes, also signal daily and seasonal changes. This elaboration provides students with the opportunity to recognise that Aboriginal and Torres Strait Islander Peoples' extensive knowledge of changes in the landscape and sky connects with daily and seasonal changes. These observations have been collected and recorded for millennia and today continue to be observed and documented by Aboriginal and Torres Strait Islander Peoples.

DETAIL

Aboriginal and Torres Strait Islander Peoples' long-held systems of determining time in days and seasons depend on acute observations of changes in the environment, including subtle changes in the sky and landscapes. As in many other cultures around the world, the passing of days and changes in seasons can be signalled by the movement of celestial bodies, weather patterns and the cyclical changes in plant life. Aboriginal and Torres Strait Islander Peoples have made observations of such changes in the sky and landscape, and have connected regular patterns with periods of time, such as the passing of days and onset of seasons. Unbroken observations for millennia have also connected less regular phenomena, such as the appearance of particular cloud types and moon halos, with seasonal and weather events. The observations of changes in the sky and landscape that indicate particular times or seasons have long been important for Aboriginal and Torres Strait Islander Peoples. These observations inform many aspects of life, including seasonal patterns of movement, the availability of resources, and the timing of gatherings and land management practices.

Aboriginal and Torres Strait Islander Peoples developed timekeeping systems based on astronomical observations of the sky, including the regular, cyclical patterns of movement of the moon, stars, planets and the sun. Time, in the form of days and months, is generally determined by the observation of the rising and setting sun and the phases of the moon over a lunar month. The Nyangumarta Peoples of northern Western Australia used the moon phases, and appearance of the sun, to distinguish time periods in months and days. In the Southern Coorong district of South Australia, the Ngarrindjeri Peoples used the number of full moons to record the age of children under the age of one, while in the Hahndorf area of South Australia, the Peramangk Peoples marked the appearance of each new moon on an object, such as a digging stick, to record their own age. The Takayna People of north west Tasmania applied the lunar phases of the moon to daily life and determined the timing of a gathering, for example, by the number of dark days after the moon

had disappeared. To this day, the appearance of particular constellations or planets in the sky is also a means of determining seasons for many Aboriginal and Torres Strait Islander Peoples. For example, the Pitjantjatjara Peoples of the central Australian desert know that the appearance of the constellation Pleiades in the dawn sky indicates the beginning of the cold season.

Many changes in the sky are indicative of changes in weather or seasons. Clouds, the colour of the sunrise or sunset, and moon halos, are examples of phenomena that have long been observed and connected with events by Aboriginal and Torres Strait Islander Peoples. Aboriginal Peoples of the Kulin Language Group in western Victoria understood that a red sunrise indicated rain, while a red sunset indicated that the following day would be warm. This knowledge is consistent with contemporary meteorological explanations; red skies are the result of high-pressure systems that trap aerosols and dust in the atmosphere. During the day the sky appears blue; air molecules and atmospheric particles scatter the shorter (blue) wavelengths of light more strongly than longer (red) wavelengths. During sunrise and sunset, the sun is low in the sky and the sun's rays pass through a greater length and denser parts of the atmosphere. This causes short (blue) wavelengths to be scattered away leaving mainly longer (red) wavelengths to pass through. The reddish colours of morning and evening skies are intensified when sinking air (high pressure) causes greater concentrations of airborne particles, such as aerosols, dirt and dust. When weather systems move from west to east, the prevailing wind direction in Victoria, a red sky at night indicates that high-pressure air is located to the west and fine weather usually follows. In the morning, the sunlight is to the east; a red sky indicates that the high-pressure system has passed and a low-pressure system, that frequently brings rain, is following.

Aboriginal and Torres Strait Islander Peoples have also connected the appearance of moon halos with the onset of rain or bad weather. Moon halos occur when ice crystals are suspended in the upper atmosphere; moonlight is refracted and reflected by the ice crystals and can result in the appearance of a halo around the moon. Contemporary science recognises that moon halos often precede a low-pressure system, frequently followed by rain and cooler temperatures within the next day. The longevity of this knowledge is attested in the cultural records of many Aboriginal and Torres Strait Islander Peoples. The Euahlayi and Kamilaroi Peoples of New South Wales have cultural records that connect the appearance of a moon halo with rain; to the Peoples of the western desert region, a moon halo signifies that the Moon-man is taking shelter from approaching bad weather.

Observations of the presence, type and patterns of clouds in the sky, observed for millennia by Aboriginal and Torres Strait Islander Peoples, are further indicators of weather and seasonal events. The "morning glory" cloud is a rare meteorological phenomenon that occurs at predictable times only in the Gulf of Carpentaria due to the configuration of land and sea. The cloud forms in rolls of up to 1000 kilometres in length; it is usually associated with frontal systems that cross central Australia and high-pressure systems in northern Australia. The Gangalidda Peoples of north-west Queensland refer to this natural phenomenon as *mabunda* or *mabuntha*; it indicates the season that flatback and freshwater turtles are nesting. To the Yanyuwa Peoples of the Sir Edward Pellew Group of Islands in

the Gulf of Carpentaria, the clouds indicate the beginning of the wet season. The clouds also signal the arrival of flying foxes, the Torres Strait pigeon, various species of parrot, and the time when seagulls and sea turtles lay their eggs in the sand.

Many Aboriginal and Torres Strait Islander Peoples distinguish between rain-bearing and non-rain-bearing clouds. In the Niyaparli language of the Palyku Peoples of the Pilbara region in Western Australia where rainfall is infrequent, call clouds *jundurba* (that translates to ‘rubbish clouds’ in English) and *nangali* (that translates to ‘rain clouds’ in English).

Observable changes in landscape are further indicators of weather and seasonal shifts. The cycles of some plant species provide information to many Aboriginal and Torres Strait Islander Peoples about the change of seasons. This information is important for many aspects of life; accessibility to resources, the timing of events such as seasonal movement or gatherings, and suitable times for land management practices, such as controlled burning. The Noongar Peoples of south-west Western Australia mark the beginning of *kambarang*, second spring, by the flowering of *balga* (grass tree; *Xanthorrhoea* spp.); and the bright orange and yellow flowers of the *mooja* (Australian Christmas tree; *Nuytsia floribunda*) indicate that hot weather is approaching. The Masigalgal Peoples of Masig Island in the Torres Strait understand that the heavy flowering of *pulla* (beach morning glory; *Ipomoea pes-caprae*) signals the beginning of the *woerr* (also known as *sagerr*) season that brings the strong south-easterly winds. The flowering of the billy button (*Craspedia* spp.) signals to the Narungga Peoples of Yorke Peninsula in South Australia that marine resources such as the mulloway are plentiful and, prior to colonisation, this was used as an indicator for the time to move to coastal areas.

Landscape changes also indicate the suitable times for the implementation of land management practices, such as the application of carefully controlled fire. The dense vegetation in the south coast region of Noongar Country in south-west Western Australia requires application of infrequent, high intensity fires to maintain plant and animal habitats. Observations of the landscape to identify when the density of the trees becomes sparse (approximately every 10 to 15 years), informs the Noongar Peoples that it is time to apply carefully monitored, high intensity fires in order to promote new growth and encourage a dense forest environment. The Peoples of the Banbai Nation of the northern tablelands in New South Wales watch for the flowering of wattle to know when to start low intensity fires. The Peoples of the Gundjeihmi Language Group in the Kakadu region of the Northern Territory observe the landscape for the emergence of the spectacular orange flowers of the Darwin woollybutt (*Eucalyptus miniata*) in *yegge* season (cooler season, May–mid-June), to know when to start patch burning. Small fires are lit in a mosaic pattern early in the year, when the weather is still and cool and the plant material still contains moisture. The fires encourage new growth and reduce fuel load, thereby preventing high intensity bushfires in the coming *gurrung* season (hot, dry season, mid-August–October).

This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples’ knowledges about observable changes in the landscape and sky are indicators

of time, weather and seasons. Changes in the landscape including observable features of plant life cycles have long been used, and continue to be used, to inform seasonal changes, times for resource harvesting, timing movement through Country or Place, and suitable times for land management practices. Aboriginal and Torres Strait Islander Peoples have observed, recorded, and used astronomical and meteorological phenomena for millennia to inform aspects of daily and seasonal life, including weather changes, timing for gatherings, and accessing of particular resources. Through this elaboration students can recognise the extensive knowledge held by Aboriginal and Torres Strait Islander Peoples about the observable changes in sky and landscape.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSSU020

Traditional music instruments

CONTENT DESCRIPTION

Light and sound are produced by a range of sources and can be sensed.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ exploring how traditional musical instruments used by Aboriginal and Torres Strait Islander Peoples produce their characteristic sounds



Aboriginal and Torres Strait Islander Peoples' musical instruments produce characteristic sounds

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have manufactured musical instruments over many thousands of years; characteristic sounds are produced by a range of resources. Sound is produced by vibrations that travel through a medium, commonly through the air, and distinct frequencies of sound can be detected by the human ear. The type of material used in making musical instruments and the action used to produce the vibrations influences the perception of sound including tone, frequency (or pitch) and amplitude (or loudness). Aboriginal and Torres Strait Islander Peoples have long used musical instruments for social and cultural purposes to preserve, represent and communicate important knowledges in music, songs and dances. This elaboration provides students with the opportunity to explore the musical instruments produced and used by Aboriginal and Torres Strait Islander Peoples for millennia. Students can learn how the source material and the actions used to generate vibrations result in the production of musical instruments with distinctive sounds.

DETAIL

Sound is a wave that is created by a vibration and can be transmitted from one location to another through a medium, such as air or water. Hearing, or auditory perception, is the ability to perceive soundwaves through an organ, such as the ear. Variation in the properties of soundwaves, including the amplitude and frequency of soundwaves, affects the perception of the sound. The frequency of soundwaves, that is, the number of vibrations experienced per unit of time, is the property that determines pitch or how high or low a sound is perceived. Soundwaves are measured in Hertz (Hz); the range of audible frequencies differs between species. Humans can detect frequencies from 20 to 20,000 Hz, while animals such as dolphins and bats can detect up to 100,000 Hz, well beyond the upper limit of human hearing. The amplitude of a soundwave influences how a listener perceives the loudness of sound; low amplitude soundwaves are detected as quiet sounds and high amplitude soundwaves are detected as loud sounds. The detection of sound from the surrounding environment is a critical sense for many animals; it is a means of communication, can warn of potential danger, and is an important tool for many animals to hunt successfully.

For millennia humans have made devices to produce sound, including musical instruments. The sounds that are produced by such devices depend on the materials used in their construction and the methods used to generate the soundwaves. Instruments are designed to produce soundwaves that vary in frequency; the instrument user can control the amplitude of the soundwaves. Aboriginal and Torres Strait Islander Peoples have for many thousands of years constructed musical instruments, including: idiophones, instruments that produce sound by the instrument itself vibrating without the use of strings or membranes; membranophones, instruments that produce sound through the vibration of a stretched membrane; and aerophones, instruments that produce sound by causing the air to vibrate. Aboriginal and Torres Strait Islander Peoples' scientific understanding of how to

produce and control sound has resulted in the development of a range of musical instruments that produce characteristic sounds.

There are many types of idiophones constructed and used by Aboriginal and Torres Strait Islander Peoples to generate a percussive sound. Wooden sticks, an example of an idiophone, are struck together to generate soundwaves. Several factors influence the frequency and amplitude of the soundwaves that the wooden sticks produce; the type of timber used in its construction, the length and shape of the sticks, and the position of the strike. The Peoples of the Tiwi Islands in the Northern Territory construct clapsticks from *kartukuni* (ironwood) due to the quality of the resulting sound that the hardwood makes on contact. In the western districts of Victoria, rounded clapsticks with tapered ends are struck against each other to produce a clear musical sound that can reportedly be heard at great distances. The Pintupi and Luritja Peoples of the western desert region of northern Australia use boomerangs as percussive instruments, clapping or rattling two boomerangs together or striking the boomerang on the ground to generate a deep resonant note. The Ngukurr Peoples of southern Arnhem Land in the Northern Territory construct a set of percussion sticks to generate musical sounds. The set consists of several pieces of wood of varying lengths that produce different soundwave frequencies when struck. Each length of wood is balanced on the shoulder of the musician who strikes the wood with another hand-held length of wood.

Percussion tubes are another type of Aboriginal and Torres Strait Islander Peoples' idiophone that are struck directly to generate sound. Hollow logs are beaten with a stick to generate a sound; the sound frequency depends on the length and thickness of the wood. It has been reported that in a region of Arnhem Land in the Northern Territory, an open-ended percussion tube was struck on its longitudinal sides with flattened stumps of pandanus palm to produce sound. Friction idiophones are instruments that produce vibrations through rubbing. The Yamatji Peoples of the Murchison region of Western Australia carve notches along an edge of the back of a spear thrower and rub a stick across the notches to produce a rasping sound. The Yawuru Peoples of the Broome region in Western Australia generate a rasping sound by scraping a small stick over notches cut into a larger stick. The Mabuag Peoples of Mabuag Island in the Torres Strait cut transverse grooves in a length of bamboo and produce a rasping sound by scraping a clam shell across the grooves.

Indirectly struck idiophones are instruments that produce vibrations through the indirect action of the operator rather than through direct contact. Such instruments include rattles and shakers, and have long been manufactured and used by Aboriginal and Torres Strait Islander Peoples to produce distinctive sounds. Many Torres Strait Islander Peoples manufacture *kulaps*, rattles made from the seeds of the matchbox bean vine. The hard, brown shells of the seeds are cut in half and strung together in a cluster using a length of twine. The Yupungathi Peoples of the western Cape York Peninsula make rattles using particular shells strung together. Soundwaves are produced through the movement of the person holding the instrument, causing the components to strike against each other. The amplitude of the soundwaves is controlled by the musician's actions while the frequency is a result of the shape and size of the seed pods or shells used in the construction of the instrument.

Aboriginal and Torres Strait Islander Peoples manufacture membranophones using animal skins stretched across the hollow end of a drum. Soundwaves are produced when the skin is struck with a hand or implement, such as a stick. The frequency of the soundwaves depends on the tension of the stretched skin, the materials used in the construction of the membranophone, and the dimensions of the wooden tube. The Wik-Mungkan Peoples of the northern Cape York Peninsula manufacture two specialised skin drums, one constructed from a hollow stem of pandanus tree wood and the other from messmate wood. Goanna skin is used to cover one end of each drum, and the drum reportedly makes loud and soft sounds when struck with the hand. The Gumbaynggir Peoples of the mid-north coast of New South Wales manufacture buljirr (that translates to drum in English) using possum skin as the drum membrane while in other regions kangaroo hide is used. The *warup* is a unique, hourglass shaped drum belonging to Peoples of the Torres Strait Islands and Papua New Guinea. One end of the *warup* remains open, and the other circular-shaped end covered with animal hide, often from monitor lizards, although skin from other organisms including pufferfish has also been recorded. The membrane is fastened in place with beeswax and twine. The musician controls the tension of the membrane to regulate the frequency of the soundwaves that are produced. Other forms of percussive instruments include stretched out and tightly rolled or folded possum skins that are beaten with the hand to generate a percussive sound. These drums may contain shells to generate a jingling or rattling sound on impact. The Murawari Peoples from the central Queensland – New South Wales border use a drum manufactured from kangaroo hide and stuffed with possum fur as a percussive instrument.

Aboriginal and Torres Strait Islander Peoples use various materials and designs to construct aerophones, musical instruments that produce soundwaves through the vibration of air. Aerophone musical instruments constructed by Aboriginal and Torres Strait Islander Peoples include whistles, trumpets, pipes and leaves. Leaf playing is an example of a simple reed aerophone that has long been used by Aboriginal and Torres Strait Islander Peoples. Leaf blowing produces sound by producing regular vibrations of the air as the leaf vibrates against the lip. The tension between the leaf and the lip can be modified to alter the frequency of the soundwaves that are produced. The Mabuag Peoples of Mabuag Island in the Torres Strait blow air from their lips through doubled over leaves of the *karbi* tree; the passage of air between the leaf folds generates a musical sound. On mainland Australia many species of *Eucalyptus* are favoured as leaf instruments. On Mer Island in the Torres Strait wind flutes are constructed from varying lengths of bamboo or reed and vibrations are generated through the air by blowing air across the top of the instrument. Air blown across the top of a whistle constructed from hollow seed pods, called a *persok* in the language of the Mer Islander Peoples, is also a means of generating distinctive musical sounds. Wind pipes are also used by Aboriginal Peoples in areas of mainland Australia, including the Jirribal Peoples of the Tully River region of north Queensland, who produce sound by blowing air across the top of hollow reeds with the ends cut off.

Trumpets are aerophone musical instruments where the air is set in motion by the player's vibrating lips. The didjeridu is arguably the most recognisable aerophone instrument of Aboriginal Peoples. Conjecture surrounds the origin of the term didjeridu. Many consider that it is not a traditional language word, introduced after European colonisation as an onomatopoeic description of the sound the instrument makes. Prior to colonisation didjeridus were restricted to northern Australia and each Language Group had their own name for the instrument. For example, in the language of the Yolgnu Peoples of eastern Arnhem Land it is referred to as a *yidaki*.

The initial soundwave is generated by the player's lips. The soundwaves travel in every available direction, both forwards into the instrument and backwards into the vocal tract of the player. The vocal tract acts as a resonator amplifying certain frequencies while suppressing others. Thus, skilled players manipulate not only the force of the air from the lungs and the vibrations of their lips, but also the shapes of their mouths and their tongue articulations. In so doing they alter the frequency, wavelength and amplitude of the sound wave as it reflects through the lips, pushed by the movement of air from the lungs and through into the bore (interior chamber) of the instrument. This produces the distinct and unique sounds for which such instruments are renowned. Each instrument is unique, and its acoustic behaviour is determined by the length and shape of its bore. The diameter of the bore also affects the amplitude (loudness) of the sound that is generated. Trumpet instruments are found in many parts of northern Australia. The Iwaidja Peoples of the Coburg Peninsula region in the Northern Territory construct a trumpet from a thick length of bamboo that is used to propagate soundwaves through the vibratory motion of a player's lips. The instrument may be moistened with water before playing to improve the tone of the sound produced.

This elaboration provides students with the opportunity to explore the many and varied musical instruments that have been constructed and used for millennia by Aboriginal and Torres Strait Islander Peoples. The variety of resources used in the construction of musical devices and the methods employed in the initiation and propagation of soundwaves results in the production of unique and characteristic sounds. Music has long been an important aspect of Aboriginal and Torres Strait Islander Peoples' social and cultural life, vital to the preservation and communication of knowledge. Students can explore a range of source materials and musical techniques used to produce soundwaves in the musical instruments of Aboriginal and Torres Strait Islander Peoples.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSHE021

Knowledge of seasons – when to harvest

CONTENT DESCRIPTION

Science involves observing, asking questions about, and describing changes in, objects and events.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- recognising how Aboriginal and Torres Strait Islander Peoples use changes in the landscape and the sky to answer questions about when to gather certain resources



The flowering of particular plant species indicates seasons and fat cycles of important food sources

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For many thousands of years Aboriginal and Torres Strait Islander Peoples have used observable changes in the sky and landscape as indicators of seasonal change and resource availability. Through continuous observation and asking questions about environmental changes, a wealth of scientific knowledge and understanding of many different ecosystems has been collated. These knowledges and understandings have long provided detailed information about resources that are important sources of food, medicines and materials for tools, material culture and shelters. Asking questions and describing changes in the landscape, such as ephemeral waterbodies and plant life cycle stages, provides information about seasonal availability of resources. Similarly, through continuous observations of changes in the sky including the patterns of movement of celestial bodies and weather indicators, and asking questions about the significance of these changes, Aboriginal and Torres Strait Islander Peoples have developed methods of monitoring time and seasons that are connected with the availability of particular resources. This elaboration provides students with the opportunity to recognise that the vast knowledges about changes in the sky and landscape held by Aboriginal and Torres Strait Islander Peoples can answer questions about when to gather certain resources.

DETAIL

For Aboriginal and Torres Strait Islander Peoples, the scientific domains of astronomy, meteorology and ecology have long been studied holistically to understand changes observed in the environment. The confluence of these scientific disciplines has resulted in a deep understanding of the interconnectedness of environmental factors and as a result, observations of changes in the landscape and sky have been connected with seasonal events. These knowledges are important as they have long informed the availability of certain resources and when they can be sustainably accessed. For millennia prior to colonisation, resources from the environment supplied Aboriginal and Torres Strait Islander Peoples with the raw materials required to provide or manufacture food, water, medicine, tools, domestic implements, weapons, clothing, shelter, and watercraft. Observations of events and phenomena including ephemeral waterbodies, plant life cycle stages, movement of celestial bodies and weather patterns have long enabled Aboriginal and Torres Strait Islander Peoples to answer questions about particular resources in the environment.

Ephemeral water bodies are those that only infrequently and irregularly contain water, usually following a large precipitation event. In regions characterised by infrequent heavy rainfall, some plants have adapted to these conditions; their seeds remain dormant until the deluge provides optimal conditions for germination and growth. The Australian native aquatic fern nardoo (*Marsilea drummondii*) is an example of such a plant. The spores of nardoo can remain viable for extensive periods of time in conditions of drought or environments of limited water availability, such as the desert environment of Australia. When rainfall or floods in these regions provide ephemeral fresh water, dormant spores

germinate and the new plants grow rapidly. The Yandruwanda Peoples of the lakes region in South Australia understand the nardoo germination process; when rainfall is observed in a desert environment, they know that large quantities of nardoo will soon be available for harvest. Prior to colonisation, the Alyawarra People of the central desert region in the Northern Territory resided near permanent water reservoirs. However, when seasonal rains were observed people travelled to known ephemeral water locations to access resources, such as roots and tubers, that only flourished at this time.

Kati Thanda-Lake Eyre in central Australia, the lands of the Arabana, Anangu, Pitjantjatjara and Yankunytjatjara Peoples, is a large ephemeral water body that fills with water only after rare periods of significant rainfall. After monsoonal rain events in Queensland, water flows through the river systems in a southerly direction and eventually drains into Kati Thanda-Lake Eyre. Subsequently, huge flocks of waterbirds arrive, including wild fowl and pelicans. Aboriginal Peoples' observations about the arrival of waterbirds have long provided answers about water availability, and accessibility to resources such as bird, marine and animal species not normally found in the region. The Arabana Peoples of the western Kati Thanda-Lake Eyre region use a complex system of environmental observations to answer questions not only about water presence, but also the quality, quantity and level of saturation of the water resource. Observations can answer questions about water resources in the region, such as: indications of soil quality by colour and cracking; the type, number and distribution of flora and fauna species; the historical presence of species; and stages of the life cycle of organisms.

Many Aboriginal and Torres Strait Islander Peoples observe the landscape for predicted changes in plant life cycle stages to answer questions about resource availability. Observations of the flowering, ripening, greening, abscission or tuber maturity of particular plants can answer questions about when to gather a range of resources from the environment. The Yawuru Peoples of the Broome region in Western Australia use observations of changes in the landscape to indicate when particular resources can be harvested. The budding of the bloodwood tree in *marrul* (April) indicates that it is the time to harvest land resources and not marine resources. During this season, the land animals such as lizards are getting fat and are good for eating, while the high tides mean that the sea animals are small and should not be harvested. *Laja* (September–November) coincides with the drying and splitting of seed pods from plants such as *Acacia* spp. The Yawuru Peoples know that *man-gala* (December–March) will follow bringing rain; this is the time to collect wood and bark for shelters needed for the wet season.

Observations of changes in the sky over millennia also provide answers to questions regarding resource availability. The Kurna Peoples of the Adelaide Plains region in South Australia mark the beginning of *Parnati* (autumn) by the position of the star *Parna* near the lower left side of the moon. This provides answers about resource availability in the area and indicates the time when: fish such as whiting are ready for harvesting in the estuaries; stone fruits are ripe and ready for consumption; and birdlife is plentiful. It also marks the time that bark is ready to be stripped to make canoes and

shelters, and animal skin cloaks need to be prepared for the impending *kudlila* (winter). For the Yolŋu Peoples of Arnhem Land the appearance of the star Arcturus in the eastern sky at sunrise, during *Worlmamirri* (wet season beginning in late October), indicates the time to harvest resources such as spike rush, a reed used to make fish traps and baskets. This means that fish traps can be prepared in readiness for *mirdawarr* (end of the wet season, March–April) when fish are plentiful and they can be caught in basket traps set in weirs. The Yanyuwa Peoples of the Sir Edward Pellew Group of Islands in the Gulf of Carpentaria know that when the *kurrumbirribirri* (dust storms) that can cause the sky to appear orange in the late hot, dry season appear, small sharks and sting rays are fat and ready for eating. The Erubam Le Peoples of Erub Island in the Torres Strait observe the sky for the rapid appearance and disappearance of *lid lid* (small clouds). This observation answers questions about the changing seasons and indicates the end of the monsoon season. At this time, important resources including sorbi (*Syzygium branderhorstii*) and mangos are ready for harvesting.

This elaboration provides students with the opportunity to recognise that over millennia, Aboriginal and Torres Strait Islander Peoples have observed, recorded and preserved information about changes in the landscape and sky. These knowledges answer questions about the environment and when to gather certain resources. Observations such as the position and patterns of movement of celestial bodies, features of plants and weather indicators, inform resource availability and sustainable harvesting practices. These indicators are rarely used in isolation; rather the observations of a number of factors combine to signify seasonal or weather changes. Aboriginal and Torres Strait Islander Peoples have described changes in the landscape and sky for many thousands of years and this knowledge is used to answer questions about the availability of important resources in the environment that provide food, water, medicine, shelter, and materials for the construction of tools, weapons, clothing and watercraft.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSHE022

Science of everyday material changes – sustainably sourcing materials

CONTENT DESCRIPTION

People use science in their daily lives, including when caring for their environment and living things.

CONTENT ELABORATION FOR CCP (OI.2, OI.3)

- ▶ considering that technologies used by Aboriginal and Torres Strait Islander Peoples require an understanding of how materials can be sustainably sourced to make tools and weapons, musical instruments, clothing, cosmetics and artworks



Botanical knowledge informs bark harvesting – only the outer bark is removed to ensure tree survival

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For Aboriginal and Torres Strait Islander Peoples, science has long been an integral aspect of everyday life for procuring resources, manufacturing implements, developing technologies and managing the environment. Prior to colonisation, resources required for all aspects of life were procured from the environment; different geographical regions encompassing a community's Country or Place produced different resources. Ongoing access to resources requires careful and considered management of the environment to ensure ecosystem balances are maintained and the continuation of plant and animal species within the environment is ensured. Plant matter is a source of natural material that has long been harvested by Aboriginal and Torres Strait Islander Peoples in the manufacture of tools, weapons, musical instruments, clothing, cosmetics and items for paintings. Bark from trees is used in the construction of shields, watercraft, blankets, clothing and canvases for painting, branches are used to manufacture musical instruments, and fruits and berries provide dyes for cosmetics and body adornment. These components have been sustainably harvested by Aboriginal and Torres Strait Islander Peoples for millennia; sustainable collection of plant materials has ensured their survival and maintained access to these resources. This elaboration provides students with the opportunity to consider how Aboriginal and Torres Strait Islander Peoples incorporate their scientific knowledge of plants to maintain an environmental balance and sustainably source materials for a variety of purposes.

DETAIL

Plants have long been an important resource for Aboriginal and Torres Strait Islander Peoples as a source of natural materials for: the construction of tools, weapons and musical instruments; the manufacture of clothing; and cosmetics and artworks. It is important to note that while in contemporary times the term artwork is used to describe Aboriginal and Torres Strait Islander Peoples' paintings and illustrations, for many Aboriginal and Torres Strait Islander Peoples this term is oversimplified. Artworks hold much more significance than mere aesthetic value and play a critical role in providing a record of information and material for teaching purposes.

In contemporary Australian society, wood is harvested from both commercial forest plantations and old growth forests, to provide timber predominantly for the building industry and for products such as wood pulp for paper and paperboard products. In the commercial forest industry, the entire tree is cut down to access all the resources. The industry is partly sustained through the re-planting of trees or the establishment of new plantations. By contrast, Aboriginal and Torres Strait Islander Peoples carefully harvest desired materials from trees ensuring the survival of the plant for continued access to resources. The scientific understanding of the requirements for growth and survival of trees is well understood by many Aboriginal and Torres Strait Islander Peoples and has long informed ongoing Caring for Country/Place practices.

In botany, trees are defined as a perennial plant, that is, a plant that lives longer than two years, that generally has roots, a trunk, elongated branches and leaves. The roots of a tree function to anchor it to the ground and gather nutrients and water from the soil that are transferred to other parts of the tree. The trunk of a tree transports water and nutrients from the roots to the aerial parts of the tree and carries compounds generated by the photosynthetic processes of the leaves to other parts of the plant. Trees grow through a process of cell division and expansion that takes place in an area of the trunk known as the cambium. The trunk of many trees, including angiosperms such as *Eucalyptus* spp., have an outer layer of bark that is composed of dead cells. This outer layer of bark provides a protective layer to the phloem, the living inner tissue of the trunk, that transports the products of photosynthesis, such as sucrose, through the plant. Removal of the phloem results in death of the tree as it can no longer transport sucrose and other products of photosynthesis from the leaves to the roots of the tree. Aboriginal and Torres Strait Islander Peoples have knowledge and understanding of this aspect of botany and carefully harvest material from trees to ensure that the phloem is not destroyed and the tree can survive.

For millennia, the outer bark of hardwood trees has been carefully harvested by Aboriginal and Torres Strait Islander Peoples for the construction of canoes, shields, tools and implements, and for painting. The removal of bark can cause damage to the cambium, the region of cell division in the tree trunk. The cells of the cambium that are exposed to air after removal of the outer bark dry out and die, and growth ceases. This can result in the formation of a scar on the still-living tree. The presence of scarred trees across southern and eastern Australia attests the application of in-depth botanical knowledge by Aboriginal Peoples in the sustainable harvest of bark as a resource. The Alyawarre People of the central desert region in the Northern Territory cut the outer bark from the ghost gum (*Corymbia aparreerinja*) to manufacture winnowing trays that are used in processing resin. Separate pieces of bark are carefully cut from opposite sides of the tree at different heights to ensure the tree will not die. Construction of bark canoes by the Wonnarua Peoples of the Hunter Valley Region is evidenced by scarred trees in the area. Canoes were constructed in the region as a mode of transport on the river, particularly during times of flood. One scarred tree in the region is believed to be more than 100 years old, and shows scars where the bark has been carefully removed from either side of the trunk. The regular elongated shape of the scar, with parallel sides and curved ends suggests the bark was removed for the construction of canoes. Similarly, an example of a 'canoe tree' remains at Lanyon, on the outskirts of Canberra, on Ngunnawal Country. Bark that has been taken from a *Eucalyptus blakeleyi* forms a long canoe scar, approximately 2.5 x 0.4 metres, on the south-west side of the tree facing the Murrumbidgee River. The tree is alive and healthy and is protected by a small fence.

The Yolŋu Peoples at Yirrkala in east Arnhem Land in the Northern Territory use stringybark as a surface for painting. The bark is cut from the tree during the wet season, taking advantage of the ambient moisture and seasonal presence of sap to facilitate its removal. Only the outer layers of the bark are removed, ensuring the survival of the tree and continued access to the bark for this

purpose. Yolŋu Peoples have applied scientific knowledge in the production of bark canvases over millennia, an example of the sustainable management of living things in the environment. The Dyirbal Peoples of the north Queensland rainforest region sustainably harvest bark from the banana fig (*Ficus pleurocarpa*) to manufacture blankets. The bark is collected from high up in the tree (up to 12 metres has been recorded) likely to prevent damage to the root system and ensure survival of the tree. Two horizontal incisions are made around the entire circumference of the tree, followed by a single vertical cut to join them. Careful removal of the bark results in a large single sheet of material that is the processed to create a soft, lightweight blanket.

Families from different Language Groups came together at Yarralumla (ACT) and gathered bogong moths from Birragai in the lands of the Ngunnawal People. When the moths were smoked out of the caves, they tumbled to the bottom of the cleft. A fine net made from *Pimelia* spp. fibre captured the insects. *Pimelia* spp. is a shrub that grows to a height of approximately one metre and provides the resources to make the bogong moth nets. The bark of the bush is stripped, allowed to dry, and then weighed down with stones under water for several days until the non-fibrous portions have partly rotted. It is then taken out of the water and allowed to dry until it becomes crisp, and beaten with sticks and/or stones until the fibre is freed. This process is undertaken by women; the final product is a strong material that can be spun into the finest thread to construct bogong moth nets.

The didjeridu, a wooden musical wind instrument long manufactured by some Aboriginal Peoples, was crafted prior to colonisation by sustainable harvesting of tree material. Conjecture surrounds the origin of the word 'didjeridu'. Many consider that it is not a traditional language word; rather, it is believed to have been introduced after European colonisation as an onomatopoeic description of the sound the instrument makes. Didjeridus are crafted from a variety of trees including species of *Eucalyptus* and *Acacia*. Trees are investigated to find a hollow branch or fallen log; attack by insects or physical damage to a tree branch can cause a hollow to form and expose the inner layers of the trunk. This can expose the inner bark to microorganisms and insects, thus causing the decay and decomposition of the inner bark tissue, while the outer bark layers remain intact. Aboriginal Peoples select such branches or logs for the construction of sound instruments as a sustainable means of obtaining the desired material. Aboriginal and Torres Strait Islander Peoples have long applied careful consideration to the sustainable harvest of bark for a range of purposes; this demonstrates ecological knowledge and understanding and ensures continued access to the resources.

Other components of plants have long been sustainably harvested by Aboriginal and Torres Strait Islander Peoples; for example, fruits, flowers and berries are used to produce cosmetics. The Kuku Yalandji Peoples of far north Queensland harvest the fruits of the cassowary pine as a source of red pigment, while the Erubam Le Peoples of Erub Island in the Torres Strait use the scarlet flowers of the hibiscus as a red pigment to stain body tints. The Noongar Peoples of south-west Western Australia use resin from the *balga* (Noongar language term for grass tree) as a yellow paint that is smeared on skin, while the Bardi Peoples of the west Kimberley region use yellow pigment from *iling* (Bardi language term known in English as caustic bush (*Grevillea pyramidalis*)).

Grass trees (*Xanthorrhoea* spp.) have long been a culturally important species for many Aboriginal Peoples across Australia and knowledge of the life cycle of these plants, and when components can be harvested for use, is well understood. The plant provides material for many purposes including resin, food, nectar, fibre, and wood to construct implements and weapons, as well as firemaking. Noongar Peoples of south-west Western Australia have documented at least 28 different uses for the plant. The growing tip of the stem is edible, although it is rarely consumed as its removal destroys the plant completely, and therefore the opportunity to produce further resources. The long, straight spike of the grass tree dries and detaches during the plant's lifecycle and has been used by Aboriginal Peoples for many purposes. It can be used for the construction of lightweight spears, as a torch or as a drill stick to create fire. The Noongar Peoples use the dried flower stem of the grass tree (*balga*) as a torch. Many First Nations Peoples, including the Yirrganydji and Yidinji Peoples of the Cairns region, the Cammeraigal Peoples of the Eora Nation in the region now known as Sydney, some Tasmanian Aboriginal Groups, and Ngunnawal people of the Canberra region, used the dried stem of the grass tree as a drill stick for starting fire.

Resin is produced at the leaf base of some species of grass trees. Aboriginal Peoples have long sustainably collected and used this resin in many different applications: as a waterproofing agent on canoes and water-carrying vessels such as coolamons; as an adhesive to fix axe heads onto handles and spear tips on spear shafts; and to repair other implements. Colonists in the early 20th century recognised the commercial value of grass tree products and exploited the resin for use in wood polish and varnish, photographic light filters, textile colouring and medicines. A lack of sustainable resin harvesting procedures resulted in widespread destruction of grass trees through large scale removal of entire plants. Several species of native grass trees are now protected by special regulations under government legislation.

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples use science in many aspects of daily life. For millennia, Aboriginal and Torres Strait Islander Peoples have worked scientifically to understand the complexities of the environment, and the living things within their Country or Place. Scientific knowledges regarding physiological processes, the life cycles of species, habitat requirements, food webs and ecosystem interdependencies provide the foundation for the sustainable harvest of environmental resources. Prior to colonisation, the procurement of natural materials from the environment was crucial for many aspects of daily life including the construction of tools, weapons, sound instruments and surfaces for painting, for body adornment and cosmetics and in the manufacture of clothing and bedding. Scientific knowledge of the environment and the living things within it ensured that these essential materials were sustainably harvested, providing ongoing access to the resources. Much of this important knowledge remains in Aboriginal and Torres Strait Islander communities where sustainable harvesting practices continue today.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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Science Inquiry Skills

New elaborations within the Science Inquiry Skills (SIS) strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander Peoples when working scientifically. These intercultural science inquiry skills are throughout Foundation to Year 6 and provide opportunities for students to develop skills relating to:

- acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
- consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
- collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.

Unlike the Science Understanding (SU) and Science as a Human Endeavour (SHE) Teacher Background Information (TBI) materials the teacher background information for the new SIS elaborations provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures. Importantly, the Science Inquiry Skills TBI illustrates how concurrent SU and SHE topics can be used to contextualise the ways in which educators may provide skill development opportunities for the development of these skills.



Animal track identification has long been taught through replication of tracks to highlight defining features

AC SIS029

Acknowledging local knowledge – whose tracks are whose?

CONTENT DESCRIPTION

Represent and communicate observations and ideas in a variety of ways.

CONTENT ELABORATION FOR CCP

- ▶ acknowledging and learning about Aboriginal and Torres Strait Islander Peoples' ways of representing and sharing observations

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things have a variety of external features (ACSSU017)

Living things live in different places where their needs are met (ACSSU211)

A potential way to approach this content description is:

In developing this science inquiry skill, students can acknowledge and learn about the ways that Aboriginal and Torres Strait Islander Peoples have long represented and shared scientific observations. The external features of animals can leave trace evidence in the environment such as tracks on the ground and scratch marks on trees. Aboriginal and Torres Strait Islander Peoples have long observed and recorded the prints, tracks and traces left by animals and they use a variety of methods to represent and communicate such scientific information, such as petroglyphs and paintings. A pedagogical practice of many Aboriginal and Torres Strait Islander Peoples is to replicate animal tracks and traces on the ground to teach children how to identify animals that move through the environment. Sand drawing of identifiable traces of native animals has long been an effective means of representing and communicating knowledges that have been observed of living things in the environment.

The Arrernte Peoples of Central Australia have long, and with great attention to detail, accurately represented animal tracks or prints in the sand; the replicated marks are used as a method of communication and for teaching children. Children are encouraged to repeat the drawings as a way to reinforce and remember this scientific knowledge. An emu print, for example, is represented by holding the index finger and thumb at an angle of approximately 45 degrees and pressing it into the sand. Then, without lifting the index finger the thumb is moved to the opposite side and again pressed into the sand. This represents the three toes of the emu foot. The Noongar Peoples of south west Western Australia use the three middle digits of the hand to represent the emu print in sand.

A lizard track may be represented by a line through the sand to indicate the furrow left by the tail, and dots at regular intervals on either side represent the mark left by the claws as the reptile moves across the ground. Sometimes sticks are used to draw the representation of the animal track or print in the sand. The game *waaiyn* (a term that refers to land animals and reptiles in the Dativuy language of northern Arnhem Land in the Northern Territory) is an Aboriginal children's game where students draw an animal track or print in the sand and others try to guess the representation.

In developing the science inquiry skill of representing and communicating observations and ideas, teachers can acknowledge the ways that Aboriginal and Torres Strait Islander Peoples represent and communicate scientific knowledges, such as the replication of knowledges in sand drawings. Teachers could facilitate the game *waaiyn* to provide an opportunity for students to replicate their own observations of animal prints or tracks in sand or earth. Online resources, such as still images and videos, can be used to demonstrate and acknowledge examples of Aboriginal and Torres Strait Islander Peoples' ways of representing and communicating scientific observations.

AC SIS213

Consulting local knowledge – what made this track? Native or pest?

CONTENT DESCRIPTION

Compare observations with those of others.

CONTENT ELABORATION FOR CCP

- ▶ consulting with Aboriginal and Torres Strait Islander peoples to compare observations and evaluate identifications of animal tracks

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s)..

Living things have a variety of external features (ACSSU017)

Living things live in different places where their needs are met (ACSSU211)

A potential way to approach this content description is:

In developing this science inquiry skill, students could consult with local Aboriginal or Torres Strait Islander Peoples to identify the presence of animals. Living things can leave trace evidence in the environment such as tracks, prints, nests, droppings and remains such as shed skin or feathers. Careful observation of this trace evidence can determine the species of animals that are living in an environment, especially those that are difficult to detect such as nocturnal or secretive animals. Aboriginal and Torres Strait Islander Peoples have observed the environment of their Country or Place over millennia and may have extensive and highly detailed knowledge that can inform the accurate identification of organisms through trace evidence. Students could make and record observations of trace evidence in their local school environment to indicate the presence of specific animals. Consultation with local Aboriginal or Torres Strait Islander Peoples may assist students to accurately identify the living things in the environment through the trace evidence.

As a result of the acute observations of trace evidence left by an animal, many Aboriginal and Torres Strait Islander Peoples possess a highly detailed database of knowledge that can be used to identify the animals that are present in an environment. The evidence can also provide a wealth of additional information about the organism. For example, animal tracks can indicate whether the animal has claws, a tail, or webbed feet; they can also provide information about an animal's size and weight. Many Aboriginal and Torres Strait Islander Peoples can also use trace evidence to deduce an animal's age, sex, life cycle stage, whether it is a native or introduced species, how long ago the animal left the evidence of its presence and the speed at which it was moving.

For example, green turtles have simultaneous limb movement and use the tail to propel themselves forward. This results in parallel flipper markings in the sand with a smooth, central drag mark and a dotted line from the tail drag. Green turtles can be distinguished from other species of turtle using these distinctive tracks and signs. The distance between the outer edges of turtle tracks can also be used to identify the species of turtle. Students who live in coastal regions where turtles are present could undertake a field trip to observe and record the tracks left in the sand by turtle species. Students could consult with local Aboriginal or Torres Strait Islander ranger groups to compare their putative identifications. In another learning opportunity, students could use a digital camera to document animal tracks within the school grounds, presumptively identify the animal responsible for the trace evidence, and consult with local Aboriginal or Torres Strait Islander Peoples to compare their observations and subsequent identification.

To develop the science inquiry skill to compare observations and evaluate identifications, students could undertake a biodiversity survey within their school environment and look for the trace evidence of living things. Students can attempt to identify the organism that has left the trace evidence. Incorporation of this elaboration could provide students with the opportunity to consult with Aboriginal or Torres Strait Islander Peoples to compare observations and identifications. Local Aboriginal or Torres Strait Islander Peoples may have intricate scientific understandings, the result of many thousands of years observing and interpreting trace evidence left by living things, and can apply this knowledge to interpret the trace evidence that students find in the environment.

Year 2

**Teacher background
information**



ACSSU031	Combining materials – manipulating, hafting and joining
ACSSU032	Finite resource conservation/ management
ACSSU033	Pushes and pulls – instructive toys
ACSHE034	Indigenous observations of life cycles
ACSHE035	Sustainable harvesting

ACSSU031

Combining materials – manipulating, hafting and joining

CONTENT DESCRIPTION

Different materials can be combined for a particular purpose.

CONTENT ELABORATION FOR CCP (OI.2, OI.5)

- ▶ investigating the ways in which Aboriginal and Torres Strait Islander Peoples combine different materials to produce utensils (hafting, weaving, sewing and gluing)



Natural materials are used to bind and glue barbs to spearheads.

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

The many and varied utensils of Aboriginal and Torres Strait Islander Peoples have long been carefully constructed to fulfil specific purposes. Often, for implements to possess particular properties such as strength, flexibility and durability, different materials need to be combined. Aboriginal and Torres Strait Islander Peoples use a range of techniques to construct composite utensils including hafting, weaving, sewing and gluing. Prior to colonisation, all the required resources to construct such implements were carefully and considerably acquired from the environment. Today, the construction of utensils continues, sometimes using natural and contemporary materials that are combined using knowledges and techniques passed down through generations for thousands of years. This elaboration provides students with the opportunity to investigate the ways in which Aboriginal and Torres Strait Islander Peoples combine materials to produce utensils such as spears, drills, blankets, spear-throwers, nets, axes and adzes.

DETAIL

For many thousands of years, Aboriginal and Torres Strait Islander Peoples have constructed utensils using a variety of methods to combine materials. Techniques such as hafting, weaving, sewing and gluing have long been essential skills required for the construction of implements that fulfil particular purposes. The combination of materials utilises their individual properties to improve the function of an implement or to confer desirable or additional properties to an implement. For example, hafting is the process of fitting a handle to a tool. This combination improves the function of the implement by increasing leverage. The many procedures that Aboriginal and Torres Strait Islander Peoples have used to combine materials in the construction of utensils for thousands of years have been carefully considered to improve the properties of an implement.

Hafting is a process that has long been used by Aboriginal and Torres Strait Islander Peoples to attach stone blades to wooden handles in the manufacture of axes, adzes, spears, drills and knives. By combining materials to add a handle to such implements, the resulting tool has a wider range of functions and can be used with greater leverage. Aboriginal and Torres Strait Islander Peoples have in-depth knowledge of the materials and combining techniques that are involved in hafting, to ensure a handle is firmly attached to a blade and can withstand the impact forces imparted during its use. Resins obtained from particular plant species are often used to cement or glue components together in the hafting process; the resins are shock absorbent and render the finished product fit for purpose.

The Djargurd Wurrung Peoples of south-west Victoria have been described as constructing stone axes by combining a wedge of green stone, ground at one end to produce a sharp edge, with a sturdy handle formed from a folded length of sapling branch looped around the stone. The components are hafted together by binding with kangaroo sinew and cemented into place with wattle (*Acacia* spp.) gum. The Kalkadoon Peoples of western Queensland construct a *wa-rum-per*

ta, a stone axe manufactured by hafting a ground stone edge onto a wooden handle. The handle is manufactured by bending a single length of wood in the middle and binding this wooden haft above and below with possum sinew. The stone head is then cemented into the wooden loop with spinifex resin or bloodwood gum.

Aboriginal and Torres Strait Islander Peoples also manufactured adzes, cutting tools with the blade hafted at right angles to the handle, by combining different materials. A particular type of adze known as a tula adze, has been recorded as being made by the Wongkanguru Peoples of South Australia. The edge of this adze is crafted from a material, such as chert, that is flaked into a sharp blade. A wide flat top allows for easy hafting and the prepared edges are hafted into the ends of a length of wood. The sharp edge is hafted to the handle using a mixture of grass tree resin combined with ash and kangaroo dung to strengthen the cement.

Hafted utensils are widely documented across Australia. An interesting example of hafting is demonstrated in the tooth drills of the Lamalama Peoples of the eastern Cape York Peninsula. These drills are constructed by incising one end of a wooden handle with two cuts at right angles. String is used to bind the distal ends of the incision to prevent it splitting further up the wooden handle. The tooth of a large animal, such as a kangaroo, is wedged into the incision and firmly fixed into place by binding with strong twine and cementing with plant resin. This hafting technique looks remarkably similar to a contemporary drill chuck. The combination of materials by hafting blades to handles using binders, adhesives and cement mixtures to secure the components in place, confers the properties of strength and durability; this makes the tool more useful as it can be used with increased force and leverage.

Spears and spear-throwers have long been constructed by combining different materials in a variety of ways. Composite spears are constructed using several different materials; the type of material depends on its intended function. Hunting spears for large game must be strong, heavy and durable for maximum impact, while fishing spears need to be buoyant, lightweight and barbed for easy recovery after discharge and to prevent the fish from escaping. An advantage of composite spears is that a damaged component, such as a broken tip, can be easily replaced rather than constructing an entirely new implement.

The Pitta Pitta Peoples of western Queensland use three different timbers to construct a *per-cha ma-ro* (Pitta Pitta language that describes a type of composite spear that translates to “peg possessor” in English, as it is thrown with a spear-thrower). A heavy wood such as *Acacia* spp. is selected for the main shaft and a lighter wood, such as pine, is used for the rear shaft to give the spear strength, optimal mass distribution and flexibility. The two shaft components are firmly attached by splicing the woods together and gluing with spinifex resin. A hook is mounted into a wooden tip, and then bound to the shaft with sinew or fibre. In the Musgrave Ranges region of the Western Desert, the Yankunytjatjara Peoples construct *oiritchanna* (composite hunting spears) from different woods to construct spears that have a flexible shaft and a hard, durable tip. A light flexible wood, obtained from

plants such as the wonga wonga vine, is used for the spear shaft, and a hard, heavy material such as mulga is used to construct the spear head. The components of the spear are bound together using kangaroo sinew.

Spear-throwers are implements that increase the velocity and accuracy of projectiles using lever mechanisms. They consist of a shaft, with a grip at one end and a small peg at the other, that is designed to fit the base of the spear to be launched. The shaft and peg are often made out of different materials to withstand the impact of different physical stresses on the components. The shaft is often constructed from timber, while the peg that holds and launches the spear and is subjected to stress forces, may be constructed from bone, tooth, stone or wood. The components are bound together using material such as animal sinew or plant fibre, and the join is reinforced with resin, gum or wax. Spear-throwers were reportedly constructed by the Ngarrindjeri Peoples of the lower Murray River region in South Australia with a small, elongated wooden shaft and a peg made of animal bone or tooth, deeply embedded in resin. The Larrakia Peoples of the coastal region of the Northern Territory near Darwin construct long wooden spear-throwers with a wooden peg attached with plant fibre and beeswax. The combination of materials and the processes used in the construction of spear-throwers ensures that they are effective levers that can withstand the stress forces associated with launching a spear.

Weaving fibres with other materials is a technique that has long been used by Aboriginal and Torres Strait Islander Peoples to construct utensils, and is widely evident across Australia. The Dyirbal Peoples of far north Queensland construct animal nets and traps from a range of materials. *Bala warrany* (that translates to turkey net in English) and *bala mugarru* (that translates to butterfly net in English, due to its winged shape), are constructed from lengths of lawyer cane onto which the net is woven. *Bala warrany* is a turkey trap that is constructed by setting several lengths of lawyer cane into the ground and bending the cane over into a semi-circular shape. The netting is then placed over the top of the frame and knotted or fixed to the frame. One end is closed while the other remains open to capture the turkey that enters the net. *Bala mugarru* is a folded fishing net that is shaped like the wings of a butterfly, giving the net its name. It is constructed by combining two lengths of lawyer cane, bent into a curved shape, with netting that is knotted along each length of cane from one end to the other. The net is used to catch fish, turtles, eels and other aquatic animals. The net is held ajar and dragged through the water so that fish and other organisms swim into the net. The two wings of the net are then brought together to close the net, thus entrapping the catch. Combining materials creates a net with a strong and flexible frame and a fine fibre mesh to capture important resources effectively.

Other woven utensils, such as baskets and bags, are also made by combining different materials. In the Alligator River region of Arnhem Land in the Northern Territory, the lands of the Gaagudju, Jawoyn and Kunwinjku Peoples, watertight baskets were reportedly constructed by weaving a combination of *Pandanus* and *Livistonia* fibres, sealing the inside with a thin layer of wax, and decorating the outside with a mixture of ochre and other pigments. The Lamalama Peoples of the eastern Cape York

Peninsula weave the reddish coloured fibres from *Acacia latifolia* alternately with white coloured fibres from *Brachychiton diversifolium* to produce a horizontally striped woven bag.

Aboriginal and Torres Strait Islander Peoples have long utilised the gluing process, using adhesives derived from gums, resins and beeswax, to manufacture and repair utensils. Adhesive cements can alter the qualities of an implement to make it fit for purpose. For example, applying adhesive cement can ensure that an item is waterproof and improve its durability. Sheaths for fire drill sticks are manufactured to protect the sticks from moisture and are constructed by combining a number of materials. Aboriginal Peoples of northern Queensland constructed and decorated protective sheaths for fire sticks. The adhesive used in the construction of the sheath acted to provide a waterproof cover for the sticks and as an adhesive to attach the ornamental seeds. In parts of the Cape York Peninsula in northern Queensland, the sheath for fire sticks is made using *Pandanus* spp. leaves bent over the sticks, bound with twine, and sealed with beeswax. These covers are decorated using the adhesive property of the beeswax to glue bright red jequirity bean (*Abrus precatorius*). On the central Queensland–Northern Territory border, the Indjalandji-Dhidhanu Peoples crafted hafted blade knives and sheaths to protect the blades. The knives were constructed with flaked stone points embedded in resin and hafted onto a wooden handle. Sheaths of paperbark sheets, wrapped tightly with fibre and bird down inserted into the end, protected and preserved the blade. The Meriam Peoples of the Island of Mer in the Torres Strait, and Peoples of the western Cape York region, crafted knives using shark teeth fixed onto a length of wood with gum-cement or resin.

Body adornments and regalia required the use of adhesives; feathers, down, seeds and leaves were glued to items such as headdresses or attached directly to the body. The Awngthim Peoples of the western Cape York Peninsula reportedly used beeswax to attach the bright feathers of the lorikeet and flowers of the batwing coral tree to their body. The Peoples of the Eora Nation in the region now known as Sydney reportedly used grass tree resin to attach animal bones and teeth into hair or onto a decorative headband.

The utensils and clothing manufactured by Aboriginal and Torres Strait Islander Peoples prior to colonisation provided physical protection and were manufactured from a range of materials that were sewn together. For warmth and for protection from wet weather, skin cloaks were typically manufactured. Waterproof protection was provided by the oily, water-repellent hairs which were further enhanced when the cloaks were rubbed with fat; this combination improved the insulating properties of the materials. The cloaks were large and could also be used to sleep on at night, acting as both mattress and blanket. Possum skin cloaks have long been a culturally important, essential item of clothing, particularly for Peoples whose Country/Place encompasses the colder climates across the south east of Australia. Often, the inner surface of each cloak was incised and painted with ochre to depict themes from nature or stories of identity, kinship, family group and Country. As cloaks were worn from a young age the cloaks are initially small with only a few skins sewn together. Additional skins are sewn onto the cloak as the individual grows. Kangaroo sinew was frequently used to sew the skins together, with up to 70 skins required to manufacture an adult sized cloak.

After European colonisation the manufacture of possum skin cloaks was prohibited. However, revival of the practice is providing a significant way for many Aboriginal Peoples, including the Gunditjmara and Yorta Yorta Peoples of Victoria, to reconnect with traditional sewing practices and restore their cultures.

This elaboration provides students with the opportunity to investigate the variety of ways that Aboriginal and Torres Strait Islander Peoples combine materials for particular purposes. Processes such as hafting, weaving, sewing and gluing have long been used, and in many cases continue to be used, to combine materials in the manufacture of utensils. Through combining materials the properties of implements can be enhanced, thus improving the functionality of the utensil for its intended purpose. Students can learn how Aboriginal and Torres Strait Islander Peoples have long carefully considered the selection of suitable materials used in the production of utensils.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU032

Finite resource conservation/management

CONTENT DESCRIPTION

Earth's resources are used in a variety of ways.

CONTENT ELABORATION FOR CCP (OI.2, OI.5)

- ▶ considering how Aboriginal and Torres Strait Islander Peoples live in regions with scarce resources or in sensitive environments



Freshwater mussels were stored a metre underground to provide ready access to a food resource

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Earth provides many natural resources that have long been accessed, sustainably harvested and utilised by Aboriginal and Torres Strait Islander Peoples. Traditionally, the plant and animal-based resources within the geographical region of a particular Aboriginal or Torres Strait Islander cultural group's Country or Place provided food, medicine and the materials required for the construction of tools, domestic implements and shelters. In sensitive environments, such as the desert regions of Australia, natural resources, including water and the plant and animal life that provide food, are ephemeral. This means that they are only available for a short period of time. In these regions, resources are used in a variety of ways to ensure an ongoing supply of water and food during times when resources are scarce. This elaboration provides students with the opportunity to consider the scientific knowledges and understandings of Aboriginal and Torres Strait Islander Peoples that inform the preservation of water and food to ensure ongoing access to essential natural resources.

DETAIL

Earth provides many natural resources that, for millennia, have been carefully and sustainably managed by Aboriginal and Torres Strait Islander Peoples. Natural resources include biotic components such as animal and plant life and abiotic components such as water, sunlight, air and rock. Prior to colonisation there were more than 500 Aboriginal and Torres Strait Islander Nations, each occupying a specific geographical region. The natural resources available within a Nation provided the resources needed for food, medicine, water, and matter for material culture. Many Nations encompass sensitive environments, such as regions of aridity, where water can be scarce, or where climatic conditions limit reliable or continual access to resources. For many thousands of years Aboriginal and Torres Strait Islander Peoples have accessed resources in a variety of ways to procure required supplies while maintaining environmental balance.

Water is a necessity for life and knowing how and where to find water is a valuable skill that has been practised by Aboriginal and Torres Strait Islander Peoples for many thousands of years. Water can be a scarce resource in arid areas of Australia, such as desert regions, due to low amounts of rainfall and high evaporation rates. Further to this, animals also seek freshwater resources so precious water sources need to be carefully protected from animal pollution and contamination. Many water sources are covered with stone slabs, leaves, branches or grass to prevent evaporation and contamination. On Damut Island in the Torres Strait, waterholes were covered using sticks and blocks of wood to protect the water within. The Baiyungu People of the north-west Australian coast preserved water supplies after rainfall by covering the water that collected in rock cavities with lids, using flat pieces of limestone. These methods of water preservation prevent wild animals polluting a water source by falling in to a well and drowning. Evidence of the understanding about the need to protect a scarce freshwater supply is found in reports of early European colonists. One such report details how local Aboriginal Peoples in the central desert protected a precious freshwater supply that was

threatened by the micturition (urination) of a camel. Handfuls of earth were rapidly piled in front of the flow to prevent the urine from contaminating the water. The preservation and management of water resources was, and still remains, an important skill to ensure the ready supply of drinking water for communities.

Plant and animal resources for the provision of food have long been carefully and sustainably accessed by Aboriginal and Torres Strait Islander Peoples. Aboriginal and Torres Strait Islander Peoples rely on deep ecological understandings of the environment to know when and where particular resources can be harvested. Often resources are only available for a short period of time; for example, the fruit of particular plants or when animals migrate or aestivate. Such resources are considerably harvested and preserved at the appropriate time, thus ensuring that a community has an abundance of food supplies during the times when access to food resources may be limited.

The Alyawarre Language speakers from Ampilatwatja in the Northern Territory hold specialised knowledge about *akatyerr* (desert raisin; *Solanum centrale*) that has been passed through generations for millennia. *Akatyerr* is a fast-growing shrub that fruits prolifically the year after fire or good rainfall. The plants fruit for only two months and during this time the *akatyerr* is harvested, processed, cleaned, dried and either stored or ground into cakes. The dried *akatyerr* fruit are ground using special grindstones, mixed with water to make a cake, rubbed with ochre, and left in the sun to dry. Once dried, the cakes, covered with spinifex grass and tied in a bundle, can be stored for at least two years, providing a ready source of nutritious *akatyerr* when the fruit or other resources are scarce. Harvesting and preserving *akatyerr* continues today, as it has for millennia, in the ways taught by Alyawarre expert knowledge holders.

The aestivation of the bogong moth in the cool caves of the Snowy Mountains on the lands of the Ngarigo Peoples in southern New South Wales has long been an occasion for Aboriginal Peoples in the region to unite for a feast. The moths, an extremely nutritious food source with a high fat content, are harvested with smoke and nets crafted specifically for the purpose. The moths are cooked gently on the edge of a fire and the nutrient-rich body is separated from wings and heads before consumption. The moths may also be preserved for later consumption by being pounded into cakes and smoked; once preserved in this way, the moth cakes can be transported down into the valleys.

Smoking, or other methods of dehydrating to preserve food, is a technique that Aboriginal and Torres Strait Islander Peoples have long utilised to preserve food resources for times of scarcity or when access to particular resources is not available. The Gunditjmara Peoples of south-west Victoria manufactured a vast and complex aquaculture network to harvest fish and eels after the Autumn rains. The aquaculture network allowed the surplus population of eels to be harvested and preserved. Eels and fish were treated by smoking in special hollowed out trees. Heat from a fire was set underneath the hanging fish and eels to encourage water evaporation, thus preserving them for trade or storage. Prior to colonisation, the Mabuygiwgal Peoples of Mabuag Island in the Torres Strait preserved meat through dehydration. In the dry season strips of dugong were dehydrated in the sun,

while cooked strips of turtle meat were elevated on sticks so that the heat of the sun could remove the water content and preserve the meat. This supply of preserved food was then available in the north-west monsoon season or for travelling.

Prior to colonisation, the Barkindji Peoples of far west New South Wales, collected and stored live freshwater mussels underground, as they understood that these shellfish can live in moist sand for several months. In this region mussels were not always consumed fresh. Larders, containing many hundreds of mussels neatly stacked in layers, were buried at depths of up to a metre to provide access to a food resource when required. Staple food resources were also stored by the Yanyuwa Peoples of the Boorooloola region in the Northern Territory who dug trenches for the storage of *Cycas* spp. seeds. The seeds of *Cycas* spp. are only available for a few months at the end of the dry season in sclerophyll regions of northern Queensland, the Northern Territory and Western Australia. The Yanyuwa Peoples stored the kernels of *Cycas* spp. for several months in trenches approximately 30 centimetres deep. When required, the seeds were recovered from the earth, ground into flour and made into loaves that were baked in hot ash. These methods of storing resources underground ensured that food supplies were preserved and available for safe consumption when needed.

Aboriginal and Torres Strait Islander Peoples have deep environmental knowledges and understandings about Earth's natural resources and have long used these resources in a variety of ways. For millennia, resources have been carefully conserved to ensure ongoing access during times of scarcity or in sensitive regions where resources may not be readily available. Important water resources that provide access to freshwater in arid environments are protected from contamination and evaporation, and food preservation methods have long ensured access to plant and animal resources when resources may be scarce. This elaboration provides students with the opportunity to consider how Aboriginal and Torres Strait Islander Peoples live and manage Earth's resources in regions with scarce resources or in sensitive environments.

CONSULTED WORKS

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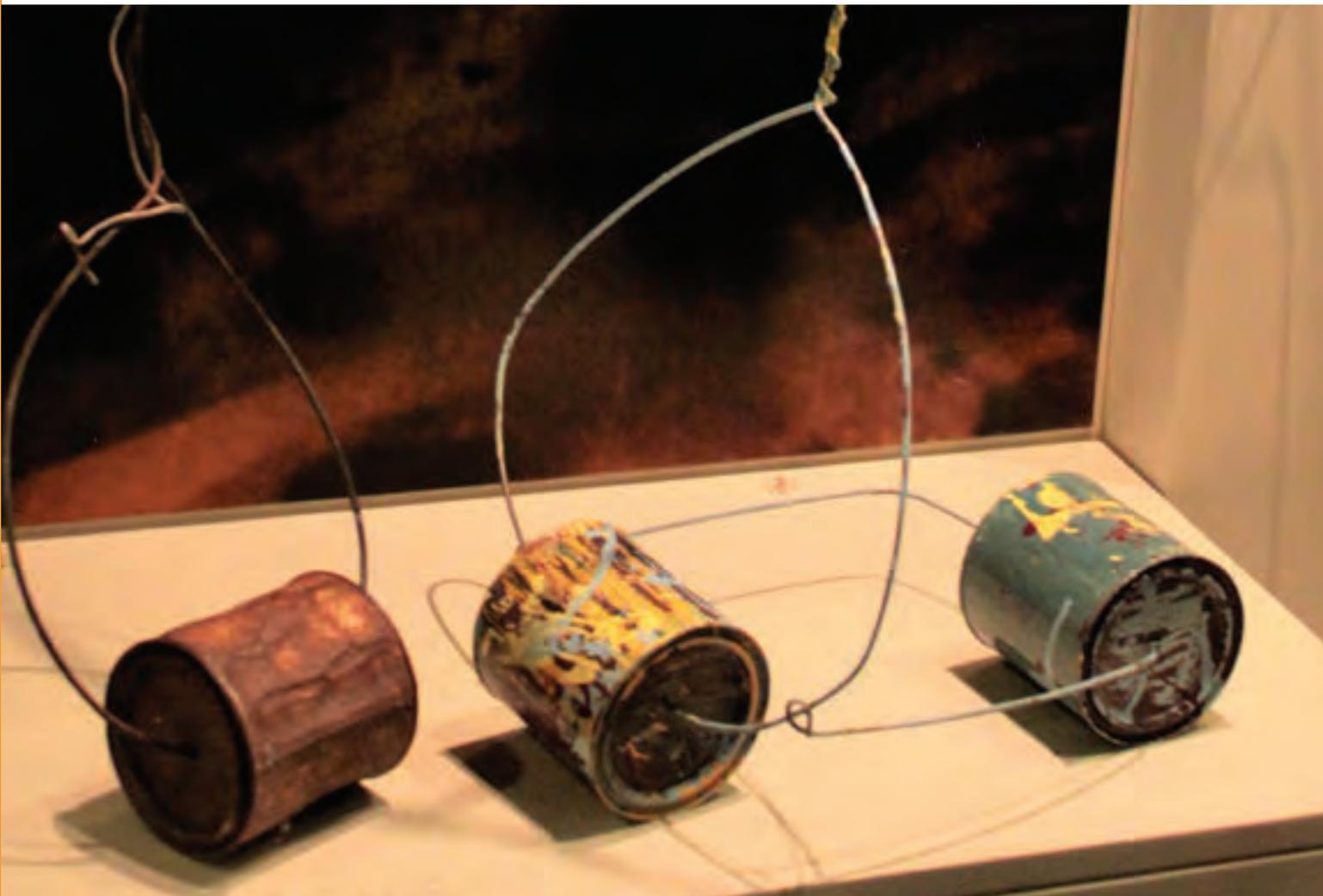
Pushes and pulls – instructive toys

CONTENT DESCRIPTION

A push or a pull affects how an object moves or changes shape.

CONTENT ELABORATION FOR CCP (01.5)

- ▶ investigating the push and pull movements of traditional Aboriginal and Torres Strait Islander children's instructive toys



Throughout central Australia pull-along and push-along toys are constructed using contemporary materials

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long used instructive toys as play-based learning objects. Instructive toys are devices or models that are objects of play, usually designed for children, that stimulate learning by promoting the development of a particular skill or providing play experiences to learn about a particular subject. Instructional toys may be simplified or miniaturised versions of objects used by adults or may model the activities and practices of adults. Movement of instructive toys is through the application of a force, such as a push or pull. Pushes and pulls are contact forces that, when applied to an object, can cause a change in the motion or direction of an object. This elaboration provides students with the opportunity to investigate Aboriginal and Torres Strait Islander Peoples' long-held understanding of the physics of movement through the push and pull movements of instructive toys.

DETAIL

For millennia, Aboriginal and Torres Strait Islander Peoples have used instructive toys and games as educational devices and models that stimulate and achieve learning in young people. Children's games and activities have long provided a context for acquiring knowledge, understanding and the development of skills required in later life. Many instructive games and toys involve objects that can be moved with the application of force. A force is an external influence applied to an object that, when unopposed, causes the object to change motion, direction or shape. A push or pull is a type of contact force exerted directly on an object, known as 'applied force'.

Many instructional devices that are used by Aboriginal and Torres Strait Islander Peoples are set into motion through the contact forces of pushes and pulls that are applied by a person. A variety of spinning tops has been recorded throughout Australia; the spinning tops have been made from materials such as the hard shell of a nut, beeswax, plaster or volcanic rock. These materials usually had a hole drilled through the centre and were fastened to a stick with resin and twine. A spinning top is set in motion by a simultaneous push and pull action. The thumb or palm of one hand exerts a push on the central stick, while the forefinger or other hand creates a pull in the opposite direction. On the Island of Mer in the Torres Strait the spinning stone tops of the Meriam Peoples are called *kolaps*. An adult game involving these spinning stone tops was recorded as creating intense competition among the Meriam Peoples, and the winner was the person whose spinning device stayed in motion the longest. The Yidinjdji Peoples of the Cairns region of far north Queensland made *bunbuj*, spinning tops from the gourd of the wax gourd plant (*Benincasa hispida*). The objects were decorated with bands of ochre; a small hole imparted a humming sound when the top was set in motion. The magnitude of the initial push and pull forces that set the spinning tops in motion influenced how long the device stayed spinning before it came to a standstill.

Water play and games have long been enjoyed by many Aboriginal and Torres Strait Islander children and are essential in building aquatic skills and knowledge. Water-based activities can assist the

development of coordination and gross motor competence, building skills for the future. Water play includes play with miniaturised objects that float and model vessels, such as canoes or rafts used by adults. Prior to colonisation, canoes were important vessels used in travel, the transportation of goods, and fishing and hunting activities. Canoes and rafts can be steered through water using paddles or poles; spears are sometimes used as poles. The Watiwati and Wemba-Wemba Peoples of the Swan Hill region of Victoria steer canoes through water using a propelling stick; great skill and ability is required as the stick is thrust to the bottom of the water to push the canoe along. Through instructive toys and games children learn the skills of both constructing water vessels and manoeuvring the vessels through water using push and pull forces. The culmination of these canoeing skills was seen in the much-celebrated adult bark canoe competitions held by the Ngarrindjeri Peoples and neighbouring groups on the lower Murray River. The Yolngu Peoples of north-eastern Arnhem Land construct toy canoes for children from bark, using the forces of pushing and pulling to bend the bark and craft the object into shape. Once completed, children push their canoe along the surface of the water to set it in motion; the canoes are often raced against each other. Larger toy canoes and rafts able to carry children are also constructed. Children play in the shallow waters on such vessels with miniature paddles or sticks, learning the skill of propelling the watercraft using pushing and pulling forces. When heavy rains inundated the Yarra River on the lands of the Kulin Nation, children paddled small canoes in the shallow waters of the flooded flats. The canoes were set into motion through the pulling action of the paddle through the water and the speed of the vessel was determined by the magnitude of the pulling force that was applied.

Many Aboriginal and Torres Strait Islander children whose Country or Place encompasses oceans, rivers, creeks or waterholes learn to swim and dive from an early age through games and play. These childhood activities develop competency and expertise in skills that may be required later in life, such as the acquisition of abalone or shellfish from aquatic environments. The Mabuiag children of Mabuiag Island in the Torres Strait play *udai*, a catching game that is played in the ocean. Children go into the ocean in two teams and attempt to throw an object using a pushing force, such as a bean or hard fruit, to other members of their team. The opposition tries to intercept the throw and obtain the object for their team.

The mud banks of tidal rivers provide an environment for sliding games and play. Lamalama children of the eastern Cape York Peninsula collect a long piece of bark to use as a board or sled. Resting on the board with one knee, the board is propelled forward by pushing backwards with the opposite leg. This pushing force is rapidly repeated so that the board skims along the mudflat at a high speed. The children of Gajirabeng Country in the Kimberley region of Western Australia also played sliding games in the mud flats. Here, one child holds the feet of another child who lay on their stomach on the ground with knees bent upwards; a push force was applied to the feet to propel the child forward through the mud. Where water was not available for such games, sleds made of bark and branches may have been used on grassy hills in a similar manner. In Central Australia, children used pushing or pulling forces to set a bark sled into motion to slide down a steep bank; the speed of travel was

determined by the magnitude of the initial pushing force. Instructive toys and games continue to fill an important role in the development of strength, balance and agility; in aquatic environments these skills build confidence and capability in children.

Since the 1940s, Aboriginal and Torres Strait Islander pull-along and push-along toys for children, such as trucks and rollers, have been constructed using a variety of contemporary materials. The Arrernte, Luritja and Pitjantjatjara Language speakers of Titjikala in central Australia continue to use their knowledges of instructional toy construction to manufacture pull-along toys; the process now incorporates contemporary construction materials. Empty powdered milk or treacle tins are crafted to replicate vehicles, such as horse-drawn carts or wagons; the tins are filled with sand or gravel and holes are created to attach a wire handle. More recently, scrap metal and old car parts including tyres are used to construct different push-along or pull-along toys, such as replica cars. Truck toys, widely distributed across Australia, are manufactured using a range of readily available materials including fencing wire, string, wheel rims, food tins and fishing line. Other instructional pull-along toys are made from a tin with holes punched at either end, wire threaded through, and filled with sand. The Pitjantjatjara children of the central Australian desert use roller toys, known as *taraka taraka*, made from two tins connected by lengths of wire and with a handle extending upwards. The Wik, Wik Way and Kugu Peoples of the Aurukun region of the western Cape York Peninsula construct push-along truck toys with two handles made from sticks or branches. The sticks are notched in at either side of a single can filled with sand. Such contemporary toys that model many modern vehicles are set in motion through push or pull forces.

This elaboration, in the context of Aboriginal and Torres Strait Islander Peoples instructive toys, provides students with the opportunity to investigate how push and pull forces affect the motion of an object. For millennia, Aboriginal and Torres Strait Islander Peoples have used instructional devices and models to stimulate learning in fundamental physics and skill development. Aboriginal and Torres Strait Islander Peoples have long applied the physics of motion and instructive toys are used to teach children how push and pull forces influence movement.

CONSULTED WORKS

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ACSHE034

Indigenous observations of life cycles

CONTENT DESCRIPTION

Science involves observing, asking questions about, and describing changes in, objects and events.

CONTENT ELABORATION FOR CCP (01.5)

- recognising how Aboriginal and Torres Strait Islander peoples observe and describe developmental changes in living organisms and answer questions about when to harvest certain resources



Magpie geese are best harvested when they are fat and heavy after abundant food

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have made continual observations about events in the environment for many thousands of years, asking questions and developing scientific explanations that describe changes in living organisms. Knowing the suitable times to sustainably access and harvest certain resources requires a comprehensive understanding of animal distribution and behaviour, including events such as reproductive cycles and migrations. Aboriginal and Torres Strait Islander Peoples have long observed developmental changes in animals. These observations can be used to provide information about when resources can be harvested, such as when an animal is most likely to be fat, when and where animals will migrate or aestivate, and nesting behaviour. This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples have long recognised and described developmental changes in living organisms and how this knowledge can be used to answer questions about when to harvest certain resources.

DETAIL

Prior to colonisation Aboriginal and Torres Strait Islander Peoples' intimate and detailed knowledge of Country or Place facilitated the acquisition of all necessary resources from the natural environment. The availability of plant and animal resources is influenced by geographical location and the seasonal cycle, and these factors are well understood by Aboriginal and Torres Strait Islander Peoples. Ontogeny is the biological development of a living organism that results in progressive changes in shape, size and function. Developmental changes in living things provide information about the life cycle and stage of life of an organism. Aboriginal and Torres Strait Islander Peoples have long observed changes in living organisms and have a wealth of information about developmental events, including: knowing where and when eggs will be laid or hatch; the time an animal will be best for consumption; when a plant will fruit; and the migratory patterns of many animals. For many thousands of years Aboriginal and Torres Strait Islander Peoples have observed and documented developmental changes in living organisms and this information is used to answer questions about when to harvest certain resources.

For many animals the deposition of fat is linked with seasonal food quality and availability, reproductive cycles and migratory patterns. Accumulation of body fat can be evidenced by weight gain in an animal and this has long been known and understood by Aboriginal and Torres Strait Islander Peoples. The English language term 'fat cycle' was coined in the 1980s as a way to describe the Yolŋu Language term *djukurmirr*, that translates to 'fat possessing' in English. Many Aboriginal and Torres Strait Islander Peoples observe animals, such as fish, birds, crustaceans, mammals and reptiles, for *djukurmirr* to indicate the developmental/cyclical stage of the animal and determine the optimal time for harvest.

The fat content of animals influences their flavour and is a highly desirable, high-energy resource for Aboriginal and Torres Strait Islander Peoples. The Kuku Yalanji, Kuku Nyungul and Jalunji Peoples of

Wujal Wujal, near the Bloomfield River in northern Queensland, assess the condition of a turtle by feeling the flesh under the front flipper of the animal. The Guugu Yimidhirr Peoples of the Hopevale region in northern Queensland identify the fatness of turtles by examining the base of the neck of the animal for the quality and quantity of flesh. Dugong hunters of the Torres Strait use a variety of observations of developmental change to select animals for harvesting. An experienced hunter can identify an animal that is fat and ready for harvest. Experienced hunters can also differentiate between male and female dugongs by the length of their faces and their position in the line of a swimming herd. Observations of developmental changes and behavioural characteristics mean that pregnant dugongs can be identified and excluded from the hunt. Zoological expertise is used to identify small dugongs, mother and calf or pregnant dugongs; hunting dugongs at these developmental stages is not permitted and only suitable animals are harvested. Experienced Aboriginal and Torres Strait Islander ecologists have the skill to determine how many times a dugong has bred by the length and size of the female's teats.

Aboriginal and Torres Strait Islander Peoples possess deep knowledges of the migratory behaviours of many native species, and understand that such behaviours can be connected with developmental changes, such as reproductive or nesting events. The Torresian imperial pigeon, *gainau* in the Kalaw Lagaw Ya Language of the western Torres Strait Islander Peoples and *daumer* in the Meriam Mir language of the eastern Torres Strait Islander Peoples, migrate from New Guinea at the end of the monsoon season to nest in the mangrove areas of the Torres Strait Islands. The pigeon lays eggs that are incubated by both parents for approximately one month; each day the adult birds flock to inland areas to feed on wild nutmeg trees. Torres Strait Islander Peoples have long understood the migratory pattern of the pigeons and its association with developmental changes in birds, and they are hunted as they migrate in predictable patterns.

The flowering of Australian blackwood (*Acacia melanoxylon*) indicates the time the *yula* (palawa kani language term of Tasmanian Aboriginal Peoples for muttonbird; *Ardenna tenuirostris*), return from their northern hemisphere migration to breed on small islands in the Bass Strait and Tasmania. The adult birds return in September to prepare their nest; they then leave the nesting islands to feed and build up body reserves before laying a single egg in late November. The incubated egg hatches in January, and the parents feed and care for the hatchling until April, when the birds migrate back to the northern hemisphere. Tasmanian Aboriginal Peoples have long understood the developmental changes of *yula*, and use this knowledge to accurately time suitable periods to harvest eggs, chicks or fat adult birds for food, oil, feathers or down. Muttonbirding remains an important cultural and economic activity; today Tasmanian Aboriginal Peoples continue the practice in the ways of their ancestors.

Many species of plant are also observed for developmental changes to answer questions about when resources can be harvested. For example, the *bonye* (traditional Aboriginal name for the Bunya pine; *Araucaria bidwillii*), is a plant that has important significance to the Wakka Wakka, Jarowair, Djaku-nde and Barrungam Peoples of *Booburrgan Ngmmunge* (Bunya Mountains) in

southern Queensland. The *bonye* produces large ovoid-shaped cones in an annual seasonal cycle, each weighing up to ten kilograms; bumper crops occur approximately every three years. Each cone can contain 60 or more seeds that are highly nutritious, rich in oils and carbohydrates. The Aboriginal Peoples who have cultural responsibilities for *Booburrgan Ngmmunge* and the *bonye* within the region, observe the developmental cycle of the tree to anticipate the times when an abundance of cones will occur. In anticipation of the three-year cycle that brings an abundance of seeds, special envoys sent by the custodians of the *bonye* carry message sticks to neighbouring communities to invite particular groups to attend the seasonal gathering. This is timed for when the seeds ripen and are ready for harvest. Thousands of Aboriginal Peoples travel great distances to attend the Bunya Gathering, trade goods and knowledges, share stories, songs and dances, conduct business, attend to personal matters, and feast on the abundant *bonye* seeds. Another plant, the Kangaroo Apple (*Solanum laciniatum*), is poisonous when unripe but a nutritious food source once ripened. For many thousands of years, Aboriginal Peoples of the south-eastern parts of Australia where the plant is found, have carefully observed the plant for developmental changes. The fruits are harvested when they are safe for consumption, that is when they change colour from yellow-green to bright blood-orange.

Aboriginal and Torres Strait Islander Peoples have observed the natural environment for millennia, and have built a wealth of knowledge about the developmental changes of the many native organisms within a Country or Place. Observing and describing developmental changes and associated events of living things in the environment ensures that the knowledges and understandings about organisms provide information about when to harvest particular resources. To ensure sustainability of species and thereby maintain the accessibility of resources, each organism and the best time for harvest are carefully considered. This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples observe and describe the developmental changes and reproductive events of living organisms, and how this information is used to answer questions about when to harvest particular resources.

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ACSHE035

Sustainable harvesting

CONTENT DESCRIPTION

People use science in their daily lives, including when caring for their environment and living things.

CONTENT ELABORATION FOR CCP (OI.2, OI.3, OI.5)

- ▶ investigating how Aboriginal and Torres Strait Islander Peoples use science to meet their needs, such as food supply



Knowledge regarding colony dynamics and organisation of beehives ensures hive survival and continued access to honey

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long used science to inform the sustainable harvest of environmental resources to meet their needs, such as the supply of food. Sustainable harvesting practices employed by Aboriginal and Torres Strait Islander Peoples demonstrate care for the environment and living things through the considered acquisition of resources. A diverse range of scientific knowledges and understandings underpins the harvest of resources to ensure that ecosystem balances are maintained and that the living things within an environment are protected for the ongoing generation of resources. Cultural protocols, founded on these deep ecological understandings, safeguard and care for living things and the environment. This elaboration provides students with the opportunity to investigate how Aboriginal and Torres Strait Islander Peoples use science in their daily lives to harvest resources sustainably in order to meet their needs.

DETAIL

In ecology, sustainable harvesting is described as sensitive and responsive harvesting that maintains environmental balance. Its methods allow population numbers to be maintained or to increase over time, and play a role to prevent the extinction of species. Furthermore, the sustainable harvest of a resource requires an understanding of ecological interdependencies and sustainable harvesting practices, that ensure that dependent species populations are unaffected by resource acquisition. Aboriginal and Torres Strait Islander Peoples have in depth scientific knowledges and understandings of the environment of their Country or Place, including life cycles and organism longevity, mating behaviours, timing, home ranges and diets, that inform when and where resources can be accessed. Organisms were, and still are, purposefully harvested at a time in their lifecycle and/or population density, to ensure the long term survival of the species and its dependent organisms. Prior to colonisation, such scientific knowledges and understandings were used daily by Aboriginal and Torres Strait Islander Peoples to care for the environment and living things, and to acquire essential resources, such as food supplies. These knowledges continue to inform harvesting practices today.

Native bees have long been an important organism for many Aboriginal and Torres Strait Islander Peoples, as they are highly valued for the resources they produce, including honey (sugarbag) and wax; these resources are used as food, adhesives and medicine. Native beehives produce only small amounts of honey, up to 50 times less than European honeybees, and as such it has long been an important social and economic resource. Wild honey can be located by skilful tracking to find the hives. Careful access using sustainable harvesting practices to collect honey from the standing tree ensures that the hive and the tree are not destroyed.

The Awngthim Peoples of western Cape York Peninsula have been recorded as collecting wild honey using a thin length of fibrous timber that acts as an absorbent sponge. A small incision is made either directly above or below the hive and the timber tool carefully inserted into the hive. The honey soaks into the fibrous timber, thus allowing it to be extracted and transferred to a container. The incision

may be resealed or blocked with mud or tightly packed grass to ensure the preservation of the hive. Harvesting native honey using sustainable methods is evidenced in trees that are still standing today; these trees bear as many as six bark incision scars, demonstrating that they have likely been revisited multiple times to access wild honey. This harvesting practice demonstrates scientific application and care for the environment as it ensures that living things in the environment, in this case the native bees and the tree hosting the hive, are not damaged and continue to thrive.

Aboriginal and Torres Strait Islander Peoples have long used scientific understandings of plant growth characteristics to sustainably cultivate tubers as a food resource. Yams are a type of plant that has stem tubers. These are enlarged structures of the stem that act as nutrient and energy storage for the plant, and enable the plant to regrow. Stem tubers have nodes from which a new shoot can sprout and develop into a new plant. On Yolŋu Country in north-eastern Arnhem Land, women have the knowledge, expertise and responsibility to cultivate and harvest *ganguri* (long yam). *Ganguri* grow deep underground and are located by acute observation of the surface vines to find the place to dig up the tubers without damaging the vine. As the *ganguri* are harvested, the vine stem and a small section of the tuber are left in position and the earth is replaced, to provide protection for the resource and encourage the yam to form again. The Meriam Peoples of Mer Island in the Torres Strait have long practiced the sustainable harvest of *ketai* (a climbing form of yam), that provides a staple vegetable food resource. When digging for the tubers, only new tubers are harvested, and care is taken to ensure that the parent tuber remains undisturbed. This practice demonstrates a botanical understanding that the parent tuber will continue to produce new tubers if it is undamaged.

Aboriginal and Torres Strait Islander Peoples have deep knowledges and understandings of aquatic ecosystems, and have developed and employed technologies and techniques for the sustainable harvesting of fish over millennia. Aquatic ecosystems are culturally, economically and socially of immense value to Aboriginal and Torres Strait Islander Peoples, as they provide resources such as foods, medicines and material for implements. The knowledge of plants that contain piscicides has long been used as a means of sustainably harvesting fish. Saponins are a group of chemicals that are natural detergents; they are found in a range of plant species and foam in aqueous solutions. Rotenone is a chemical that occurs naturally in some plant species. When crushed in water, plants that contain saponins or rotenone release the chemical that affects the respiratory organs of the fish, producing a temporarily stupefied or paralysed state. When affected, the fish rise to the surface of the water where they can easily be harvested. This sustainable method of harvesting fish relies on the knowledge that the effect of the chemical, in the correct concentration, is short-lasting and not fatal to the fish or detrimental to the ecology of the aquatic environment. The application of such biochemical and physiological knowledge is widely documented across Australia. For example, on Mer Island in the Torres Strait, leaves of the vine sad (Meriam Mir language of the Eastern Islands of the Torres Strait for *Derris uliginosa*) are pounded to release rotenone and the crushed leaves are thrown into the water to stupefy fish. The Mitakoodi Peoples of the Cloncurry River region in north Queensland use the plant *Tephrosia astragaloides* for the same purpose. Again, the leaves

are crushed and bruised before bundles of leaves are thrown into a waterhole, stunning the fish and allowing easy harvest as they rise to the surface. The Bindal and Wulgurukaba People of the Townsville region use the saponin-containing leaves and fruit of the red ash (*Alphitonia excelsa*) to harvest fish from small waterholes.

The construction of fish traps, long and widely used across Australia, is a further example of sustainable harvesting technologies developed by Aboriginal and Torres Strait Islander Peoples. The practice of sustainable fishing is governed by cultural protocols that ensure that the marine environment is protected; this knowledge has been passed down through generations for millennia. Fish traps or weirs are human-made structures, generally constructed from stone, that are positioned in an inter-tidal area. Fish and other marine organisms are carried into the trap as the tide rises; as the tide recedes and the water flows out of the structure, fish are trapped and can be harvested. The scientific knowledges that underpin the construction of the fish traps ensure that the marine environment is undisturbed; that is, tidal flows are not interrupted and the patterns of movement of marine organisms are not impeded. The Burgiyana fish trap at Point Pearce in the Yorke Peninsula region of South Australia was constructed by the Narungga Peoples and positioned within the minimum and maximum tidal range. At high tide the walls of the trap are submerged, allowing any unharvested organisms to return to the marine environment. The arc shaped fish traps on Erub Island in the Torres Strait are constructed so that at high tide the boulders are completely covered by water and when the tide recedes the trapped fish, crabs and other marine animals can be easily harvested. The Erubam Le Peoples of Erub Island have familial responsibility for the fish traps and continue to use and maintain the fish traps today. Aboriginal and Torres Strait Islander Peoples' scientific understandings of marine resources govern fishing practices to ensure sustainability of both the environment and the food source. Cultural laws and protocols determine the number and species that can be acquired and prevent the harvest of undersized or reproducing organisms. This ensures that the marine populations continue to breed and grow, maintaining environmental balance and providing sustainable access to the food resource.

This elaboration provides students with the opportunity to investigate how Aboriginal and Torres Strait Islander Peoples have long used many disciplines of science in their daily lives, including in the sustainable procurement of food resources. The processes and practices that have been employed for millennia by Aboriginal and Torres Strait Islander Peoples, in the acquisition of natural resources, is underpinned by a deep understanding of the environment. Knowledges and understandings of the life cycles of living things and the interdependence of organisms within an environment are critical in sustainable harvesting practices. Such knowledges inform the carefully considered harvest of food supplies, to ensure populations continue to thrive, providing ongoing access to important resources while the environmental balance is maintained.

CONSULTED WORKS

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Year 3

Teacher background information



ACSSU044	Indigenous classification systems – beyond Linnaeus
ACSSU044	Indigenous classification – comparing and contrasting taxonomy
ACSSU046	States of matter
ACSSU048	Day and night
ACSSU049	Heat transfer
ACSHE050	Applied use of astronomy
ACSHE051	Sensitive fire application – timing, frequency, intensity
AC SIS060	Consulting local knowledge – tracks tell us who lives here
AC SIS060	Acknowledging understandings of anatomy
AC SIS054	Consulting local knowledge – what’s dangerous?
AC SIS053	Consulting local knowledge – what’s here?

ACSSU044

Indigenous classification systems – beyond Linnaeus

CONTENT DESCRIPTION

Living things can be grouped on the basis of observable features and can be distinguished from non-living things.

CONTENT ELABORATION FOR CCP (01.2, 01.3, 01.5)

- ▶ investigating Aboriginal and Torres Strait Islander Peoples' systems of classifying living things and how these systems differ from those used by contemporary science



First Nations classification systems often group organisms by function and use, such as the spear tree

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For millennia, Aboriginal and Torres Strait Islander Peoples have used observable features of organisms to classify and group organisms and distinguish living and non-living things from each other. This elaboration provides students with the opportunity to investigate Aboriginal and Torres Strait Islander Peoples' systems of classifying living things based on observations of features or behaviours of organisms. While some systems of classification are similar to the Linnaean system of classification, Aboriginal and Torres Strait Islander Peoples also have ways of classifying organisms that differ from western science. Such classification systems reflect long-held cultural, scientific and practical understandings of the complex interrelationships of organisms within an environment. This Teacher Background Information considers how Aboriginal and Torres Strait Islander Peoples classificatory systems compare and contrast to the Linnaean system. In this elaboration students can investigate the various systems of classification used by Australia's First Nations Peoples and compare and contrast these with that used in western science.

DETAIL

Classification of living things by Aboriginal and Torres Strait Islander Peoples reflects the complex interrelationships of organisms within the environment. For millennia Aboriginal and Torres Strait Islander Peoples have made observations of the natural world and have used commonalities between organisms to group and classify living things in the environment. Organisms may be classified based on physical features, habitat or purpose with sub-classifications that may incorporate life cycle stage, sex, age or reference a particular custom or practice. Western systems of organism classification are based on Linnaean taxonomy, a hierarchical naming convention that conveys information about the species and its relatedness to other organisms. The Linnaean system of classification, developed in the 18th century, initially evaluated organisms based on their structural similarities. The system now ranks organisms by domain, kingdom, phylum, class, order, family, genus, species and strain. Contemporary western science continues to classify organisms based on their relatedness. Modern scientific technologies now enable scientists to evaluate the genetic relatedness (DNA) of organisms, in addition to structural similarities.

There are similarities between the western system of classification and some Aboriginal and Torres Strait Islander Peoples' systems of classification. For example, when it was first developed, Linnaean classification described only two distinct kingdoms – plants and animals. Similarly, many Aboriginal Peoples also recognise two main distinctions of living organisms – animal and vegetable. The Barngarla Peoples of the Eyre Peninsula region in South Australia classify all animal matter as *paru* and all vegetable matter as *mai*. A similar distinction is made by the Ngaanyatjarra Peoples of the Western Desert region who classify animals as *kuka* and vegetable materials as *mirrka*. Like Linnaean taxonomy, many Aboriginal and Torres Strait Islander classification systems of edible plants and animals are hierarchical, with organisms grouped in levels, and each of the higher levels encompassing the levels below.

The diverse classification systems of Aboriginal and Torres Strait Islander Peoples also differ in many respects from western systems of grouping and classifying animals. Living things were sometimes put into groups based on features, such as form and function, and not always according to relatedness as in the Linnaean classification system. For example, some First Nations' Australians classify turtles, barramundi and dugong into the same group of organisms, based on the observation that they are all aquatic and have fins or flippers. In contrast, the Linnaean classification system categorises turtles as reptiles, barramundi as fish and dugong as mammals. In a further example of difference in classification systems, the Eora Peoples of the Sydney Basin area in New South Wales do not classify the flightless emu (*maroang*) as a bird but as a land animal, whereas by western classification the emu is classified within the Linnaean class Aves (birds) due to the presence of physical characteristics, including wings, feathers and beak.

In many of the classification systems of Aboriginal Peoples organisms are grouped based on function and use. For example, the classification of wood-bearing plants may have the same name as the function of the finished object such as spear trees, string trees, shield trees, canoe trees or resin trees. In other function-based classifications, organisms may be placed in a group identified as material for use in the construction of tools or implements. The Gurindji Peoples of the Victoria River region in the Northern Territory group the three main types of wattle that are found in the area collectively as *parrawi*. The straight sections of the *parrawi* are used to make small spears. The Pitta Pitta Peoples of the Boulia region of Queensland classify both the tree *Erythrina vespertilio* and shields constructed from *Erythrina vespertilio* as *koon-pa-ra*.

Aboriginal and Torres Strait Islander Peoples have long used botanical and zoological knowledge of Australian native plants and animals to classify organisms in diverse systems that were often ignored or misunderstood by early European naturalists. The term *ganguru* from the Guugu Yimithirr Peoples of far north Queensland specifically refers to the eastern grey kangaroo. This term was recorded by European naturalists early after colonisation, who failed to understand that this classification referred to a specific species, and assumed that it was a general term, in universal use, to describe all kangaroos. When the term kangaroo was used in communications with the Eora Peoples in New South Wales, whose language is vastly distinct from that of the Guugu Yimithirr Peoples, the Eora Peoples believed they were being taught the European term for 'edible animal', as the word does not exist in their language. The Eora Peoples began to apply the term kangaroo to other mammals, causing much hilarity and confusion when cattle were unloaded from ships in early European colonisation, as the Eora Peoples enquired whether they were kangaroos. The Eora term for the eastern grey kangaroo is in fact *patagarang*, and the species is part of the *goa-long*, the land animals, in the Eora Peoples' classification system.

Aboriginal and Torres Strait Islander Peoples and their knowledge were, and continue to be, instrumental to scientists endeavouring to apply western classification systems to Australian native plants and animals. As Europeans colonised Australia, there was an immediate desire to explore

and classify the biota of the continent in the framework of the western classification system. This resulted in many scientific expeditions throughout Australia, the success of which largely relied upon the contributions made by Aboriginal members of the expedition. For example, the first inclusion of Bennett's tree kangaroo into the Linnaean taxonomy was made possible through the astute observations and contributions of an integral Aboriginal member of the 'Northern Expedition' to southern Cape York Peninsula in 1872.

As scientific knowledge about living things continues to emerge, the classification of organisms is continually refined to reflect current understandings. In today's Linnaean system, the classification of organisms may shift due to new developments in genetic analysis that reveal the phylogenetic relatedness of organisms not previously known. Aboriginal and Torres Strait Islander Peoples' classification systems also shift, but unlike Linnaean systems, in Aboriginal and Torres Strait Islander Peoples' classification systems organisms can move between categories depending on their current conditions or circumstances. For example, the Yanyuwa Peoples of the Northern Territory have two broad categories that distinguish biological organisms as being either coastal and marine, or inland. Certain animals and plants can move between these two broad categories depending on circumstance. Organisms may be reclassified in Aboriginal or Torres Strait Islander Peoples' systems of classification based on sex, age, condition, size or the life cycle stage of the organism.

This elaboration provides students with the opportunity to investigate how Aboriginal and Torres Strait Islander Peoples' diverse classification systems compare and contrast with contemporary classification systems. Students can compare and contrast these systems with the Linnaean system of classification and investigate the similarities, differences and underlying rationale between the systems of classification. Students can learn that Aboriginal and Torres Strait Islander Peoples' ways of grouping and classifying organisms are unique, complex and sophisticated and reflect a deep scientific understanding of the interrelationships within ecosystems.

CONSULTED WORKS

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ACSSU044

Indigenous classification – comparing and contrasting taxonomy

CONTENT DESCRIPTION

Living things can be grouped on the basis of observable features and can be distinguished from non-living things.

CONTENT ELABORATION FOR CCP (01.2, 01.3, 01.5)

- ▶ recognising Aboriginal and Torres Strait Islander Peoples' use of observable features to group living things



Wik Mungkan Peoples classify taipan (Coastal taipan) as a venomous snake based on observable features, including fangs

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to recognise how Aboriginal and Torres Strait Islander Peoples have observed the organisms within an environment and classify organisms based on similar features or function. Classification is the process by which scientists group living organisms based on observable features. Aboriginal and Torres Strait Islander Peoples' systems of classification reflect a long-held and deep scientific understanding of the environment and the complex interrelationships of the organisms within that environment. The diversity of systems of classification by Aboriginal and Torres Strait Islander Peoples is reflective of the many Nations of First Peoples across the Australian continent and the equally diverse environments that each Nation encompasses. This Teacher Background Information focuses on Aboriginal and Torres Strait Islander Peoples' classification systems. Students will have the opportunity to explore the observable features that Aboriginal and Torres Strait Islander Peoples have used to develop classification systems for living organisms and understand that these systems continue to be used by Australia's First Nations Peoples.

DETAIL

The classification of living things by Aboriginal and Torres Strait Islander Peoples reflects complex interrelationships within the environment, including the relationship of Peoples with living things and how the organisms are used, for example, as resources for tools, food and medicine. For millennia Aboriginal and Torres Strait Islander Peoples have made observations of the natural world and have used commonalities between organisms to group and classify living things in the environment. As well as using the observable physical characteristics of an organism in classification, noticeable ecological similarities may also be used. Alongside diversity in language and customs, the diversity of Aboriginal and Torres Strait Islander Peoples has resulted in unique classification systems for living organisms across Australia that reflect a deep cultural, biological, spiritual and social understanding of the environment.

The importance of plant life as a resource for Aboriginal and Torres Strait Islander Peoples, in particular the use of wood in material culture, is reflected in the classification systems of such organisms. In many Aboriginal classification systems, plants are distinguished as either wood-bearing plants or non-woody plants. For example, the Yankunytjatjara Peoples of north-west South Australia distinguish wood bearing plants (*punu*) from green plants (*ukiri*), such as vines and succulents. Similarly, the Warnindhilyagwa Peoples of Groote Eylandt classify woody plants (*eka*) distinct from other flora (*amarda*) of the region. The woody plants of the Groote Eylandt region are classified into a further eight categories based on observations that group the plants as either similar in form or similar in habitat. For example, paperbark trees are all classified into a group called *alyukwurra*. In many of the languages of Aboriginal Peoples, further classification of wood-bearing plants is associated with the tools or implements that they are used to construct. The Gurindji Peoples of the

Victoria River region in the Northern Territory classify the three main types of local wattle collectively as *parrawi*, used to make small spears. Often the classification of wood-bearing plants has the same name as the function of the finished object. For example, the Pitta Pitta Peoples of the Boulia region of Queensland classify both the tree *Erythrina vespertilio* and shields constructed from *Erythrina vespertilio* as *koon-pa-ra*.

Many Aboriginal and Torres Strait Islander Peoples classify living organisms into plant or animal groups, including the Warnindhilyagwa Peoples, whose term *akwalya* broadly encompasses all animal life. Animal life is then further distinguished into groups, such as land animals, marine animals and winged organisms, based on observable characteristics of the organism and their habitats. The Yanyuwa Peoples of the Sir Edward Pellew group of Islands in the Gulf of Carpentaria classify living organisms as belonging to the sea (*wurralngu*) or belonging to the mainland (*ankawangul*), with many sub-classifications within this binary system. Organisms may be further classified based on observations of the particular habitats they occupy, such as the inter-tidal zone or the open sea. Other methods of classifying organisms may result from observations of animal behaviours, such as consumers of big seeds or consumers of small seeds. In the classification systems on the Torres Strait Islands, living fauna specific classifications are made; birds are classified as *urui*, distinct from fish that are classified as *whapi*. The Mabuiag Peoples of Mabuiag Island in the Torres Strait have specific nomenclature for most species of plant and animal life, determined by observable features of the organism. For example, snakes are generally classified as *thabu*, and are further differentiated by whether they are known to be venomous or not; non-venomous are classified as *kasa thabu* (that translates to 'just snakes' in English) and venomous snakes are *emar thabu* (that translates to 'death snakes' in English).

While most animal classification systems of Aboriginal and Torres Strait Islander Peoples tend to be based on important observable characteristics, there can be complex differences between systems used in different Nations. For example, the saltwater crocodile, although a water-based animal, is classified as a land animal by the Warnindhilyagwa Peoples as the eggs are laid on land. However, the Yolŋu Peoples of north eastern Arnhem Land in the Northern Territory classify the crocodile as *gal 'yunamirr* (animals that drag) based on observations of movement. Further examples of species classification use structural and other visual features of the organism. The Yolŋu Peoples classify the five species of turtle found in the region using prominent observable features, such as small nose, flat back, large head or dark head. The Yanyuwa Peoples classify bees based on the size and colour of the species, including red/black body, long legged, large or small.

Aboriginal and Torres Strait Islander Peoples may also have systems for classifying organisms within the same species based on observable features such as the sex, age, life cycle stage and physical features such as size or colour of an organism. For example, the Yanyuwa Peoples have terminology that distinguishes the flatback turtle, *wimdiwimdi*, from other species of turtle. They further differentiate this species based on sex; female flatback turtles are classified as *a-karnlnja* and male flat back turtles are classified as *dilhali*.

This elaboration provides students with the opportunity to recognise that Aboriginal and Torres Strait Islander Peoples' observations of the features of organisms have informed methods of classification. Aboriginal and Torres Strait Islander Peoples have observed organisms within the environment for millennia and have used these observations to group and classify organisms. Students can learn that the observable characteristics of organisms have long been used to develop complex methods of classifying living things and reflect Aboriginal and Torres Strait Islander Peoples' deep cultural, biological, spiritual and social understanding of interrelationships within an environment.

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ACSSU046

States of matter

CONTENT DESCRIPTION

A change of state between solid and liquid can be caused by adding or removing heat.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ investigating how changes of state in materials used by Aboriginal and Torres Strait Islander Peoples, such as beeswax or resins, are important for their use



Beeswax can be changed between solid and liquid states by adding or removing heat

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to investigate Aboriginal and Torres Strait Islander Peoples' long-held scientific understanding of states of matter and the knowledge that the application or removal of heat can cause changes in state. For millennia Aboriginal and Torres Strait Islander Peoples have applied or removed heat to substances, including resins and beeswax, to manipulate the substance into the desired state. Resin and beeswax are substances that change state from solid to liquid with the application of heat and return to a solid state when the heat is removed. The reversible properties of such substances make them an important commodity and have long been used, and continue to be used, by Aboriginal and Torres Strait Islander Peoples to waterproof, repair, decorate, modify and to construct items and implements. Students can investigate changes in the state of materials that for millennia have been understood and utilised by Australia's First Nations Peoples for a variety of purposes.

DETAIL

For millennia Aboriginal and Torres Strait Islander Peoples have recognised that matter exists in different states, including solids and liquids, and have long used the application or removal of heat to induce a change in state of specific materials for desired purposes. Solids consist of particles that stick tightly together and vibrate around a fixed position, giving solids a definite volume and shape. The application of heat to certain solid substances results in the particles vibrating more rapidly until they can move past each other. This results in the substance changing into a liquid state and having a defined volume but no longer a defined shape. For some substances this change in state is reversible, that is, the removal of heat from the material reverses the change in state, with the liquid returning to a solid.

Aboriginal and Torres Strait Islander Peoples have long understood that heat softens certain substances into molten, viscous liquids that are malleable and can be manipulated for a desired purpose. Removal of heat from the viscous liquid results in the material cooling and hardening back into a solid state. This is known as having thermoplastic properties. Resin and beeswax are examples of thermoplastic materials that can change state. Resins were, and continue to be, widely used by Aboriginal and Torres Strait Islander Peoples as adhesives in the manufacture of implements, such as attaching spear points to shafts, hafting stone hatchet heads and knife blades to handles, and attaching pegs to spear-throwers. Similarly, the ability of beeswax to change state from a solid to liquid makes it useful as an adhesive to affix items such as feathers, seeds and other adornments to implements and regalia or to the body. Both resins and beeswax are used for other purposes; to waterproof items, preserve and protect wooden implements, and as a fixative.

A wide range of plants naturally exude resin, and the type of plant used by Aboriginal and Torres Strait Islander Peoples as a resin source depends on the vegetation that is available in their

geographical territory. Aboriginal Peoples most commonly use spinifex (*Triodia* spp.) and grasstrees (*Xanthorrhoea* spp.) to source resin. Beeswax is a hydrophobic compound produced as the bees manufacture honeycomb, and the composition of the wax differs depending on the species of bee. For example, the wax of a native Australian bee, *Austroplebeia australis*, is known to manufacture wax that is more malleable over a wide range of temperatures than the wax from the European honeybee. Resin and beeswax are insoluble in water but soluble in organic solvents, making them ideal waterproofing agents. Both resin and beeswax have been used for this purpose for millennia by Aboriginal and Torres Strait Islander Peoples.

The Wimaranga Peoples of the western Cape York Peninsula region in Queensland use fire to heat beeswax and change its state from a hard, rigid solid material to a softer, malleable molten liquid. Once molten, the wax is used to repair cracked water carriers, to attach decorative articles to hair and mend and preserve twined fibres. When the heat is removed, the wax hardens again to a solid state, extending the durability of the repaired implements.

The Turrbal Peoples of the Brisbane region were observed by early European colonists to frequently carry beeswax due to its usefulness in many applications. When required, the wax was held to a flame to allow the heat to cause a change in state from solid to liquid. The Turrbal Peoples then rubbed the molten wax onto shields and allowed the applied wax to cool and harden on the shield surface, to preserve the wood. Beeswax has also long been used in this region, and continues to be used to attach stingray barbs to spears, fix handles to axes, and to waterproof water vessels carved from the wood of the bat-wing coral tree.

The Yidinji Peoples of far north Queensland apply wax from native bees to preserve string manufactured from natural fibres. The applied wax makes the string waterproof and more resistant to weathering. The Peoples of the Tiwi Islands north of Darwin in the Northern Territory melt the wax of the native bee to use as a binder that reduces the flaking of paint on wooden implements. The Kuku-Yalanji Peoples of the rainforest region of far north Queensland use beeswax to attach the bright red seeds of *Abrus precatorius* (jequirity bean) to hair. The Wik-Mungkan Peoples and other Peoples of the Cape York Peninsula manufacture fire stick covers using beeswax to waterproof the fire sticks and to embed the seeds for decoration. Torres Strait Islander Peoples use beeswax to attach the skin of goanna or snake over the mouth of the *warup*, a large, distinctive, hourglass-shaped drum. Additional pellets of beeswax are stuck to the *warup* and used to tune the drum. When required, the beeswax pellets are heated in a flame to change to a molten and malleable state, and used to tune the drum and enhance the quality of the sound produced.

The property of beeswax, to change state from solid to liquid with the application of heat and return to a solid state on the removal of heat, has long made it an important resource for Aboriginal Peoples and Torres Strait Islander Peoples. Beeswax continues to be used for many purposes due to this property. Beeswax is today commercially produced for use as a preservative for wooden surfaces.

Resin has long been considered a critical product that was frequently part of the supplies carried on a person to provide ready access for repairing items or hafting tools. Resin is obtained from the leaf base of grass trees and from damaged areas of the trunk of resinous plant species. Some Aboriginal Peoples have been documented to apply heat by directly firing spinifex grass, changing the plant's resin from a solid state to a liquid state and thereby maximising the yield of resin. Aboriginal Peoples, including the Ngaatjatjarra and Ngaanyatjarra Peoples of the western desert region in Western Australia, have long harvested the resin from such plants and prepared the resin as an adhesive or cement, using heat to change the hard, solid resin into a viscous liquid state more suited to application. As many of the resins are flammable, and can be damaged through direct exposure to flame, a change of state is achieved through the indirect application of heat. There are many techniques that have been developed and implemented to soften solid resin into a liquid state, such as heating on hot coals or in the ashes of fire, warming in the hands, passing a burning stick over resin lumps, hammering to generate heat until pliable or boiling the resin. The Alyawarre Peoples of the Central desert region in the Northern Territory heat resin by placing it on a stone heated in fire and rolling additional hot stones over the lump of resin until it is malleable.

Resins have many uses and have long been used by Aboriginal and Torres Strait Islander Peoples for a variety of purposes. The Gadigal Peoples of the Eora Nation in the Sydney basin region used grasstree resin to reinforce the joints of fishhooks and to mend damaged canoes. In the Cairns/Yarrabah region of North Queensland, the Yidinji Peoples used the exudate from scrub turpentine to seal the sewn side of a bark waterbag. Resins and gums have reportedly been used to tan the hide of wallabies in the manufacture of water carriers. The process of drying hide and tanning improves durability and ensures the carrier is watertight. The Noongar Peoples of south west Western Australia use grasstree (*balga*) resin to fasten granite edges to wooden handles to manufacture an axe, while the Yamatji Peoples of the Murchison region in Western Australia use grasstree resin to attach stone flakes to cutting tools. On Groote Eylandt, the Warnindilyakwa Peoples melt resin over a small fire to change it to a liquid state. Then the resin is smeared over spearheads to fix to the spearshaft, the joints are bound with string, and another layer of resin is applied to strengthen the join and form a smooth, hard surface on cooling.

This elaboration provides students with the opportunity to investigate how Aboriginal and Torres Strait Islander Peoples' understandings of states of matter is long evidenced in the use of resins and beeswax. For many thousands of years Aboriginal and Torres Strait Islander Peoples have heated resins and beeswax to change the solid substance into a viscous liquid state. In the more malleable liquid form resins and beeswax are used in the manufacture and repair of implements, to attach decorative materials to the hair, body and regalia, to waterproof items, and to improve the durability and longevity of such items. Students can learn that the long-held scientific understanding about the application and removal of heat to cause a change in state of resin and beeswax has long facilitated their use, and this understanding continues to be used by Aboriginal and Torres Strait Islander Peoples for many purposes.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU048

Day and night

CONTENT DESCRIPTION

Earth's rotation on its axis causes regular changes, including night and day.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ exploring how cultural stories of Aboriginal and Torres Strait Islander Peoples explain the cyclic phenomena involving sun, moon and stars and how those explanations differ from contemporary science understanding



The sun features prominently in many Aboriginal and Torres Strait Islander Peoples' cultural stories

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For millennia Aboriginal and Torres Strait Islander Peoples have observed and recorded the repeated patterns of phenomena in the sky. The rotation of Earth on its axis causes regular changes, such as day and night, and the long-held scientific understanding of these events is recorded in the cultural stories of many Aboriginal and Torres Strait Islander Peoples. Vibrant, living stories are an important cultural aspect of Australia's First Nations' Peoples. Often, cultural stories hold insights and records of complex scientific phenomena including explanations of celestial bodies. This elaboration provides students with the opportunity to explore the cultural stories of Aboriginal and Torres Strait Islander Peoples that explain regular changes in the sky that have been observed and understood for many thousands of years.

DETAIL

Stories and storytelling have long been, and continue to be, an important part of Aboriginal and Torres Strait Islander Peoples' cultures and ensure the continuation of cultural knowledges through generations. Cultural stories hold complex knowledges and insights, and the retelling of stories is a powerful way to ensure knowledges are shared and preserved. The stories are instructive or informing; the intention is to communicate knowledges in a highly engaging and memorable manner. Cultural stories may contain more than a single knowledge or lesson. They may incorporate lessons about kinship and belief systems, customs, animal behaviour, land maps, domestic skills, moral behaviours or resources. Many cultural stories incorporate scientific knowledges and understandings that have been observed for millennia, including stories to explain the phenomena of cyclical patterns in the sky.

The pattern of day and night is a result of Earth's eastward rotation on its own axis in prograde motion, that is, Earth's rotation is in the same direction as the rotation of the sun on its own axis. Daytime is the period of Earth's rotation when a particular point on Earth receives natural light from the sun. It is often considered that daytime commences when Earth's rotation towards the east first causes the sun to appear above the horizon. By contrast, night-time is the period of time when a given point on the surface of Earth receives no natural illumination from the sun. Night-time occurs when the continuing rotation of Earth causes the sun to disappear below the horizon to the west. The central importance of the sun in the distinction of daytime and night-time is reflected in the cultural stories of many Aboriginal and Torres Strait Islander Peoples.

A cultural story from the Yolŋu Peoples in Arnhem Land in the Northern Territory describes the sun as a woman who lights a fire in the morning and scatters red ochre across the sky to create dawn. She is described as travelling across the sky from east to west, carrying a torch to create daylight, and at the end of the day extinguishing her torch to create night. In the story, she is told to return to her morning camp by travelling underground through the night, to again light her morning fire. The Tangane-kald Peoples of the Coorong region in South Australia have a cultural story that explains

daytime and night-time by describing the sun as a woman carrying firesticks. The sun story of the Wotjobaluk Peoples of western Victoria describes a woman carrying a bark torch as she journeys across the sky. In the cultural stories of the Meriam Peoples of Mer Island in the Torres Strait, the sun returns to its place in the east by travelling underwater. In the cultural stories of the Ramindjeri Peoples of the Encounter Bay region in South Australia, the sun woman was gifted a red kangaroo skin, which she wears daily as she rises and appears in her red dress at dawn. The Noongar Peoples of south-west Western Australia also explain the passage of the sun across the sky in cultural stories that depict the sun as a woman carrying a burning *Banksia* cone. Noongar Peoples distinguish at least nine sequential phases of daylight: *nanga warloo* (dawn), *djidar* (daybreak), *nangar mooreejoon* (sunrise), *mirgaduk* (morning), *mal-yarak* (noon), *biddurong* (early afternoon), *garbala* (late afternoon), *garreembee* (sunset) and *ngallanang* (twilight), based on the position of the sun in the sky as Earth spins on its axis.

Such stories, and countless others, demonstrate the understanding of the rotation of Earth that results in the apparent passage of the sun to provide light across the sky during daytime and an absence of light from the sun at night-time. The oral narrative record of knowledge is safeguarded through engaging and memorable stories; retelling cultural stories ensures that living knowledge is deeply learned and passed on through successive generations.

The rotation of Earth on its axis causing regular phenomena, including daytime and night-time marked by the appearance and setting of the sun, has been observed for many thousands of years by Aboriginal and Torres Strait Islander Peoples. Aboriginal Peoples used these observations to make important connections. For example, the position of the setting sun was noted when annual events occurred, such as the solstices (the longest and shortest days of the year) and equinoxes (the days when the length of daytime and night-time are equivalent). Features of the landscape that correlate with the position of the sun are believed to have informed the construction of stone arrangements. The Wathaurong Peoples of Victoria constructed Wurdi Youang, an important stone arrangement in deliberate alignment with astronomically significant positions. The egg-shaped arrangement of over 50 basalt stones evidences and records the knowledge of the movement of the stars and sun. In a Western context the arrangement is aligned in an east-west direction, with prominent stones on the western side indicating the position of the setting sun at the equinoxes and solstices. The Wurdi Youang arrangement is believed to represent annual recurrent patterns in astronomical observations of the sun and other celestial bodies made by the Wathaurong Peoples over thousands of years.

The rotation of Earth on its axis also means that the moon and stars appear to rise in the east at night and set at sunrise in the west. The appearance of the moon is due to Earth's rotation on its axis as well as the orbit of the moon around Earth. From Earth it appears as though different portions of the moon are illuminated by the sun over a lunar month. Many Aboriginal and Torres Strait Islander Peoples' cultural stories contain detailed knowledge of the lunar cycle. The lunar phase, that is, the appearance of the moon that is visible from Earth, changes gradually and cyclically as the orbital positions of the moon, Earth and sun shift. The visible phases of the moon are described in many

cultural stories, often as a fat man who becomes thinner over the lunar month before feasting to become fat and round again. A story from the Tiwi Peoples of the Northern Territory explains that when the moon man gorges on mangrove crabs he becomes fat and round, and when he becomes sick from over-eating he wanes.

Aboriginal and Torres Strait Islander Peoples' observations of the recurrent patterns of celestial bodies, including the sun and moon in the sky, have long been used as markers of time and as indicators of certain events. In the Southern Coorong district of South Australia, the Ngarrindjeri Peoples used the number of full moons to record the age of children under the age of one, while in the Hahndorf area of South Australia, the Peramangk Peoples marked the appearance of each new moon on an object, such as a digging stick, to record their own age. The Tarkinener Peoples of north west Tasmania applied the lunar phases of the moon to daily life. For example, they determined the timing of a gathering by the number of dark days after the moon had disappeared.

Aboriginal and Torres Strait Islander Peoples' observations of the celestial bodies in the sky include astronomical features outside Earth's solar system, such as constellations that appear at certain times of the day or year due to the rotation of Earth on its axis and its orbit around the sun. The Pitjantjatjara Peoples of the central Australian desert know that the appearance of the constellation Pleiades in the dawn sky indicates the beginning of the cold season. The Mabuig Peoples of Mabuig Island in the Torres Strait time important ceremonies by the appearance of the star Kek (known as Arcturus in Western cultures), as it coincides with a plentiful supply of resources. The significance of this timing is encoded in the cultural stories of some of the islands in the Torres Strait, which serve as an important transgenerational system of transferring and maintaining knowledge.

This elaboration provides students with the opportunity to explore how many cultural stories of Aboriginal and Torres Strait Islander Peoples contain the recognition and understanding of phenomena, such as the cyclical changes seen in the sky as a result of Earth's rotation on its axis. Cultural stories are designed to be a highly engaging and memorable way of embedding knowledges to instruct and inform others about such phenomena. Cultural stories are often underpinned by fundamental scientific ways of working, such as acute and detailed observation and pattern recognition. The retelling of stories is a way that knowledge can be communicated and preserved. Students can learn the contemporary scientific understandings of the rotation of Earth on its axis and can see how this phenomenon has been recognised for millennia, as evidenced through the cultural stories of Aboriginal and Torres Strait Islander Peoples.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSSU049

Heat transfer

CONTENT DESCRIPTION

Heat can be produced in many ways and can move from one object to another.

CONTENT ELABORATION FOR CCP (01.5)

- ▶ investigating the production and transfer of heat in Aboriginal and Torres Strait Islander Peoples' methods of cooking, such as the use of ground ovens



Rocks, pre-heated by fire, provide a heat source for cooking food in a ground oven

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to investigate Aboriginal and Torres Strait Islander Peoples' understanding of the concept of heat transfer through the context of cooking methods such as the use of ground ovens. Over millennia, heat has been produced through various methods to initiate combustion and utilised for many purposes such as the production of heat for cooking. Combustion and the transfer of heat from one object to another, such as from hot stones to food in an oven, was utilised by Aboriginal and Torres Strait Islander Peoples prior to colonisation. Across Australia ground ovens remain an important cooking method for many people. Through this elaboration students can investigate methods of heat transfer in cooking practices that have long been understood and implemented by Aboriginal and Torres Strait Islander Peoples.

DETAIL

Aboriginal and Torres Strait Islander Peoples have a long-held scientific understanding of the techniques that can produce heat and the knowledge that heat can be transferred from one object to another. For millennia Aboriginal and Torres Strait Islander Peoples have used a variety of techniques to make fire by friction, including methods of generating heat through the friction between two pieces of wood (fire drill, fire saw, fire plough) or between two rocks (percussion), resulting in the production of heat. Generation of heat through friction is used to initiate combustion (the rapid oxidation of such materials in air); however, sufficient heat must be attained to reach an ignition point that results in flames. The process of initiating combustion has long been understood and employed by Aboriginal and Torres Strait Islander Peoples to produce fire for many purposes, including the generation of heat for cooking processes.

Heat transfer is the process whereby heat (thermal energy) moves from a warmer object to a cooler object until thermodynamic equilibrium is reached, that is, the objects are at the same temperature. Aboriginal and Torres Strait Islander Peoples have long used this fundamental scientific concept to transfer heat from one object to another for specific purposes. Many Aboriginal and Torres Strait Islander Peoples' methods of cooking provide clear examples of the knowledge, understanding and application of heat transfer between objects.

For example, for millennia the Barindji Peoples of south central New South Wales built a substantial fire to heat stones for cooking large animals in a ground oven. Immense heat is applied to the stones until they glow red hot. Such stones have considerable thermal inertia and long radiate (transfer) heat to their surroundings. The hot stones are placed into a pit oven and the animal is then placed into the oven on the hot stones. The oven is covered with grass, more hot stones placed on top and the oven completely enclosed with earth. The process of using hot stones both underneath and above the meat ensures that heat is transferred from the stones in both directions so that the meat is cooked through without needing to be dug up and turned.

The success and efficiency of ground ovens is due to the heat transfer principles of conduction and convection. The method of transferring heat from one object such as hot stones, to another

object, such as food, is called conduction. Convection is the process of heat transfer due to the bulk movement of particles within fluids such as liquids and gases. Cooking food in a pit oven acts in a very similar manner as a pressure cooker on a stove. The stove conducts heat into the pressure cooker and the contents are cooked evenly and efficiently through the convection of gases that form within the cooker. Similarly, the earth that encloses a ground oven acts as a lid that retains the heat and pressure generated by the hot stones.

The Bindal and Wulgurukaba Peoples of far North Queensland also cook meats in earth ovens, digging a hole in the ground and setting a large fire in the pit. Stones are placed in the fire, heated until they are red-hot, then removed from the pit and the fire is extinguished. Once the fire is cleared away a number of the hot stones are returned to the pit, the uncooked meat is placed on leaves covering the hot stones, and the remaining hot stones are placed on the top of the meat. Again, the practice of surrounding the meat with hot stones ensures that heat is transferred to the meat to thoroughly cook from all directions. This cooking process rests on a thorough understanding of the process of heat transfer, as using only a single layer of hot stones may result in only one side of the food being cooked due to an uneven transfer of heat.

Ground ovens have long been used, and continue to be used, widely on the Torres Strait Islands. *Amai* in the Meriam Mir language of the eastern Torres Strait Islands and *ame* or *netebu* in the Kala Lagaw Ya language of the western Torres Strait Islands, that translate to “earth oven” in English, consist of a large shallow hole built in sandy soil lined with stones. A large fire is set on top of the stones and is kept burning until the stones are red hot. The fire is then extinguished and some of the stones are removed from the oven. Food is layered alternately with hot stones, and the number of layers depends on the amount of food that is to be cooked. Stones are not the only material that can be heated to facilitate cooking of food through the process of heat transfer. The Wik-Mungkan Peoples of the western Cape York Peninsula in northern Queensland use heated pieces of termite mound (ant-bed) to cook food. A fire is set in a hole in the ground containing the termite pieces, and once they are sufficiently heated, food is placed on top and the hole is enclosed with earth and bark to create a hot oven for cooking. Industrial steel offcuts are frequently used, in combination with rocks or as substitutes for rocks, in many contemporary ground ovens to take advantage of their excellent thermal properties.

Aboriginal and Torres Strait Islander Peoples also employ heat transfer by convection when heating liquids over a fire. When air is heated by fire, the warmer air becomes less dense than the cool air and it rises, and is then replaced by the cooler air underneath. Placing a vessel of water over a fire allows the heat energy from rising air to contact the vessel and transfer heat to the object. The water closest to the heat source in the vessel warms and rises, being replaced by cooler, more dense water molecules to create a convection current. The continual exchange of water molecules in this way results in the entire vessel of water being heated to the desired temperature. Prior to colonisation, the Kuku-Yalanji Peoples of the rainforest region of far north Queensland used large bailer (melon) shells or bark troughs for boiling water over a fire. The Meriam Peoples of Mer Island in the Torres Strait boil water or coconut milk in a bailer shell over a fire, with the large shell supported over the fire on

stones. Alternatively, water is heated by adding hot stones into the vessel of water. Tubers, roots, fish and meats are then cooked or boiled in the heated liquid. These processes require an understanding of the transfer of heat through both convection and conduction processes.

This elaboration provides students with the opportunity to investigate Aboriginal and Torres Strait Island Peoples' long-held scientific understanding and utilisation of methods of heat production and heat transfer. For many thousands of years Aboriginal and Torres Strait Islander Peoples have produced and controlled heat in a variety of ways, including the use of different fire-starting techniques. Fire has long been used as a source of heat and the understanding of methods of heat transfer, including convection and conduction, is evidenced in cooking methods. Through exploring this context students can learn that heat can be produced in many ways and can move from one object to another.

CONSULTED WORKS

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ACSHE050

Applied use of astronomy

CONTENT DESCRIPTION

Science involves making predictions and describing patterns and relationships.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ researching how knowledge of astronomy has been used by some Aboriginal and Torres Strait Islander Peoples



Lunar and tidal cycle knowledge informs the use and operation of tidal fish traps

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

For millennia Aboriginal and Torres Strait Islander Peoples have made continuous observations of the night sky, recording the repeated patterns and relationships between celestial bodies to build a wealth of astronomical data. Aboriginal and Torres Strait Islander Peoples' astronomical knowledges contain useful scientific information that, through the longevity of data collected, connects phenomena in the sky with occurrences and events on Earth. The knowledge accumulated by astronomical observation has long facilitated the prediction of environmental events, and records are preserved and communicated in cultural stories, petroglyphs, stone arrangements and paintings. This elaboration provides students with the opportunity to research how Aboriginal and Torres Strait Islander Peoples' astronomical knowledges are applied and used to predict events, including tides, weather and seasonal changes.

DETAIL

Aboriginal and Torres Strait Islander Peoples have observed the patterns of the motions of celestial bodies in the sky for many thousands of years. The recurring patterns were, and continue to be, used as a system for many purposes, such as to track time, signify important events and indicate seasonal changes. Aboriginal and Torres Strait Islander Peoples continuous surveillance observed relationships between celestial phenomena and events on Earth. Regular cyclical phenomena involving the sun, moon and Earth have informed many Aboriginal and Torres Strait Islander Peoples' practices and technologies, such as systems of time keeping and the construction and utilisation of fish traps that are based on tidal events. Not all astronomical events occur in regular cyclical patterns; some can be unexpected and irregular. Unexpected phenomena observed in the sky, such as solar eclipses, moon halos and stellar scintillation, have long been understood by Aboriginal and Torres Strait Islander Peoples to be unique, irregular events. However, the continuous observations of such events over millennia have enabled Aboriginal and Torres Strait Islander Peoples to connect these celestial occurrences with particular events on Earth, such as weather patterns and seasonal changes.

Astronomy is the branch of science that studies celestial objects and phenomena, including the stars, moons, planets and comets, and the effort to understand and explain such objects and phenomena. Astronomy depends on the acquisition of data from observations of astronomical objects; data can be analysed and evaluated to explain celestial objects, events and phenomena, and the connection with, or influence on, events on Earth. For millennia Aboriginal and Torres Strait Islander Peoples' vast knowledge of celestial objects and events has informed investigations to describe the patterns and relationships of these objects and make predictions about events on Earth.

Tides are the rise and fall of sea levels caused by the gravitational forces of the sun and moon, and Earth's rotation on its axis. The gravitational force of the moon is strongest at the point of the

earth that is directly facing the moon. The effect of this force is seen when the movement of ocean water pulls in the direction of the moon, causing a high tide. Due to Earth's rotation on its axis and differential gravitational forces, the side of Earth that is farthest away from the moon also experiences a high tide. The two high tides draw water away from other oceans, resulting in two low tides between the high tides. When the sun and moon are directly in line with Earth, that is, at times of a full moon or new moon, the gravitational effects of the sun and moon combine to produce a larger high tide known as a spring tide. As there is a new or full moon approximately every two weeks, spring tides are also seen about every fortnight. When the line from the Earth to the moon is at right angles to the line from the Earth to the sun (known in astronomy as quadrature), the sun negates some of the effect of the gravitational force of the moon resulting in tides lower than usual, or neap tides.

The Yolŋu Peoples of north eastern Arnhem Land have long understood these patterns and have recorded the knowledge connecting tides with phases of the moon in cultural histories. The Dampier Peninsula region of Australia experiences immense tidal variation due to a unique combination of an unusually large continental shelf and a recessed coastline. These factors, combined with the gravitational forces of the moon and sun, amplify the tides and can cause tidal variation of up to 11 metres. The Bardi Peoples of the Dampier Peninsula region of Western Australia have long travelled between islands, using the knowledge of lunar phases and the connection with tides to time the travel with the occurrence of neap tides when passage between the Islands can be safely undertaken. For millennia Bardi Peoples have taken advantage of low tides to access vast intertidal reefs, rock shelves and mudflats. Rich sources of food, cultural and economic resources, such as fish, and pearl and trochus shells, can be found in these areas. Similarly, Torres Strait Islander Peoples use neap tides to access crayfish.

Aboriginal and Torres Strait Islander Peoples' regular, continuous observations of the position and phase of the moon and the correlation with ocean tides, have long enabled predictions about the time and height of the next tide. Cyclical patterns of celestial objects and the relationship with events on Earth informed the construction of tidal fish traps. Fish traps are human-made structures, generally constructed from stone, that are positioned in an inter-tidal area. Tasmanian Aboriginal Peoples of the north west coast used boulders to construct tidal fish traps for the regular harvest of fish. At high tide, the walls of the fish traps are submerged, allowing fish to move into the area to feed. As the tide recedes, the water flows out of the structure, leaving the fish trapped in shallow pools within the stone walls. The Tommeginer People understood the timing of low tides and they returned to the traps to harvest the fish at this time.

Tidal fish traps constructed by the Narungga Peoples of the Yorke Peninsula region of South Australia are positioned perpendicular to the shoreline and the direction of tides and currents. In the same area, the *Burgiyana* fish trap at Point Pearce in this area is constructed within the minimum and maximum tidal range, so that at high tide the walls of the trap are submerged and, as the tide recedes and the water flows out of the structure, fish are trapped and can be harvested. The fish

traps on Erub Island in the Torres Strait are constructed from basalt boulders placed in an arc shape over a distance of approximately 200 metres. At high tide the boulders are completely covered by water and when the tide recedes the trapped fish, crabs and other marine animals can be easily harvested. The Erubam Le Peoples of Erub Island have familial responsibility for the fish traps and continue to use and maintain the fish traps today. The regular patterns of the appearance and phases of the moon have long enabled Aboriginal and Torres Strait Islander Peoples to accurately predict tidal stages. The relationship between Earth's moon and tides has long been observed and the application of knowledge and understanding is evident in the construction of tidal fish traps that provide reliable access to marine resources.

While the relationship between the phase and position of the moon from Earth with ocean tides can be predicted with regularity, other astronomical events can be unexpected and appear only occasionally. Information about such events has long been monitored and recorded by Aboriginal and Torres Strait Islander Peoples, who have used this body of knowledge to correlate astronomical phenomena with incidences on Earth. When ice crystals are suspended in the upper atmosphere, light from the moon is refracted and reflected by the ice crystals. This can result in the appearance of a halo around the moon. Contemporary science recognises that moon halos often precede a low-pressure system that frequently brings rain and cooler temperatures within the next day. Aboriginal Peoples have long understood the relationship between moon halos and weather changes. The Euahlayi and Kamilaroi Peoples of New South Wales have cultural records that connect the appearance of moon halos with rain, and the moon halo signifies to the Peoples of the western desert region that the Moon-man is taking shelter from approaching bad weather.

Stellar scintillation is a term that describes variation in the brightness of stars caused by atmospheric disturbances. It is caused by the passing of light through atmospheric effects, such as changes in air density, temperature, humidity and turbulence. These changes affect the refractive index of incoming starlight resulting in the scintillation effect, or twinkling, that can be observed from Earth. For millennia, Aboriginal and Torres Strait Islander Peoples have observed the scintillation of stars and used the observation to predict changes in weather and seasons. On the island of Mer in the Torres Strait, the beginning of the monsoon season (kuki) is characterised by stormy weather and strong winds. The Miriam Elders predict the onset of this season by the appearance of rapidly twinkling stars. When fishing out on the reefs, Peoples of the Torres Strait also use knowledge of stellar scintillation and the correlation with strong winds to gauge when it is safe to travel back to the islands.

Aboriginal and Torres Strait Islander Peoples' continuing astronomical observations over millennia have resulted in an abundance of astronomical knowledge of the patterns and relationships between celestial objects and phenomena and events on Earth. Today, much of this knowledge is now recognised by contemporary astronomers and is being used to inform the field of astronomy. This elaboration provides students with the opportunity to research how Aboriginal and Torres Strait Islander Peoples have used and applied this knowledge in a multitude of ways. For millennia, these

astronomical knowledges have been applied to successfully make predictions regarding times to travel, seasonal and weather changes, and when to harvest resources. Students can learn that the astronomical knowledge of Aboriginal and Torres Strait Islander Peoples is interwoven into cultural and social aspects and patterns of life.

CONSULTED WORKS

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ACSHE051

Sensitive fire application – timing, frequency, intensity

CONTENT DESCRIPTION

Science knowledge helps people to understand the effect of their actions.

CONTENT ELABORATION FOR CCP (OI.2, OI.3, OI.5)

- ▶ researching Aboriginal and Torres Strait Islander Peoples' knowledge of the local natural environment, such as the characteristics of plants and animals



Environmental responses to fire underpin the judicious application of fire in land management practices

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples' deep scientific understanding of the complex interrelationships of biotic and abiotic factors within the natural environment has long informed and continues to inform the management of Country/Place. Scientific knowledge of the behaviour of fire ensures that the effects of burning Country/Place are well understood and appropriately implemented. Aboriginal and Torres Strait Islander Peoples possess detailed understanding of the characteristics of flora and fauna in the local natural environment, including adaptations to fire and how organisms respond to fire management practices. This elaboration provides students with the opportunity to research Aboriginal and Torres Strait Islander Peoples' knowledge of the local natural environment and how this knowledge informs human actions, such as fire management of the environment.

DETAIL

Aboriginal and Torres Strait Islander Peoples have long understood the effects of human actions including managed burning of the environment. Long-held botanical and zoological knowledges of the organisms in respective ecosystems are critical to informing fire management practices. Combined, these knowledges inform the timing, frequency, intensity and area of fire application to an environment. The behaviour of fire depends on the variables involved. The intensity of a fire is impacted by the type and amount of fuel, the moisture content of the fuel and the surface area of an environment. Weather, including wind, humidity, temperature and rainfall, further impacts the behaviour of fire, and the shape of the terrain can influence the spread of a fire. These factors are carefully considered by Aboriginal and Torres Strait Islander Peoples in the controlled application of fire to an environment. Scientific knowledge of the natural environment, including the characteristics of flora and fauna and how the organisms respond to fire, is also considered.

For effective management of Country/Place through fire regimes, it is crucial that the fires are not too hot or extensive. Extremely hot fires can destroy an environment, sterilising the soil and preventing regrowth of important plant species. The Peoples of the Gundjehmi Language Group in the central Kakadu region in the Northern Territory begin systematic application of fire after the monsoon season when the ground still has a high moisture content that prevents the fires from spreading uncontrollably. Throughout the dry season, small, low intensity fires are set systematically and progressively through the Country. Regular burning of floodplains serves to keep fuel loads low and promotes the growth of important resources, such as the lotus and water chestnut, for both Peoples and animals. At the beginning of the hot season burning of Country ceases, due to the risk of widespread destruction caused by uncontrolled fire, fanned by warm evening winds spreading through the land.

Peoples of the Olkola Nation on the central Cape York Peninsula time fires to coincide with the first wet season storms to maintain the open structure of grasslands and grassy woodlands. The endangered golden-shouldered parrot, described as a fire-dependent species, is of immense cultural

significance to the Peoples of the Olkola Nation. The birds feed on the seeds of native grasses, in particular, fire grass (*Schizachyrium fragile*). The disruption of fire management regimes at the time of European colonisation resulted in decreased availability of grass seeds for the parrot and an increase in woody plants such as *Melaleuca* spp. that concomitantly attracted predatory species. As a result, the golden-shouldered parrot has now been classified as endangered. Part of the recovery plan for the species has involved the reinstatement of storm-burning fire management practices by the Olkola Peoples, to increase seed availability and provide appropriate habitats.

On the island of Saibai in the Torres Strait, fires that are purposefully set within the narrow seasonal window from September to October, burn with greater intensity and cover larger areas than fires used in mainland Australia. The environmental habitats of Saibai, which support a diverse range of flora and fauna species, are a product of this more intensive burning regime; continuation of these practices is essential to maintain these environments.

As a result of burning on the Australian continent for millennia, a significant amount of Australia's vegetation is fire tolerant. The Noongar Peoples of south-west Western Australia variably use both cool burning and fires of higher intensity based on an intimate knowledge of the vegetation and the response of the flora to fire. Lower intensity fires are set in a mosaic pattern in a biennial cycle to facilitate the growth of grasses and trigger germination of the seed bank stored in the soil. The Noongar Peoples understand the different characteristics of the vegetation types in the region and know that thicker growth is required in some areas. Vegetation in the south coast area, made up of a thick homogeneous community of trees, requires higher intensity fires to maintain dense plant and animal habitats. The Noongar Peoples apply higher intensity fires to this region when the density of the trees starts to become sparse, which occurs about every 10 to 15 years. The area is protected from the cooler fires set more frequently in other parts of the Country and the application of carefully monitored and controlled high intensity fire promotes new growth to maintain the dense forest environment.

Many Australian native plants are pyrophytic, that is, they have adapted to be tolerant to fire. For example, the seeds of some *Banksia* spp. are contained within a cone that is sealed with resin. On exposure to fire the resin melts and the seed pod dries, releasing the seeds from the cone onto soil that is nutrient-rich from the ash of the fire. *Banksia* spp. is an important resource for many Aboriginal Peoples. Noongar Peoples use the *Banksia* cone as a fire torch and the liquid nectar as a drink in its raw form or fermented into mead, while the Gunditjmara peoples of southwest Victoria use the empty cones of *Banksia* spp. to filter impurities from drinking water. Aboriginal Peoples understand the characteristics of the *Banksia* spp. and ensure that the action of applying appropriate fire regimes provides the optimum conditions for germination, growth and maintenance of important plant resources.

The productivity of other important plant resources, such as cycads, can be increased through the systematic and purposeful application of fire. The Yuin Peoples of the south coast of New South Wales have long harvested cycad seeds; they have developed detoxification processes so that the

seeds can be consumed as a reliable and nutritious food source. The application of short, intense fires in the appropriate season on Yuin Country improves the productivity of cycad seeds with approximately an eight-fold increase in food energy per area (kJ/m^2) due to the increased proliferation of seeds.

Fire management of Country/Place requires a deep understanding of animal habitats and behaviour. Careful application of fire to particular environments results in rapid regeneration of native grasses that provide feed for animals. The Martu Peoples of the Western Desert use fire in specific areas to encourage the regrowth of plants that provide important food sources for people and animals, create habitats for species, including endangered species such as the *mankarr* (bilby), and prevent larger, damaging fires. Other areas of Country are not burnt intentionally, to protect flora and to provide patches of mature growth as protection from predators.

Aboriginal and Torres Strait Islander Peoples' fire management techniques involving cooler, more controlled burning assist in the regeneration and propagation of native flora, thus protecting the biodiversity of plant and animal species. These cultural practices clearly illustrate deep understanding of the environment, and the environmental responses to fire regimes, that are believed to be responsible for the biodiverse landscapes across the Australian continent prior to European colonisation. The significance of purposeful ecosystem management through continued Aboriginal Peoples' fire management practices is evident in the research regarding the Dukaladjarranj Peoples of north-central Arnhem Land. Unbroken custody of the Country of the Dukaladjarranj Peoples has ensured that fire regimes have provided abundant and diverse plant and animal species, in contrast to areas of broken custodianship and practices. The scientific knowledge that underpins the continued application of long practiced fire regimes fulfils cultural obligations to the land and maintains healthy ecosystems and the diversity of native flora and fauna in the region.

This elaboration provides students with the opportunity to research how Aboriginal and Torres Strait Islander Peoples' deep scientific understanding of the natural environment is critical in the application of fire to the landscape. The purposeful application of fire has long been informed, and continues to be informed, by Aboriginal and Torres Strait Islander Peoples' knowledge of the local environment, including local conditions, climate, and the characteristics of plants and animals. Aboriginal and Torres Strait Islander Peoples' action of implementing fire regimes is underpinned by intimate scientific understanding of the outcomes of such practices. Students can learn how the application of fire is carefully considered, including timing, intensity and frequency, and how fire regimes continue to be informed by a scientific understanding of the plant and animal life of the environment.

CONSULTED WORKS

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Science Inquiry Skills

New elaborations within the Science Inquiry Skills (SIS) strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander Peoples when working scientifically. These intercultural science inquiry skills are throughout Foundation to Year 6 and provide opportunities for students to develop skills relating to:

- acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
- consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
- collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.

Unlike the Science Understanding (SU) and Science as a Human Endeavour (SHE) Teacher Background Information (TBI) materials the teacher background information for the new SIS elaborations provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures. Importantly, the Science Inquiry Skills TBI illustrates how concurrent SU and SHE topics can be used to contextualise the ways in which educators may provide skill development opportunities for the development of these skills.



The communication of ideas and understandings through visual representations has occurred for millennia

AC SIS060

Consulting local knowledge – tracks tell us who lives here

CONTENT DESCRIPTION

Represent and communicate observations, ideas and findings using formal and informal representations.

CONTENT ELABORATION FOR CCP

- ▶ consulting Aboriginal and Torres Strait Islander Peoples' representations of living things as evidenced and communicated through formal and informal sharing of information

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

A potential way to approach this content description is:

To develop the science inquiry skill of representing and communicating observations, ideas and findings, students could consult local Aboriginal or Torres Strait Islander communities to understand the formal and informal ways living things have been, and continue to be, represented and communicated by Australia's First Nations Peoples. An aspect of the study of living things is the analysis of trace evidence left by living things, such as tracks left on the ground, scratch marks on plants and animal dung, that can provide a signature to identify an animal. Aboriginal and Torres Strait Islander Peoples have long used, and continue to use, trace evidence to identify an animal's species, habitat, location and behaviours. Tracks often provide information about the observable features of an animal, such as whether it has claws, a tail, or webbed feet and what size or weight the animal is likely to be.

For millennia Aboriginal and Torres Strait Islander Peoples have communicated the knowledge of tracking and identifying mammals and other animals in formal ways, such as in paintings and petroglyphs and through song, dance and storytelling. For example, petroglyphs carved into rock by the Arrernte Peoples at the Napwerte/Ewaninga Rock Carvings Conservation Reserve south of Alice Springs, show arrow shaped motifs that represent bird tracks. The Jardwadjali Peoples recorded and communicated knowledge of animal tracks, including emu and kangaroo, by painting representations on the surfaces of rocks at Billimina Shelter in the Western Grampians in Victoria. Scientific knowledges are also communicated in informal ways, with many Aboriginal and Torres Strait Islander children learning animal and bird tracks by studying representations drawn in the earth or

sand. Many early European naturalists acknowledged the expert skill in Aboriginal and Torres Strait Islander Peoples' ability to reliably track and collect animal specimens through the acute observations of trace evidence left by the animal. For example, on the lands of the Kuku-Yalanji Peoples in far north Queensland an Aboriginal expert located a Bennett's tree-kangaroo for observation by the first European naturalists by detecting distinctive scratches on the bark of a tree.

In identifying living things in an environment, students could take photographs or sketch animal tracks to represent and record evidence. Animal track records help students to recognise observable features of the animal. Students may consult local Aboriginal or Torres Strait Islander Peoples' knowledges to identify the animals in the local environment. Such knowledge may be available in books, online resources, or through direct consultation or correspondence with local Aboriginal or Torres Strait Islander Peoples. Incorporation of this elaboration can provide students with the opportunity to consult with local Aboriginal or Torres Strait Islander Peoples to learn about the many formal and informal ways that scientific knowledge of living things has been, and continues to be, represented and communicated. In developing the science inquiry skill to represent and communicate observations, ideas and findings, teachers can guide students to use a variety of methods, such as photographs and sketches, to collect information about living things in the environment, and consult with Aboriginal or Torres Strait Islander Peoples to assist in the identification of the animal.

AC SIS060

Acknowledging understandings of anatomy

CONTENT DESCRIPTION

Represent and communicate observations, ideas and findings using formal and informal representations.

CONTENT ELABORATION FOR CCP

- acknowledging and exploring Aboriginal and Torres Strait Islander Peoples' ways of communicating information about anatomical features of organisms

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

A potential way to approach this content description is:

In engaging students in the development of the science inquiry skill of representing and communicating observations, ideas and findings, it may be useful to explain that Aboriginal and Torres Strait Islander Peoples have long developed and used informal and formal means of communicating observations about important information. This elaboration provides students with the opportunity to explore the ways Aboriginal and Torres Strait Islander Peoples represent and communicate scientific knowledges, including the anatomical features of living things. The use of a variety of means to represent and communicate scientific knowledges fosters a deep understanding and memorisation of the information. Methods for communicating the observable features of living things include storytelling, song, dance, petroglyphs and iconography.

Aboriginal and Torres Strait Islander Peoples have long represented and communicated knowledge of the behaviours and observable features of organisms through song and dance. An excellent example of this was recorded by the Guugu Yimithirr Peoples of the Hopevale region of far north Queensland who represent and communicate important information about dangerous organisms using song, dance and models of animals. The potential danger of the venomous stonefish is communicated through a cultural dance, with a warning about the consequences of treading on the stonefish spines. A beeswax model of the stonefish, including anatomical details of the spines, is used to represent its structural features and communicate the dangers of the organism.

The Muralag Peoples of Muralag Island in the Torres Strait represent and communicate observable features of the sawfish in song, dance and masks. Masks are constructed that represent the structural features of the sawfish, including the distinctive long series of teeth along the snout, the dorsal fins and heterocercal tail. Scientific information about living things, embedded in Aboriginal and Torres Strait Islander Peoples' song, dance and various visual representations, ensures the behaviour, characteristics and locations of the living organism are expressed and communicated.

This elaboration provides students with the opportunity to acknowledge and explore the ways that Aboriginal and Torres Strait Islander Peoples represent and communicate information. Students can explore Aboriginal and Torres Strait Islander Peoples' songs and dances online to recognise different methods of representation and communication, and evaluate the knowledge and information about the observable features of living things that they convey. Additionally, teachers may seek permission, in consultation and with the support of the local community, for students to learn an Aboriginal or Torres Strait Islander Peoples' dance that demonstrates the observable features of organisms.

AC SIS054

Consulting local knowledge – what’s dangerous?

CONTENT DESCRIPTION

With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment.

CONTENT ELABORATION FOR CCP

- ▶ consulting with Aboriginal and Torres Strait Islander Peoples to guide the planning of scientific investigations, including safety considerations for field investigations

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

A potential way to approach this content description is:

In developing the science inquiry skill of planning and conducting scientific investigations, students can plan a field investigation to identify and group living organisms in their local region. As part of the planning for such an investigation, students could consult with local Aboriginal or Torres Strait Islander Peoples to understand potential safety risks in the area. For further information, students could consult material published by Aboriginal and Torres Strait Islander Peoples or information that acknowledges Aboriginal and Torres Strait Islander Peoples’ knowledges about the local environment, found in internet sources and/or library resources. In planning a scientific investigation such as a local survey for living things, students need to be aware of the safety risks of the environment and consider how to manage the risks to ensure a safe working environment. The risks differ depending on the location of the field investigation, and the potentially dangerous plants and animals that students may encounter. Many local Aboriginal and Torres Strait Islander Peoples have a deep understanding of the environment and may be able to help students to understand the possible risks they may encounter.

Many dangerous insects in Australia, such as bees, wasps and ants, can inflict painful stings or bites or cause allergic reactions. For example, the bite of the assassin bug that is found in the open forest of Yugambah and Bundjalung Countries can cause intense pain to humans. Consultation with local Yugambah or Bundjalung community members may raise students’ awareness of where the bug might be found, and how bites can be prevented and treated. This information assists field trip planning by raising awareness about the protective clothing that should be worn, safe ways to catch insects using equipment such as bug catchers and first aid equipment that should be available.

Animals may also pose safety risks for students. For example, when students are investigating living things in coastal environments, they may need to be aware of the venomous stonefish. Many local Aboriginal and Torres Strait Islander Peoples have highly localised knowledge of the presence and risk of stonefish and may be able to help students plan safe locations for field work.

Many plants also pose hazards that need to be considered prior to undertaking a field investigation. For example, the hooked spikes of the wait-a-while vine (*Calamus muelleri*) can catch onto and puncture exposed skin; further injury can occur if the barbs are not removed properly. The Gympie-Gympie stinging tree found in rainforest areas of Queensland is one of Australia's most dangerous plants. The leaves have fine hairs on the serrated edge that cause extreme pain on contact that can persist for several weeks. The common name for the plant, Gympie-Gympie, is derived from the Gubbi Gubbi Language of the south-east Queensland region. Consultation with the local Aboriginal or Torres Strait Islander community can inform students about the safety precautions that they should consider in planning their scientific investigation.

As well as considering dangerous plants and animals in the local environment, consultation with local Aboriginal or Torres Strait Islander Peoples may also help students identify behaviours that may pose safety risks. For example, scrub typhus is a mite-borne infection that can be transmitted to humans when they sit or lie on bare ground or grass. The infection, which can cause significant health complications, is spread through the bite of infected chiggers (larval mites) found in grassland areas at the edge of dense monsoon forests or forested creeks. In Australia, infections have originated in the lands of the Larrakia, Woolner and Djowei Peoples in the Litchfield National Park region in the Northern Territory. Consultation with local Aboriginal community members in this region may provide students with safety advice, such as not sitting on bare ground or on rotting logs, that can help prevent such infections. Similarly, significant health complications or even death can be caused by the bite of the venomous Sydney funnel-web spider, found within a 100 km radius of Sydney. The Sydney funnel-web spider generally burrows in sheltered habitats with a moist, humid climate, such as under rocks, logs or borer holes in rough-barked trees. Local Aboriginal Peoples, including the Awabakal and Worimi Peoples of the Newcastle region, may be able to advise students of the risk of moving rocks when undertaking field investigations.

Safety considerations are an important aspect in developing the science inquiry skill of planning and conducting investigations. Incorporation of this elaboration can provide students with the opportunity to consult with local Aboriginal or Torres Strait Islander community members to access knowledge about the local risk and safety issues that may need to be considered when planning a field investigation. This knowledge can be used to guide student awareness about the need for safe behaviours and safety measures, such as materials and equipment, including protective clothing and first aid kits, when working scientifically in the field.

AC SIS053

Consulting local knowledge – what’s here?

CONTENT DESCRIPTION

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge.

CONTENT ELABORATION FOR CCP

- ▶ consulting with and using existing knowledge held by Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions regarding invasive species

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

A potential way to approach this content description is:

In developing the science inquiry skill of identifying scientific questions and making predictions, students consult with Aboriginal or Torres Strait Islander Peoples to gain prior knowledge about their local environment and invasive species. Aboriginal and Torres Strait Islander Peoples may hold information about living things in the local environment and changes that have occurred over time. Teachers can guide students to reflect on changes to living organisms within the region; some changes may be recent, while other changes may extend back in time significantly, prior to colonisation. Students have the opportunity to understand that prior knowledge of the environment is held by Aboriginal and Torres Strait Islander Peoples, who have long and ongoing connections to the local environment. In developing scientific questions and predictions about invasive species, students consult with the local Aboriginal or Torres Strait Islander community to find out about the living things that have always been present, and those that are new and may not belong. Aboriginal and Torres Strait Islander Peoples’ classification systems for organisms, based on observable features, assist in the identification of living things that do not belong in a particular environment.

Students may be familiar with some introduced and invasive species in their local environment, such as the weed *Lantana* spp. or the European honey bee. Such species have changed the balance of living things within some environments due to factors such as competition with native organisms for habitats and resources. Some living things within an environment may be destructive to the

ecosystem balance and pose threats to existing species. For example:

- on Noongar Country in south-west Western Australia the invasive European honey bee builds hives in tree hollows that limit the nesting space for native animals, including the native black cockatoo and possums. Consultation with Noongar Peoples about the effect of invasive species on Noongar Country may help provide students with prior knowledge to inform the development of a scientific question or prediction about living things in that environment.
- feral pigs on Gerbar Island in the Torres Strait are impacting on the nesting sites of populations of native turtles. Consultation with the Kala Lagaw Ya Peoples may help students understand the impact of invasive species on native living things in the central Torres Strait Islands and formulate scientific questions and predictions based on this prior knowledge.
- Recent research in the Port Sorrell region of northern Tasmania has shown that sugar gliders, believed to have been introduced to Tasmania from mainland Australia early last century, are contributing to the decline of the swift parrot, one of Australia's most endangered birds. Students may be able to gain prior knowledge about the changes to living things in this area of northern Tasmania through consultation with Tasmanian Aboriginal people.

Since European colonisation more than 3,000 living things, including plants, mammals, marine species, birds and reptiles have been introduced to Australia, affecting all habitats across the continent. Incorporation of this elaboration can provide students with the opportunity to consult with Aboriginal or Torres Strait Islander Peoples to access prior knowledge about living things in the environment and the effect of invasive species. Teachers can guide students to use this knowledge in the development of the science inquiry skill, to identify and formulate scientific questions about living things in the environment and make predictions regarding the environmental impact of invasive species.

Year 4

Teacher background information



ACSSU072	Knowledge and use of fauna and flora life cycles
ACSSU073	Interconnected world view
ACSSU074	Experts in the properties of natural and processed materials – tools, clothing and shelter
ACSSU074	Experts in the properties of natural and processed materials – paints
ACSSU075	Managed country
ACSSU076	Toy science
ACSHE061	Classification, sorting and estimation
AC SIS064	Acknowledging knowledge of life cycles and migrations

ACSSU072

Knowledge and use of fauna and flora life cycles

CONTENT DESCRIPTION

Living things have life cycles.

CONTENT ELABORATION FOR CCP (OI.2, OI.3, OI.5)

- ▶ investigating how Aboriginal and Torres Strait Islander Peoples understand and utilise the lifecycles of certain species



Wood moths (witchetty grubs) are harvested at the pupae stage of development

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to investigate the long-held scientific understanding Aboriginal and Torres Strait Islander Peoples have of the life cycles of species within their Country/Place. For millennia Aboriginal and Torres Strait Islander Peoples have used knowledge and understanding of the life cycles of organisms to acquire and utilise resources from the environment. These resources are important for the construction of tools, weapons, implements and shelters, to manufacture clothing and to procure food and medicines. An understanding of the life cycles of organisms informs the appropriate time for the careful, considered harvest of flora and fauna species to protect the sustainability of the organism and provide continued access to the resource. Students will learn how the intricate understanding of the life cycles of organisms has long informed Aboriginal and Torres Strait Islander Peoples' decisions regarding when to acquire and utilise resources.

DETAIL

Phenology is the study of plant and animal life cycle events and how these are influenced by changes in season, climate and habitat. For millennia, Aboriginal and Torres Strait Islander Peoples have studied patterns in the environment and have developed an intimate understanding of these interconnected factors. Aboriginal and Torres Strait Islander Peoples' understanding of seasons is quite different from the European perspective which divides the calendar year into four distinct seasons based on the Gregorian calendar months. Aboriginal and Torres Strait Islander Peoples distinguish seasons based on many factors including, but not limited to, climatic conditions, and plant and animal life cycle indicators, and events.

Australia's First Nations Peoples' seasonal calendars vary due to the diversity of environments and climatic conditions across the Australian continent. For example, the seasonal calendar of the Miriwoong Peoples, whose Country encompasses the east Kimberley region of Western Australia and extends into the Northern Territory, comprises three seasons, whereas the seasonal calendar of the D'harawal Peoples of the region north of Sydney encompasses six seasons. Aboriginal and Torres Strait Islander Peoples hold a wealth of knowledge about the life cycles of species and the intrinsic relationship with seasonal variation can be seen in such seasonal calendars. Documenting the calendars has informed the scientific understanding of the relationships between Aboriginal and Torres Strait Islander Peoples and the seasonal cycles of resource availability.

The coastal floodplain Country in the Kakadu region of the Northern Territory encompasses a vast wetland area that has long been managed and maintained by the Bininj and Mungguy Peoples to support the vast diversity of wildlife in the region. Magpie geese breed in the wet season; this timing coincides with wetland flooding which supplies abundant food resources for the birds. Aboriginal Peoples of these regions understand the life cycle of magpie geese and the behaviour associated

with their breeding patterns. In *Gudjewg* (monsoon season, December–March on the Gregorian calendar), magpie geese flock to the Kakadu region where heat and humidity provide a plentiful supply of rushes and grasses for the magpie geese to build nests. For millennia, the land has been managed by burning intrusive plants to maintain a plentiful supply of food resources that ensure the return of the birds for breeding every monsoon season. The magpie geese begin laying about two months after nest building and clutch size varies from a single egg up to 14 eggs per breeding cycle. Aboriginal Peoples' knowledge of the life cycle informs the sustainable harvest of eggs that provides a staple food source through the wet season. Goslings hatch after approximately 25 days of incubation and spend a day in the nest before being led through the swamp by their parents. The goslings are able to fly after about 10 weeks but remain with their parents until the following breeding season. Hunting the magpie geese begins in *wurrngeng* (the cold time; June–August on the Gregorian calendar) when the magpie geese are fat and heavy after abundant food, and continues into *gurrung* (the hot, dry season; mid-August–October on the Gregorian calendar). Aboriginal Peoples' intricate understanding of the life cycle of the magpie goose and the interrelated seasonal factors has informed sustainable harvesting of eggs and adult birds for millennia. Understanding and utilising the life cycle of the magpie goose facilitates hunting for eggs and birds and ensures the fulfilment of cultural obligations in the ongoing management of Country.

Peoples of the Islands in the Torres Strait also eat birds, in particular the Torresian imperial pigeon called *gainau* in the Kalaw Lagaw Ya Language of the western Torres Strait Islander Peoples and *daumer* in the Meriam Mir language of the eastern Torres Strait Islander Peoples. At the end of the monsoon season, the pigeons migrate from New Guinea and nest in the mangrove areas of the Islands. The pigeon lays one or two eggs that are incubated for about 27 days by both parents and the adult birds flock daily to inland areas to feed on the wild nutmeg trees. Many Torres Strait Islander Peoples understand and utilise the behavioural patterns of the pigeons associated with their life cycles and hunt the birds as they migrate in predictable patterns.

Grass trees (*Xanthorrhoea* spp.) have long been a culturally important species for many Aboriginal Peoples across Australia and knowledge of the life cycle of these plants, and when components can be harvested for use, is well understood. The plant provides material for many purposes, including resin, food, nectar, fibre and wood to construct implements and weapons. Grass trees are endemic to Australia and are found across all states and territories, although some species are restricted to particular regions. *Xanthorrhoea* spp. are monocots, flowering plants that have only one embryonic leaf in their seeds. The plant begins as a crown of rigid grass with a stem root that grows slowly underneath. Grass trees may take several years to flower. Flowers form in a spiral arrangement on a spike that protrudes from the centre of the leaves that skirt the trunk of the plant. The first flowers on the spike to emerge have been recorded as indicators of direction as they always open facing north. The flowers produce a nectar that attracts birds and insects and can also be used to sweeten drinks. Peoples of some Language Groups of Tasmania soak the flowers of the grass tree in fresh water to release the nectar and make a sweet drink. In the southwest of Western Australia, the Noongar Peoples produce a fermented beverage by soaking grass tree (*balga*) flowers in boat shaped bark

vats for several days. The pollinated flowering stem of the grass tree can produce up to 10,000 seeds that can take up to a year to germinate. The Gunditjmara and Wurundjeri Peoples of the Mornington Peninsula region in Victoria grind the seeds into a flour to make bread.

The growth rate of the grass tree is very slow; the plant extends approximately one to two centimetres annually, although the long spike can grow to a length of up to four metres. The growing tip of the stem is edible, although it is rarely consumed as its removal destroys the plant completely, and the opportunity to produce further resources. The dried spike has long been used for many purposes by Aboriginal Peoples. It can be used in the construction of lightweight spears and as a drill stick for starting fire. The Noongar Peoples of south-west Western Australia use the dried flower stems of grass tree (*balga*) as a torch. Many First Nations Peoples, including the Yirrganydji and Yidinji Peoples of the Cairns region, the Cammeraigal Peoples of the Eora Nation in the region now known as Sydney, and the Peoples of some Language Groups of Tasmania use the dried stem of the grass tree as a drill stick for starting fire. The young, soft leaf bases of the grass tree can be eaten fresh and this has long provided many peoples, including the Woiwurrung Peoples of the Kulin alliance in central south Victoria, with a nutritious food resource. The older leaves become tough and are used by the Wurundjeri Peoples of the Yarra River Valley in Victoria as a tool to cut meat. The Noongar Peoples also use the leaves in the construction of roofs for shelters, as the structure of the leaves directs rainwater along the underside of the fronds, keeping the occupants of the shelter dry. The Woppaburra Peoples of the Keppel Island region in Queensland use the butt of the grass tree to construct educational toys called *kamma*, named after the Language name of the grass tree. Resin is produced at the leaf base of some species of grass trees. Aboriginal Peoples have collected and used this resin in many different applications: a waterproofing agent on canoes and water-carrying vessels such as coolamons, as an adhesive to fix axe heads onto handles and spear tips on spear shafts, and to repair other implements.

Aboriginal Peoples across Australia understand the complex life cycle of the grass tree and utilise components of the plant through the various life cycle stages. For millennia the grass tree has provided materials for many important purposes, and Aboriginal Peoples' management of the environment that supports and sustains the growth of grass trees reflects a deep understanding of the life cycle of the organism and ensures that the plant continues to yield resources.

The life cycle of insects, such as moths, is also well understood by Aboriginal Peoples and important food resources have long been harvested at identified stages of the insect life cycle. There are four main stages in the life cycle of moths – egg, larva, pupa and adult. During the first stage, the embryonic stage, the embryo develops inside an egg. The embryo hatches into a larva, commonly known as a caterpillar. The larval stage of a particular large wood moth, known to the Adnyamathanha Peoples of the Flinders Ranges region in South Australia as *witjuri*, bores into the wood of *Acacia* to feed on plant sap. Sawdust that accumulates on the ground as the larvae bore into the plant provides evidence of their presence. The Adnyamathanha Peoples harvest the larvae as a food source which is rich in protein.

Peoples of some Language Groups of Tasmania harvest and eat the larval stage of a moth species that bores into *Banksia* spp., and in parts of Queensland Aboriginal Peoples harvest, and lightly roast or eat raw, the larvae of moths found in blue gum saplings or at the base of grass trees. When larva is ready to pupate, it spins a protective cocoon where metamorphosis takes place. The time from pupation to the emergence of the adult moth from the cocoon can take up to three weeks. Caterpillars of a particular species in Victoria form a procession in large numbers along the stems of gum trees to find a place to rest and pupate. The Gunditjmara Peoples of western Victoria have an intricate understanding of the life cycle of these insects and dig the pupal form of the moth from the foot of gum trees in winter to roast in the ashes of a fire as a source of food. Specific adult moth species have immense cultural significance to Aboriginal Peoples. The aestivation of the bogong moth in the cool caves of the Snowy Mountains on the lands of the Ngarigo Peoples in southern New South Wales has long been an occasion for Aboriginal Peoples in the region to unite for a feast. The moths, an extremely nutritious food source with a high fat content, are harvested with smoke and nets crafted specifically for the purpose. The moths are cooked gently on the edge of a fire and the nutrient rich body is separated from wings and heads before consumption. Aboriginal Peoples' knowledge of the life stages of moth species in Australia has long informed the suitable times for harvesting particular species to benefit from their nutritious properties.

For millennia Aboriginal and Torres Strait Islander Peoples have harvested resources from the natural environment to construct tools, weapons and other implements, manufacture clothing and shelter, and to procure food, drink and medicines. This elaboration provides students with the opportunity to investigate the understanding Aboriginal and Torres Strait Islander Peoples have of the life cycles of species and how this knowledge is used to inform the utilisation of plants and animals. Students will learn how the intricate knowledge of the life cycles of organisms has long informed, and continues to inform, how Aboriginal and Torres Strait Islander Peoples sustainably harvest resources to fulfil these requirements.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU073

Interconnected world view

CONTENT DESCRIPTION

Living things depend on each other and the environment to survive.

CONTENT ELABORATION FOR CCP (OI.2, OI.3)

- ▶ recognising how Aboriginal and Torres Strait Islander Peoples perceive themselves as being an integral part of the environment



Lardil Peoples are integral to their environment and maintain laws that govern how Land and Sea Country is treated

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have the longest continuing living cultures on record. As such, many people feel that this is evidence of perhaps the most successful model of sustainability in existence. For millennia Aboriginal and Torres Strait Islander Peoples have maintained a careful balance of the environment and the complex ecosystems within their Country/Place. This elaboration provides students with the opportunity to recognise Aboriginal and Torres Strait Islander Peoples' world view and understand how such cultures identify themselves as a fundamental part of the environment. Aboriginal and Torres Strait Peoples have deep knowledge of the dependencies of living things in an environment and perceive themselves as integral to these systems. This elaboration will deepen students' understanding of the place of Peoples in the environment and the consequences of removal of Aboriginal and Torres Strait Islander Peoples from the environment.

DETAIL

As the First Peoples of Australia, Aboriginal and Torres Strait Islander Peoples have established and maintained a shared living culture with their environment since time immemorial. As Noonuccal woman Karen Martin-Booran Mirraboopa of North Stradbroke Island explains:

“We believe that Country is not only the Land and People, but is also the Entities of Waterways, Animals, Plants, Climate, Skies and Spirits. Within this, one Entity should not be raised above another, as these live in close relationship with one another. So People are no more or less important than the other Entities.” (Martin & Mirraboopa, 2003, p. 207).

Aboriginal and Torres Strait Islander Peoples live in a symbiotic relationship with their Country or Place and see themselves as belonging to the environment rather than having dominion over the environment. A reciprocal interrelationship exists between Aboriginal and Torres Strait Islander Peoples and the environment, which integrates sustainable practices with obligations to Country/Place. Humans, other animals, and the natural environment are all fundamentally connected in this holistic, ecocentric environment. Aboriginal and Torres Strait Islander Peoples view themselves as living components required by the environment, and dependent on other living things, for the environment to thrive.

Environmental understandings held by Aboriginal and Torres Strait Islander Peoples have been developed through long-held intellectual practices to generate, validate and interpret scientific knowledges gained empirically about the natural environment. This knowledge base is often called 'traditional ecological knowledge' (TEK). For millennia in Australia, First Nations Peoples have been an integral part of the environment and have developed deep understandings of the interrelationships that exist in the environment. This has resulted in potentially the most successful example of long-term environmental sustainability. For example, prior to colonisation, Aboriginal and Torres Strait Islander Peoples used their long-held knowledge to protect parts of the environment that provided

sanctuary for specific animal species. Within the boundaries of a sanctuary, no hunting, fishing, burning or gathering was allowed. The sites were refuges to protect a breeding or nesting ground for a particular species, as well as the organisms in that area. The species is protected from human interference for the benefit of the environment and the Peoples. Eunonyhareenyha, north-east of Wagga Wagga in New South Wales, is a breeding ground for emu that, prior to colonisation, was protected by the Wiradjuri Peoples. Similarly, in the central desert of Australia, Aboriginal Peoples manage parts of the land by banning human activities such as hunting, gathering and burning, to ensure there are areas of sanctuary for the Red Kangaroo.

Care of the environment by Aboriginal and Torres Strait Islander Peoples has changed the land, and over many thousands of years, the animals and plants within delicately balanced ecosystems have adapted to human interaction. As Aboriginal and Torres Strait Islander Peoples were completely dependent on the environment, they implemented carefully considered practices that ensured the existence of co-dependent species. For millennia Aboriginal and Torres Strait Islander Peoples have used fire to consciously and deliberately promote the wellbeing of organisms within their environment. This is often referred to by Aboriginal and Torres Strait Islander Peoples as “cleaning up the Country”, and reflects a practice of care and consideration in maintaining a healthy and well-managed environment. The Martu Peoples of the Western Desert use fire in specific areas to encourage the regrowth of plants that are important food sources for people and animals, to create habitats for species, including endangered species such as the *mankarr* (bilby), and to prevent larger, damaging fires. Some areas of Country are not burnt in order to protect flora and to provide patches of older growth as refuge from predators. As humans are an integral part of the environment, changes to human interactions can impact other species within that environment.

Colonisation in Australia led to forced dispossession and physical disconnection from Country/Place for many Aboriginal and Torres Strait Islander Peoples. Consequently, the Australian environment, of which people are such a vital component, changed from the carefully balanced and managed system to an unbalanced system. For example, prior to colonisation, the Kuku-Yalanji Peoples of the rainforest regions in far north Queensland carefully managed large areas of tropical rainforest, and areas of open sclerophyll forest, through the implementation of fire regimes. Different types of environments require different fire regimes. Rainforest environments contain species that are susceptible to fire and rely on the dense tree canopy to provide a shaded, humid environment. Many sclerophyll forest plants are resistant to fire or may require fire for germination, and thrive in open well-lit conditions. For millennia, the Kuku-Yalanji Peoples have applied fire only to specific areas of their Country, to provide the environmental conditions necessary for plants to thrive. The disruption of these practices by policies of fire suppression following colonisation of the region has impacted the environment, as the integral role of People within the environment became disconnected. This disruption had a significant impact on biotic and abiotic factors within the environment, and as a consequence, caused significant change in the structure and composition of communities within ecosystems. Another consequence was the encroachment of dense, shaded rainforest into

sclerophyll regions, which overshadowed open well-lit conditions and prevented the germination and establishment of seedlings of plant species such as *Eucalyptus* spp. This, in turn, impacted other living things in the interdependent environment.

The physical disconnection and forced displacement of Aboriginal and Torres Strait Islander Peoples at the time of colonisation affected Peoples from fulfilling their obligations to Country/Place. Aboriginal and Torres Strait Islander Peoples have intimate and highly detailed knowledge of their Country/Place and understand the complex and intricate processes required for healthy, productive Country/Place. As the land no longer had Aboriginal and Torres Strait Islander Peoples' careful and controlled interactions, not only did the environment become unbalanced, but the Peoples who could no longer carry out their cultural responsibilities to Country also suffered greatly. As an integral part of the environment, Aboriginal and Torres Strait Islander Peoples are needed for the balance and survival of all living things within that environment.

This elaboration provides students with the opportunity to understand the interconnected world view of Aboriginal and Torres Strait Islander Peoples. This ecocentric perspective places Peoples within the environment, as an intrinsic part of the larger system rather than in a place of dominance. Aboriginal and Torres Strait Islander Peoples have long understood the intricate relationships within the environment and have carefully implemented management practices that promote the sustainability of all organisms within the environment. Students will have the opportunity to understand how living things depend on each other and the environment to thrive, and that the change to Aboriginal and Torres Strait Islander Peoples' role as living components within the environment impacts other elements within systems.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSSU074

Experts in the properties of natural and processed materials – tools, clothing and shelter

CONTENT DESCRIPTION

Natural and processed materials have a range of physical properties that can influence their use.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ considering how Aboriginal and Torres Strait Islander Peoples use natural and processed materials for different purposes, such as tools, clothing and shelter, based on their properties



Grain processing technology such as millstones utilise the abrasive properties of sandstone

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to learn that Aboriginal and Torres Strait Islander Peoples have for millennia selected and used natural and processed materials for many purposes, based on the physical properties of the material. Aboriginal and Torres Strait Islander Peoples understand the physical properties of natural materials and have procured and utilised materials from the environment to construct tools, manufacture clothing and construct shelters. Furthermore, Aboriginal and Torres Strait Islander Peoples understand how natural materials can be processed in particular ways. Such processes modify the physical properties of natural materials and enable them to be used for particular purposes that could not occur in their natural form. Students will have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples' longstanding scientific knowledge of the physical properties of materials has informed, and continues to inform, the selection of natural and processed materials for specific functions.

DETAIL

Prior to European arrival in Australia, there were more than 500 distinct Aboriginal and Torres Strait Islander Nations, each occupying a specific geographical territory. The region occupied by an Aboriginal or Torres Strait Islander People determined the resources that were available; these resources were sustainably harvested to provide medicines, tools, shelter, clothing, food and weapons. In the development of material culture, Aboriginal and Torres Strait Islander Peoples understood the physical properties of the natural materials available in their Country/Place, such as hardness, flexibility, absorbency, strength, buoyancy, permeability, malleability and elasticity. The physical properties of materials required for different aspects of daily life, such as the construction of shelters or manufacture of tools and clothing, varied greatly and required resources with suitable physical properties. These materials may have been processed prior to use, to improve specific physical properties of the material, thus making it more suited to its function. Aboriginal and Torres Strait Islander communities throughout Australia utilise their material science knowledge and understanding in the continuation of cultural practices.

Plant materials have long been used by Aboriginal and Torres Strait Islander Peoples in the construction of tools, weapons and shelters. Many parts of a plant can be used, including the wood, bark, roots and leaves. Knowledge of the natural properties of the various species of plants in a given geographical region informs the selection of materials for specific purposes, such as in the construction of domestic implements and weapons. For example, dense woods are used to construct implements for striking and digging that need to be hard, heavy and durable, whereas implements such as boomerangs are constructed from material that is strong but not heavy. The manufacture of different types of spears demonstrates Aboriginal and Torres Strait Islander Peoples' understanding of the physical properties of natural materials and illustrates the careful and purposeful selection of a material based on the desired purpose. The construction of fishing spears requires the selection

of a natural material that is lightweight, buoyant and flexible, so that the spear will float to the water surface to be retrieved after use. The Meriam Peoples of the eastern Torres Strait Islands use lightweight bamboo to construct *baur* (multi-pronged fishing spears). The Gumbaynggirr Peoples of the mid north-west coast of New South Wales construct *biguurr* (fishing spears) from lightweight woods native to the area, such as cottonwood, hibiscus and grass tree. Spears used for hunting large game, such as emu and kangaroo, require wood of a higher density to maximise the impact on the target. In the past, the Paredarerme people of the Oyster Bay region of Tasmania constructed *perenna* (hunting spears) from tea tree or *Eucalyptus* spp., materials that are light and durable. In the Musgrave Ranges region of the Western Desert, the Yankunytjatjara Peoples construct *oiritchanna* (composite hunting spears) from different woods that are selected for their natural properties. A light flexible wood obtained from plants such as the wonga wonga vine is used for the spear shaft, and a hard, heavy material such as mulga is used to construct the spear head. The combination of materials achieves the optimal physical properties for a hunting spear – strength, flexibility and durability.

Aboriginal and Torres Strait Islander Peoples apply processes to wood and bark, such as steaming, to alter the physical properties of the material. Steam bending is a technique whereby heat and moisture are applied to wood or bark to modify its physical properties. Wood and bark, when they are separated from the tree and dried, become rigid, difficult to bend and break easily. Steaming adds moisture and heat to wood and bark and results in plasticisation of the material. This treatment process confers the physical properties of improved malleability, the ability to mould the material into a desired form, and a reduced tendency to break. Steam bending has long been used, and continues to be used, by Aboriginal and Torres Strait Islander Peoples to treat wood and bark for a variety of applications.

Prior to European colonisation, the Punnilerpanner Peoples of the Port Sorell area in northern Tasmania constructed unique beehive-shaped shelters. The dome-shaped shelter was constructed using wooden structural supports that had been steamed by fire to facilitate bending. Heat can be applied to moist sections of freshly harvested bark. The heat generates steam within the bark and allows the curled section of bark to be flattened into sheets for the construction of shelters and as a canvas for painting. The Wodiwodi Peoples of the Illawarra region on the south coast of New South Wales used flattened sheets of *warreeah* (a Dharawal word that translates to stringybark in English) to cover the frame of a shelter. The Yolŋu Peoples at Yirrkala in east Arnhem Land in the Northern Territory use stringybark as a canvas. The bark is cut from the tree during the wet season to take advantage of the ambient moisture which facilitates its removal. It is then heated over a fire to alter the physical properties of the bark, making it flexible and malleable so that it can be flattened. Yolngu Peoples have utilised this scientific knowledge for millennia in the production of bark canvases, including in the production of the 1963 Yirrkala bark petitions, and continue to use this knowledge today.

Steam processing of bark is also used in the construction of water vessels. The Gunaikurnai Peoples of the Gippsland region of Victoria steamed sheets of stringybark over a fire to improve pliability for the construction of canoes. Once steamed, the bark could then be shaped by turning up the sides and folding the edges together to construct a watertight vessel with the capacity to carry multiple passengers.

Other plant parts are used to manufacture domestic implements and are selected based on their physical properties. Many raw, unprocessed fibres are lightweight, strong and flexible, making them ideal for use as string. Aboriginal and Torres Strait Islander Peoples use fibres in their natural state for tying materials and objects together and in the manufacture of clothing. The Yir Yoront Peoples of the Kowanyama region of Cape York Peninsula use lengths of the strong, flexible lawyer cane stem to tie roofing material onto shelters. The Koeybuway and Moegibuway Peoples of Saibai Island in the Torres Strait have long-used lawyer cane for its tough, pliable physical properties; split into strips it is used in the construction of houses. Natural fibres were also used prior to colonisation in the manufacture of clothing. For example, lawyer cane was used to stitch together clothing, such as dresses made from bark, and on the north-west coast of Western Australia, the Nyangumarta Peoples manufactured sandals from the unprocessed creepers of the dodder vine.

Aboriginal and Torres Strait Islander Peoples also process fibre to improve its strength and durability. Processed string and cord are used to manufacture nets, baskets, bags, belts and mats for fishing and to catch game, and for other woven or netted items. The Gunai Peoples of the Gippsland region in Victoria have long processed kangaroo grass to manufacture string for nets. The collected grass is steamed to soften the natural fibre and allowed to cool. The pulp is removed through chewing and the fibre is then washed and dried. Twine is then made by twisting and winding two strands of the processed fibre together. The Mabuag Peoples of Mabuag Island in the Torres Strait process coconut husk to manufacture string. The husks are soaked for up to two weeks in water until soft and then they are pounded. Individual fibres are separated and scraped to remove pulp or broken remnants, dried in the sun, and then twisted together into strands. The processed material is strong and durable and is used to manufacture fishing lines. The Mabuag Peoples understand the physical properties and limitations of the string, and they twine up to four strands together to increase the tensile strength of the string, to use when fishing for large marine animals.

Additional processing may be incorporated in the manufacture of string to confer specific physical properties. The Dharawal Peoples of the Beecroft Peninsula region on the southern New South Wales coast tan fishing lines with plant gum to prevent fraying and to increase durability. The Yidinji Peoples of far north Queensland use wax from native bees to make string waterproof and more resistant to weathering. In parts of Australia, oil such as emu oil is rubbed into the fibre while it is being twined, to impart suppleness and flexibility to the cord.

Rock is a natural material that has long been used by Aboriginal and Torres Strait Islander Peoples in the construction of stone tools. Knowledge of the properties of different types of rock informed the selection of specific rock types for particular purposes. Aboriginal and Torres Strait Islander

Peoples have used grindstones for millennia to process seeds, carefully selecting the appropriate rock type based on its physical properties. Sandstone has long been widely used as a grindstone across Australia as it has a rough surface to efficiently process seeds. However, Aboriginal Peoples also understand that another physical property of sandstone is that it is porous and has a higher absorbency rate than other rock types. The Jirrbal Peoples of the Atherton Tableland region in far north Queensland do not use sandstone grindstones for processing the toxic cycad nut, as the process may deposit toxic residue in the stone. In this region, cycad seeds are processed using slate grinding stones. The physical properties of slate, a metamorphic rock, include low porosity and thereby low absorbency and potentially reduced retention of dangerous toxins.

Aboriginal and Torres Strait Islander Peoples use their understanding of the properties of stone to carefully select stone that allows processing to confer particular physical properties, such as sharpness. Metamorphic rocks such as quartzite and chert have the physical properties of being fine grained, uniform in texture, hard and dense. They fracture in a predictable pattern on impact, known as a Hertzian (conchoidal) fracture, that results in a sharp edge. The Nyikina Peoples and the Karadjeri Peoples of the Kimberley region of Western Australia used local quartzite to manufacture stone tools with unique bifacial points known as Kimberley Points. These items maintain enduring importance as spearheads and surgical tools. The points are produced by percussion flaking to partly form the desired shape. Then the delicate, serrated edges are honed using a bone tool for careful, controlled pressure flaking at specific points along the edge of the stone. In parts of Australia, raw quarried stone blanks were also pre-processed, using heat to improve flaking quality.

Aboriginal and Torres Strait Islander Peoples understand the physical properties of natural materials that are used to manufacture clothing. Prior to colonisation, clothing was manufactured to suit the environmental conditions, and varied greatly across the Australian continent. Aboriginal Peoples whose Country encompasses cool, wet climates manufactured clothing from the furs of a variety of animals, including wallabies, kangaroo, possum, platypus and quoll. The physical properties of the fur of these animals provided thermal insulation and impermeability to water. In wet weather, the Wiradjuri Peoples of central New South Wales wore animal furs with the fur side to the rain as this orientation protected the wearer from water, whereas the skin side became saturated when exposed to the rain. In cool, dry weather the Gunditjmara Peoples of western Victoria wore possum furs with the fur side inwards, providing thermal insulation through trapping of warm air between the fibres. Similarly, the Noongar Peoples of south-west Western Australia manufactured *buka* (kangaroo skin cloaks) from the hide of kangaroos, also worn with the fur facing inwards for warmth.

Tanning is the chemical process of treating skins and hides of animals to produce leather employed by many First Nations Peoples of the world. Aboriginal Peoples use the tanning process to alter the physical properties of animal skins to make them more durable and to prevent decomposition. The Wodiwodi Peoples of the Illawarra region on the south coast of New South Wales use the sap from *Myimbarr* (a Dharawal word that translates to two-veined hickory, a species of *Acacia*, in English) to tan the hides of animals. Water carriers, essential for storing and carrying water over long distances,

can hold up to 19 litres of water. The capacity of the water carrier depends on the size and type of mammal hide used, including kangaroo, possum, wallaby and bandicoot. Tanning, to preserve the material and ensure the waterproof nature of the container, is carried out using resinous materials from a variety of plants, including *Eremophila* spp. and *Acacia* spp. The Wiradjuri Peoples of central New South Wales tanned the hide of wallabies to manufacture water carriers. The wallaby skin was removed in one piece, taking care not to pierce or puncture the skin. The hide was then dried and tanned with resin to improve durability and ensure that it was waterproof. In Queensland, kangaroo skin water carriers were tanned with bloodwood gum. These specialised hydration backpacks are called *nilpa* by the Pitta Pitta Peoples and *norlo* by the Kalkadoon Peoples of far western Queensland.

This elaboration provides students with the opportunity to learn that Aboriginal and Torres Strait Islander Peoples have longstanding scientific knowledge and understanding of the physical properties of natural and processed materials. The properties of natural materials influenced, and continue to influence, their use in a range of contexts, including in the construction of shelters, manufacture of clothing and production of tools. Furthermore, Aboriginal and Torres Strait Islander Peoples understand the processes that can be applied to modify the physical properties of natural materials to fulfil a particular purpose. Students can learn how Aboriginal and Torres Strait Islander Peoples have long understood and applied knowledge of the physical properties of natural and processed materials to many applications.

CONSULTED WORKS

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ACSSU074

Experts in the properties of natural and processed materials – paints

CONTENT DESCRIPTION

Natural and processed materials have a range of physical properties that can influence their use.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ considering how Aboriginal and Torres Strait Islander Peoples' knowledge of natural and processed materials informs the preparation of effective, vibrant and long-lasting paints



Traditional paints contain natural ingredients that confer fixative and binding properties

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to learn that Aboriginal and Torres Strait Islander Peoples' scientific knowledge of the properties of natural materials has long informed, and continues to inform, the careful selection of natural materials to manufacture paint. Aboriginal and Torres Strait Islander Peoples use paint to record and communicate knowledges using a variety of mediums, including rock paintings, bark paintings, body decoration and embellishment of implements. Effective, vibrant and long-lasting paint is made from a variety of natural materials. The selection and preparation of paint materials requires scientific knowledge of the physical properties of the material, including absorbency, stability, vibrancy and durability. Aboriginal and Torres Strait Islander Peoples use pigments to confer additional physical properties and incorporate binders to thicken the paint. After the paint has been applied, fixatives are used to prevent smudging and preserve the paintwork. Students will have the opportunity to learn that Aboriginal and Torres Strait Islander Peoples' longstanding scientific knowledge of the physical properties of materials has informed, and continues to inform, the preparation of effective, vibrant and long-lasting paints.

DETAIL

Paint is a liquid mixture, coloured with the addition of pigments and dyes, that is spread over a surface to leave a solid film after drying. Aboriginal and Torres Strait Islander Peoples have long used, and continue to use, paint as part of a larger system of recording, communicating and preserving knowledges. Paint is used on a variety of substrates (surfaces), including rock, bark, wood and skin. The selection of paint preparation materials differs depending on the surface on which it is to be applied and the purpose of the painting. For millennia, Aboriginal and Torres Strait Islander Peoples have prepared pigments for paint using natural resources, including mineral and plant materials. Understanding the physical properties of resources informs the careful selection of natural materials to ensure that the materials are fit for purpose. Paints are further enhanced by adding other natural materials to act as binders and fixatives to preserve paintings or to achieve desired styles, such as sharp, defined edges.

Many of the paints that have long been used, and continue to be used, by Aboriginal and Torres Strait Islander Peoples contain pigments extracted from minerals. The mineral pigments that are selected for the manufacture of paint are insoluble in water to ensure that the prepared paint cannot easily be removed from a surface, even when exposed to rain, groundwater or perspiration. The manufacture of paint begins with the mining of ochre to obtain the natural, raw pigment, followed by the cracking, crushing and grinding of the ore into a uniform powder. Minerals that are used as pigments are selected based on the colour they impart to the paint and include: kaolin or huntite for white; ochres (ferric oxide) for yellow, red and orange; manganese oxide for black; haematite for red and limonite for yellow. Paint is prepared by combining the powdered pigments with a binder, the liquid component that allows the paint to be applied as a film onto a surface.

Aboriginal Peoples understand the physical properties of the mineral pigments that they use in paints, such as durability and stability. The selection and quality of materials, and changes in climatic conditions, can impact the longevity of a painting. For example, the white huntite pigment sourced by the Ngarinyin Peoples of the north west Kimberley region in Western Australia is known to be powdery and can flake from the rock surface after application. For millennia, rock sites in the Kimberley region were revisited regularly to repaint and restore the paint pigment to the rock surface so that the illustrations were preserved. Aboriginal and Torres Strait Islander Peoples use their knowledge about the special properties that make some pigments, such as the deep red iron oxide mineral haematite, more resistant to degradation. In Tasmania, haematite was mixed with animal fat, blood, saliva or water to create paint for application to rock surfaces. Rock paintings created using red pigmented paints at Jowalbinna in north Queensland have persisted under water, due to the physical properties of the pigment.

Pigments for paint can also be extracted from plant material. Aboriginal and Torres Strait Islander Peoples understand the physical properties offered by biological pigments, such as stability and solubility, and use this knowledge to select plant rather than mineral material for paint. The non-toxic red fruits of the saltbush are used by the Arrernte Peoples of the central desert region in the Northern Territory and the Wurundjeri Peoples of the Yarra River area in Victoria to make face paint. The Wimaranga Peoples of the western Cape York Peninsula use the bark of the mountain ash to produce a red-brown paint that is applied to wooden implements such as spears.

Binders are selected based on the properties they confer to the paint, including adhesiveness, viscosity or thickness and the finishing effect. Binders can be derived from carbohydrate (honey, orchid sap), protein (egg, blood) or lipid (oils, fats). Binders can be used to control the painting style; viscous paints are used for clear, defined lines and thinner paints produce a translucent effect.

The Anindilyakwa Peoples of Groote Eylandt use the sap of the native orchid as a binder in bark painting due to its physical properties of adhesion and viscosity. Before the sap is added, the ground pigment is mixed into a paste with water. Then, the stem of the orchid is used to incorporate the mucoid orchid secretion. The viscosity of paint can be controlled by the careful addition of water to the paint mixture, until the desired consistency is achieved. The Peoples of the Tiwi Islands north of Darwin in the Northern Territory understand the adhesive properties of various binders. They mix mineral pigments with binders, such as the wax or honey of the native bee or turtle egg yolk, to reduce paint flaking on wooden implements. The Barnjarla Peoples of the Port Lincoln area in South Australia use animal fats as a binder prior to applying mineral pigments and charcoal as adornment to the body. Animal fats have the physical property of being insoluble in water and pigments applied to the body with fat as a binder can preserve pigment on the skin for several days. Pigments applied with fats also impart a sheen to the skin, contributing to a shimmering effect of the cosmetic paint in firelight. For example, Torres Strait Islander Peoples from many of the Islands in the Torres Strait use coconut oil to apply mineral pigments to the skin.

Fixatives are important in the preservation of paintings to ensure that the paint remains fixed to the surface. Aboriginal and Torres Strait Islander Peoples understand the physical properties of natural materials, such as water resistance and finishing effects, that can be used as fixatives for paints. The suitability of a fixative depends on the materials that are used to manufacture paint and the surface to which it must adhere.

The Tiwi Peoples use the sap from various plants, including the green plum, to fix paints to wooden implements such as musical instruments. The sap acts as a fixative and ensures that the colours of the pigments remain strong and vibrant. The Ngaatjatjarra Peoples of the Central Desert region in Western Australia use emu fat as a fixative for rock paintings; the hydrophobic property of the fat protects the painting from water damage. Resin from plants, such as grass tree and spinifex, is also insoluble in water and has long been used to fix paint to wooden implements. In areas of Arnhem Land in the Northern Territory designs are carved into the wood of musical instruments, such as the *yidaki*, and pigments made from ash and minerals are mixed with resin to colour and fix the designs into the wood. In north Queensland, the Anguthimri Peoples prepare a paint for wooden implements using pigment and the resinous material from yellow tea tree. The paint is warmed before application to permanently fix the colour to implements such as spears. The Walmbaria Peoples of Wurrima (Flinders Island) in north Queensland use candlenut oil as a fixative for paints, preserving the vibrant colours on wooden implements.

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples' long-held scientific understanding of the physical properties of natural materials has informed the careful and considered selection of natural materials to manufacture paints. For millennia Aboriginal and Torres Strait Islander Peoples have used paint on a variety of surfaces such as rock, bark, wooden implements and skin. Knowledge of the physical properties of natural materials, including durability, water resistance, viscosity and stability has long informed the selection of natural materials to manufacture effective, vibrant and long-lasting paints. Students can learn that Aboriginal and Torres Strait Islander Peoples' paint technologies show remarkable longevity, with many painting sites proving to be thousands of years old.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU075

Managed country

CONTENT DESCRIPTION

Earth's surface changes over time as a result of natural processes and human activity.

CONTENT ELABORATION FOR CCP (OI.3, OI.6)

- ▶ considering how Aboriginal and Torres Strait Islander Peoples' fire management practices over tens of thousands of years have changed the distribution of flora and fauna in most regions of Australia



Tropical savannah of Australia has long been influenced by Aboriginal fire regimes

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to consider the impact of human activity on the Australian continent through the fire management practices of Aboriginal and Torres Strait Islander Peoples. The flora and fauna on the surface of the Australian continent have changed over millennia as a result of human activity. Aboriginal Peoples first came to the Australian continent in the late Pleistocene and adapted to life on the unfamiliar Australian continent. While Australia's First Peoples were adjusting to the new environment and employing scientific practices to gain information about previously unknown species of plant and animal life, the environment was also adjusting to the ecological pressures caused by the arrival of humans. The Australian environment had long adapted to the presence of fire prior to the arrival of humans. However, the arrival of humans altered these fire regimes, and ultimately Aboriginal and Torres Strait Islander Peoples developed and implemented fire management practices that purposefully changed the distribution of flora and fauna in many environmentally diverse regions of Australia. This elaboration provides students with the opportunity to consider these changes to the Earth's surface over millennia and understand the impact of human involvement through fire-managed environmental changes.

DETAIL

An aspect of paleoecology, the study of past ecosystems, involves the analysis of fossil charcoal and pollen to reconstruct the vegetation and presence of fire in past landscapes. Such analyses of areas of the Australian continent provide the scientific evidence base used to postulate reasons for environmental changes and to reconstruct the Australian landscape over time. During the late Pleistocene the Australian continent was colder and drier than it is today, glaciers existed across the south east of mainland Australia and Tasmania, and sea levels were at their lowest. The large size and climatic diversity of Australia supported a wide range of vegetation. Rainforest vegetation predominated in parts of the Australian continent including the area to the east of the Great Dividing Ranges where rainfall was high and regular. Climatic variation in the late Pleistocene caused the continent to become drier; this resulted in the spread of sclerophyll vegetation to the west of the Great Dividing Range, where rainfall was lower and arid conditions prevailed.

The expansion of sclerophyll vegetation in relation to rainforest vegetation in many parts of the Australian continent, and associated increases in fossil charcoal indicating increased biomass burning, suggest that fire has been a part of the Australian landscape for more than 15 million years. Natural fire has long been a part of the Australian environment, triggered by lightning, volcanic activity or other initiators of combustion. The sclerophyll vegetation and seasonal arid conditions provided fuel that facilitated the maintenance of fire by these natural causes. Parallel increases in fossil charcoal and sclerophyll pollen suggests that the late Pleistocene fires further dried out the environment, favouring the spread of fire-adapted sclerophyll vegetation. Australian fauna has evolved along with fire. Some Australian species such as *Eucalyptus* spp. reproduce vegetatively after fire,

re-sprouting from a dormant bud under the thick bark, while other species, such as *Banksia* spp., require fire, heat or smoke for seed germination.

The arrival of humans on the Australian continent more than 60,000 years ago further altered the habitat balance of ecosystems as flora and fauna adjusted to respond to the presence of human activity. Charcoal evidence in lakes and swamps in Australia suggests an increase in landscape burning approximately 40,000 years ago, coinciding with human activity. In north eastern and northern Australia charcoal records indicate an increase in landscape burning and vegetation change that may suggest evidence of Aboriginal Peoples' fire management regimes. Frequent application of fire to the environment can result in permanent vegetation changes through alterations to the physical and chemical properties of the soil, changes to the moisture holding capacity of the soil, and an impact on species germination. Such environmental changes favour the growth of more open sclerophyll vegetation.

Fire regimes implemented by the Jirrbal Peoples in the Atherton Tablelands region of north Queensland about 45,000 years ago resulted in sustained replacement of drier rainforest vegetation with sclerophyll vegetation. The charcoal analysis of this region shows an increase in the presence of fire and an absence of significant climatic factors that could account for the change, leading researchers to interpret the vegetation change to be the result of Aboriginal fire management. Similarly, an increase in fire activity by the Gundangara and Ngunnawal Peoples of the Lake George region near Canberra, as evidenced in charcoal and pollen records, may have caused a shift from evergreen vegetation to eucalypt woodland.

Contemporary science acknowledges that vegetation changes that were the result of natural fire prior to the human occupation of Australia have been understood and utilised by Aboriginal Peoples for tens of thousands of years. There is a belief that these fire regimes were responsible for the Australian landscape that was documented at the time of early European exploration.

When Australia's First Peoples arrived on the continent, the landscape was populated by megafauna, a group of large land animals that existed in the last 2.5 million years. In Australia, many species of megafauna became extinct approximately 46,000 years ago in the late Pleistocene. However, not all Australian megafauna is extinct; the red kangaroo, cassowary, emu and crocodiles are all species of megafauna that exist on the Australian continent today. The reason/s for the demise of many species of megafauna in Australia remains contested by scientists as research continues to investigate the cause/s of extinction. One hypothesis is that the burning of the landscape that altered the vegetation types, whether by Aboriginal Peoples or natural causes, diminished the food supply for the megafauna and led to their extinction. Other hypotheses include climate change that led to an increase in arid conditions and less surface water availability, anthropogenic pressures following the arrival of humans to the Australian continent, and various combinations of these theories.

Recent scientific research provided evidence that Aboriginal Australians co-existed with some extinct megafauna for at least 17,000 years and possibly up to 30,000 years. Fossil remains of the

wombat-like marsupial *Zygomaturus trilobus* recovered from the lands of the Muthi Muthi, Nyiampaar and Barkindji Peoples of the Willandra Lakes region in far west New South Wales have been dated to 33,000 years ago, while the presence of humans in the region is dated to 50,000 years ago. Further association of megafauna and Aboriginal Peoples is evidenced by the depictions of the large marsupials in iconographic records. A painting of the large emu-like bird, *Genyornis newtoni*, is depicted in the caves of the Jawoyn Peoples in western Arnhem Land and a representation of a marsupial lion, *Thylacoleo carnifex*, is evident on the lands of the Wenamba and Gamberre Peoples in the Admiralty Gulf region of Western Australia. While recent scientific investigations associate fire with changes to both the plant and animal life on the Australian continent, the extent and significance of the impact is yet to be fully explained.

The current geological epoch, the Holocene, commenced approximately 12,000 years ago at the end of the last glacial period. At this time the climate changed, becoming wetter and warmer. Sea levels rose, inundating the coastal regions of the continent and isolating Tasmania from the mainland. Aboriginal Peoples' records and contemporary science clearly demonstrate the longevity of the controlled and skilful application of fire to maintain the landscape. Carefully considered Aboriginal fire use is important in maintaining the function of ecosystems. Aboriginal fire regimes, including the application of frequent, low intensity fires, remove the woody understory of the landscape, prevent fuel accumulation, allow grasses and tubers to flourish, increase the productivity of important food resources such as cycads, and protect fire-sensitive vegetation. In Aboriginal fire regimes, fire is purposely applied in a mosaic pattern so that nearby unburnt areas of land can provide refuge for wildlife. This practice enhances habitat diversity.

The significance of ecosystem management through the continued fire management practices of Aboriginal Peoples is evidenced by the Dukaladjarranj Peoples of north-central Arnhem Land. The Dukaladjarranj Peoples have used fire regimes to manage the Country of which they have had unbroken custody, and this has ensured abundant and diverse plant and animal species. The scientific knowledge that underpins the continued application of long-practised fire regimes fulfils cultural obligations to the land and maintains healthy ecological distribution of native flora and fauna in the region.

European colonisation of the Australian continent resulted in changes of flora and fauna distribution caused by the suppression of Aboriginal Peoples' fire-based agricultural practices and the clearance of vast tracts of lands for European agricultural practices. Research has shown that when long-held Aboriginal fire management practices were disrupted there were significant ecological effects. For example, the Leadbeater's possum, believed to have evolved about 20 million years ago, is now critically endangered. A wildfire that swept through the possums' habitat in the central highlands region of Victoria caused massive population decline in an already endangered species. Wildfires can be the result of a loss of Aboriginal fire management regimes; carefully controlled fuel loads can prevent uncontrolled wildfires. Ecological changes in this region through the disruption of the necessary Aboriginal fire regimes have changed the habitat structure, reducing the availability of

suitable habitats for mammals. Since European colonisation, 30 Australian land mammal species have become extinct. Although there is no single cause that can be attributed to these extinctions, the suppression or removal of Aboriginal fire regimes are thought to be a significant contributing factor.

Areas of Australia's savanna regions provide further evidence of the impact of Aboriginal fire management practices. The lack of Aboriginal fire management has resulted in the decline of the cypress pine, an ethnobotanically important species that requires very specific fire management to sustain healthy populations. The cypress pine has long been used by the Tiwi Peoples medicinally and as an insect repellent. Fire ecologist Bowman's evaluation of fire management in northern Australia that has affected the cypress pine led to the conclusion that "conservation of biodiversity in Northern Australia will hinge on land managers returning to fire regimes that approximate those used by Aboriginal people" (1995).

Similarly, on Saibai Island in the Torres Strait, the reinstatement of fire management practices is conducted to suit Saibai's unique fire adapted habitats and regimes. These are carefully considered and respond directly to the unique habitat structure that exists as a result of fire regimes implemented long prior to colonisation. Saibai Elder, Mebai Warusam, has contributed to the body of knowledge for the reinstatement of effective fire regimes suitable to the vegetation of Saibai that differs from mainland Australia. Prior to colonisation, fires were purposefully set within a narrow seasonal window (September–October), were of greater intensity and covered larger areas than fires used on mainland Australia. It is now acknowledged that the habitats of Saibai are a product of this more intensive burning regime. Maintenance of these habitats, which support a diverse range of flora and fauna species, will depend on the reinstatement of burning practices that mimic those of the original fire practitioners.

This elaboration provides students with the opportunity to consider how the fire regimes of Aboriginal and Torres Strait Islander Peoples over millennia have changed the distribution of flora and fauna on the Australian continent. The Earth's surface changes as a result of human interaction, and in Australia, fire management practices implemented by Aboriginal and Torres Strait Islander Peoples have influenced the diversity of vegetation and wildlife. Students can learn about the impact of human arrival on the Australian continent, the impact of fire (or removal of fire) on the environment for tens of thousands of years, and the resulting ecological changes. Students can also learn how current environmental fire management strategies are being informed by the long-held scientific knowledges of Australia's first fire practitioners.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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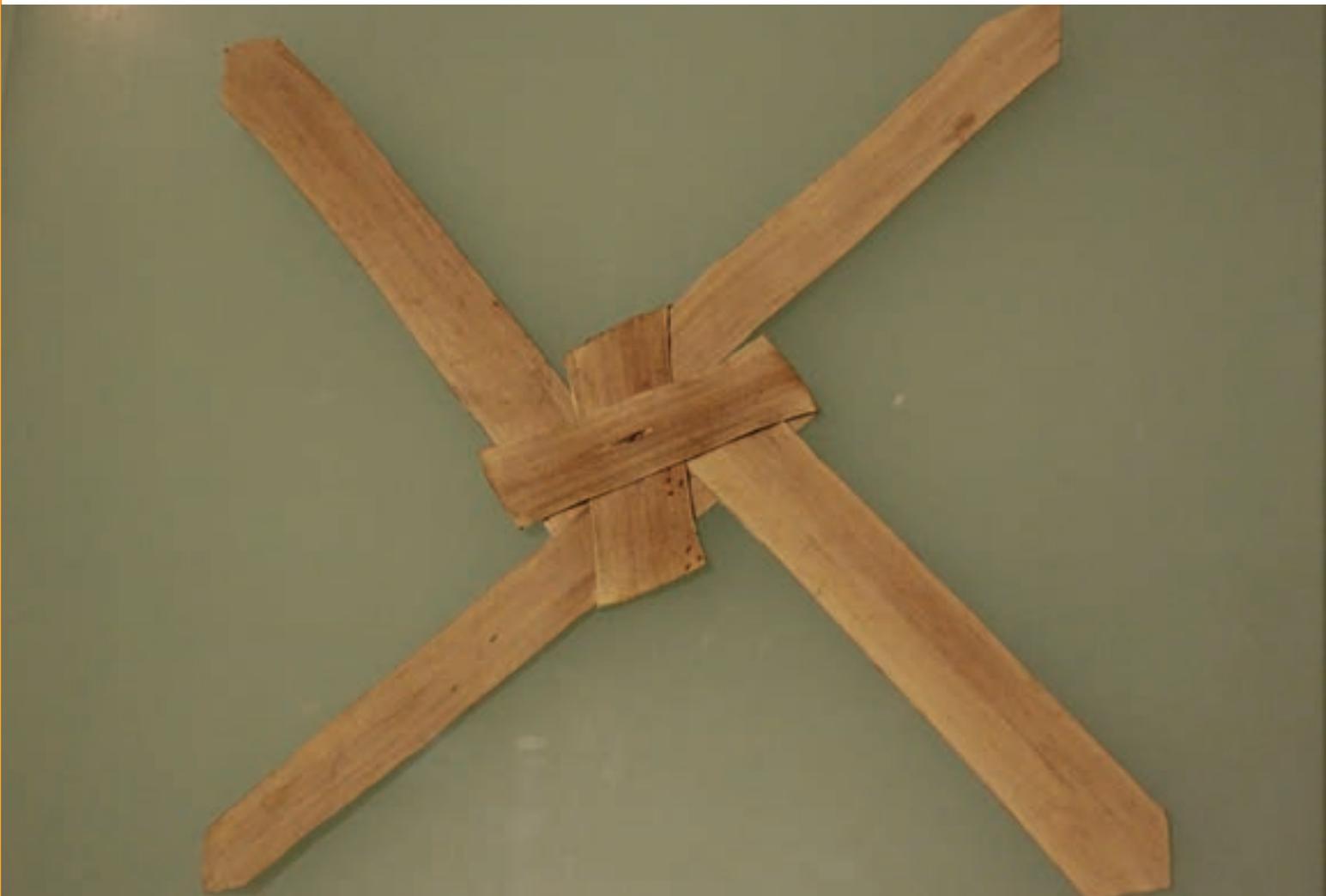
Toy science

CONTENT DESCRIPTION

Forces can be exerted by one object on another through direct contact or from a distance.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ investigating the effect of contact and non-contact forces on the movement of objects in traditional Aboriginal and Torres Strait Islander children's instructive toys and games



Propeller flight involves both contact and non-contact forces

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have long used instructional devices and models as play-based learning objects. Instructive toys are objects of play mostly designed for children, that stimulate learning by promoting the development of a particular skill or providing play experiences to learn about a particular subject. Instructional toys may be simplified or miniaturised versions of objects used by adults, or model the activities and practices of adults. The movement of instructive toys can be the result of contact or non-contact forces. Contact forces are the forces that act on objects that are the result of physical touch, such as hands pushing a ball. Non-contact forces are the forces that act on objects that are physically separate from each other, such as gravitational force. Aboriginal and Torres Strait Islander Peoples have long-held scientific understanding of the physics of movement and have used, and continue to use, the exertion of contact and non-contact forces to cause movement in instructive toys.

DETAIL

For millennia Aboriginal and Torres Strait Islander Peoples have used instructive toys and games as educational devices and models to stimulate learning of young people. Children's games and activities have long provided a context for acquiring knowledge, understanding and the development of skills required in later life. Many instructive games and toys involve objects that are moved through the application of both contact and non-contact forces. Several types of contact forces are evident in Aboriginal and Torres Strait Islander Peoples' instructional toys and games, including applied force, frictional force and air-resistance. Applied force is force exerted directly on an object resulting in movement of the object, such as a throw, push or pull. Frictional force refers to the force between surfaces that are in contact, while air-resistance is the force in opposition to the relative motion of an object as it passes through the air. Non-contact forces include gravitational force, magnetic force and electrostatic force. The only non-contact force that affects the moving objects in Aboriginal and Torres Strait Islander Peoples' instructional devices is gravitational force, the pull of objects towards the Earth's centre.

Imitation implements often simplify, miniaturise or model objects used, or activities practised by adults. They teach or enhance skills required in adulthood. For example, smaller versions of implements such as boomerangs and spears are made for children to develop skill and accuracy in hunting techniques. A variety of Aboriginal and Torres Strait Islander Peoples' games are designed to develop skills such as aim and coordination; spears and a target are manufactured to suit the child's size and ability. The Pitjantjatjara Peoples of the central desert manufacture toy spears from the long stems of bushes and a circular bark disc. The players divide into two groups and applied (contact) force is exerted on the disc to roll it between the groups. As the disc passes, each group in turn tries to spear the moving target, and applied forces are exerted on the spear for its launch. Once launched the forces acting on the spear include contact forces, in the form of air-resistance, and non-contact forces, in the form of gravitational forces, causing the spear to fall. To challenge older children, the

disc is carved in an irregular shape, causing it to wobble and roll less predictably and requiring greater skill to accurately hit the moving target.

Similarly, miniaturised boomerangs are made to engage and instruct children in the skill of boomerang throwing. A variety of games with boomerangs are played by both children and adults. The Jagara Peoples of the south-east Queensland region play a game of accuracy called *buran* that involves the players throwing boomerangs at a target. Similar to spear throwing, the contact and non-contact forces exerted on the boomerang include applied force to launch the boomerang and gravitational force that returns it to the ground or hand. The Jagara Peoples use different boomerangs according to the strength of the wind. Large boomerangs are used in high wind and smaller boomerangs used in light wind, likely due to the impact of air-resistance as a contact force affecting the game.

Australia's First Nations Peoples played numerous ball games for amusement, often to teach or reinforce kinship or social relationships. In many ball games that Aboriginal and Torres Strait Islander Peoples have played for millennia, contact force is exerted on the ball by throwing or kicking. The amount and direction of the contact force applied to the ball determines the trajectory and distance the ball will travel.

The Wurundjeri Peoples of the Yarra Valley area in Victoria have long played the game of *marn-grook* (a Gunditjmara word that translates to game ball in English) using a ball made from possum fur. Many believe that the game *marn-grook* was the foundation of Australian Rules football that continues to be played today. The game begins with a player using non-contact gravitational force to drop the ball onto the foot. On contact with the foot, the player then kicks the ball, with the applied force determining the height and direction the ball travels. In western Victoria the best player is determined by who can kick the ball the highest, that is, the player who can exert the greatest contact force onto the ball. The Mabuiag Peoples of Mabuiag Island in the Torres Strait play a ball game called *kokan*, where the contact force applied to the ball is exerted with the use of a club or bat crafted from a bamboo stick. The game is played on the beach, where the contact force of friction from the sand impacts the speed of the ball.

Many instructional devices that are used by Aboriginal and Torres Strait Islander Peoples are set into motion through contact force applied by the person. For example, spinning tops made from materials such as the hard shell of a nut, beeswax, plaster or volcanic rock with a hole drilled through the centre and fastened to a stick with resin and twine, are set in motion by twisting between the thumb and forefinger or between the palms of the hands. On the Island of Mer in the Torres Strait the spinning stone tops of the Meriam Peoples are called *kolaps*. This game can create intense competition among the Meriam Peoples. The winner is the person whose spinning device stays in motion the longest. The applied force sets the spinning top in motion, and competitors prolong the time the object is in motion by sheltering the device from wind, thereby limiting the contact force of air-resistance that slows the device.

Other Aboriginal and Torres Strait Islander Peoples' toys and games rely on the non-contact force of gravity. Propeller devices and objects that spin in the air fall to the ground due to gravitational force. The Jangga Peoples of the central Queensland region play a game called *bindjhera* using leaves from the *Acacia* tree folded into boomerang shapes. The leaves are set into motion using the contact force from the rising air current over a fire. Once the leaves are beyond the contact force of the air current, gravitational force causes them to spin and spiral back to the ground. The Biyaygiri and Djiru Peoples of the north Queensland coastal region construct propeller and aeroplane devices from the leaves of the *Pandanus* palm. A *piar-piar*, is carefully constructed by folding and interlocking four strips of pandanus leaf. It whirls in the air, set in motion by applied contact force causing it to spin, or by non-contact gravitational force, where, on release it spirals to the ground.

This elaboration provides students with the opportunity to investigate the effect of contact and non-contact forces through Aboriginal and Torres Strait Islander Peoples' use of instructional devices as toys and in games to develop particular skills or to learn about a subject. Aboriginal and Torres Strait Islander Peoples have long-held scientific knowledge of the effect of the application of force. Contact forces, including applied force, air-resistance and frictional force, and the non-contact force of gravity are used to cause the movement of educational objects used as toys and games by Aboriginal and Torres Strait Islander Peoples.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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ACSHE061

Classification, sorting and estimation

CONTENT DESCRIPTION

Science involves making predictions and describing patterns and relationships.

CONTENT ELABORATION FOR CCP (OI.1, OI.5)

- ▶ considering how scientific practices such as sorting, classification and estimation are used by Aboriginal and Torres Strait Islander Peoples in everyday life



Shells are sorted, classified and categorised before manufacturing important items of material culture

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have complex ways of organising knowledges including knowledges of living organisms (plants, animals, other organisms), non-living components of the landscape (waterways, celestial bodies, once living materials such as shells and wood), and Peoples (kinship and family structures). Scientific systems of organising knowledges based on particular features or similarities differ across Australian Nations and communities. To sort and classify information, patterns and relationships are identified and described. These systems of organising knowledges can be used to make estimations and predictions. This elaboration provides students with the opportunity to learn how longstanding scientific practices using systems to sort, classify and estimate have long informed, and continue to inform, aspects of everyday life for Aboriginal and Torres Strait Islander Peoples.

DETAIL

Aboriginal and Torres Strait Islander Peoples developed complex systems over millennia to sort and classify knowledges. These systems have long been used, and continue to be used, in everyday life. The various methods that Aboriginal and Torres Strait Islander Peoples use in their classification systems can reflect Peoples' interactions with their Country/Place. Some classification systems parallel Western methodologies, for example, in naming the components of plants. The Maikulan Peoples of the Cloncurry River region of north Queensland describe the following components of the blue water lily as *thindah* (tubers), *thoolambool* (stalk) and *millc* (seed head). Other classification methods identify common features such as the presence or absence of fins, the taste or ripeness of a consumable resource or its value or usefulness.

Sorting is the process of arranging items systematically and consists of ordering items, such as low to high or small to large, and grouping items with similar properties, such as colour or shape. Classifying is the categorisation of items based on similar characteristics. Estimation is the process of finding an approximation of a value that is useful for some purpose when not all the required information is available. Estimation can be informed by the classifications of items. For millennia, Aboriginal and Torres Strait Islander Peoples have used observations of patterns and relationships to sort and classify items and to make estimations in daily life. In contemporary times sorting, classification and estimation continue to play an important role in working scientifically.

The culturally important practice of shell stringing by Tasmanian Aboriginal women to manufacture necklaces and bracelets incorporates the scientific processes of sorting, classifying and estimating. The knowledge and skills of shell processing and stringing has been passed down through generations of Tasmanian Aboriginal women who continue to practise and uphold this custom to this day. Shell jewellery is classified as: adornments, gifts and tokens of honour, items for trade, and ceremonial objects. The collection of shells, including *marina* (pronounced ma-rin-a and known in English as maireener) and rice shells used to manufacture the intricate shell necklaces, requires

detailed knowledge of Sea Country. Shells are classified by species, and within an identified species such as the *marina* shell, further classification is based on size and grade. *Marina* shells suitable for shell stringing are collected directly from the ocean during the spring tides; dry shells found on the beach are brittle and faded and are not used in shell stringing. Rice shells are found in dry seaweed and are sorted based on weight. The seaweed is collected in buckets which are then filled with water so that the shells, heavier than the seaweed and water, fall to the bottom. The shell stringers estimate how many shells will be required to manufacture their item, taking into account the proposed length of the finished item and the size of the shells. Each shell stringer has a unique style of shell combinations and patterns that informs the sorting and classification of collected shells.

A shell necklace on display at the National Museum of Australia, manufactured by Tasmanian shell worker and senior custodian of shell stringing knowledge, Auntie Dulcie Greeno, illustrates the scientific practices of sorting, classification and estimation used in this practice. This necklace is manufactured from brown and white rice shells, pink button shells, and conical *marina* shells that have been treated to reveal their lustrous, green iridescence. The shells were sorted by colour and size and classified according to these characteristics. The diameter of the finished necklace is 15mm, requiring shells to be estimated and sorted by size at the time of collection and during the stringing process. To achieve a necklace length of approximately one metre, estimation of the number of small shells of each classification was also required. The shells were strung in sections using a regular pattern of two pink button shells flanked on each side by a pair of green *marina* shells. The sections were separated by a length of brown and white rice shells. Intricate shell necklaces can feature more than 2,000 shells and may require up to 12 months preparation to locate, collect, sort and classify suitable shells before the item can be made.

Estimation is used by Aboriginal and Torres Strait Islander Peoples in many aspects of daily life. For example, in the arid regions of the central desert where water can be scarce, Aboriginal Peoples know the location of waterholes and use estimation to approximate the amount of water they are likely to contain. The amount of rain and other climatic factors affect the availability of water sources. Aboriginal and Torres Strait Islander Peoples, through direct and indirect observations of past, present and predicted weather events, estimate how much water such sources may contain at any given time. Estimation is critical in predicting water supplies for the community as access to water reservoirs may require travel over significant distance. Estimating is also important when determining the resources a family or community group may require. For example, on Yolŋu Country in north eastern Arnhem Land women have the knowledge, expertise and responsibility to cultivate and harvest *ganguri* (long yam). *Ganguri* grows deep underground and digging to harvest the tuber is intensely physical work. The Yolŋu women use estimation to evaluate the size and number of tubers collected, and decide how many are needed for families and the wider community. On return, estimation is again used to determine the size of the ground oven needed to cook the meal, using seasonal knowledge of the *ganguri* crop and other produce collected by the community.

For many thousands of years Aboriginal and Torres Strait Islander Peoples from different Countries and Places have gathered for feasts and significant events. Such gatherings may be seasonal and are scheduled to coincide with a time when resources are abundant. For example, the Bunya festival occurs triennially to coincide with the time the bunya nuts ripen on the lands of the Waka Waka, Barrungam, Jarowair and Djaku-nde Peoples in south-east Queensland. In Victoria, at the time of the autumn rains when eels migrate towards the ocean to breed, Aboriginal Peoples come from great distances to gather on the lands of the Djadjawurung Peoples to celebrate and harvest the eels. At the time of such gatherings, the host community plans and prepares for the visit of many hundreds of Peoples who may stay for the duration of the event. Estimation is required, taking into account the numbers of people who may attend and the duration of the event, to roughly calculate the amount of resources needed. The Miriam Peoples of the eastern Torres Strait Islands host frequent social gatherings that require classification and estimation in planning and preparation to ensure events are sufficiently resourced. Special occasions, such as completing the construction of a new house or clearing and digging waterholes, warrant celebration with a feast. Estimation is required to determine the amount of resources that may be needed, based on the number of family members and friends who helped with the work that will attend.

This elaboration provides students with the opportunity to consider how the scientific practices of sorting, classification and estimation have long informed, and continue to inform, aspects of daily life for Aboriginal and Torres Strait Islander Peoples. Benefits to everyday life are demonstrated in the application of these fundamental scientific processes to define patterns and relationships and make informed predictions for cultural practices such as the manufacture of adornments or planning for social gatherings. Students will learn that for millennia Aboriginal and Torres Strait Islander Peoples have used characteristic features to develop structured systems that order and categorise knowledges and define relationships. These systems continue to be used today by Aboriginal and Torres Strait Islander Peoples across Australia.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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Science Inquiry Skills

New elaborations within the Science Inquiry Skills (SIS) strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander Peoples when working scientifically. These intercultural science inquiry skills are throughout Foundation to Year 6 and provide opportunities for students to develop skills relating to:

- acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
- consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
- collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.

Unlike the Science Understanding (SU) and Science as a Human Endeavour (SHE) Teacher Background Information (TBI) materials the teacher background information for the new SIS elaborations provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures. Importantly, the Science Inquiry Skills TBI illustrates how concurrent SU and SHE topics can be used to contextualise the ways in which educators may provide skill development opportunities for the development of these skills.



First Nations Peoples hold knowledge of cryptic life cycles of many organisms, including honey ants and lerp

AC SIS064

Acknowledging knowledge of life cycles and migrations

CONTENT DESCRIPTION

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge.

CONTENT ELABORATION FOR CCP

- ▶ acknowledging and using information from Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions regarding life cycles

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things have life cycles (ACSSU072)

A potential way to approach this content description is:

In the formulation of questions that can be investigated scientifically, students can acknowledge and use information from Aboriginal and Torres Strait Islander Peoples to refine and focus their question. Aboriginal and Torres Strait Islander Peoples have a wealth of knowledge relating to living things and their life cycles. This elaboration provides students with the opportunity to formulate scientific questions about a known life cycle derived from the many diverse and interesting Australian native species. Investigating the knowledge Aboriginal and Torres Strait Islander Peoples hold about the life cycles and migration events of certain species can provide students with valuable information that can help in the refinement of their scientific question.

For example, in learning about the life cycle of honey ants, students can look to the knowledge of Aboriginal Peoples who have long harvested the ant for a source of sugar. A key stage in the life cycle of the honey ants, *tjupi* in Luritja Language, is the collection of crystallised honeydew (lerp) left on tree branches by the larval form of an organism known as a lerp insect. The worker caste ants collect and take this sugary substance into their nests which can be up to two metres underground and feed the storage caste ants the honey that is subsequently stored in their distended abdomens. The storage caste ants act as a living larder that can regurgitate the honey, releasing it to the colony when required.

Aboriginal Peoples whose Country encompasses the desert environments where honey ants can be found, including the Arrernte, Luritja and Pitjantjatjara Peoples, hold detailed knowledge of the life cycles of the ants and their relationship with trees and lerp insects. Such knowledge informs the

accurate identification and location of the honey ant nests. The trees under which the honey ants nest can be identified by the characteristic lerps that form on the branches, and the nests are usually found on the shady side of the tree. Aboriginal Peoples who understand the life cycles and behaviour of the honey ants know not to dig directly down from the top of the nest, rather to dig from the side to locate the underground chambers where the storage caste ants reside, and to sustainably harvest the ants for their honey filled abdomens without destroying the nest. Students can acknowledge the knowledge held by Aboriginal Peoples who have long understood honey ant behaviour, and use this information to formulate and refine scientific questions about the life cycle of this insect.

The Leichardt grasshopper represents another example of life cycle knowledge held by Aboriginal Peoples. The cultural records of the Jawoyn and Gundjeibmi Peoples of western Arnhem Land demonstrate connections between the interesting, annual life cycle of the grasshopper and seasonal events in the Northern Territory. *Alyurr*, the English translation of which is ‘the children of the lightning man’ (the Leichardt grasshopper), is a unique red, blue and orange-coloured grasshopper endemic to areas of the Northern Territory, where it feeds almost exclusively on three species of the shrub *Pityrodia*. In Aboriginal iconography in the region, the grasshopper is depicted with stone axes on its elbows, knees or head. The stone axe is a tool long used by First Nations Peoples that makes loud noises and sparks on impact. The area of Arnhem Land where the grasshopper is endemic has one of the highest incidences of lightning in Australia. The emergence of the brightly coloured adult grasshopper from its nymph stage coincides with the onset of the wet season in Arnhem Land that brings storms with thunder (noise) and lightning (sparks). By acknowledging and using the knowledge that Aboriginal and Torres Strait Islander Peoples hold about the life cycles of the organisms in their Country/Place, students can form and refine investigable scientific questions and make predictions.

The knowledge of Aboriginal and Torres Strait Islander Peoples may inform the scientific questions that students formulate, and may include: the timing of life cycles, the time of year certain life cycle events take place, and the seasons or triggers for a particular life stage or weather patterns associated with the emergence of a life stage of an organism. This elaboration provides students with the opportunity to identify questions and make predictions about organisms important to the local environment by acknowledging and using information from local Aboriginal and Torres Strait Islander communities.

Year 5

Teacher background information



ACSSU043	Knowledge and exploitation of adaptations
ACSSU077	Knowledge of evaporation – causes and reduction
ACSSU077	Knowledge of states of matter
ACSSU078	Time keeping
ACSSU080	Knowledge and application of refraction and reflection
ACSHE083	Traditional ecological knowledge and sustainable harvesting
ACSHE083	Contemporary water management – developing technology
ACSHE081	First Nations' navigation
AC SIS086	Consulting local knowledge – field work considerations
AC SIS093	Acknowledging understanding of how structural adaptations are communicated
AC SIS231	Acknowledging knowledge and use of organism adaptations

ACSSU043

Knowledge and exploitation of adaptations

CONTENT DESCRIPTION

Living things have structural features and adaptations that help them to survive in their environment.

CONTENT ELABORATION FOR CCP (OI.5, OI.9)

- ▶ investigating Aboriginal and Torres Strait Islander Peoples' knowledge of the adaptations of certain species and how those adaptations can be exploited



Structural adaptations such as stingray barbs are repurposed as spear tips

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to understand how Aboriginal and Torres Strait Islander Peoples have observed the structural adaptations of organisms and exploited these adaptations for material culture and domestic use. Aboriginal and Torres Strait Islander Peoples have long recognised the structural adaptations of organisms and such adaptations figure prominently in many facets of life including weaponry, utensils, regalia and costumes. Students have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples understand that the structural adaptations of organisms have enabled the survival of the organism in the environment and that these adaptations can be exploited for other purposes.

DETAIL

Scientists often look to how nature has developed solutions to problems to inform strategies for new technologies and processes. One aspect of this is the investigation of unusual and interesting structural adaptations of organisms and how these have evolved. Biomimicry is the “examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems” (Library of Congress, 2017). Biomimicry, although considered a cutting-edge approach, has been exploited over millennia as a source of innovation. Some contemporary examples include the development of: wind turbines modelled on the propeller action of humpback whale fins, swimwear fabric created using the structure of sharkskin to reduce drag in water, and building ventilation design based on the intricate network of air pockets in termite mounds. Aboriginal and Torres Strait Islander Peoples have long employed the same approach to explore the adaptations in ecosystems for potential applications and solutions to problems. Structural adaptations are the physical features of an organism that have evolved to aid its survival in the environment. For example, teeth, claws, and spines provide defence mechanisms and assist in obtaining food. Aboriginal and Torres Strait Islander Peoples observed structural adaptations in their environment and incorporated them into a variety of innovative applications comparable to contemporary biomimicry.

Aboriginal and Torres Strait Islander Peoples have long observed the structural adaptations of organisms within their environment and understood that such adaptations can be useful in other contexts. One of the adaptations of the stingray is the barb (or stinger) located on the stingray’s tail. The barb has an extremely sharp point, often has backward serrations, and can also be venomous. The barb is a defence mechanism that the stingray uses when threatened by predators. When a stingray encounters danger it may strike the predator with this barb: the sharp tip helps to pierce the skin, the serrations ensure the barb does not fall out, and the venom causes pain and tissue damage.

Weapons constructed by Aboriginal and Torres Strait Islander Peoples throughout Australia demonstrate the adoption of stingray defence mechanisms in their design and structure. The Koko Tai’Yuri Peoples of the Kunjen Nation in Cape York used the stingray spine as a spear tip designed

to shatter on impact. Prior to colonisation, the Gadigal People of the Eora nation, in the area now known as Sydney, also used stingray barbs as spear tips. They attached multiple stingray barbs in a downward orientation on the spear shaft so that the serrations secured the tip in the flesh. In the Brisbane region, one or two stingray barbs were fastened to a fighting spear, using twine and beeswax to attach the barbs to the spear shaft. The Kaurareg Peoples of Muralag Island in the Torres Strait Islands also used stingray barbs as spear tips in the construction of javelin style spears. Prior to colonisation, some Aboriginal and Torres Strait Islander Peoples crafted barbed or denticulate spear tips from wood, bone, shell or stone to mimic the structure and function of the stingray barb. For example, the Yanyuwa Peoples, Traditional Owners of the Sir Edward Pellew Islands and surrounding seas and coastal environments in the Gulf of Carpentaria, constructed a spear called a *birnkili*, featuring two denticulate prongs to prevent the spear from dislodging when hunting large fish.

In these instances, Aboriginal and Torres Strait Islander Peoples observed defensive stingray behaviour in its natural habitat, and this led to the exploitation of the stingray barb for their own purposes. In similar habitats, Aboriginal and Torres Strait Islander People also observed that the mouth of a shark was a highly effective structural adaptation that was ideal for cutting through flesh. The sharp serrated teeth of some sharks, such as tiger sharks and great white sharks, are highly adapted to cutting the flesh of animals, such as seals and other ocean mammals. Prior to colonisation Aboriginal and Torres Strait Islander Peoples exploited this knowledge and used the teeth of a hunted shark to manufacture knives. The Meriam Peoples of the Island of Mer in the Torres Strait and Peoples of the western Cape York region crafted knives using shark teeth fixed onto a length of wood with gum-cement or resin, to emulate the flesh-cutting capacity of the sharks from which the teeth were harvested.

For many Aboriginal Peoples whose Country encompasses areas of dry arid or desert environments, knowing how and where to find water is critically important. The water-holding frog inhabits temporary swamps, claypans and creeks in these regions and adapted the ability to store water underneath its skin which can be absorbed into the body when water is scarce. The water-holding frog burrows underground to seek cooler temperatures and reduce evaporation. Early colonisers observed that Aboriginal Peoples found these frogs underground by identifying markings on the surface of the ground or by tapping the ground with the butt of a spear. When the frogs were located and retrieved, gentle squeezing released water from underneath the skin that was fit for human consumption. An early colonist credited his survival in the central desert region to a local Aboriginal man who provided lifesaving drinking water through his ability to source water-holding frogs when there was no other water source available. Aboriginal Peoples in desert regions understand the water holding adaptation of this species and in times of drought or emergency these adaptations may be exploited as a water source. This vital knowledge is still taught by the Traditional Owners in these regions to ensure that this potentially lifesaving skill is passed on.

The lawyer cane plant, often called wait-a-while, is a climbing palm that grows as a vine and is endemic to Queensland. It has adapted to its environment with curved hooks along the leaf sheath

that help it catch onto other plants so that it can climb further into the canopy of the rainforest. The hooks can catch onto the flesh of passing animals and lodge in the skin; they can only be removed by slowly withdrawing the hooks in reverse, hence the name 'wait-a-while'. Aboriginal Peoples exploited this structural adaptation of the plant to hook freshwater prawns and extract witchety grubs from bores in trees. Prior to colonisation, the Jirrbal Peoples of the Tully River region in north Queensland used the sharp spines on the lawyer cane in a cross-saw manner to cut and prepare meat for cooking or to saw through soft timber to harvest insects. They also inserted up to two metre lengths of lawyer cane into tree butts to extract the grubs of moths caught on the hooks of the vine. Prior to colonisation, the Kuku-Yalanji Peoples used the spikes to manufacture fishing hooks. Aboriginal Peoples' knowledge of the adaptations of the lawyer cane led to the exploitation of the hooks of the plant for a multitude of purposes in domestic life.

Possum skin cloaks have long been a culturally important, essential item of clothing, particularly for Peoples whose Country/Place encompasses the colder climates across the south east of Australia. After European colonisation the manufacture of possum skin cloaks was prohibited. However, revival of the practice is providing a significant way for many Aboriginal Peoples, including the Gunditjmara and Yorta Yorta Peoples of Victoria, to reconnect with, and restore their cultures. Possum fur is a structural adaptation that is unique to this Australian mammal and enables the possum to survive in extremely cold and wet climates. Possum fibres feature a hollow structure that traps air to provide insulation. This lightweight fur can also draw moisture away from the skin, keeping the possum warm and dry. In extremely cold temperatures the presence of air in the hollow of the possum fibre also means the material will not freeze. Aboriginal Peoples observed the habitat of possums and exploited possum fur to manufacture possum cloaks and other clothing. Up to 70 possum skins were required to manufacture a single cloak. While a single larger animal, such as the kangaroo, may have provided a larger surface area of fur when compared with a single possum skin, the superiority of possum fur was well understood by Aboriginal Peoples, and possum fur was therefore a valuable commodity. Echidna quills were used to pin the fur to a flat surface (another example of exploitation of a structural adaptation by Aboriginal Peoples) to treat and dry the hide of the possum. The dried pelts were then sewn together to make a possum fur cloak or blanket, guaranteed to keep its wearer warm and dry regardless of the weather and climate.

There are many more examples of the structural adaptations of organisms exploited by Aboriginal and Torres Strait Islander Peoples that developed from observations of the organisms in their environment. The sea snail, *Turritella* spp. has a long, tightly coiled, spiral shaped shell that resembles a drill. Aboriginal Peoples in the Gulf region exploited these sea snail shells for their drilling capability, making holes in pearlshell for personal adornment. The Kuku-Yalanji Peoples of the tropical rainforest region in far North Queensland exploited the rough surface of the leaves of the sandpaper fig to smooth spear throwers or other wooden implements. The sharp edge of the shell of a particular bivalve mollusc (*Tellina pharaonis*) was used by the Tepiti and Tjungundji Peoples of the western Cape York region to manufacture surgical knives.

This elaboration provides students with an opportunity to deepen their understanding of the structural adaptations of organisms that help them to survive in their environment. Students can learn how Aboriginal and Torres Strait Islander Peoples' observations of organisms in their natural habitat over millennia, have provided a deep understanding of the structural adaptations that facilitated the survival of organisms, including defence mechanisms, weaponry, attachment, and protection from the elements of nature. Students will have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples have long practiced biomimicry by utilising adaptations of organisms for various purposes.

CONSULTED WORKS

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ACSSU077

Knowledge of evaporation – causes and reduction

CONTENT DESCRIPTION

Solids, liquids and gases have different observable properties and behave in different ways.

CONTENT ELABORATION FOR CCP (OI.2, OI.5)

- ▶ recognising Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of evaporation and how the effect of evaporation can be reduced to conserve water, such as by covering surfaces



Gnamma holes in desert regions are often covered to reduce evaporation. Photo credit: David Broun

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

In this elaboration students have the opportunity to understand the methods that Aboriginal and Torres Strait Islander Peoples used prior to colonisation to reduce the evaporation of water resources. Students learn that evaporation is a type of vaporisation that occurs when a liquid changes into a gas. This process is responsible for accelerated rates of water loss in high temperature arid regions. While some parts of Australia receive reliable rainfall, other areas experience low rainfall and high rates of evaporation. In such environments water sources require conservation strategies. This elaboration provides students with the opportunity to learn that Aboriginal and Torres Strait Islander Peoples recognised and understood the phenomenon of evaporation and developed a variety of methods to mitigate its adverse effects.

DETAIL

Water is a necessity for life and knowing how and where to find water is a valuable skill that has been practised by Aboriginal and Torres Strait Islander Peoples for many thousands of years. Prior to colonisation Aboriginal and Torres Strait Islander Peoples used a variety of techniques to locate water including plant and animal indicators, maps, landscape references, and the oral transfer of knowledge. Preserving and managing water resources was, and remains today, an important skill to ensure the ready supply of drinking water for communities. Aboriginal and Torres Strait Islander Peoples have long and continuing practices for preserving precious water resources including evaporation prevention measures.

Within the natural environment evaporation of water is the change in state from liquid to gas that occurs when the water surface is exposed to heat from the sun and becomes water vapour. While some parts of Australia receive high annual rainfall rates, other areas are extremely arid. For example, in the desert regions of Australia rainfall is episodic and unreliable, with an average annual rainfall of less than 200 mm and evaporation rate exceeding 3,000 mm per annum in many areas. The rate of evaporation depends on factors such as air temperature, humidity, wind speed, and sunlight. Sources of water vary and depend on the bioregion of one's Country/Place. In the desert regions of Australia there are generally no permanent rivers or freshwater flows. However, water can be found in rock-holes (often referred to as *gnammas* (Noongar term)), soaks and claypans. The maintenance and conservation of these water sources is important to ensure water availability. Prior to colonisation, methods of water conservation included using slabs of flat rock and branches over pools. Large rocks were placed over rock-holes containing water to provide a lid or cap, that slowed evaporation. Similarly, small soakages were always covered with branches, sticks or grasses after use, to reduce evaporation. The covers ensured that, as the water vapourised, the water vapour was contained within the water hole and not lost to the external environment.

The evaporation rate of water sources depends not only on the climatic conditions in the region, but also on the surface area of the water that is exposed to the sun. Aboriginal and Torres Strait

Islander Peoples also understand that the greater the surface area of a water source exposed to the environment, the greater the rate of evaporation. Water sources in claypans that have a large surface area and little depth diminish quickly through evaporation. For this reason, after rainfall, claypan water resources were used first, before moving to more permanent water sources. Some *gnammas* were enlarged by gouging debris and loose rock from the bottom and sides of the rock-hole, demonstrating an understanding that evaporation of water occurs at the surface. Enlarging the rock-hole increases its water storage capacity without affecting water loss through evaporation, as the surface opening of the rock-hole remains the same. This knowledge is also evidenced in the flask-shaped wells dug by Aboriginal Peoples, specifically designed to limit evaporation by creating a narrow entrance.

In the non-desert areas of Australia, Aboriginal and Torres Strait Islander Peoples also understand the importance of managing and conserving water resources. Apart from the wet seasons, freshwater is often scarce on the islands of the Torres Strait. On Damut Island in the Torres Strait, waterholes were covered using sticks and blocks of wood to protect the water within. The Baiyungu People of the north west Australian coast preserved water supplies after rainfall by covering the water that collected in rock cavities with lids, using flat pieces of limestone. In the Crystal Brook region of South Australia, the Nukunu People prevented evaporation of water from a deep spring by covering it with bushes and boughs. Early European explorers who observed these practices speculated that at times the spring may have dried up, and that the Nukunu Peoples found that this was the most efficient way to provide shade and prevent water evaporation. In Yankuntjatjara Country, around the Everard Range region of South Australia, there are many rock-holes capable of holding hundreds of litres of water. To prevent evaporation of the water in these rock-holes, the Yankuntjatjara Peoples placed sand in the holes to sequester water into the interstitial space that exists between each sand grain. This effectively covered the water and reduced exposure of the water surface to the atmosphere, thereby reducing evaporation. To access the water, a hole was dug in the sand, into which fresh water drained. This demonstrates deep scientific understanding of water evaporation, as the rate of evaporation from an open water surface exceeds that of water saturated sand.

Techniques used to cover waterholes to reduce evaporation are still applied today. For example, in drought affected areas, swimming pool owners are encouraged to purchase pool covers that reduce water loss by evaporation. This knowledge is also being applied on a much larger scale where biodegradable plastic spheres, known as shade balls, or other plastic coverings on large water reservoirs can reduce evaporation by up to 70 per cent.

This elaboration provides students with the opportunity to understand the chemical science content of changes in states of matter through Aboriginal and Torres Strait Islander Peoples' knowledge of evaporation. Aboriginal and Torres Strait Islander Peoples' understanding of how and why evaporation occurs has led to the development of practices to conserve water supplies, particularly in desert environments, dry seasons or where freshwater is scarce. Students have the opportunity

to learn that Aboriginal and Torres Strait Islander Peoples' practices of covering water sources, minimising water surface area openings, and prioritising access to different types of water sources, demonstrate a deep and long-held understanding of water evaporation and how to reduce its effects to conserve water.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU077

Knowledge of states of matter

CONTENT DESCRIPTION

Solids, liquids and gases have different observable properties and behave in different ways.

CONTENT ELABORATION FOR CCP (OI.5)

- recognising Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of solids, liquids and gases



Steam cooking occurs when water in food is converted to gas that is trapped when wrapped in plant material

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to recognise Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of changes in states of matter. Aboriginal and Torres Strait Islander Peoples have worked, and continue to work, with materials that have the chemical propensity for changing state. The scientific knowledge of applying or removing heat to produce changes in states of matter is evidenced in many long-held and ongoing Aboriginal and Torres Strait Islander practices, including the extraction of oils (solid-liquid), medicinal therapies (liquid-gas) and cooking practices (liquid-gas). Students will have the opportunity to understand how Aboriginal and Torres Strait Islander Peoples' knowledge about states of matter is used in many processes and practices.

DETAIL

Aboriginal and Torres Strait Islander Peoples have long demonstrated an understanding of the scientific principle that matter comes in the form of solids, liquids and gasses and that these various states of matter have different properties. The application or removal of heat is related to changes in states of matter and Aboriginal and Torres Strait Islander Peoples have long used temperature to change the state of matter of a substance for a desired purpose. The application or removal of heat is employed in many different circumstances, including the preparation of foods and medicines, to obtain a desired state of matter or utilise its observable properties.

Aboriginal and Torres Strait Islander Peoples have knowledge about which plant species contain important therapeutic oils and how to extract the oil. Some plant oils are highly volatile and can be vaporised at temperatures below the boiling point of the oil. The controlled application of heat to such plant material results in the therapeutic compound being released in the vapour (steam).

Prior to colonisation, the Wiradjuri People of central New South Wales treated colds by building steam pits that were heated by fires, lined with *Eucalyptus* spp. leaves and overlaid with possum-rugs. The *Eucalyptus* spp. oil is vaporised through this process and inhaled as a decongestant treatment for coughs and colds. *Melaleuca* spp. (tea tree) is a plant that also contains important medicinal oils. The Yaegl Peoples of the Coffs Harbour region of New South Wales heat tea tree leaves to release the oil in the vapour to treat respiratory conditions by inhalation. Products containing *Eucalyptus* spp. or *Melaleuca* spp. oil continue to be used in this manner today for the treatment of colds and respiratory conditions. The Anindilyakwa Peoples of Groote Eylandt and Bickerton Island in the Gulf of Carpentaria boiled the fresh leaves of a species of *Calytrix* and inhaled the vapours to unblock the sinuses and clear head colds. The Ngarrindjeri Peoples of the Murray River region in South Australia developed a sauna-like therapy utilising the steam released from wet plant material.

Many Aboriginal Peoples also use heat from fires to vaporise plant oils from foliage, bark and wood, to use as insect repellent. The Ngarrindjeri Peoples in South Australia use the green foliage of the

daisy-bush for this purpose, while the Gugadja Peoples of the Western Desert use the conkerberry bush to repel insects. Steam from heating water or from fires is also useful in making wood more pliable and is used in the manufacture of canoes and wooden implements such as spears. The Warnindhilyagwa Peoples of Groote Eylandt use steam and fire to cure wood to complete the construction of dugout canoes.

Aboriginal and Torres Strait Islander Peoples also applied heat to liquefy fats into oils, a process known as rendering. The application of heat to the fat of an animal results in a change of state from solid to liquid. Rendered oils have many useful properties, making the process of liquefying fats an important practice and the extracted oils highly valuable. On the western Cape York Peninsula, the Anguthimri and the Awngthim Peoples rendered stingray fat by heating it in a large bailer shell. The liquid oil has long been used as a treatment in the manufacture and repair of wooden implements such as the spear-thrower. In the Torres Strait, the Mabuygiwgal People of Mabuag Island today continue the long-held practice of boiling the fat of turtles, liquefying the solid turtle fat into oil, and collecting and storing the resulting oil. Similarly, the Quandamooka Peoples of Minjerribah (North Stradbroke Island) in Queensland boil down the fat of the dugong to a liquid state and use the oil medicinally to treat ailments such as colds, aches and pains.

Aboriginal and Torres Strait Islander Peoples used the technique of cold-pressing to release oils from nuts. This process uses heat generated through friction to extract a liquid oil from a solid seed or nut. Prior to colonisation, the Miriam People of Mer Island in the Torres Strait extracted coconut oil through a process of scraping and straining. Candlenut oil was extracted by the Dinggaal People of the Cape York Peninsula region and has long been used as a fixative for pigments on wooden implements. In the southwest of Western Australia, the Wiilman Peoples of the Noongar Nation pounded the seeds of sandalwood into oil for rubbing onto skin. The application of heat by Aboriginal and Torres Strait Islander Peoples to change solid animal fats into liquid oils demonstrates the long-held understanding of the properties of solids and liquids.

Other means of preparing and cooking food also utilised heat to change water into steam. Aboriginal and Torres Strait Islander Peoples understand that all foods contain water and the application of heat to food changes the state of water from liquid into gas. This knowledge is applied by Aboriginal and Torres Strait Islander Peoples in the preparation and preservation of food. For millennia, food has often been cooked through a process of steaming, either in ground ovens or by wrapping food in leaves to retain the moisture when cooking. Such processes demonstrate Aboriginal and Torres Strait Islander Peoples' understanding that the water within the food will evaporate into gas when heated. This steam remains within the oven or wrapping to provide moisture in the cooking process.

Over millennia, the Barindji Peoples of south central New South Wales have cooked large animals in a ground oven into which hot stones were placed. The animal was then placed into the oven, covered with grass, more hot stones placed on top, and completely enclosed with earth. At various cooking intervals a hole was made in the oven and water was poured in to steam the food. The addition of

water to the oven demonstrates the knowledge that the steaming process requires water, as a liquid to generate steam for cooking. The Bindal and Wulgurukaba Peoples of far North Queensland also cooked meats in dug out ovens using hot stones and covering the entire ground oven with earth. If an opening was noticed it was immediately covered to keep the steam trapped and the heat and moisture within. The Luritja People of the Central Desert use a species of *Zygophyllum* as a source of moisture to generate steam for cooking cress and other plant foods. To cook plants, the *Zygophyllum* sp. is placed on hot rocks in the sand with the plants to be cooked sandwiched between another layer of *Zygophyllum* sp. More hot stones are placed on top and the whole oven covered with wet sand. When the surface of the sand cracks the plants are recovered for consumption and the *Zygophyllum* sp. is discarded. Alternatively, food may be wrapped in leaves, such as banana leaves or leaves of native ginger, or moistened paperbark, to steam on hot coals or ash. This ensures that the water content from the food remains contained during the cooking process, and that the steam is not lost to the atmosphere.

Aboriginal and Torres Strait Islander Peoples also use the knowledge of water evaporation to preserve foods. Prior to colonisation, the Mabyugiwal Peoples of Mabuag Island in the Torres Strait prepared strips of dugong in the dry season by dehydrating the meat in the sun. Cooked strips of turtle meat were elevated on sticks so that the heat of the sun could remove the water content through evaporation and preserve the meat. This supply of preserved food was then available in the north-west monsoon season or while travelling. The Gunditjmarra Peoples of south west Victoria preserved eels and fish by smoking them in special hollowed out trees. This process uses heat from a fire set underneath hanging fish to evaporate water from the fish, to preserve them for trade or storage. In Central Australia, the Pitta Pitta Peoples desiccated (removed all water from) pituri, a narcotic sourced from the plant *Dubosia hopwoodii*. This was done by hanging the tops of the plant to dry in the heat of the sun, sweating the leaves beneath a layer of fine sand, and powdering the dried leaves in preparation for transport. Such long and enduring practices demonstrate how Aboriginal and Torres Strait Islander Peoples have used knowledge of states of matter to evaporate water from food and other resources.

This elaboration provides the opportunity for students to understand changes in state of matter through Aboriginal and Torres Strait Islander contexts. Aboriginal and Torres Strait Islander Peoples have long used temperature to change the state of a particular material for a desired purpose or to exploit the observable properties of matter. This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples have long used, and continue to use, heat to change state for medicinal purposes, insect repellents, the preparation and preservation of food resources, and engineering wooden vessels and implements.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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ACSSU078

Time keeping

CONTENT DESCRIPTION

The Earth is part of a system of planets orbiting around a star (the sun).

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ researching Aboriginal and Torres Strait Islander Peoples' understanding of the night sky and its use for timekeeping purposes as evidenced in oral cultural records, petroglyphs, paintings and stone arrangements



The lunar cycle has long been used to monitor the passing of days and months

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Over millennia, periodic events and periodic motion have been used as measures of time, such as the motion of the sun across the sky and the phases of the moon. In its simplest form, time is often counted in days, months and years based on the Earth's rotation and orbit around the sun. Time is important across all facets of life, including when to travel, in music, scheduling and attending events, quantifying rates of change and knowing when to harvest. Globally and historically there are many different systems that record the passage of time and mark significant events. This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples developed timekeeping systems based on astronomical observations of the night sky, including the moon, stars, planets and appearance of the sun, and that these ways of monitoring and communicating significant times continue to be used today. Students will have the opportunity to research Aboriginal and Torres Strait Islander Peoples' systems for monitoring and communicating time, including the use of oral records, stone arrangements, paintings and petroglyphs.

DETAIL

In the development of time keeping methods Aboriginal and Torres Strait Islander Peoples observed the patterns of the motions of celestial bodies in the night sky for many thousands of years. The recurring patterns were, and continue to be, used as a system to track time and signify important events. For many First Nations Peoples, the moment a certain planet, star or constellation is first visible on the horizon (heliacal rising) indicates an important time, such as the beginning of a season, ceremony or the time for travel. Aboriginal and Torres Strait Islander Peoples track time using the complex patterns of the moon, stars, planets and sun and record and communicate methods of timekeeping through oral language, paintings, petroglyphs and stone arrangements. Such records are important within a community. However, the cultural diversity of Aboriginal and Torres Strait Islander Peoples, encompassing a diverse range of languages and dialects, necessitated a means of communication by which to synchronise time across communities and Nations.

Aboriginal and Torres Strait Islander Peoples' observations of the recurrent patterns of celestial bodies in the sky have long been used as markers of time and as indicators of certain events. The Ngarrindjeri Peoples of southern South Australia explain the patterns of the moon and the sun in oral records that have been sustained through generations. The oral records include knowledge of the phases of the lunar month, understood through unbroken astronomical observations of the night sky over millennia. The records also detail knowledge of the timing of the appearance of the sun as a way of monitoring the coming or passing of days. In the Southern Coorong district of South Australia, the Ngarrindjeri Peoples used the number of full moons to record the age of children under the age of one, while in the Hahndorf area of South Australia, the Peramangk Peoples marked the appearance of each new moon on an object, such as a digging stick, to record their own age. The patterns of the stars have also long been used as indicators of time, particularly in relation to the life cycles of organisms within their Country/Place to indicate a particular season, time for travel, or availability of

a certain resource. For example, the appearance of *Dhinawan* (the emu) in the Milky Way indicates to the Ngemba, Kamilaroi and Euahlayi Peoples of north western New South Wales that it is time to harvest emu eggs.

Aboriginal and Torres Strait Islander Peoples distinguish planets visible to the naked eye in the night sky from other celestial objects such as stars. The planets of Earth's solar system are distinguishable from stars as they move in complex paths across the sky, whereas stars appear in fixed positions with respect to each other. The peoples of the Tiwi Islands, 80 kilometres to the north of Darwin where the Arafura Sea joins the Timor Sea, have long known that the planets are different from stars and they exist in a connected system, and this knowledge is passed down in oral records through generations. The Tiwi Peoples describe the planets as wives of the moon, as they follow the same path across the sky, in what astronomers now call a planetary parade. On the island of Mer in the Torres Strait, the planet Venus is differentiated from surrounding stars by the fact that the planet does not twinkle like a star, and it can be seen moving in relation to the stars as it orbits around the sun. Such observations inform the Meriam people of Mer Island in the Torres Strait of changes in the season and weather that are used to time planting and harvesting.

Knowledge of the planet Venus can be found in many Aboriginal and Torres Strait Islander Peoples' cultural records. Venus is in closer proximity to the sun than Earth and orbits the sun inside the orbit of Earth. When Venus trails the sun in the sky, it appears in the night sky just after the sun sets (Evening Star), and when it is on the other side of the sun it is visible in the early dawn before the sun rises (Morning Star). In an event that occurs every 548 days, the Yolngu People of north eastern Arnhem Land use Venus to time the commencement of a special ceremony to celebrate the first rising of Venus, the Morning Star, as it transitions from the Evening Star. The detailed scientific knowledge of the orbital pattern of Venus, developed from monitoring the night sky for millennia, demonstrates one method of astronomical observation that the Yolgnu Peoples use to monitor time and is told in story and song within the Yolgnu community. The movement of other planets visible to the naked eye, Mercury, Mars, Jupiter and Saturn, has also been documented in the oral records from Aboriginal Language Groups across Australia, and has significance in the timing of events, such as harvests and important meetings.

Aboriginal and Torres Strait Islander Peoples' observations of the night sky also include astronomical features outside Earth's solar system, such as constellations that appear at certain times of the day or year, due to the rotation of the Earth on its axis and its orbit around the sun. The Pitjantjatjara Peoples of the central Australian desert know that the appearance of the constellation Pleiades in the dawn sky indicates the beginning of the cold season. For the Yirrkala Peoples of east Arnhem Land in the Northern Territory the visibility of Scorpius in the morning sky indicates the beginning of the *beche de mer* (sea cucumber) trading season. The Boorong Peoples of north western Victoria observe that when *Neilloan*, the mallee fowl constellation (Lyra), appears in the night sky the birds build their nests, and when the constellation disappears approximately six months later, mallee fowl eggs have been laid and can be collected. On the western islands of the Torres Strait, the first appearance of *Baidam* (the Shark constellation) on the horizon indicates that yams are ready for harvesting and the start of

the turtle mating season. The people of Mabuiag Island in the Torres Strait time important ceremonies by the appearance of the star *Kek* (known as Arcturus in western cultures), as it coincides with a plentiful supply of resources. The significance of this timing is encoded in the songs and dances of some of the islands in the Torres Strait, which serve as an important transgenerational system of transferring and maintaining knowledge.

Aboriginal and Torres Strait Islander Peoples' seasonal calendars are timed through complex combinations of astronomical and environmental interactions. Observations of weather, changes in climate, the flowering or fruiting of plants, the behaviour of animals within the environment, and the patterns of stars and constellations, all work in conjunction to indicate certain times in the cycle of seasons. The Arrernte Peoples whose lands encompass regions of the central desert of Australia surrounding Alice Springs, differentiate between the nightly movement of the stars from east to west, as well as the more gradual annual shift of the constellations. Notable events, such as the ripening of tubers and bulbs and the appearance of migratory birds and animals, are correlated with the positions of stars and constellations such as Orion, Pleiades and the Southern Cross. The timing of these events is detailed in cultural records, and the oral transmission of these knowledges to successive generations ensures the associations, with their significant connection to important resources, are remembered. Retelling such narratives through song and paintings ensured, and continues to ensure, the knowledges continue unbroken over millennia. The Wardaman Peoples of central north Australia created paintings to depict significant representations of such knowledges, including astronomical phenomena such as the Milky Way. The Anindilyakwa Peoples of Groote Eylandt created bark paintings to preserve knowledges about constellations, such as the Southern Cross and the Pointers, and their connection with important resources.

The abundance of important resources within a particular community has been an opportunity for seasonal gatherings and celebrations for thousands of years. Time, measured through a variety of means such as the constellations and seasonal indicators, is measured and recorded differently in the diverse Aboriginal and Torres Strait Islander Language Groups. Within Aboriginal and Torres Strait Islander languages and dialects there is much vocabulary relating to time, indicating the knowledge of timekeeping by Aboriginal and Torres Strait Islander Peoples and its importance for many purposes. Diversity of languages and dialects across Aboriginal and Torres Strait Islander Peoples means that oral language alone cannot be the only means of communication. Hence, the complexity of relaying the details of an important gathering, and finding ways to synchronise time across Language Groups, required innovative means of communication. This has long been the responsibility of messengers from the community, who were tasked with the responsibility of relaying important information about a gathering to invited guests that included: when the event was scheduled, the location and duration of the event, and who was invited to attend.

The use of a message stick was a common means of remembering and communicating such information. The Yidinji Peoples of far north Queensland developed a method of communicating time through a combination of message sticks, fern fronds and hand mnemonics. Notches carved

into a message stick indicated the number of days, while the number of leaflets on the fern frond, folded over in half onto itself, indicated the number of interval days. Additionally, points on the palm of the hand indicated to a neighbouring community the number of days before they are expected to arrive for the gathering. Further notches on a message stick may have been used, if required, to communicate other important information. The Wotjobaluk Peoples of Victoria used the message stick to communicate the distance to the gathering place, what a community may be required to bring, and the number of people invited. Each community then used their own ways of monitoring time, including the tracking of constellations and the appearance of stars in the night sky, to synchronise their timing for the event. The Tarkiner Peoples of north west Tasmania applied the lunar phases of the moon to daily life and determined the timing of a gathering, for example, by the number of dark days after the moon had disappeared.

Petroglyphs, images engraved into a rock surface, provide evidence of Aboriginal Peoples' understanding of the night sky and its connection with time. In Ngarrindjeri Country in South Australia, depictions of the sun and moon are engraved in a rock site called Ngaut Ngaut. The Traditional Owners of the site share the knowledge of a series of dots and lines carved into the rock to show the phases of the moon. The Guringai Peoples of the Sydney region recorded and communicated their observations and understandings of the phases of the moon in rock engravings at a site within what is now known as Ku-ring-gai Chase National Park, north of Sydney. A series of eight engravings of the phases of the moon portray the lunar calendar used by the peoples of this region. The Wathaurong Peoples of Victoria constructed a sophisticated stone arrangement, Wurdi Youang, in deliberate alignment with astronomically significant positions. The egg-shaped arrangement of over 50 basalt stones evidences and records the knowledge of the movement of the stars and sun. In a western context the arrangement is aligned in an east-west direction, with prominent stones on the western side indicating the position of the setting sun at the equinoxes (the times when day and night are of equal length) and solstices (the longest and shortest days of the year). The Wurdi Youang arrangement is believed to be the result of astronomical observations made by the Wathaurong Peoples over thousands of years, and that the recurrent patterns observed each year over time were used in its construction.

This elaboration provides students with the opportunity to research how Aboriginal and Torres Strait Islander Peoples understand the night sky and used observations of the recurrent astronomical patterns as a means of keeping time. The diversity of Aboriginal and Torres Strait Islander Peoples in Australia gives rise to equally diverse systems of keeping time, and recording and communicating the knowledges both intergenerationally among a community and across different language groups. Oral language records, stone arrangements, paintings and petroglyphs all contain evidence of Aboriginal and Torres Strait Islander Peoples' astronomical knowledge and understanding relating to time. Through this elaboration students have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples used the night sky to monitor time and the diverse ways that this knowledge has been preserved over millennia.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSSU080

Knowledge and application of refraction and reflection

CONTENT DESCRIPTION

Light from a source forms shadows and can be absorbed, reflected and refracted.

CONTENT ELABORATION FOR CCP (01.3, 01.5)

- ▶ recognising Aboriginal and Torres Strait Islander Peoples' understanding of refraction as experienced in spear fishing and in shimmering body paint, and of absorption and reflection as evidenced by material selected for construction of housing



Spear fishing requires an understanding of the behaviour of light passing from air to water

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to learn about Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of how light behaves in contact with different materials. The refraction, reflection and absorption of light as it passes from one substance into another is a phenomenon that Aboriginal and Torres Strait Islander Peoples have long observed. This is evidenced in the various ways that Aboriginal and Torres Strait Islander Peoples counter and utilise light. Such knowledge is critical to accurately spear fish in water and to construct housing that provides optimal protection in the environment. This elaboration provides students with the opportunity to learn about the properties of light and how such knowledge has informed Aboriginal and Torres Strait Islander Peoples' technologies and practices.

DETAIL

Aboriginal and Torres Strait Islander Peoples have a long and ongoing understanding of the properties of light and how light behaves when it contacts or passes through different materials. When light strikes a surface, the rays may be absorbed and converted to heat energy, reflected into the atmosphere or refracted modifying the optical perception of objects. The optical properties of light are well understood by Aboriginal and Torres Strait Islander Peoples, and have informed the development of many successful practices and technologies for millennia.

Ochre is a mineral that has long been a valuable commodity for Aboriginal Peoples and is used as a pigment for decorative and artistic purposes. The types of ochre that can be mined from different sites across Australia vary in type, quality and colour, and some rare ochres are widely sought after and traded over vast distances. Among the most highly prized ochres are those that have a silvery sheen caused by the admixture of other minerals such as cinnabar (mercury sulfide) or fragments of mica, a silicate mineral. These components have high refractive indexes when compared with air, contributing to a shimmering effect when light passes through the air to ochre.

Cinnabar has the highest refractive index of any known mineral. The Adnyamathanha Peoples of the Flinders Ranges region in South Australia quarried the Parachilna mine for the red ochre deposits that contain such mercury compounds. This ochre was highly prized and Aboriginal Peoples, such as the Dieri Peoples who occupied the lands over 500 kilometres north west of Parachilna, and the Mitakoodi Peoples from the Cloncurry region in Queensland more than 1300 kilometres away, travelled to barter and trade ochre with the Adnyamathanha Peoples. The Wilgie Mia ochre deposits on Wajarri Yamatji Country in Western Australia contain a high mica component, giving the deep red ochre a silvery sheen. This ochre was a widely sought-after ochre of significant value prior to colonisation and remains so today. Aboriginal Peoples utilised the firelight refraction from these precious ochres to create a shimmer effect. Such ochres have long been used, and continue to be used today, as body decoration by Australia's First Peoples. Mica flakes are an important ingredient in contemporary cosmetic products globally. The tiny particles refract light and cause the popular

shimmering effect. The use of mica for cosmetic purposes can be traced back many millennia in Australia.

Aboriginal and Torres Strait Islander Peoples use the understanding of the refraction of light in the practice of spear fishing. Spear fishing is a hunting practice that has been undertaken for many thousands of years by many Aboriginal and Torres Strait Islander Peoples. On Mer Island in the Torres Strait, the Meriam Peoples catch fish by spear fishing in both shallow waters while walking along the shore, and in deeper waters from a boat. The Wardandi Peoples of the Noongar nation in south west Western Australia spear fish in traps set to utilise the changing tide. Prior to colonisation, bark canoes were used for spear fishing along the Murray River at night, and firelight from an elevated scaffold in the centre of the vessel was used to provide light and to attract the fish.

Accurate and successful spear fishing requires an understanding of the behaviour of light as it passes from air into water. Refraction is a phenomenon in which the speed of light slows as it passes into a material of higher optical density, resulting in a change of direction of the path of light. Due to this refraction of light, an object in the water appears higher than its actual position. Consequently, to successfully spear an object, the aim of the spear needs to be adjusted to target a lower position. The degree to which light refracts when it passes from air into water depends on whether it is salt or fresh water and the depth of the water. The deeper the water, the greater the effect of refraction. Therefore, in deep water, a greater adjustment is needed to counter the effects of refraction, and a hunter needs to aim well below its apparent position to successfully spear the fish. These differences are well understood by Aboriginal and Torres Strait Islander Peoples and such knowledge has been used for millennia, and continues to be used, to accurately and successfully hunt fish using spears.

Aboriginal and Torres Strait Islander Peoples' knowledge of the properties of light facilitated the construction of shelters prior to colonisation across a range of geographical locations and in varying climatic conditions. Depending on the environment, homes were constructed to provide shade and protection from the heat or to absorb heat to provide insulation against the cold. When light strikes a surface, the rays may be absorbed, reflected or refracted. If the light strikes a light-coloured surface most of the light is reflected, while dark surfaces absorb light which is then converted to heat. Aboriginal and Torres Strait Islander Peoples understand which natural materials absorb or reflect light in the selection of suitable resources to construct shelters to meet their needs. The Warlpiri Peoples of the Tanami Desert north west of Alice Springs construct shade structures known in Warlpiri language as *malurnpa*. These shelters consist of a wall that is orientated to maximise shade from the sun and remains open on all other sides to allow air flow. These shade walls are constructed using *Spinifex* spp. or *Eucalyptus* spp. leaves due to their light silvery colour that maximises the reflection of light, ensuring the shelter provides the best possible protection from the intensity of the sun. Prior to colonisation, the Jardwadjali Peoples in eastern Victoria constructed large circular huts that were entirely coated with clay to protect against the cool climate; the clay served a dual purpose as it absorbed sunlight for warmth and provided insulation to retain warm internal air.

This elaboration provides students with the opportunity to understand Aboriginal and Torres Strait Islander Peoples' knowledge of the optical properties of light and examples of the technologies and practices that are informed through this knowledge. The application of this knowledge in different technologies and practices demonstrates Aboriginal and Torres Strait Islander Peoples' understanding of refraction, reflection and absorption. Students will have the opportunity to learn how the historical practices utilising this knowledge in different technologies and practices continue to be of importance in Aboriginal and Torres Strait Islander Peoples' lives in contemporary Australia.

CONSULTED WORKS

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ACSHE083

Traditional ecological knowledge and sustainable harvesting

CONTENT DESCRIPTION

Scientific knowledge is used to solve problems and inform personal and community decisions.

CONTENT ELABORATION FOR CCP (O1.2, O1.6)

- ▶ investigating how Aboriginal and Torres Strait Islander Peoples' traditional ecological and zoological knowledge informs sustainable harvesting practices of certain species, such as dugongs and turtles



Sustainable harvesting practices that protect culturally important species are underpinned by deep species-specific knowledge

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have accumulated sophisticated ecological and zoological knowledge about culturally important key species, including life cycles, organism longevity, mating systems, and diets. This knowledge and understanding about organisms and their life cycle requirements is applied to the careful selection of organisms when they are harvested. Over millennia, in every aspect of life, Aboriginal and Torres Strait Islander Peoples have considered the impact of their practices on the environment to ensure that the growth, regeneration and reproductive cycles of organisms are not interrupted. This elaboration provides students with the opportunity to understand how Aboriginal and Torres Strait Islander Peoples' ecological and zoological knowledge of particular species, such as dugongs and turtles, informs sustainable harvesting practices to protect the species from endangerment and provide continued access to culturally important species. Students will have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples' scientific knowledges, that have long ensured the continuous population growth of these species, are now critical in the co-development of conservation practices.

DETAIL

The cultural practices of Aboriginal and Torres Strait Islander Peoples have sustainably managed the coastal waters of Australia for thousands of years. Traditional ecological knowledge considers the impact of community practices on the environment to ensure that the organism populations within the ecosystems are not detrimentally affected. Organisms are purposefully harvested at specific times in their lifecycle, drawing on knowledge about population density and dynamics, to ensure the long-term survival of the species and its dependent organisms. Dugongs and turtles are culturally important species for many Aboriginal and Torres Strait Islander Peoples. Careful and controlled dugong and turtle harvesting practices are undertaken according to cultural laws and protocols and this system informs community decisions regarding take (acquisition). Sustainability of these species, now affected by a multitude of contemporary issues, requires consultation and co-development of programs that incorporate Aboriginal and Torres Strait Islander Peoples' scientific knowledges, co-management and cultural perspectives.

Aboriginal and Torres Strait Islander Peoples use zoological knowledge pertaining to dugongs and turtles such as animal size, sex, egg clutch size, nesting frequency, and species maturation to inform harvesting practices. Ecological knowledge built over millennia includes the location of animal habitats, food sources of the species, seasonal patterns of movement, and nesting and breeding locations. This essential scientific knowledge, that is well understood by Aboriginal and Torres Strait Islander Peoples, safeguards the habitats of species thereby ensuring that species are protected. For many thousands of years Aboriginal and Torres Strait Islander Peoples have implemented carefully considered protocols for harvesting these marine species, informed by the zoological and ecological knowledge of the organisms and ecosystem.

The Kaurareg Peoples of the lower Western Islands of the Torres Strait developed a collaborative approach with the Traditional Owners of surrounding Islands and all levels of government, for sustainable harvesting of turtles and dugongs. This not only ensures conservation of species, but also safeguards the continuation of important cultural practices associated with these organisms. Such an approach is informed by the long held scientific knowledges of the behaviours and habitats of these species and aims to incorporate such practices with contemporary management strategies. Only a certain quota of dugongs and turtles can be harvested to maintain population numbers; Peoples of some of the Western Torres Strait Islands keep the skull bones of dugong and turtle to monitor the number of animals being harvested in a season. Small dugongs, mother and calf or pregnant dugongs, are not permitted to be hunted and it requires zoological expertise to identify and safeguard these animals so that only suitable animals are harvested. Experienced Aboriginal and Torres Strait Islander ecologists have the skill to determine how many times a dugong has bred by the length and size of the female's teats. The practice of harvesting turtle eggs is also limited to a specific quota and requires ecological knowledge to identify the beaches where turtles return to lay eggs and the time within the season that the eggs can be harvested. Such long held zoological and ecological knowledges have ensured sustainable population numbers of dugongs and turtles for thousands of years.

The declining populations of dugongs and turtles is a recent occurrence. Middens demonstrate that Aboriginal and Torres Strait Islander Peoples have harvested dugongs and turtles for millennia. Sustainable harvesting practices that are informed by the zoological and ecological knowledges of Aboriginal and Torres Strait Islander Peoples have ensured population stability. Recent research pertaining to dugong and turtle populations has confirmed that traditional hunting rights of Aboriginal and Torres Strait Islander Peoples are not responsible for recent population declines, rather these species are being impacted on by contemporary issues, such as climate change affecting native habitats, marine debris including ghost (fishing) nets, pollution, commercial fishing, feral animals that destroy turtle nests, and strikes from marine vessels. These contemporary issues are more predominant in areas of higher human presence and activity. For example, dugong populations extend from the lands of the Malgana, Nhanda and Yingkarta Peoples in the Shark Bay area of Western Australia along the northern and eastern coastlines to Quandamooka Country in the Moreton Bay region of southeast Queensland. The minimal contemporary pressures on dugong populations in the Shark Bay region have made this population the safest dugong population in the world, while the dugong populations in the Great Barrier Reef region of northern Queensland face many threats, such as shark nets and tourist boats, that are endangering these populations.

Currently, programs to collect data are designed to monitor and record changes in the populations of these important Australian marine species. These programs acknowledge that the zoological and ecological knowledges of Aboriginal and Torres Strait Islander Peoples developed over thousands of years are integral to the successful design, implementation and management of these programs. Aboriginal and Torres Strait Islander Peoples' management of marine species has developed over thousands of years and Aboriginal and Torres Strait Islander Peoples wish to maintain responsibility in

managing marine resources to ensure continued cultural connections and sustainable use. Successful programs conduct conservation, management and research activities for marine animals in areas of coastal Australia in collaboration and consultation with the Traditional Owners of those regions. Aboriginal and Torres Strait Islander Peoples' long held knowledges can inform seasonal patterns of movement, feeding sites, knowledge of nesting beaches, population distribution, sexing of adult animals, and capture techniques.

Effective monitoring and research practices are those co-developed with Aboriginal and Torres Strait Islander ecologists who have informed, and continue to inform, sustainable use and conservation of marine species. In Western Australia contemporary population monitoring of dugongs and turtles has involved aerial surveys for dugongs and beach surveys for turtles. However, the success of these strategies has been limited by a number of factors, including Aboriginal engagement and ownership in the monitoring programs. Consultation between the research organisation and the Dambimangari community, the Traditional Owners of the north west Kimberley region, led to a trial program in 2012 which monitored both species using boat-based survey methods on the advice of the Dambimangari rangers and community members. The outcomes of the boat-based survey yielded robust scientific data on the distribution and abundance of turtles and dugongs in the area and incorporated many environmental variables. Aboriginal ownership of the process, outputs and outcomes, enables decision making to be a collaborative process between the local Aboriginal or Torres Strait Islander community and research or government organisations, for the mutual benefit of environmental conservation. Aboriginal and Torres Strait Islander ecologists are crucial in the implementation of policies and agreements, ensuring the monitoring and research activities are administered in their Country/Place in close association with the cultural protocols and laws of the local community.

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples' scientific knowledges have ensured population stability of important species for millennia. The extensive zoological and ecological knowledges relating to specific species such as turtle and dugong that have been developed over many thousands of years are crucial in the development of contemporary scientific monitoring and conservation practices. This elaboration provides students with the opportunity to investigate how the harvesting strategies of Aboriginal and Torres Strait Islander Peoples have long ensured, and today continue to ensure, sustainability of species, of environment, and of cultural rights and obligations. The co-management and continued research into turtles and dugongs by Aboriginal and Torres Strait Islander Peoples are empowering these communities and directly informing personal and community harvesting decisions.

CONSULTED WORKS

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ACSHE083

Contemporary water management – developing technology

CONTENT DESCRIPTION

Scientific knowledge is used to solve problems and inform personal and community decisions.

CONTENT ELABORATION FOR CCP (OI.5)

- ▶ investigating how Torres Strait Islander Peoples and Aboriginal Peoples of arid regions of Australia use scientific knowledge to manage precious water resources



In regions of water scarcity, local communities implement innovative scientific solutions to treat water

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Water is a vital life resource. Access to clean safe water in parts of arid Australia has become a contemporary issue that requires innovative scientific solutions. This elaboration provides students with the opportunity to investigate challenges in the provision of clean, safe water to remote communities in parts of arid Australia, and the scientific knowledges that are being implemented to solve these problems. Aboriginal and Torres Strait Islander Peoples have long understood how to obtain and purify water. However, changes in land usage in contemporary times, including changes in agricultural practices and land use affecting groundwater resources, have posed new challenges for Aboriginal and Torres Strait Islander communities. This elaboration provides students with the opportunity to understand how scientific knowledge is being used to solve water supply issues that affect communities in remote and regional Australia.

DETAIL

Small regional Australian communities experience greater challenges in accessing and maintaining clean, safe water than communities in larger urban areas. In regional and remote communities in arid Australian environments much of the water supply is bore water that is drawn from underground water sources. Many of these bores were drilled and equipped for stock watering purposes and were not planned or designed to provide potable water for human consumption. Ground water in arid areas of Australia commonly contain high concentrations of minerals. Livestock and underground mineral resources, such as uranium, further contaminate the ground water with heavy metals and other harmful substances. These contaminants make the water unsafe for drinking and can result in a wide range of health complications, such as lead or nitrate poisoning that can cause kidney disease. The contaminants also hinder regular, safe sanitation practices, such as handwashing and bathing. In such communities this has resulted a higher prevalence of preventable diseases caused by pathogens such as *E. coli* and rotavirus. Higher temperatures in arid areas mean that people need to consume more water than people who reside in more temperate climates. Therefore, exposure rates are much higher with contaminants accumulating at a greater rate, culminating in rapid and more frequent cases of health issues or long-term complications. Water contamination issues mean that other types of drinks may be consumed to maintain hydration. Alternative options, such as soft drinks, can negatively impact health as they are associated with conditions including obesity and diabetes.

Aboriginal and Torres Strait Islander communities challenged with water contamination and supply issues are seeking to resolve the problems through innovative scientific solutions and modern technologies, in partnership with scientific research and funding from government organisations. Arrernte Elders of Central Australia are investigating solar-powered water treatment plants as a solution to the water contamination problem, and they plan to monitor health outcomes in the surrounding communities. Solar-powered water purification plants can potentially remove up to

99.9 per cent of toxic heavy metals from the underground bore water currently consumed by remote communities. The water purification strategy is being driven by the local central Australian communities who framed a proposal to develop, trial and test the outcomes of the project, in their endeavour to meet the needs of the community.

Community engagement is actively driving the implementation of scientific solutions to address water contamination issues, in particular, identification of a suitable site for installation of the plant and identification of the technology that best meets the needs of the community. Local Aboriginal community members are being trained in the installation, maintenance and monitoring of the plants in their community. The training program ensures that the technological solution remains managed and sustained within the community rather than relying on external technicians, flown in at great expense, for repairs or routine servicing. The installation and successful operation of water treatment plants requires key actions: an initial evaluation of the existing infrastructure, calculation of the volume of water required for drinking, cooking and sanitation purposes, analysis of climate conditions and a chemical analysis of the existing bore water supply for evaluation of the treatment strategy. Development, delivery and implementation of these scientific solutions by local communities ensures that cultural values and self-sustainability remain at the forefront in resolving these problems.

The term arid refers to those environments where there is a severe lack of available water, and while tropical areas are not normally equated with arid climates, they can experience extreme seasonal aridity. Water is rationed in some remote communities in tropical Australia during the dry season in order to conserve the water supplies. For example, some communities in the Torres Strait Islands can access rationed drinking water for only nine hours per day. While water tanks offer a potential solution to collect and store fresh water, many parts of Australia, including the Torres Strait Islands, do not receive enough regular rainfall to maintain tank supplies. In the Torres Strait, a program to supply clean water has been implemented. Community consultation has produced a program specifically designed for the region and the requirements of its peoples. The program builds capacity and self-determination in the community by training local community members in the technologies and water monitoring systems used to ensure water is safe for consumption. The program also works with communities to identify their water requirements and to develop awareness and implementation of water conservation strategies.

While many communities rely on existing scientific knowledges and technologies to expedite water contamination solutions, new technologies may be more efficient. An Aboriginal school student from the Kimberley region in Western Australia, engineered a water filter motivated by his experience with water contamination. His school project prototype uses neodymium magnets (a permanent magnet), carbon-coated mussel shells, and charcoal to filter heavy metals from contaminated water to safe levels. This promising method may offer small communities an innovative solution that converts heavy metal-contaminated water to safe drinking water.

This elaboration provides students with the opportunity to investigate scientific knowledges regarding water contamination and fresh water supply in parts of arid Australia and remote areas with irregular rainfall. Community-specific projects led by Aboriginal and Torres Strait Islander communities offer scientific solutions to provide good quality water, critical for good health and wellbeing. This elaboration provides students with the opportunity to learn how projects led by Aboriginal and Torres Strait Islander communities are providing those communities with scientific solutions that ensure enough water of good quality is available. Students can learn how trained local personnel are responsible for the installation of fresh water supply facilities and monitoring of the water supply, for the benefit of the community.

CONSULTED WORKS

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ACSHE081

First Nations' navigation

CONTENT DESCRIPTION

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions.

CONTENT ELABORATION FOR CCP (OI.3, OI.5)

- ▶ learning how Aboriginal and Torres Strait Islander Peoples use observation of the night sky to assist with navigation



Astronomical knowledge enables 'over the horizon' navigation techniques

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Aboriginal and Torres Strait Islander Peoples have navigated the lands and waters of Australia for many thousands of years using knowledge of astronomical phenomena and the omnipresent patterns in the sky as a navigational system. Aboriginal and Torres Strait Islander Peoples have made repetitive observations of the patterns in the sky for thousands of years, collecting a significant bank of astronomical data in the process. As a result, Aboriginal and Torres Strait Islander Peoples recognised that many of these phenomena occur in regular, dependable cycles of known intervals. This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples gathered data on astronomical events and phenomena. Students also learn how Aboriginal and Torres Strait Islander Peoples used this data to test the prediction that astronomical knowledge enables ‘over the horizon’ navigation techniques.

DETAIL

Aboriginal and Torres Strait Islander Peoples have navigated across the Australian landscape for many thousands of years and for many purposes, such as seasonal movement, trade, significant gatherings, and to manage Country/Place. These purposes often required Aboriginal and Torres Strait Islander Peoples to travel vast distances, further than the eye can see. Astral navigation of both land and sea was developed by the long-term observation of the night sky. Over thousands of years, Aboriginal and Torres Strait Islander Peoples gathered data about the night sky through continual observation, and they recognised that patterns in the sky were aligned with a range of fixed landmarks. This recognition led to the understanding that these patterns can be used to navigate to specific geographical locations across land and sea. Some stars, constellations and celestial bodies were, and still are, used for guidance while at other times the sky was used as a star map to assist in remembering directions.

Star maps overlaid onto contemporary road maps of mainland Australia show significant overlap, indicating the critical contribution that Aboriginal Peoples’ astronomical knowledge played in assisting early European colonists to transverse the continent using established routes. Many of the routes that were originally established by Aboriginal Peoples are now major roads and highways. For example, the star map from Goodooga in Kamilaroi Country in New South Wales to the Bunya Mountains in Waka Waka Country in Queensland overlaps with today’s Carnarvon and Warrego Highways. Euahlayi Elder Ghillar Michael Anderson continues to educate people about pathways, such as the Warrego, that connected communities prior to colonisation, and that these pathways are founded on navigational star maps.

Prior to colonisation, Aboriginal Peoples used the information gathered from thousands of years of unbroken observations of the night sky to navigate across the continent using the stars for direction or by using star maps. Observation of the night sky has provided many Aboriginal Peoples with

knowledge and understanding about the pattern of stars, how the pattern rotates from east to west over the course of a night, and the changes over the course of a year. Star maps are a way of teaching information about navigation using the night sky in areas outside a person's own Country/Place as they correlate star patterns and constellations with landscape features. During a particular season, the pattern of stars indicates the location of important landmarks, such as waterholes, or a traveller's waypoint for stopping or turning.

One example is a star map that provides a navigation route from parts of New South Wales to the Sunshine Coast region in Queensland. This map has long been used to navigate to the Bunya Gathering. North-west of Brisbane, the Bunya Mountains are of immense significance to the Traditional Owners of the lands, the Waka Waka, Barrungam, Jarowair and Djaku-nde Peoples. The Bunya pine of this region produces large pine cones containing highly nutritious seeds in a triennial seasonal pattern. For millennia, thousands of Aboriginal Peoples travelled great distances to attend the Bunya Gathering. Traditional Owners sent messengers to invite selected groups to attend this important seasonal ceremonial gathering when the nuts ripened and were ready for harvesting. Invited guests, using a star map to guide their route, travelled distances in excess of 700 kilometres, from areas as far as Muruwari and Kamilaroi Nations in New South Wales. The star map indicated turning points so that travellers could navigate to the gathering place in the Bunya Mountains. The star map is committed to memory and may be preserved in a songline. Wardaman Elder Bill Harney and astronomer Ray Norris describe songlines as "effectively oral maps of the landscape, enabling the transmission of oral navigational skills in cultures that do not have a written language".

Another example of a star map is one that has long been used by the Euahlayi Peoples in New South Wales that provides the navigation to a waterhole on the lands of the Maranganji Peoples near Quilpie in Queensland. This is another significant site for gatherings of Aboriginal Peoples from a wide area, including the Arrernte Peoples of the Central Desert region, who travel vast distances to this site. The star map of the Euahlayi Peoples provides several waypoints connected to the position of the stars that facilitated navigation to the meeting place. The presence of many Aboriginal groups at such a meeting place suggests that Aboriginal groups had their own star maps that provided ways of navigating to the location. A complex network of trade routes transverses Australia over long distances and has long been used to exchange resources of significance or those that may have been unavailable in particular geographical regions. Some trade routes were memorised and incorporated into songlines aligned with patterns in the night sky.

On the Island of Mabuag in the Torres Strait, gathering information about the appearance of stars has long been the responsibility of expert astronomers in the community. When the appearance of a star was expected the astronomers would rise early and watch the sky until daybreak, observing patterns in the appearance of the stars and constellations. The setting of stars was observed in the same way. Such observations and the information gathered over long periods of time led to detailed knowledge of these star patterns informing navigation among the Islands of the Torres Strait. European surveyors considered the Torres Strait to be a dangerous area to navigate and it was recorded that errors in

navigation by the compass would result in wreckage. However, Torres Strait Islander Peoples used the patterns in the night sky to develop routes of safe passage through the Strait. For example, the warrior constellation of *Tagai* is important for navigation between the Islands. The Erubam Le People of Erub Island sail to Mer Island steering the vessel towards the left hand of *Tagai*. The constellation of *Baidam* (the Shark) and *Tagai* are used by Torres Strait Islander Peoples to orientate navigation to the north or south. The stars in these constellations provide a reference point on the horizon to orient navigation. The Peoples of the Torres Strait Islands have recorded information about phenomena in the night sky for millennia and continue to observe the sky to gather information today. The unbroken collection of observations of Torres Strait Islander Peoples has resulted in accumulated evidence that recognises the patterns in the night sky and how they can be used as positional markers to accurately navigate across land and water, including predicting weather conditions.

The concept of cardinal points is also evident in Aboriginal cultures. The Warlpiri Peoples of the Central Desert in the Northern Territory use cardinal directions that closely align with the Western cardinal points of north, south, west, and east and have terminology to describe position through these points of reference (*yatuju*, *kurlulu*, *karlu*, and *kakarru* respectively). The Wardaman Peoples of the Katherine region in the Northern Territory also use cardinal points for navigation. Many Aboriginal Peoples have terminology that describes the directions of east and west that are based on the observations of the rising and setting sun.

This elaboration provides students with the opportunity to understand how Aboriginal and Torres Strait Islander Peoples' observations over millennia have connected astronomical phenomena with landscapes to accurately navigate over vast distances. Aboriginal and Torres Strait Islander Peoples acquired information over many thousands of years to understand the patterns of the night sky and predicted that such patterns were connected to patterns and landmarks on the ground. Testing this prediction created an evidence base that supports this correlation. The result is the development of a sophisticated system of navigation that has long been utilised by Aboriginal and Torres Strait Islander Peoples to accurately travel across challenging land- and sea-scapes. Aboriginal and Torres Strait Islander cultures have contributed to, and continue to contribute to, understandings about the astronomical phenomena of the southern hemisphere.

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Science Inquiry Skills

New elaborations within the Science Inquiry Skills (SIS) strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander Peoples when working scientifically. These intercultural science inquiry skills are throughout Foundation to Year 6 and provide opportunities for students to develop skills relating to:

- acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
- consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
- collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.

Unlike the Science Understanding (SU) and Science as a Human Endeavour (SHE) Teacher Background Information (TBI) materials the teacher background information for the new SIS elaborations provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures. Importantly, the Science Inquiry Skills TBI illustrates how concurrent SU and SHE topics can be used to contextualise the ways in which educators may provide skill development opportunities for the development of these skills.



Potential hazards are identified when the risk assessment of planned field work involves local communities

AC SIS086

Consulting local knowledge – field work considerations

CONTENT DESCRIPTION

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks.

CONTENT ELABORATION FOR CCP

- ▶ consulting with Aboriginal and Torres Strait Islander Peoples to guide the planning of scientific investigations, considering potential risks for field investigations

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

A potential way to approach this content description is:

In the planning for conducting an environmental survey to identify the presence and adaptations of flora or fauna species, consultation with local Aboriginal and/or Torres Strait Islander community members can provide information about specific environmental safety issues. Biological surveys that are undertaken by scientists, including ecologists, provide the scientific basis for decisions regarding environmental management. They are used to collect data on the distribution, ecological relationships and conservation status of animal and plant species in an environment, and highlight patterns of biodiversity within that environment. A flora or fauna survey may show the dominance of a particular organism that is out-competing other species due to adaptations. Prior to undertaking a flora or fauna survey, members of the local Aboriginal and/or Torres Strait Islander community can be consulted about potential safety risks in the region. It is likely that the Aboriginal and/or Torres Strait Islander community can provide highly detailed local knowledge about potential safety risks in the survey area. This knowledge may include information regarding risks, such as crocodile locations in mangrove swamp environments, peculiar tidal events in coastal regions, dangerous geology or hazardous flora species. Consultation with the local Aboriginal and/or Torres Strait Islander community in the planning stages of a flora or fauna survey can provide highly detailed local knowledge about the safety risks that need to be considered in field investigations.

AC SIS093

Acknowledging understanding of how structural adaptations are communicated

CONTENT DESCRIPTION

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts.

CONTENT ELABORATION FOR CCP

- ▶ acknowledging and exploring Aboriginal and Torres Strait Islander Peoples' ways of representing and communicating information about anatomical features, including structural adaptations

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

A potential way to approach this content description is:

Acknowledging and exploring how Aboriginal and Torres Strait Islander Peoples traditionally communicated their understanding about structural features and adaptations of organisms, including internal organs.

A scientific diagram is a visual representation of scientific information and is usually intended to communicate a particular scientific concept or process. Scientific illustrations are precise and detailed diagrammatic representations of knowledge and are produced according to specific rules to ensure clarity of the information communicated. Aboriginal and Torres Strait Islander Peoples have long used multimodal ways to represent and communicate the scientific knowledges of the anatomical features and structural adaptations of organisms. For example, X-ray paintings dated at over 8,000 years old, at Burrunggui on the lands of the Gun-djeihmi People in Kakadu National Park, record details of the human skeletal and circulatory systems. The X-ray paintings at Injaluk Hill, on the lands of the Kunwinjku Peoples in Arnhem Land, depict anatomical features of birds, fish and mammals including internal organs and skeletal structures. In other sites around Australia, the paintings of Aboriginal Peoples further depict the structural adaptations of species such as echidna quills and sawfish teeth that helped these organisms survive in their environment. In the Torres Strait, highly detailed masks and headdresses are a method of representing and communicating the structural features and adaptations of important species such as turtles, crocodiles and sharks.

This elaboration provides students with the opportunity to explore Aboriginal and Torres Strait Islander Peoples' methods of representing and communicating anatomical and physiological features of organisms. Students have the opportunity to learn how scientific knowledge in contemporary science is represented and communicated in similar ways and using similar rules to the long-held practices of Aboriginal and Torres Strait Islander Peoples. Students can learn how to represent and communicate key information about structural features of organisms using scientific illustrations.

AC SIS231

Acknowledging knowledge and use of organism adaptations

CONTENT DESCRIPTION

With guidance, pose clarifying questions and make predictions about scientific investigations.

CONTENT ELABORATION FOR CCP

- ▶ acknowledging and using information from Aboriginal and Torres Strait Islander Peoples to guide the formulation of investigable questions about adaptations

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083) & (ACSHE100)

A potential way to approach this content description is:

Students use Aboriginal and Torres Strait Islander Peoples' knowledges of structural features and adaptations of organisms to guide the formulation of scientific questions for an investigation.

Aboriginal and Torres Strait Islander Peoples have long recorded scientific knowledges in paintings, oral records and song. Through online research students can investigate these knowledges to pose clarifying questions for scientific investigation. An example of the advantage of acknowledging and using information from Aboriginal Peoples can be found in the early European investigation of the platypus. As an egg laying monotreme, the platypus has many adaptations that facilitate its survival in the environment. European naturalists who described the platypus in Western journals were met with skepticism, and the scientific details reported by European scientists were initially considered a hoax. Scientific knowledge, such as a deep understanding of the structural features and adaptations of the platypus, has been accumulated by Aboriginal Peoples over millennia and is documented in cultural records. Acknowledgement of this scientific knowledge could have assisted early European colonials in Australia to clarify the question "Is a platypus a mammal?"

Similarly, acknowledgement and use of the detailed scientific knowledge Aboriginal and Torres Strait Islander Peoples have of the structural adaptations of organisms within their environment can assist students in the formulation and refinement of scientific questions. Aboriginal and Torres Strait Islander

Peoples have long-held scientific knowledge about the distribution of plants and animals, both past and present, in Australia. Some biologists investigate the distributions of organisms to understand the adaptations that facilitate an organism's survival in a specific environment. For example, until recently sawfish were considered to be a predominantly a salt-water coastal species. However, the Gurindji Peoples, whose traditional lands are 800km south of Darwin in the Northern Territory, have long been aware that sawfish can live far from the ocean. This fact was recently brought to the attention of Western scientists when the Gurindji Peoples shared their records of sawfish in paintings located at a site near Kalkarindji, far distant from the ocean.

Online research can assist students to understand the scientific knowledge held by Aboriginal and Torres Strait Islander Peoples and to inform the clarifying questions they pose about adaptations. Students can research sawfish records in Aboriginal paintings to broaden their understanding about sawfish distribution in order to pose clarifying questions for investigation of adaptations. Students can also research Aboriginal Peoples' scientific knowledge about the structural adaptations of the thorny devil, that can gather water into its mouth by capillary action, or the water-holding frog, that can successfully inhabit desert environments. Online research to understand and use Aboriginal and Torres Strait Islander Peoples' records can provide students with information to assist the formulation of scientific questions about the structural features and adaptations of organisms that help them survive in specific environments.

Year 6

Teacher background information



ACSSU094	Traditional ecological knowledge and ecological restoration
ACSSU095	Reversible/irreversible change
ACSSU096	Earthquakes and volcanoes
ACSHE098	The first scientists
ACSHE100	First Nations led wildfire/bushfire reduction strategy
ACSHE098	First Nations' contributions to deeper science understanding
ACSIS232	Consulting local knowledge – what's changed?

ACSSU094

Traditional ecological knowledge and ecological restoration

CONTENT DESCRIPTION

The growth and survival of living things are affected by physical conditions of their environment.

CONTENT ELABORATION FOR CCP (OI.2, OI.3)

- ▶ investigating Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of the physical conditions necessary for the survival of certain plants and animals in the environment



*Understanding that *P. spiralis* often grows in saline soils in warm coastal regions with high rainfall*

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration enables students to study how Aboriginal and Torres Strait Islander Peoples' knowledge and understanding of the complex ecosystems that exist across the Australian continent are reliant on physical conditions that exist within a defined geographical region. Aboriginal and Torres Strait Islander Peoples' understanding of the requirement of specific physical conditions for the growth and survival of particular plant and animal species is evidenced through intricate seasonal calendars, land management practices and important cultural gatherings. Such knowledge is essential in maintaining or restoring particular environmental physical conditions that ensure the continued availability of resources and support the reproductive/migratory cycles of important organisms.

DETAIL

The Australian continent encompasses a vast diversity of environments and climatic conditions, including savannah, alpine, riverine, desert, montane and coastal environments. Aboriginal and Torres Strait Islander Peoples have a long and continuing occupation of the geographical region that encompasses their Nation and this connection to Country and Place is often highlighted by broad group identities, for example, 'salt-water', 'desert' and 'rainforest' people. This has resulted in each cultural group having a comprehensive, deep understanding of the complexities, interrelationships and resources available in each ecosystem. Traditionally, the plant- and animal-based resources within the geographical region of a particular Aboriginal or Torres Strait Islander cultural group's Country or Place provided the foods, medicines and materials required for the construction of tools, domestic implements and shelters. Many contemporary Aboriginal and Torres Strait Islander Peoples continue to recognise that the growth and survival of plant and animal resources is intrinsically connected to the seasonal variation of physical conditions and use this knowledge for sustainable harvesting and management of their Country or Place.

Physical conditions that influence the growth and survival of plant and animal life in an ecosystem include such factors as salinity, nutrient availability, temperature and water availability. These physical factors work synergistically rather than in isolation, evident in the unique biodiversity of organisms seen in different geographic regions of Australia.

Salt is a natural component of soil in the coastal regions of Australia. Aboriginal and Torres Strait Islander Peoples understand the specific requirements of the organisms within such environments and have sustainably managed the ecosystems of Australia's coastal areas, and the salt tolerant organisms that exist within these environments, for thousands of years. *Pandanus spiralis* is a coastal shrub common along the coast of northern Queensland including the Torres Strait Islands, the extreme north of Western Australia, and the Northern Territory. The growth and distribution of *P. spiralis* is restricted to the warm coastal regions of Australia in areas of saline soils and high seasonal rainfall. Aboriginal and Torres Strait Islander Peoples understand the physical requirements

for the growth of *P. spiralis* and the plant is used for many purposes. It provides a source of food, the fibre is used for making resources and parts of the plant are used for medicinal purposes. The Bardi Peoples of the Kimberley region of Western Australia have long recognised that the season of king tides (*Iralbu*) is time to travel to the coastal regions, as the fruit of the *Pandanus* spp. will be ripe and ready to harvest. Prior to colonisation, the Bardi Peoples also used the leaves of *Pandanus* spp. to weave shoes and the palms to construct shelters. In contemporary times, *Pandanus* spp. remains a culturally significant plant group to the Bardi Peoples. On Murrunga Island off the coast of north-east Arnhem Land, *Pandanus* spp. also flourishes due to the physical conditions of the coastal environment. Here the Yan-nhanju, and other peoples of the wider Yolŋu Nation, used *Pandanus* spp. leaves to twine fibre for the construction of fish traps, and this process is still in use today.

Many native Australian plants are sensitive to salt and cannot grow in environments of high salt salinity. Bulrushes (*Typha* spp.), for example, are an aquatic plant that flourishes in Australia's wetland environments. For the Peoples who inhabit these wetland areas, bulrushes are an important resource used in the manufacture of fibre for the construction of fishing and game nets. The Wirramayo Language speakers of Ngadjuri country in the mid-north of South Australia constructed nets up to 12 metres in length from the fibre of the bulrush to capture kangaroo and emu. In these freshwater environments Aboriginal Peoples, including the Ngarrindjeri of southern central Australia, also sustainably harvested bulrushes as a starchy food source.

The aquatic fern nardoo (*Marsilea drummondii*) is also sensitive to soil salinity, and it thrives only in areas of Australia that can provide the ephemeral freshwater it needs for germination. However, the spores of nardoo can remain viable in conditions of drought, or environments of limited water availability, such as the desert environment of Australia. In such ecosystems the spores remain dormant for extensive periods of time and germinate in times of rainfall or floods. The Yandruwanda Peoples of the lakes area in South Australia utilised this knowledge to cultivate and harvest large quantities of nardoo. The spores provide a nutritious food source when appropriately prepared, and ground spores can produce flour for baking.

On the Island of Saibai in the Torres Strait, community groups lived on, and continue to occupy, both the coastal areas and interior regions of the island. The differences in the physical conditions of these regions affect the type of resources that are available. The Traditional Owners of Saibai, the Koeybuway and Moegibuway Peoples, understand the physical conditions of their environments. The freshwater inland areas are cultivated to grow plants such as taro, while saltwater environments are carefully managed to ensure saltwater produce is maintained. Traditionally, freshwater produce, such as taro and ducks from the inland regions, was traded for saltwater produce, such as fish, dugong or crayfish harvested by coastal communities.

Seasonal changes that alter the physical conditions of an environment, such as temperature and water availability, also impact the species within these ecosystems. The intricate seasonal calendars of many Aboriginal and Torres Strait Islander Peoples demonstrate the availability of resources within

a geographical region during the different seasons. The seasons inform the timing of the harvest and procurement of resources, and influence timing for gatherings and inter-cultural meetings. For example, the bogong moth demonstrates an annual pattern of summer migration from southern Queensland and northern New South Wales during the hot summer months when their food source becomes scarce due to the warmer temperatures. The moths navigate to the Australian Alps where they aestivate in cool caves. When the temperature drops and food supplies replenish in the north, they return to breed. This annual migration of bogong moths united families from different Language Groups who came together to roast the moths on hot rocks in areas including the lands of the Ngarigo Peoples in the Snowy Mountains region near Canberra. Families from different Language Groups also came together at Yarralumla (ACT) and gathered bogong moths from Birragai in the lands of the Ngunnawal People. Paths through Uriarra can still be seen where people travelled to this region.

The cultivation and sustainable acquisition of resources including food and fibres by Aboriginal and Torres Strait Islander Peoples demonstrates a complex understanding of how the physical conditions of an ecosystem affect the availability of animal and plant species in diverse regions. This long held and sophisticated knowledge is today being used to inform land management practices and restoration processes in areas where the impact of colonisation and introduced species have damaged environments. Aboriginal and Torres Strait Islander Peoples understand the fragility of their ecosystems and are acutely aware of the impact that alterations in physical conditions may have on these environments. For example, one of the most significant environmental issues of the Murray-Darling Basin wetlands, the traditional lands for more than 40 Aboriginal Nations, is the increased soil salinity that has resulted from land clearing and irrigation schemes. Traditional Owners of the area, represented by the Northern Basin Aboriginal Nations and the Murray Lower Darling Rivers Indigenous Nations organisations, are working with scientific and government organisations to restore the Murray-Darling Basin wetlands through water research, planning and management. This includes the reintroduction of salt tolerant native flora, such as saltbush, to improve the health and biodiversity of the ecosystem.

This elaboration provides the opportunity for students to understand how the growth and survival of plant and animal species are influenced by the physical conditions of the environment they inhabit. Students will gain an understanding of how Aboriginal and Torres Strait Islander Peoples used, and continue to use, this environmental knowledge to maintain balanced ecosystems and sustainably acquire resources. Students will be informed of long held, deep understandings about the unique physical requirements of species, and the critical role this knowledge plays in contemporary land management practices and land rehabilitation projects.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU095

Reversible/irreversible change

CONTENT DESCRIPTION

Changes to materials can be reversible or irreversible.

CONTENT ELABORATION FOR CCP (O1.5)

- ▶ investigating Aboriginal and Torres Strait Islander Peoples' knowledge of reversible processes, such as the application of adhesives, and of irreversible processes, such as the use of fuels for torches



The burning of fuel in traditional torches utilises irreversible chemical reactions

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples developed adhesive technologies thousands of years ago through the knowledge of reversible and irreversible changes. Aboriginal and Torres Strait Islander Peoples used, and continue to use, resins in the manufacture, maintenance and repair of various implements and regalia. The reversible thermoplastic properties of resins are used to advantage; when heat is applied, the resins change state from solid to liquid, and when heat is removed, they return to a solid state. Aboriginal and Torres Strait Islander Peoples understand the thermal limits of resins, that is, if too much heat is applied to the resin it causes an irreversible change to the material, rendering it unusable. Students will have the opportunity to learn about Aboriginal and Torres Strait Islander Peoples' understanding of reversible changes as evidenced in the use of resins as adhesives, and irreversible changes, such as the use of fuel for torches.

DETAIL

Aboriginal and Torres Strait Islander Peoples use resin for a wide range of purposes. Resin can be used as an adhesive in the manufacture, maintenance and repair of implements, a waterproofing agent, fuel for a torch, and to add strength to a join. A wide range of plants exude resin. The type of plant used by Aboriginal and Torres Strait Islander Peoples for this purpose depends on the vegetation that is available in their specific geographical territory. Aboriginal Peoples most commonly use spinifex (*Triodia* spp.) and grasstrees (*Xanthorrhoea* spp.) to source resin. Spinifex plants are widely distributed across Australia, especially in arid and semi-arid regions, and grasstrees are found along the east and west coasts of Australia. Resin has long been a highly valued commodity and continues to be traded into areas without resin producing plants.

The use of resins by Aboriginal and Torres Strait Islander Peoples demonstrates an understanding of reversible change, and the application of this knowledge. Resins become soft and malleable with the application of direct or indirect heat. However, once the source of heat is removed, the resin cools and hardens again, demonstrating a reversible change in the state of matter. This knowledge is evidenced in the use of resins for a range of purposes by Aboriginal and Torres Strait Islander Peoples. Resins were, and continue to be, widely used as adhesives in the manufacture of implements such as attaching spear points to shafts, hafting stone hatchet heads and knife blades to handles and attaching pegs to spear-throwers. Preparation of the resin depends on its intended use. It can be enhanced, when mixed with other substances, to form a cement with stronger adhesive properties. The Ngarrindjeri Peoples of the Murray River region in South Australia mix the resin of the grasstree with sand to adhere sharp quartz tips to spears. In far North Queensland the Yidinji Peoples mix grasstree resin with beeswax, charcoal, sand or dust, to prepare a cement for fixing stone heads to wooden handles and spear shafts to tips. The reversible property of resin is important in the manufacture of such implements as it allows the opportunity to reshape and repair. In Central Australia, early European anthropologists observed Aboriginal Peoples heating the spinifex resin

that bound the cutting edge of an adze to remove the blunted edge and replace the flint for a fresh cutting edge. A ready supply of resin was required so that tools and implements could be repaired or manufactured as needed. Resin was traditionally stored as a block or on sticks for accessibility when travelling, and for trading. Resins are insoluble in water, making them ideal as a sealant and to waterproof implements and vessels. The Gadigal Peoples of the Eora Nation in the Sydney basin region used grasstree resin to reinforce the joints of fish hooks and to mend damaged canoes. In the Cairns/Yarrabah region of North Queensland the Yidinji Peoples used the exudate from scrub turpentine to seal the sewn side of a bark waterbag.

In the Torres Strait, knowledge of reversible properties is applied in the use of heat to mould turtle shell, for example, in the manufacture of fishing hooks and masks. Fish hooks can be manufactured from turtle shell by cutting or scraping the shell, before applying heat to soften the shell, and bending it into shape. Traditionally, masks required the use of a hot stone to soften the shell sufficiently for it to be moulded into the desired shape. In both cases the removal of heat results in the cooling of the shell, returning it to a hardened state to set the desired form.

Irreversible changes can be indicated by a change in colour, release of odour, gas, light or sound or a change in temperature. Overheated resin undergoes an irreversible change and is no longer useful as an adhesive. Aboriginal and Torres Strait Islander Peoples treat resin carefully to ensure the thermal limits of resin are not exceeded. Early Europeans observed the Wadjari Peoples in central Western Australia heating grasstree resin too quickly so that it frothed and crumbled, and this irreversible change rendered the resin unusable. Studies have also shown that prolonged and repeated heat applied to *Xanthorrhoea* spp. resin causes irreversible chemical changes to the cement; it becomes more brittle and lessens the adhesive properties of the resin.

Aboriginal and Torres Strait Islander Peoples use plants, many of which are highly resinous, as fuel for torches, demonstrating an understanding of the irreversible changes that result from combustion. Spinifex is highly flammable and burns intensely for a long period of time, making it useful as a torch to transport fire. In the Torres Strait, coconut fronds are used as torches, with the peoples of Mer Island using such torches for spear fishing at night. The Ngarrindjeri Peoples of the Murray River region in South Australia traditionally sourced a resinous timber to use as a torch during spear fishing expeditions by canoe at night. This timber burns to emit a very bright light and produces little smoke. Branches or leaves from plants coated with resins are useful as torches. However, the prolonged application of heat causes irreversible changes that can be observed when the resins blacken and become brittle, and the branches are charred.

This elaboration provides students with the opportunity to learn the concept of reversible and irreversible changes using Aboriginal and Torres Strait Islander Peoples' knowledges of adhesives and fuels. Students will also have the opportunity to learn how Aboriginal and Torres Strait Islander Peoples carefully controlled the application of heat to utilise reversible changes, and understand that the prolonged application of heat, for example, using fuel for torches to transport fire, results in irreversible changes to the materials.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSSU096

Earthquakes and volcanoes

CONTENT DESCRIPTION

Sudden geological changes and extreme weather events can affect Earth's surface.

CONTENT ELABORATION FOR CCP (OI.3)

- ▶ researching Aboriginal and Torres Strait Islander Peoples' cultural stories that provide evidence of geological events



Bungandij Peoples' cultural stories contain information about volcanic activity that formed Victoria's Blue Lake

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration will build students' understanding of Australian geological changes through recordings by Aboriginal and Torres Strait Islander Peoples. Aboriginal and Torres Strait Islander Peoples use oral language to document and record knowledge, retelling such records to enable the knowledge to endure through subsequent generations. This elaboration provides students with the opportunity to understand Aboriginal and Torres Strait Islander Peoples' knowledge of geological events from many thousands of years ago, prior to European exploration of the region. The cultural stories of Aboriginal and Torres Strait Islander Peoples contain scientific evidence that explains the changes to Earth's surface that gave rise to geological structures observed across Australia. Today, scientists are researching how such knowledges provide evidence for, and a deeper understanding of, geological events in Australia. As Aboriginal Peoples of Australia have been present for more than 60,000 years, they have witnessed many geological changes and extreme weather events. Similarly, Torres Strait Islander Peoples have lived for more than 7,000 years in a region susceptible to the effects of geological events such as earthquakes and tsunamis.

DETAIL

The oral traditions of Aboriginal and Torres Strait Islander Peoples are highly detailed and complex and enable knowledge from many thousands of years ago to be passed down unbroken through generations. Such narratives include scientific evidence of geological events such as volcanic eruptions, earthquakes and tsunamis, that have shaped Australia's landscape. The knowledge that is held by Aboriginal and Torres Strait Islander Peoples precedes European investigations of Australia, and hence today provides a deeper understanding of historical geological events that have led to specific land structures.

In far north Queensland recent volcanic activity is dated to more than 10,000 years ago. Volcanic activity in this region created many land formations including lakes and watercourses. Lake Barrine, in Crater Lakes National Park, is situated in the Atherton Tablelands in northern Queensland and encompasses the traditional lands of the Ngadjon-Jii and Yidinji Peoples. The geomorphic features of this region are the result of volcanic activity more than 17,000 years ago; Lake Barrine was formed by explosions from super-heated groundwater. The Ngadjon-Jii Peoples have passed on their geological and ecological knowledge of these volcanic events since this time, explaining not only the origin of the volcanic crater lakes of this region, but also the environmental and landscape changes that resulted from the volcanic eruption. The accuracy of this knowledge, dating back over 10,000 years, has been reaffirmed by Western scientific methods, and provides an example of how First Nations Peoples' oral language traditions are an important repository of geological knowledge.

The eruption of Kinrara on the lands of the Gugu Badhun Peoples was another major volcanic event in the north Queensland region, dated to approximately 7,000 years ago. This volcanic activity generated geological changes in the region through lava flows that extended down the Burdekin

River valley. The Gugu Badhun Peoples hold detailed knowledge of this volcanic event that explains the geological formations of the landscape and reaffirms recent volcanological research in the area. Bungandidj Country in the Mount Gambier region in south eastern Australia has also experienced volcanic activity in the last 10,000 years. The oral records of the Bungandidj Peoples have preserved, for at least 4,000 years, the knowledge of volcanic events that formed the crater lakes at Budj Bim National Park.

Earthquakes can be caused by the movement of the earth's tectonic plates, resulting in shaking on the earth's surface. When the centre of an earthquake occurs offshore, the ocean floor may be disrupted sufficiently to generate a tsunami. Movements of the Indo-Australian tectonic plates have been the cause of earthquakes in Australia. Oral narratives of the Awabakal Peoples of the mid north coast region of New South Wales demonstrate the longevity of the knowledge of earthquake activity in this region. Similarly, tsunami events that inundated Australia's coastal regions are preserved, for example, in the knowledges of the Gundungarra Peoples of south eastern New South Wales and the Kambure Peoples of the Kimberley region in Western Australia. Many geological events over millennia have shaped the landscape of the Australian continent. Details of a considerable number of these geological events are detailed in the oral records of the Aboriginal or Torres Strait Islander Peoples who have a continuing connection to those geographical regions.

This elaboration provides students with an opportunity to learn about geological changes that have shaped the Australian landscape. Students also learn how Aboriginal and Torres Strait Islander Peoples use oral based practices to record and convey knowledge, thereby preserving details of historical geological events for millennia. Students will have the opportunity to research the geological data in cultural stories and understand how the reaffirmation of oral records by recent scientific research endorses the importance of consulting these records as a historical source.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

The following sources were consulted in the construction of this teacher background information. They are provided as evidence of the research undertaken to inform the development of the teacher background information. It is important that educators recognise that despite written records being incredibly useful, they can also be problematic as they are often based on non-Indigenous interpretations of observations and records of First Nations Peoples' behaviours, actions, comments and traditions. Such interpretations privilege western paradigms of non-First Nations authors and include, at times, attitudes and language of the past. These sources often lack the viewpoints of the people they discuss and can contain ideas based on outdated scientific theories. Furthermore, although the sources are in the public domain, they may contain cultural breaches and cause offence to the Peoples concerned. With careful selection, evaluation and community consultation, the consulted works may provide teachers with further support and reference materials that could be culturally audited, refined and adapted to construct culturally appropriate teaching and learning materials. The ability to select and evaluate appropriate resources is an essential cultural capability skill for educators.

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ACSHE098

The first scientists

CONTENT DESCRIPTION

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions.

CONTENT ELABORATION FOR CCP (OI.5, OI.9)

- ▶ investigating how Aboriginal and Torres Strait Islander Peoples test predictions and gather data in the development of technologies and processes



Scientific inquiry resulted in the development of heat lithic treatment to improve flaking

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples have longstanding science capabilities. Science is a body of empirical, theoretical and practical knowledge about the universe that is constructed through the scientific processes of observing, predicting and gathering data to understand and explain events and phenomena. Aboriginal and Torres Strait Islander Peoples have worked scientifically for millennia in the development of technologies and processes, often in isolation from other cultural influences and ideas, for thousands of years. These intellectual ways of working have resulted in the successful and continued occupation of Australia's diverse geographic landscapes and climatic conditions for more than 60,000 years. This elaboration allows students to deepen their knowledge and awareness of the ways that Aboriginal and Torres Strait Islander Peoples worked, and continue to work, scientifically through testing, trial and error, observation, verification through repetition, inference and prediction. The development of myriad technologies and processes, for example, lever mechanisms and cutting-edge tools, demonstrates the ingenuity, science capability and innovation of Australia's First Nations' Peoples.

DETAIL

The word science originated in the 14th century from Latin *scientia* meaning knowledge and scire to know, although the practice of science existed well before this time. Science is a dynamic, collaborative and creative human endeavour that strives to build knowledge and understanding of events and phenomena through a systematic process. Although the term science is a Western construct, Aboriginal and Torres Strait Islander Peoples have worked scientifically to develop knowledge, technologies and processes.

All science is founded on careful observation. For many thousands of years Aboriginal and Torres Strait Islander Peoples made scientific observations using their acute observational skills without the highly sophisticated technologies available in contemporary science today. A clear example of this can be found in the Aboriginal knowledge of the lime content of the plant *Acacia salicina* which contains the highest lime content of any known native Australian plant. Aboriginal ways of working scientifically identified a way to expedite the release of alkaloids from alkaloid-containing plants such as *Duboisia hopwoodii*. Aboriginal Peoples in the Central Desert were observed chewing *D. hopwoodii* mixed with ash from *A. salicina*. The saliva provided the moisture and *A. salicina* provided the lime necessary for release of the alkaloid from *D. hopwoodii*. In the early 1900s *A. salicina* was investigated by Western scientific methods using litmus paper as a chemical indicator, technology that at the time was only 100 years old. This research reaffirmed the high lime content of *A. salicina* and highlights the effectiveness of the scientific processes of testing predictions and gathering data employed by Aboriginal Peoples in the identification, liberation and use of this important chemical compound. The scientific processes employed by Aboriginal Peoples resulted

in extensive chemical knowledge of plant constituents and their concentrations across a diversity of species.

A lever is an example of a simple machine that confers a mechanical advantage to a system by altering the magnitude or direction of a force on an object. Aboriginal Peoples have demonstrated understanding of the phenomenon of leverage through the design and development of the spear-thrower, a lever mechanism that imparts greater force to a spear. The spear-thrower acts as an extension of the thrower's arm and the increased force within the lever system results in the spear having the capacity to travel further and impact with greater force than when a spear is thrown by arm alone. It has been suggested that in Australia, this technology may have existed more than 20,000 years ago. Spear-thrower technology incorporates many variables that need to be considered in the design and construction of both the spear-thrower and the spear projectile. Modern scientific evaluation of the technology of the spear-thrower acknowledges the sophisticated scientific inquiry that is employed in the design and construction of a spear-thrower. For example, variation in the shape, length and mass of the spear-thrower will affect the distance and accuracy of the launched projectile. Similarly, the spears that are used with a specific spear-thrower need to be carefully constructed with respect to variables such as mass, length and balance for optimum performance. The development of spear-thrower technology clearly demonstrates the scientific process Aboriginal peoples used in the formulation of predictions, and the testing and gathering of data, to develop the optimal tool set.

As another example, Aboriginal and Torres Strait Islander Peoples use the knowledge of plants containing saponin as a means of sustainably harvesting fish. On Mer Island in the Torres Strait, leaves of the vine *Derris uliginosa* (sad in the Meriam Mir language of the Eastern Islands of the Torres Strait) are pounded to release saponin and the crushed leaves are thrown into the water to stupefy fish. The Mitakoodi Peoples of the Cloncurry River region in north Queensland use the plant *Tephrosia astragaloides* for the same purpose. Again, the leaves are crushed and bruised before bundles of leaves are thrown into a waterhole, stunning the fish and allowing easy harvest as they rise to the surface of the waterhole. The development of this biochemical process required the scientific processes of observation of the phenomenon, hypothesising, gathering data, and using evidence. In addition, the understanding that the phenomenon of secondary poisoning did not occur required further scientific evaluation and complex physiological understanding. Secondary poisoning can occur when a second organism ingests a poisoned organism and is then also affected by the substance. Aboriginal and Torres Strait Islander Peoples who ingest fish that have been harvested using plant saponins are not affected by the poison. The knowledge and understanding underpinning this process required the use of the scientific method such as careful observation, formulating predictions, testing of predictions, and gathering of data and evidence. For example:

Which plant species contain poisons that only target fish?

Will using plant poisons kill other important living organisms in the ecosystem?

How much of the poison is required to be effective?

How do I administer the poison?

Will the poisoned fish make me sick after eating it?

Aboriginal Peoples are acknowledged as the first cultures to develop ground edge axes. This technological innovation required the development of complex grinding and abrading techniques. The earliest ground edge axe recovered from Bunuba Country in the south of the West Kimberley region in Western Australia has been dated to about 49,000 years ago. Stone tool production demands detailed geological knowledge to source the appropriate type of stone for a specific tool, and knowledge of the processing technologies required to manufacture that implement.

Aboriginal and Torres Strait Islander Peoples used scientific methods to identify the particular rock types that can be manipulated to flake and produce a highly effective cutting edge as sharp, and at times sharper, than a modern steel blade. Rocks, such as obsidian, flint, quartzite and chert are highly sought after as they lack pre-existing fault lines or planes. These rock types form conchoidal fractures (Hertzian cones); predictable fractures that occur when a high energy impact is applied. Aboriginal Peoples understand the physics of fracturing rocks in this manner to produce sharp edges and enable the manufacture of cutting tools. The Warumungu and Kaytetye Peoples of the Northern Territory applied the knowledge and understanding of physics and geology in the manufacture of quartzite cutting implements.

Heat lithic treatment is a process whereby rock is carefully heated to precise temperatures for defined durations to improve the flaking quality of the rock and obtain better quality cutting tools. Over time, Aboriginal Peoples have refined the heat lithic treatment process through significant testing and trial and error. This involved the careful application of heat, monitoring the time and temperature to ensure heating and cooling of rock was not too rapid and that the thermal limit of the rock was not exceeded. Successful heat lithic treatment to improve the flaking properties of rocks requires the understanding and application of the scientific process to make observations, predict outcomes and test predictions by gathering data and information to answer questions. For example:

What types of rock are improved by heat treatment?

What size of rock can be treated?

How much heat needs to be applied and for how long?

This process is indicative of how Aboriginal Peoples used prediction, scientific testing and gathering evidence to determine whether (or not) heat-treating rocks would improve stone tool production.

This elaboration provides students with the opportunity to learn how Aboriginal and Torres Strait Islander Peoples have long used scientific methods, such as making predictions and gathering data, in the development of technologies and processes. Aboriginal and Torres Strait Islander Peoples have used, and continue to use, scientific methods across all disciplines of science to explain events and phenomena such as leverage and lithic fractures, and apply this knowledge to develop new technologies and processes.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

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ACSHE100

First Nations led wildfire/bushfire reduction strategy

CONTENT DESCRIPTION

Scientific knowledge is used to solve problems and inform personal and community decisions.

CONTENT ELABORATION FOR CCP (OI.2, OI.9)

- ▶ discussing how modern approaches to fire ecology in Australia are being informed by Aboriginal and Torres Strait Islander Peoples' traditional ecological knowledge and fire management practices



In many parts of Australia traditional fire regimes are being reinstated

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

This elaboration provides students with the opportunity to understand how solutions to contemporary environmental issues in Australia are being informed by the traditional ecological knowledges of Aboriginal and Torres Strait Islander Peoples. Traditional ecological knowledges of Aboriginal and Torres Strait Islander Peoples have long been used to manage and maintain the environment. Contemporary environmental issues such as uncontrolled bushfires, carbon emissions and endangered biodiversity require complex scientific approaches to slow or prevent continued damage to the environment and danger to Australian communities. Scientists are turning to the ecological knowledges of Aboriginal and Torres Strait Islander Peoples to inform and implement solutions to these contemporary environmental issues.

DETAIL

For many thousands of years fire has been used to manage the Australian landscape and has influenced the way Aboriginal and Torres Strait Islander Peoples have lived on and with their Country and Place. Many Australian ecosystems have adapted to regular fire management, and the biodiversity within these ecosystems is dependent on those fire regimes. Fire regimes traditionally implemented by Aboriginal and Torres Strait Islander Peoples fulfilled many requirements including: to clear the ground for travel and camp sites, to facilitate hunting by attracting animals with fresh grasses, and to ensure the plentiful supply of important food resources. European colonisers who interpreted burning of Country as an environmentally destructive practice prevented traditional fire regimes being implemented. This has resulted in an increase in the number of large, uncontrolled bushfires, greater soil erosion and soil salinity, and the intrusion of introduced weeds and feral animal populations. More recently, the importance of carefully controlled and managed fire regimes has been recognised as an essential tool to manage the Australian environment. Contemporary science is now looking to Aboriginal and Torres Strait Islander Traditional Owners to develop solutions to these issues based on traditional ecological knowledges and practices. It is now recognised that Aboriginal and Torres Strait Islander fire practices can positively influence the Australian environment and inform future implementation of fire regimes.

Bushfires are a severe threat to the Australian environment and communities, damaging or destroying ecosystems, habitats, human lives and properties, and contributing to environmental pollution and greenhouse gas emissions. Current research suggests that bushfires in Australia are increasing in number, intensity and severity due to a changing climate and changes in land management practices. The impact on communities is also significant with bushfires destroying property and homes, crops, livestock and infrastructure. It has been estimated that the economic impact of bushfires in Australia in the last 200 years exceeds \$1.6 billion. The risk of bushfire and the extent of the landscape that is affected by an uncontrolled fire is dependent on several factors including the weather, type of

vegetation and fuel load in the environment. In Australia on average approximately 50 million hectares of land are affected by bushfire every year.

The devastation that bushfires reap on Australian communities and ecosystems has led to a drive to implement strategies that will prevent such destruction. Traditional low intensity, slow burning fires that are intentionally set during cool seasons are carefully monitored and managed to reduce the leaf litter debris on the ground. A mosaic pattern of burning is placed through the landscape to reduce heavy fuel loads in these environments and to create firebreaks, preventing the possibility of a high intensity uncontrolled fire spreading in the area.

Specially trained Indigenous rangers working with the Kimberley Land Council in north Western Australia use these long held and enduring practices in conjunction with modern technologies, such as satellite imaging, to reduce the possibility of uncontrolled bushfires in the region. The Tjuntjuntjara Peoples in the Great Victoria Desert region implement small controlled fires in strategic locations to alter the path and minimise the impact of bushfires. The benefit of traditional land management practices can be seen in Tathra on the south coast of New South Wales. Since 2017, the Bega Local Aboriginal Land Council has implemented traditional cultural burn practices to manage the land. An area of more than three hectares of land was strategically burnt by Aboriginal fire practitioners, using methods informed by traditional knowledge, before a bushfire swept through the region in 2018. Six months after the bushfire, native grasses had sprouted on the land that had been strategically managed by traditional fire management techniques, while burnt areas not strategically managed by traditional fire management techniques remained scorched and unviable.

The risk of uncontrolled bushfires is significantly increased in areas where introduced grasses such as buffel and gamba grasses have spread uncontrollably, increasing the fuel load in the environment. The introduced grasses, intended as pasture for livestock, were selected based on rapid growth rates, hardiness, prolific seed production and seed dispersal, as well as their nutritional value. However, these properties facilitated the uncontrolled spread through vast areas of Australia, displacing native vegetation and contributing to ground level fuel loads. Compared with native grasses, gamba grass has a higher photosynthetic rate – using sunlight more efficiently to produce more biomass. This higher biomass means that the ground level fuel load increases in areas where these grasses predominate and produces fire of greater intensity. Gamba grass, for example, facilitates fire of up to 48,000 kilowatts per metre compared with 2,000 kilowatts per metre for native grass. Without the removal or control of such fuel on the ground, large amounts of combustible material can accumulate.

Aboriginal and Torres Strait Islander Peoples have long used fire as a means of clearing land and ensuring that fuel loads are minimised to reduce the potential of high intensity bushfires. The Bidwell Peoples of the Gippsland region in Victoria were observed by early European explorers to set fires for the purpose of burning off dry grass, while in other parts of south east Australia fires were set to burn off old grass, leaves and fallen branches. Such practices are now being reintroduced in areas where the risk of high intensity fires is high. The careful and controlled application of fire by Aboriginal and

Torres Strait Islander Peoples is complex and considers factors such as the extent of the land to be covered, the season and ground moisture. These factors ensure that the low intensity fire remains controlled and is effective in removing the fuel load from the environment, thus reducing the risk of a bushfire in the region.

This elaboration provides students with the opportunity to learn how the traditional ecological knowledges and practices of Aboriginal and Torres Strait Islander Peoples are being consulted to solve current environmental problems in Australia. Students learn how the deep and enduring scientific knowledges of Aboriginal and Torres Strait Islander Peoples are informing land management practices that impact the Australian community.

CONSULTED WORKS

In the construction of this teacher background information, a list of consulted works has been generated. The consulted works are provided as evidence of the research undertaken to inform the development of the teacher background information.

Please note that some of the sources listed in the consulted works may contain material that is considered culturally offensive or inappropriate. The consulted works are not provided or recommended as classroom resources.

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ACSHE098

First Nations' contributions to deeper science understanding

CONTENT DESCRIPTION

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions.

CONTENT ELABORATION FOR CCP (OI.9)

- ▶ learning how Aboriginal and Torres Strait Islander Peoples' knowledge, such as the medicinal and nutritional properties of Australian plants, is being used as part of the evidence base for scientific advances



The medicinal properties of Emu bush (Eremophila spp.) are currently under investigation

CONNECTING THE ELABORATION AND CONTENT DESCRIPTION

Many First Peoples of the world, including Aboriginal and Torres Strait Islander Peoples, have been observed by Western scientists to have sophisticated health therapies and low rates of dietary deficiencies. Students will have the opportunity to learn how contemporary scientists in many fields derive important data from First Nations Peoples' scientific knowledge of plant species that contain medically and nutritionally important ingredients. Western scientists have long understood that the pharmacopoeia and diets of Indigenous peoples have already undergone testing and trialling for efficacy. Biochemists and medical scientists continue to screen the diet and pharmacopoeia of Indigenous peoples globally to identify important constituents responsible for resolving various natural phenomena (i.e. effective health therapies and absence of dietary deficiencies). Many contemporary medicinal and nutritional developments are founded on the scientific knowledge and understanding of First Nations Peoples. This elaboration is about how scientists work and where their inspiration originates. It provides students with the opportunity to learn how the scientific method, that is the process of observing, predicting and experimenting, may be initiated by observations of Aboriginal and Torres Strait Islander Peoples' use of native Australian plants. Contemporary pharmaceutical and nutritional science in Australia after colonisation has frequently turned to the knowledge Aboriginal and Torres Strait Islander Peoples have of the medicinal and nutritional properties of native Australian plants. This has provided, and continues to provide, scientists with a basis for the formulation of research questions that are designed to investigate potential pharmaceuticals and nutritionally important ingredients.

DETAIL

Scientists gain ideas for research questions through observations of phenomena and events that occur in the world. Modern science has globally acknowledged that a potential avenue for developing new effective medicines and pharmaceuticals is to look to the traditional uses of plants. There is now recognition that much of the knowledge pertaining to the medical and nutritional properties of plants already exists, and that much of the process of research in identifying and optimising the use of such plants has already been done. Scientists acknowledge that "even in the era of cheap powerful molecular biology, traditional knowledge can make bioprospecting programmes more effective" (Yong, 2012).

Anecdotal observations of Aboriginal and Torres Strait Islander Peoples' use of plants have led scientists to predict that useful pharmaceuticals may be found in the pharmacopoeia and diets of First Nations Peoples. Scientists gather data to test such predictions through studies such as the 1946 Australian Phytochemical Survey, a 25-year study to evaluate the chemical constituents of native plants. This, and similar studies, have been undertaken for the purpose of identifying plants that have the potential for new drugs or contain other important substances such as vitamins. Today,

scientists are developing predictions and undertaking research projects based on observations of Aboriginal and Torres Strait Islander Peoples' pharmacopoeia and traditional uses of plants.

Observations of the effectiveness of traditional use of plants by Aboriginal and Torres Strait Islander Peoples have led to the production and commercialisation of modern pharmaceutical products. For example, the Wiradjuri Peoples of central New South Wales were observed to treat colds by building steam pits that were heated by fires, lined with *Eucalyptus* spp. leaves and overlaid with possum-rugs. Such observations led Western scientists to formulate predictions about the medicinal potential of *Eucalyptus* spp. and gather data to test these predictions. The observations of how the Wiradjuri Peoples used *Eucalyptus* spp. informed Western scientists about the specific plant to use, the condition it treated and how to prepare the plant for effective use. Today commercial products containing *Eucalyptus* spp. oil are manufactured for the treatment of colds in the same manner as the Wiradjuri Peoples have done for thousands of years.

In an endeavour to (re)discover effective pharmaceuticals, scientists are looking to the knowledge of Aboriginal and Torres Strait Islander Peoples. *Eremophila* spp. are native Australian plants that have long been observed to be used medicinally by Aboriginal Australians. The Arrernte Peoples of the southern central desert region in the Northern Territory use *Eremophila* spp. as a topical treatment for skin sores and wounds. This observation has led scientists to suggest that *Eremophila* spp. may be useful as an antimicrobial. Current research, in collaboration with Aboriginal communities, includes gathering data to evaluate this prediction. Furthermore, observations of the Kamilaroi Peoples, whose Country encompasses northern New South Wales and southern Queensland, who used this native plant to sterilise surgical instruments has led to research proposals investigating the potential of *Eremophila* spp. to sterilise surgical implants.

Plants of the genus *Ipomoea* are used globally in traditional medical practices to treat a range of conditions and ailments. The peoples of Mer Island in the Torres Strait use heated leaves of *Ipomoea* spp. (*wakor* in the Meriam Mir language of the Eastern Islands of the Torres Strait) as an analgesic to relieve pain. The observations of *Ipomoea* spp. being used for this purpose has stimulated scientific research that has identified the analgesic compounds in the leaves. These observations continue to initiate research into the pharmacological properties of the plant to better understand its medical potential.

Aboriginal and Torres Strait Islander Peoples also have extensive knowledge of the nutritional properties of native plants that is informing developments in the health industry. Early observations of the diet and preparation of foods by Aboriginal and Torres Strait Islander Peoples demonstrated a clear understanding of nutritional requirements and the food sources best able to provide those requirements. The Garrwa and Wardaman Peoples of the Northern Territory were observed to not overcook meat “to get the most benefit from their foods” and the absence of a particular vitamin from their foods “drove them elsewhere to procure the needed diet” (Harney, 1951). Such observations by Harney provide insight into an applied understanding of food procurement and careful processing

to ensure important nutrients are not destroyed and a complete diet is maintained. Observations of Aboriginal and Torres Strait Islander Peoples harvesting and preparing plant foods has provided the stimulus for western science to investigate and gather data to provide more detail of the nutritional analysis of many native Australian plants. Native Australian millet (*Panicum* spp.) has long been used by Aboriginal Peoples in the arid regions of Australia as a cereal source. The Paakantyi Peoples of the Darling River region in New South Wales harvested and processed millet to produce a type of bread, and dried and stored millet for times when the seasonal plant was not available. Recently, scientists have turned to this traditional knowledge in the search for alternative grain sources that are resistant to climate change. Observations of Aboriginal use of native millet has led scientists to predict that native millet may be a useful grain suitable for producing breads with dietary benefits. The researchers acknowledge that they need to “look to the past and conduct research alongside Australia’s original farmers to inform the way forward” (The University of Sydney, 2017).

Students will learn that contemporary scientists in many fields initiate research (formulate predictions and gather data) founded on Aboriginal and Torres Strait Islander Peoples’ scientific knowledge of native Australian plants that contain medically and nutritionally important ingredients. Students will learn that Aboriginal and Torres Strait Islander Peoples have made, and continue to make, significant contributions to scientific advances.

CONSULTED WORKS

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Science Inquiry Skills

New elaborations within the Science Inquiry Skills (SIS) strand provide contexts for the inquiry process and include reference to skills required to engage with Aboriginal and Torres Strait Islander Peoples when working scientifically. These intercultural science inquiry skills are throughout Foundation to Year 6 and provide opportunities for students to develop skills relating to:

- acknowledging the scientific knowledge and skills of Aboriginal and Torres Strait Islander Peoples
- consulting with Aboriginal and Torres Strait Islander communities in the planning or evaluation of scientific investigations
- collaborating with Aboriginal and Torres Strait Islander communities in mutually beneficial scientific research.

Unlike the Science Understanding (SU) and Science as a Human Endeavour (SHE) Teacher Background Information (TBI) materials the teacher background information for the new SIS elaborations provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures. Importantly, the Science Inquiry Skills TBI illustrates how concurrent SU and SHE topics can be used to contextualise the ways in which educators may provide skill development opportunities for the development of these skills.



Many communities are acutely aware of the impact of invasive species, such as feral pigs

AC SIS232

Consulting local knowledge – what’s changed?

CONTENT DESCRIPTION

With guidance, pose clarifying questions and make predictions about scientific investigations.

CONTENT ELABORATION FOR CCP

- ▶ consulting with Aboriginal and Torres Strait Islander Peoples to clarify investigable questions based upon their traditional ecological knowledge, such as predictions regarding the impact of invasive species

DETAIL

This elaboration provides students with an opportunity to develop this core Science Inquiry Skill whilst addressing intercultural science inquiry skills relevant to Aboriginal and Torres Strait Islander Histories and Cultures within the context of the following content description(s) from the Science Understanding and/or Science as a Human Endeavour strand(s).

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

A potential way to approach this content description is:

Consulting with Aboriginal and Torres Strait Islander Peoples to understand the impact of environmental change. To develop this scientific skill, students can inform their thinking about local environmental issues by talking with members of their local Aboriginal and/or Torres Strait Islander community. For example, students may consider whether their school or local environment is affected by highly adapted pest species (living things), such as cane toads or the aquatic fern *Salvinia* spp. Consultation with Aboriginal and Torres Strait Islander Peoples will help students understand the knowledge they hold about the environment prior to the introduction of pest species, and the impact following the introduction of the species. Students can then formulate and pose clarifying questions to gain more information, and use this knowledge to make predictions about the impact of invasive species in their local environment.

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ISBN: 978-0-6485981-1-4

