Australian National Botanic Gardens

Lesson Plan

Module 4

Seeds

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging.

Plant Science Learning Hub

Students need a space to learn that is fun and rewarding. The Australian National Botanic Gardens has developed a Plant Science Learning Hub that aims to inspire and engage students in plant science and the stories surrounding Australian flora. With clear links to the Australian Curriculum for school years four to six, the Plant Science Learning Hub will provide a valuable resource for students and educators.

- Plant Life Cycles
- Plant Structure
- Pollination
- **Seeds**

This series provides educators with authoritative plant science content that has a uniquely Australian perspective. The Gardens manages globally significant scientific collections of living plants and herbarium specimens of Australian native flora. We provide educational experiences for students from pre-primary to tertiary levels, leveraging our scientific collections, participation in national and international conservation projects and outreach programs to engage the community in valuing, conserving and appreciating Australia's diverse plant heritage.

Module learning objectives

The following learning objectives apply to the Seeds Module.

1. Understand the role of seed banks in conserving plant species.
2. Identify features that assist in different seed dispersal techniques.
3. Explore the anatomy of a seed and discover how they are adapted to different environmental germination triggers.

Each lesson within the lesson plans and the field kits has individual learning intentions appropriate to the activity.

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Lesson Two: Seed adaptations and dispersal methods

LEARNING INTENTIONS

Students will be able to:

- Understand and discuss why and how seeds are dispersed
- Understand and identify different seed dispersal methods
- Use knowledge of seed dispersal methods to create a seed suited to a specific environment

CURRICULUM LINKS

This material provides opportunities for students to engage in the following Australian Curriculum **(Version 9)** content descriptions:

Science understanding

AC9S5U01 examine how particular structural features and behaviours of living things enable their survival in specific habitats (year 5)

AC9S6U01 investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions

Science inquiry

AC9S4I01 pose questions to explore observed patterns and relationships and make predictions based on observations (year 4)

AC9S4I04 construct and use representations, including tables, simple column graphs and visual or physical models, to organise data and information, show simple relationships and identify patterns (year 4)

AC9S4I06 write and create texts to communicate findings and ideas for identified purposes and audiences, using scientific vocabulary and digital tools as appropriate (year 4)

AC9S5I01 pose investigable questions to identify patterns and test relationships and make reasoned predictions (year 5)

AC9S5I04 construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships (year 5)

AC9S5I06 write and create texts to communicate ideas and findings for specific purposes and audiences, including selection of language features, using digital tools as appropriate (year 5)

AC9S6I01 pose investigable questions to identify patterns and test relationships and make reasoned predictions (year 6)

AC9S6I03 use equipment to observe, measure and record data with reasonable precision, using digital tools as appropriate (year 6)

AC9S6I04 construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships (year 6)

AC9S6I06 write and create texts to communicate ideas and findings for specific purposes and audiences, including selection of language features, using digital tools as appropriate (year 6)

CONTENT INFORMATION

Introduction to seeds

Seeds allow flowering plants (**angiosperms**) and non-flowering seed plants (**gymnosperms**) to reproduce. This module focusses on the seeds produced by native Australian angiosperms.

Seeds are the first stage in the life cycle of a flowering plant. The **ovary** of a flower contains **ovules** that are fertilised during pollination. The fertilised ovules develop into seeds and the surrounding ovary grows into a **fruit** or **seedpod** to protect the developing seeds. The seeds are **dispersed** from the parent plant by different methods and may travel individually or within a fruit. For more information on flowers and plant structure check out the **Plant Structure Teachers' Notes** available on the Plant Science Learning Hub.

Seeds and fruits come in a variety of shapes, sizes, textures and colours, as seen in this group of native seeds and fruits.
Images: ©M.Fagg, 2014

Seeds of a Dwarf Cup-flower (*Gnephosis tenuissima*).
Image: B.Clinton©ABRS, 2017
The Australian native seeds: a digital image library project which is supported through funding from the Australian Government's Australian Biological Resources Study (ABRS) Bush Blitz Program.), Scale is in microns.

There is an incredible range in the texture, shape, size and colour of seeds. Orchids (family *Orchidaceae*) produce the smallest seeds in the world, often appearing to the naked eye as a cloud of dust. The world's smallest seed is just 0.05 millimetres long and belongs to New Caledonia's Jewel Orchid, *Anoectochilus imitans*. Orchid seeds often contain an under-developed **embryo** and little or no food supply (**endosperm**), instead relying on **mycorrhizal fungi** to provide them with nutrients after they germinate. By contrast, the world's largest and heaviest seed grows in the Seychelles Islands, East Africa, and belongs to the Double Coconut (*Lodoicea maldivica*). These enormous seeds grow up to 50 centimetres in diameter, weigh up to 25 kilograms and take up to seven years to mature!

Orchid seeds being processed in a seed bank. Orchids produce the smallest seeds in the world.

Image: ©ANBG, 2023

Close up seeds of a *Caladenia* species of orchid.
Image: ©ANBG, 2023

The Double Coconut (*Lodoicea maldivica*) is the largest and heaviest seed in the world, weighing up to 25 kilograms!

Image: Karelj, Public domain, via Wikimedia Commons

Seed dispersal

Seed dispersal is the process of a seed moving away from the parent plant to another location. Seed dispersal can occur via **biotic** (living) or **abiotic** (non-living) methods and can be **allochorous** (occurring with help from external **vectors**), or **autochorous** (occurring without assistance).

Dispersing seeds away from the parent plant has several benefits for the species and the ecosystem. Seeds of most species have a better chance of survival the further away from the parent plant they can establish. If seeds fall directly under the parent plant and begin to grow, they usually face high rates of competition for sunlight, water and nutrients from other seedlings and from the parent plant itself. This high **competition** reduces each individual seedling's chance of survival and their ability to thrive but can produce the **fittest** population overall. Moving away from the parent plant can allow seeds to establish in areas where their species has not grown before, potentially leading to an extension of its distribution. However, travelling far away from the parent plant means the seeds may encounter unfavourable growing conditions where they land, presenting a trade-off between lower rates of competition and finding a suitable growing location. In this way, seed dispersal can influence the structure of plant communities and ecosystems.

Seed dispersal syndromes and adaptations

Seeds and fruits come in many different shapes, sizes, colours and textures, depending on the plant species. Seeds of some species are dispersed while still inside the fruit, and others are dispersed as a seed alone. Plants have evolved various strategies to disperse their seeds, and often seeds are adapted to optimise dispersal. This allows us to predict a seed's **dispersal syndrome** based on its shape and characteristics. Common syndromes include dispersal by animals, wind, water, ballistics and gravity, which are discussed in more detail below.

Animal dispersal

Seed dispersal by animals is called **zoochory**. There are three sub-categories of this dispersal syndrome, including:

- **endozoochory**, where an animal disperses seeds by eating and excreting them,
- **epizoochory**, where an animal accidentally disperses seeds that are stuck to their body, and
- **synzoochory**, where animals disperse seeds by collecting and storing (**caching**) them for later use.

Tasty treats

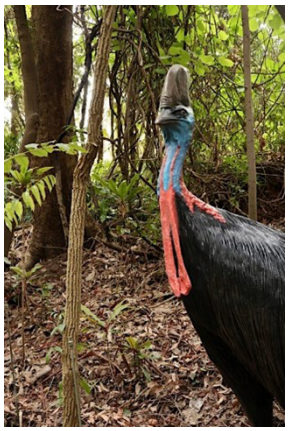
Seeds that undergo **endozoochory** are often brightly coloured and have a tasty coating to attract animals to eat them. This is often in the form of fleshy fruit surrounding the seeds. The seeds pass through the animal's digestive system and are exposed to their gut flora and digestive fluids before being excreted in their poo. The poo can provide nutrients and act as a fertiliser to assist the seeds to grow.

Being eaten can also promote germination or alleviate dormancy in some seeds. Passing through an animal's gut passage can remove **germination inhibitors** such as the fruit pulp surrounding a seed, or alleviate physical dormancy through seed coat **scarification**. Scarification physically damages and weakens the seed coat, allowing the embryo to absorb water and begin to germinate. This process can increase germination capacity but the longer a seed remains in an animal's gut the higher the risk of its embryo being damaged and becoming non-viable. Seeds thus face a trade-off between passage time in the gut and dispersal distance.

Emu poo with the seeds of Sandalwood (*Santalum spicatum*).
This is an example of endozoochory.
Image: ©M.Fagg, 2005

Cassowaries

Cassowaries (*Casuarius casuarius*) are a **keystone species** in Queensland's tropical rainforests, meaning that the biodiversity and ecological balance of the rainforest relies on their presence. Cassowaries eat the fruit over 238 plant species and disperse their seeds throughout the rainforest, often being referred to as 'rainforest gardeners' for their efforts. Cassowaries eat fruits that are toxic and too large for other animals to consume so over 70 rainforest species rely solely on cassowaries to disperse their seeds. Sometimes other animals eat the seeds in cassowary poo and disperse them further.



A sculpture of a cassowary (*Casuarius casuarius*) in a rainforest.Image: ©M.Fagg, 2020

Mammals

A historically overlooked group of seed dispersers in Australia is our digging mammals. Bilbies (*Macrotis lagotis*), bettongs (*Bettongia* species) and bandicoots (*Isoodon* and *Perameles* species) are known to eat fruits and seeds, but limited research has been conducted into their role as seed dispersers. Through their digging activities these mammals can bury seeds and provide favourable sites for their germination. Their scats can contain both viable seeds and spores of mycorrhizal fungi, providing a co-dispersal event that can improve germination outcomes. Many of these mammals are threatened species, so any decline in their populations will be reflected in decreased seed dispersal activity and seed germination over time.

Bilbies (*Macrotis lagotis*) are important environmental engineers and play a role in seed dispersal of some plant species.

Image: State of Queensland, CC BY 4.0, via Wikimedia Commons

A Western Australian study looked at the effects that captive Woylies (*Bettongia penicillata ogilbyi*) and Quenda (*Isoodon fusciventer*) have on the dispersal and germination outcomes of seeds from *Acacia acuminata* (Mangart), *Dodonaea viscosa* (Broadleaf Hopbush) and *Gastrolobium calycinum* (York Road Poison). Less than half of the seeds consumed were retrieved intact from the animals' scat, but of those seeds retrieved whole, the rate of seed viability was very high (see Table 1).

Seed species	**Seed viability after consumption (whole seeds only)**		**Germination capacity after consumption (compared to control)**	
	Quenda	**Woylie**	**Quenda**	**Woylie**
Acacia acuminata	100%	80%	No change	No change
Dodonaea viscosa	96%	100%	Lower	No change
Gastrolobium calycinum	97%	87%	Higher	Lower

The outcome of seed viability and germination capacity of three native species after being eaten by Quenda and Woylies.
Source: https://www.nespthreatenedspecies.edu.au/media/4mbgfwbf/4-1-7-seed-dispersal-by-australian-digging-mammals-report_v4.pdf

Comparing the germination capacity of these seeds with control samples of the same species showed that seed-animal interactions are not the same in each case. Some seeds benefitted from the digestion process and some seeds had worse outcomes after being eaten. This indicates that not all seeds are adapted for dispersal by digging mammals and some may be adapted to dispersal by only one mammal species. Seeds that showed no change in their germination capacity may not benefit from being digested, instead benefitting from the increased dispersal distance that the mammals can provide for them.

Digging mammals may be effective dispersers of some seeds, but they also have capacity to disperse weed seeds. Their role in seed dispersal will depend on how disturbed their environment is and what species of plants predominate.

Woylies (*Bettongia penicillata ogilbyi*) are also known as Brush-tailed Bettongs and may be important seed dispersers for some plant species.

Image: Calistemon, CC BY-SA 4.0, via Wikimedia Commons

Hitchhikers

Many seeds disperse by sticking to an animal as it brushes past. This is called **epizoochory**, and the seed is usually covered in sharp spines, burrs, hooks or a very sticky substance that helps them attach to fur, feathers or even human clothing. Seeds can travel great distances in this way before being dislodged in a new environment.

One such hitchhiking seed is that of *Corymbia torelliana*, or Cadaghi. As the fruits of *C. torelliana* ripen their flesh dries out, leaving only seeds and globs of golden resin inside. The resin attracts Meliponine bees (stingless bees) which use it as a nest construction material. As the bees enter the fruit to collect the resin they encounter the seeds, which attach to the sticky resin and their bodies. The seeds can block structures inside the bees' nest so they try to dislodge as many Cadagi hitchhikers as they can, but those seeds remaining are dispersed along the bees' flight path and at their nest site.

As the fruit of *Corymbia torelliana* ripens it dries out (top and bottom left), leaving the seeds and resin behind (right). The bees coming to collect the resin are covered in seeds that they then transport away from the parent plant.

Image: ©www.bobthebeeman.com.au

A Meliponine bee transporting the resin from *Corymbia torelliana*.

Image: ©www.bobthebeeman.com.au

Seed snack packs

Seed dispersal by ants is called **myrmecochory**. Ants are beneficial seed dispersers as they can help seeds to travel up to 180 metres from their parent plant. Across the world 11,000 species of flowering plants and their ant dispersers have developed a **symbiotic myrmecochorous** seed dispersal relationship. The seeds of these plants have a lipid-rich structure called an **elaiosome** that acts as a 'snack pack' reward for the ant who collects it. The ant eats the elaiosome and discards the seed near the entrance of their nest or in an underground midden. Seeds that are discarded above ground have better germination outcomes than those discarded underground.

Myrmecochory is a globally significant method of seed dispersal that occurs in 334 plant genera and has evolved independently over 100 times. Myrmecochory is especially important to Australian ecosystems, and occurs in 78 native genera, including many in the families Fabaceae, Goodeniaceae and Proteaceae.

The process of removing the elaiosome also performs a kind of **scarification**, where the seed coat is physically damaged. This scarification can occur through the removal of the elaiosome by the ant or by the seed being dragged across the ground. This can allow the embryo inside the seed to access and absorb water and can improve germination outcomes. Some seeds require scarification to germinate, whereas others may die if they are damaged in this way.

Seeds of *Goodenia* species around an ant nest.

Image: ©M.Fagg, 2010

Acacia rhodophloia

Acacia fulva

Acacia oswaldii

Wattle (*Acacia* species) with varying elaiosomes. Ants will eat these 'snack packs' and the seeds will undergo scarification in the process.

Images: B.Clinton©ABRS, 2017

The Australian native seeds: a digital image library project which is supported through funding from the Australian Government's Australian Biological Resources Study (ABRS) Bush Blitz Program.), Scale is in microns.

Wind Dispersal

Seed dispersal by wind is called **anemochory**. Wind-dispersed seeds have structures resembling wings or a parachute (**pappus**) that allow them to be caught by the wind and 'fly' away from their parent plant, as well as slowing their descent so they fall gently to the ground. Wind-dispersed seeds can be classified as gliders, parachutes, helicopters, flutterers or tumbleweeds. Wind-dispersed seeds can be carried long distances away from their parent plant, providing opportunities to colonise new areas and expand their distribution. However, seed dispersal by wind is not very precise and seeds may land anywhere. Some plants with wind-dispersed seed produce hundreds or thousands of seeds to hedge their bets and ensure that some will find suitable growing environments.

Asteraceae (daisy family)

Many species in the plant family Asteraceae (daisies) have wind-dispersed seeds. A well-known example are the non-native dandelions (*Taraxacum* species) that produce distinctive ball-shaped heads of up to 200 seeds each. These seeds have a feathery pappus that acts as a parachute to catch the wind and ensures a gentle ride for the seed. Each seed can travel on the wind up to 100 metres away from the parent plant. There are numerous Australian native plants with similar seeds.

The seeds of *Microseris lanceolata* will be dispersed by the wind.

Image: A.N.Schmidt-Lebuhn ©CANBR, 2012

The seeds of a *Microseris lanceolata*.

Image: B.Clinton©ABRS, 2017

The Australian native seeds: a digital image library project which is supported through funding from the Australian Government's Australian Biological Resources Study (ABRS) Bush Blitz Program.)

Scale is in microns

Proteaceae (Protea family)

The Proteaceae contains many plant groups that rely on the wind to disperse their seeds. One such Australian **endemic** genus is *Lambertia*, which includes 10 species known commonly as Mountain Devils and Wild Honeysuckles. The seedpods of *Lambertia formosa* (Mountain Devil) contain two small, flat, winged seeds that are suited to dispersal by the wind. Similarly, the seeds of *Lambertia multiflora* (Many-flowered Honeysuckle) are winged and contained in woody seedpods.

Another member of the Proteaceae with wind-dispersed seeds is the genus *Telopea* (Waratahs). The number of seeds that each Waratah flower head produces depends on how many individual flowers were fertilised and the seed pods take up to six months to mature. Waratah seeds can 'fly' on the wind as they have a papery appendage that resembles an insect's wing.

Image: M.Crisp©ANBG, 1984

Image: B.Hall©ANBG, 2018

Waratah (*Telopea* species) seeds are papery and winged to aid in their dispersal by the wind.

Water dispersal

Seed dispersal by water is called **hydrochory**. Seeds of **terrestrial** plants can be dropped, carried or blown into the water for dispersal, whereas **marine** and **aquatic** plants can release their seeds underwater. Buoyancy is an important trait for water-dispersed seeds, so they are often small, lightweight, fluffy or have air pockets to allow them to float. Water-dispersed seeds can have a thick outer coat to protect them from water infiltration, such as the husk of a coconut (*Cocos nucifera*).

Flooding

Some plant species rely on flood waters to disperse their seeds, and others require flooding for germination success. The River Red Gum (*Eucalyptus camaldulensis*) occurs across Australia and is considered the 'ecological engineer' of Australia's floodplains. The living trees provide habitat for birds and mammals, while fallen branches provide habitat for arthropods and reptiles. The health of the tree is an indicator of the health of the floodplain ecosystem. River Red Gums require flooding every seven years to stay healthy, but during a drought this often does not occur. After five years without flooding they adapt to use 70% less water, including dropping leaves to minimise water loss through evaporation. Although they can adapt to drought conditions, River Red Gums experiencing drought for 10 years will begin to die. To survive after an extended drought, they require flooding every two years for an eight-year period.

River Red Gum (*Eucalyptus camaldulensis*) seed capsules.

Image: A.V.Slee©CANBR, 1996

River Red Gum (*Eucalyptus camaldulensis*) seeds.

Image: Anon©CANBR

Ocean currents

Plants that grow on tropical beaches are commonly dispersed by water. They often have seeds contained in woody, waterproof seed pods or coverings that allow them to float in salt water for long periods of time. This is true for the coconut (*Cocos nucifera*), with seed that has been successfully germinated after floating on the ocean for 110 days. The seed coat in a coconut is the thin, brown layer between the flesh and the hard outside casing. The embryo is under one of the coconut's three holes (pores), and when it germinates the plant sprouts from one of these pores. The edible parts of the coconut, including the 'water' and flesh, are components of the endosperm.

A coconut (*Cocos nucifera*). The seed coat is the thin, brown layer between the flesh and the hard outside casing. The embryo is under one of the coconut's three holes (pores), the plant sprouts from one of these pores. The edible parts of the coconut, including the 'water' and flesh, are components of the endosperm.

Image: ©J.L.Dowe

The Matchbox Bean (*Entada phaseoloides*) is a vine that grows in Africa, Asia, the Western Pacific and Queensland. Its distinctive seed pods can be up to two metres long and contain seeds that are similar in size to a matchbox (approximately six centimetres long and one centimetre thick). The vines often grow near waterways, so the seeds are adapted for dispersal by water. They are transported from rivers out to the ocean and can remain viable at sea for long periods of time due to their hard, protective casing.

Seed of the Matchbox Bean (*Entada phaseoloides*).

Image: Muséum de Toulouse, CC BY-SA 4.0, via Wikimedia Commons

The Matchbox Bean (*Entada phaseoloides*) is a vine that uses water dispersal to spread its seeds. Its seed pods (left) can grow up to two metres long and its seeds (right) up to six centimetres in diameter.

Image: ©CANBR, 1979

Mangroves are shrubs and trees that grow along coastlines around the world. Their life cycle is unusual as many release live **propagules** (seedlings) into the water rather than seeds, making them one of the world's few **viviparous (live-bearing)** plants. Mangrove propagules have an **obligate dispersal period** and an **obligate stranding period** that they must undergo to successfully establish, so still require water to complete their life cycle.

An *Avicennia marina* propagule after it has established itself in the sediment, with its cotyledons visible.

Image: ©M.Fagg, 2014

Ballistic dispersal

Seed dispersal by ballistics (explosions) is called **ballochory**. Ballistic dispersal involves the forceful expulsion of seeds from a fruit or seedpod, sometimes accompanied by an audible 'pop' sound. Ballistic seed dispersal is usually the result of pressure building within the cells of the fruit as it dries out. The release of seeds can happen when undisturbed or may be triggered by the movement of wind, water or an animal. Fruits of the Quinine Tree (*Petalostigma triloculare*) explode after drying out, sending seeds up to 2.5 metres away from the parent plant.

Fruits of the Quinine Tree (*Petalostigma triloculare*). The seeds will explode from the fruit after drying.
Image: ©M.Fagg, 1977

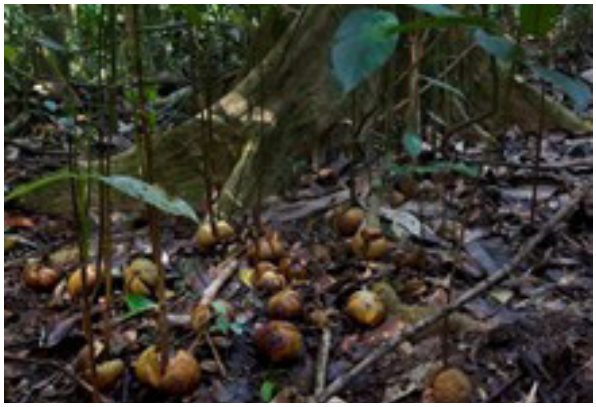
Unlike animals, plants cannot use muscles to throw their seeds away from them. Instead, they have developed intricate devices for 'throwing' seeds via explosive dispersal. Fruits of the Western Australian endemic species *Baxteria australis* retain some of their floral structures and as the fruit dries out these structures contract into a shape resembling a catapult. The seeds sit in the **catapult** ready to be launched, travelling up to one metre away from the parent plant when they are deployed!

Baxteria australis is endemic to south-west Western Australia and releases its seeds via ballistic dispersal. Structures of *B. australis* are shown as follows: (a) flowers, (b) fruit that has split open, (c) catapult mechanism for seed dispersal and (d) seed.

Images: ©Paula J. Rudall & John G. Conran (2012), Systematic Placement of *Dasypogonaceae* Among Commelinid Monocots: Evidence from Flowers and Fruits, Bot. Rev. 78:398–415. DOI 10.1007/s12229-012-9103-6

Gravity dispersal

Seed dispersal by gravity is called **barochory**. Gravity dispersal occurs most commonly when a parent plant drops their seeds on the ground directly below them. Gravity dispersed seeds often grow in heavy fruits that will not be caught by the wind when falling to the ground. Fruits with a hard outer coating may roll some distance from the parent plant before they release their seeds, whereas softer fruits may break open and scatter their seeds when they hit the ground.



Green Dinosaur seeds rely on gravity for seed dispersal, which means they grow near the parent plant in small pockets of humid rainforest in northern Queensland.

Image: ©Neil Hewitt, Cooper Creek Wilderness, Daintree Rainforest.

Gravity dispersal helps seeds to grow in suitable habitat, as the parent plant is already growing in the required environmental conditions. The parent plant also benefits by having a colony form around it. Seeds falling directly below the parent plant are subject to high levels of competition for resources from other seedlings and the parent plant. Only the **fittest** seedlings survive this intense competition which helps to create a healthy plant population. Gravity dispersal means

seeds grow wherever they land or roll, which can lead to very limited species distributions. This is true for the weird and wonderful rainforest tree *Idiospermum australiense*, known commonly as the Green Dinosaur, which has seeds dispersed by gravity. It exists in small pockets in Queensland's rainforests with stable and humid conditions, which covers a total area of only 23 square kilometres.

Green Dinosaur seeds are some of the largest in Australia, weighing more than 200 grams, and are too toxic to be dispersed by animals.

Image: ©J.W. Wrigley, 1999

Directed dispersal

Directed dispersal describes the disproportionate or non-random movement of seeds to favourable growing sites. This is often associated with **zoochory**, as animals travel and transport seeds to different locations selectively. For example, a bird that eats a seed at one location is very likely to poo it out in a similar environment, as that is where it commonly travels. But scientists have found that seeds transported by **abiotic** methods, such as wind and water, can also undergo directed dispersal. In a wetland environment plants growing in permanently inundated areas released large seeds that sank to the bottom of the body of water and were transported by subsurface currents. These currents only exist in water so the seeds can only move to other inundated areas, providing them with favourable growing conditions. Conversely, plants growing on the waterline produced light seeds that floated on top of the water until they were deposited on a different shoreline. Seeds of plants that grew further away from the water underwent wind dispersal, allowing them to avoid the water altogether and land in a favourably dry area.
These wetland species are differently adapted to seed dispersal by water and wind, enabling them to be selectively transported to a location with favourable growing conditions. In this way, directed dispersal can be feature of both **biotic** and **abiotic** methods of seed dispersal.

INQUIRY QUESTIONS (ENGAGE)

Explain the learning intentions for the lesson and introduce the topic to the students.

Ask the students a series of questions such as:

Are seeds moved away from the parent plant (dispersed)?

How do you think they are dispersed?

Are all seeds dispersed the same way?

Can you tell how a seed is dispersed by looking at it?

Why do seeds need to be dispersed?

Are all seeds moved far away from the parent plant?

What would happen if seeds could not be dispersed and stayed on the parent plant?

STRATEGIES TO FACILITATE QUESTIONING AND DISCUSSION

- Talk with a partner (turn and talk).
- Think, Pair, Share. (Project Zero Thinking Routine)[1]
- KWL Chart to track what a student knows (K), wants to know (W) and has learned (L) about a topic, can be used before during and after research projects.
- Write in journal and share with others.
- Individual student writing.
- Drawing.

Record students' answers and wonderings on the board or a flipchart.

LESSON SEQUENCE (EXPLORE)

There are four activities in this lesson:

In Activity 1, students will be introduced to seed dispersal, learning what it is and how it occurs.

In Activity 2, students will learn about different seed dispersal methods and explore and identify the physical features of seeds that assist with their dispersal.

In Activity 3, students will design a seed based on a specific environment. They will then create, test and refine the seed design to ensure it is dispersed effectively.

In Activity 4, students will explore the ballistic method of seed dispersal. They will model and test an exploding seed.

[1] The Think, Pair Share thinking routine was developed by Project Zero, a research center at the Harvard Graduate School of Education. Project Zero adapted this routine from Frank Lyman: Lyman, F. T. (1981). The Responsive Classroom Discussion: The Inclusion of All Students. In A. Anderson (Ed.), Mainstreaming Digest (pp. 109-113). College Park: University of Maryland Press.

ACTIVITY 1 – SEED DISPERSAL – WHAT IS IT?

In this activity, students will learn the reasons behind seed dispersal and different seed dispersal methods. Students will discover how various features of seeds assist in dispersal. Students will also explore how plants have evolved seed dispersal methods to suit their environment.

To do this, you will need:

- Resource: Dispersal method fact sheet for each group (a different dispersal method for each group)
- Resource: Dispersal methods worksheet for each student
- Resource: Native seed images
- Resource: Native seeds images – teacher notes
- Students' science journals

Instructions Part 1: Introduction to seed dispersal

1. Introduce the lesson intentions and discuss the inquiry questions.
2. As a class, discuss the following:

What is a seed?

Seeds are the first stage in the life cycle of a flowering plant.

The tiny seeds of the Mountain Ash (Eucalyptus regnans) hold all the genetic material necessary to grow the largest flowering plant in the world!

Seeds allow plants to reproduce so that the species can survive into the future. Without seeds, there wouldn't be many flowering plants.

Seeds come in weird and wacky shapes and sizes.

Seed dispersal

Seed dispersal is the process of seeds moving away from the parent. Most seeds have a better chance of germinating if they move away from the parent plant. This also helps to spread the plants across the landscape.

Different plant species produce different types of seeds. Each different seed type has evolved incredible mechanisms to disperse away from its parent plant and across the landscape. Some plant species produce seeds that can float across oceans, explode out of seed pods, hitchhike on animal fur – some even have little parachutes to help them float on the breeze.

Here's why it's important for a seed to disperse:

- *If seeds germinate directly under their parent plant, they may have to compete with the parent plant and other seedlings for sunlight, water and nutrients.*
- *Moving away from the parent plant enables seeds to germinate and seedlings to grow in places where their species has never grown before. This can lead to a new population of plants in that area.*

There are some risks for a seed when it is dispersed far and wide.

- *Being dispersed far away from the parent plant means the seeds may face an environment that doesn't have what it needs to germinate and grow into a seedling. The seed might not be able to germinate at all, or it might germinate but then the seedling doesn't survive.*

Seeds can disperse via wind, water, gravity, animals or even by exploding from the fruit in a process called ballistic seed dispersal.

Seeds of some species can be dispersed and lay dormant for years until a nosy little animal like a potoroo digs them up and moves them. Seeds can hitch a ride with a bird or a bat, go for a long walk through the rainforest in the belly of a cassowary until it poos. Seeds can stick to a jumping kangaroo or our socks! Seeds can even descend to Earth like a helicopter!

3. Divide students into eight groups (one for each seed dispersal mechanism). Give each group a copy of Resource: Dispersal methods fact sheet. Each group should have a different type of seed dispersal to read through.
4. In their groups students read and discuss the fact sheet and write key points in their science journal.
5. Bring the class back together. Explain that each group is going to present information about the dispersal technique they learned about and the rest of the class. As the groups present, each student will complete a worksheet that prompts them to write their own definitions for each dispersal method.
6. Have each group present their seed dispersal technique to the class. Students can either read the fact sheet or their notes.

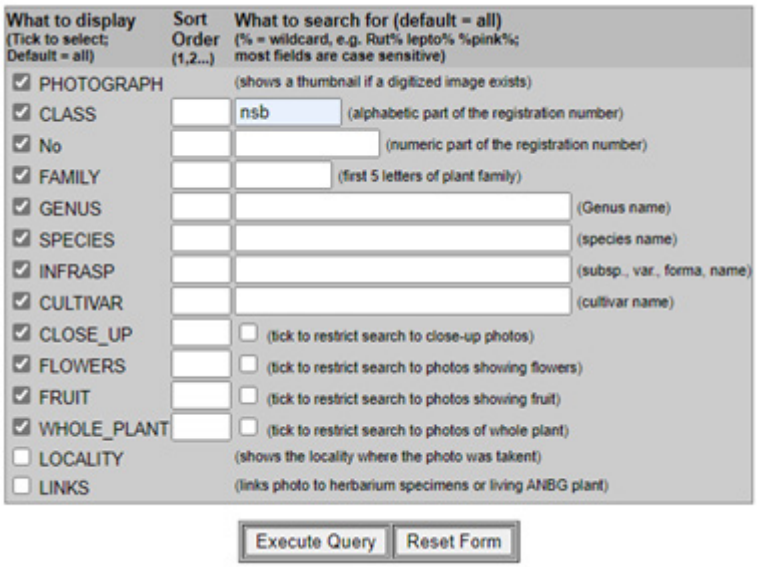
   Ensure that each of the dispersal techniques is presented.
7. As groups present, each student should work through the Dispersal Methods Worksheet. You may wish to allow students time to complete this worksheet after each presentation.

Part 2: Describing the physical traits of seeds

1. Split students into pairs and assign each pair a seed image from the Resource: Native seed images.
2. Students should take turns describing the seed without showing it to their partner. Ask the student to describe the features of the seed in as much detail as possible. Encourage students to think about:
   - Shape
   - Texture
   - Any parts that are protruding
   - Comparisons, e.g. it looks like paper
   - Colour
3. The other student in the pair will listen closely and draw what they think the seed looks like based on the description given.
4. Students swap roles and repeat the activity for a different seed.
5. Students can then compare their drawing to the original seed image. Are they similar or quite different? Do the features the student drew suit the description that was given?
6. Ask students to think about the features of the seed and what they might be used for. Ask how the physical features of the seed might assist with seed dispersal.
7. Display the seed images from Resource: Native seed images on a smartboard. As a class, brainstorm the dispersal techniques each seed might use. Which features made you decide on this dispersal method? The Resource: Native seeds card – teacher notes may assist in this discussion.

You may also like to look up seeds for discussion on the Australian Plant Image Index, available at Search Australian Plant Image Index - Australian Plant Information (anbg.gov.au).

Type 'nsb' (which stands for 'National Seed Bank') into the Class category and look at the diversity of seeds.



Discussion Points:

Why do you think plants need to disperse their seeds?

Why do you think there are so many different dispersal methods? Why don't all plants use the same methods?

Can you think of any plants that use wind, water, ballistic, gravity or animals to disperse their seeds?

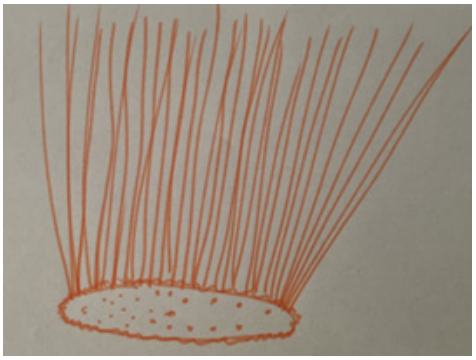
How easy is it to determine the dispersal method from the seed's physical features?

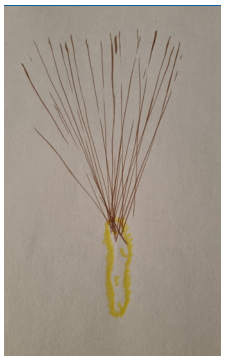
Which dispersal method might be most effective in a dense bushland? Why?

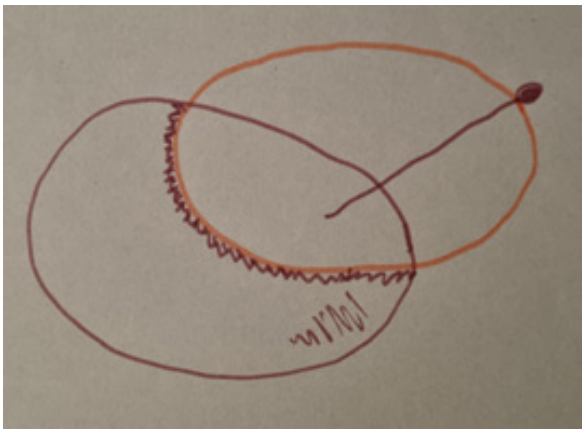
Which seed dispersal method might be most effective in an open grassland? Why?

Think about your local environment. Which seed dispersal methods might be best suited to it?

What might happen if seeds disperse to a new environment they haven't been in before, for example, another country?







ACTIVITY 2 – SEED FEATURES TO SUIT DISPERSAL METHODS

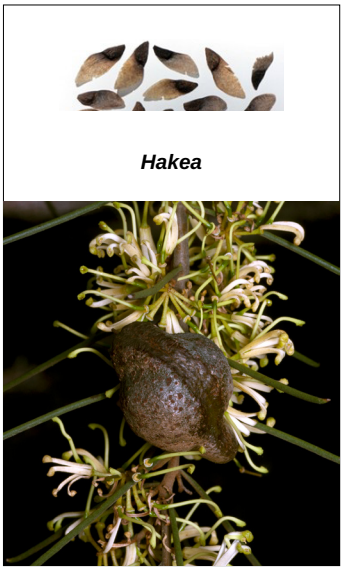
In this activity, students will look at the physical features of seeds of different Australian native plants to determine which dispersal technique each one utilises. Students will discuss which adaptations make the seeds suitable for each dispersal method.

To do this, you will need:

- Resource: Seedy tricks poster for each group
- Resource: Seedy tricks cards for each group
- Resource: Seedy tricks labels
- Students' science journal or paper and pencil

Instructions:

1. Show students the Resource: Seedy tricks poster and use it to review some different seed dispersal techniques. This poster summarises some 'tricks' that seeds use to ensure they are dispersed by wind and animals but does not cover gravity, ballistics or water.
2. Lay each of the labels from the Resource: Seedy tricks labels on the ground or table.
3. Split students into groups. Using the Resource: Seedy tricks cards, have them discuss the features of each seed and try to determine its most likely dispersal method.
4. Encourage students to organise the seedy tricks cards into the correct categories.
5. Once cards have all been categorised, students can learn more and find out if they are correct by reading the back of the cards.



Fliers and Floaters

Hakeas have a woody fruit, which often only opens after fire. When opened one seed can be seen in a small depression on either side of the open fruit.

The seed has a papery wing that allows it to travel on the wind.

Hakeas can be some of the first seedlings to emerge after a fire clears an area.

Photo: *Hakea tephrosperma*
© M.Fagg, ANBG

Discussion Points:

Can you determine each seed's dispersal method by looking at it?

How do the different dispersal methods vary?

Are there any features of the plants/seeds you have seen that are common among different dispersal methods?

ACTIVITY 3 – DESIGN A SEED

This activity is designed to explore how different features of seeds can aid in their dispersal. Students will become familiar with some key features of wind-dispersed seeds by designing, testing and refining their own seed.

To do this, you will need:

- Craft materials (e.g. feathers, leaves, ribbon, coloured paper and cardboard, aluminium foil, pipe cleaners etc.)
- Double-sided tape
- Air drying clay
- PVA glue
- Sticky tape
- Styrofoam (balls work well, but any Styrofoam will work)
- A fan to blow the seed or a high place to drop the seed from
- Tape measure
- Pencil and paper

Instructions:

1. Introduce the lesson intentions and discuss the inquiry questions.
2. Discuss different methods of seed dispersal with the class. Show students different types of wind-dispersed seeds found in the Resource: Wind dispersed seed images. You may also wish to look up videos of wind-dispersed seeds.

   Discuss which features assist the seed with dispersal via wind.
3. Students will now design and build their own models of wind-dispersed seeds.

   Students should write or draw design ideas for their wind-dispersed seed.

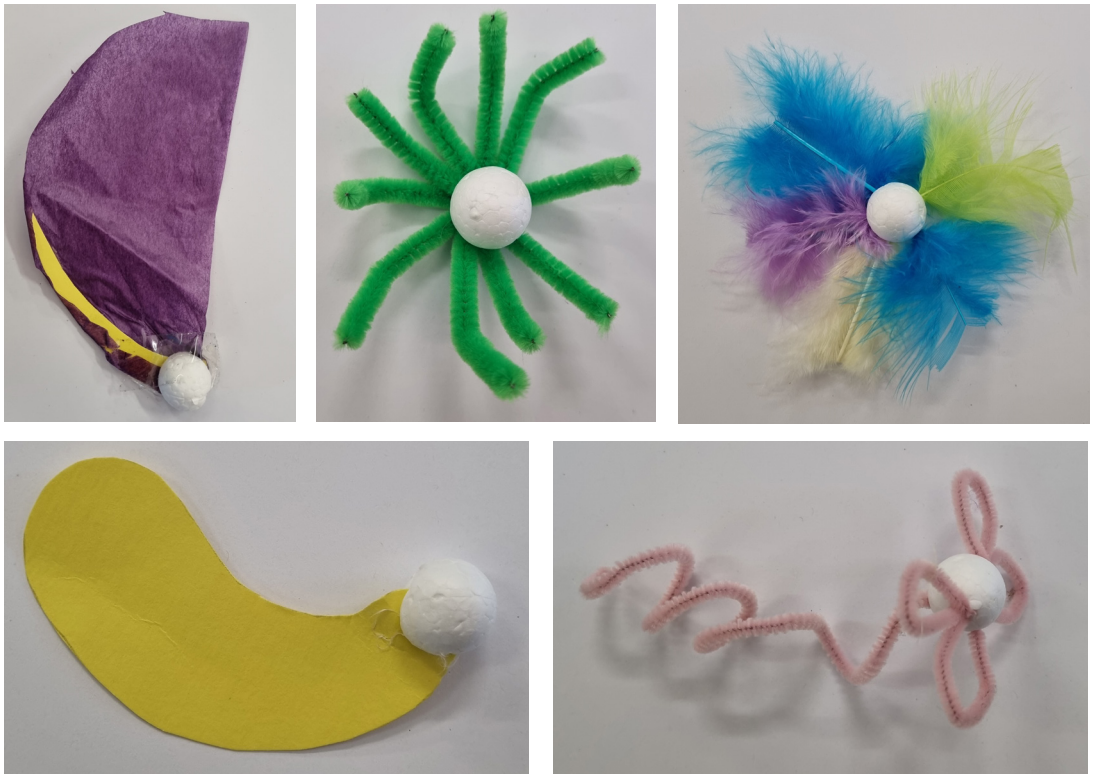
   Ensure they think about the seed's features, for example;
   - Does it have a wing?
   - Does it have a parachute?
   - Do you want it to spin, fly or float?
   - How heavy is it going to be?

   Ask students to draw their designs, including labels and descriptions of their seed's features.
4. Once students have a design, they can use the provided craft materials to create a model of their seed.
5. Come together as a class and make predictions about how far they think each seed will travel.
6. Students can now test their seed and determine if wind effectively disperses it.

   Students will need a tape measure and either a fan or somewhere high to drop their seed.

   - Option 1: Set up a fan facing forward. Place the seed in front of the fan and let it go, then measure and record how far it travelled.
   - Option 2: Take students to a high place. Launch the seed and measure how far the seed has dispersed from the starting point.
7. After students have tested their seeds and recorded the distance, come together as a class and compare the students' findings to their predictions.

8. Encourage students to reflect on their designs and make notes about what went well, what wasn't as successful and how they could improve their design. Students may then modify their seed design and re-test to see if their changes have made the seed disperse further.



Discussion Points:

Was there a difference between the predicted distance the seed would travel and how far it actually travelled?

Whose seed design travelled the furthest? Why do you think this seed design dispersed further than the others?

How are the designs people made similar to real seeds? How are they different?

Did the design change how the seed moved? For example, which feature/s made the seed spin, float or glide? What are the advantages and disadvantages of different designs?

Do you think wind is an efficient method of seed dispersal? What are the limitations of wind dispersal?

In which environments would wind be an effective seed disperser? Where would it not be effective?

Does the experiment replicate nature well? If not, what are some of the limitations of the experiment, and how could it be improved?

ACTIVITY 4 – EXPLODING SEED CHALLENGE

This activity is designed to introduce students to ballistic seed dispersal. Students will replicate a fruit and seed using a balloon and bird seed, then use a pin to simulate its dispersal trigger.

To do this, you will need:

- Balloon
- Fine bird seed
- Measuring tape
- Sharp object to pop the balloon (e.g. a pin)

Instructions:

1. Introduce the lesson intentions and discuss the inquiry questions.
2. Review the different methods of seed dispersal with the class with a focus on ballistic dispersal. You may wish to watch videos of ballistic seed dispersal.
3. Explain that students will replicate ballistic seed dispersal using a balloon and birdseed. The balloon will be the fruit, and the bird seed is the seed that is to be ballistically dispersed, or exploded, out of the fruit.
4. Fill a balloon with about half a cup of birdseed. Blow the balloon up and tie it off.
5. Have one student hold the balloon and the other students stand in a circle around them. Ask students to sit at the furthest point from the balloon that they think the seed will fall. Students should sit where they believe they will not be hit with the birdseed when the 'seed pod' explodes. You may wish to guide the students to at least 2 metres away.

   Measure the distance from the balloon to the closest student.
6. Have a student (or teacher) use a sharp item to pop the balloon.
7. As a class, discuss who has seed near them; remember to check behind everyone. Measure the distance between the balloon and the student furthest from the balloon that has seed near them. Discuss why the seed exploded this far.
8. Ask students to write a summary of the activity, what they had predicted and compare it to what happened.
9. Guide the class in a discussion about what could be changed in the experiment to ensure the seeds are dispersed further (e.g. more air in the balloon, holding the balloon higher).

Discussion Points:

Was there a difference between the predicted distance the seed would travel and how far it actually travelled?

How did this activity replicate ballistic seed dispersal?

Do you think ballistic seed dispersal is an efficient dispersal method? What are the limitations of ballistic dispersal?

In which environments would ballistic seed dispersal be effective? Where would it not be effective?

Does the experiment replicate nature well? If not, what are some of the limitations of the experiment, and how could it be improved?

CONCEPTS EXPLAINED AND VOCABULARY DEFINED (EXPLAIN)

The following resources are provided to assist teachers in facilitating a class session to explain concepts and terms that have been introduced to students through the activities.

- Seeds Teachers' Notes (these can be found in the Seeds resources section of the Plant Science Learning Hub).
- If you have not already shown the video produced by the Gardens, you could use it to engage students in this topic. The video explores the anatomy of a seed, seed features, seed dispersal techniques and the purpose of seed banks.
  This video can be found in the Seeds resources section of the Plant Science Learning Hub.
- Word wall
- Discussion questions
- Life Cycles Video 1 – Seed to seedling (this can be found in the Life Cycles resources section or by searching on the Plant Science Learning Hub).

APPLYING AND EXTENDING THE LEARNING (ELABORATE)

Applying the learning

Observe seeds in action. Go to a local park or bush area and look at the different plants. Can you see any seeds? What do they look like? Can you see any evidence of different dispersal methods from these plants?

Visit your local botanic gardens. Visit your local botanic gardens to try and identify plants that use different dispersal methods. Write down your observations, sketch the seeds and include information on the plants.

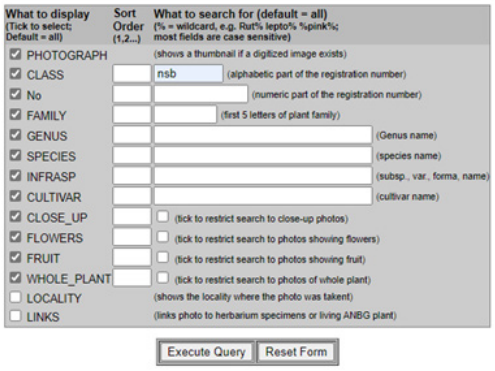
Create a poster display. Using what you have learned from this lesson, create an information poster that shows the different dispersal methods, with some examples of plants from your area.

Create a seed model medley. Using clay or craft materials, construct models of seeds that have different means of seed dispersal.
Make information cards and display them as a class exhibition.

Extension ideas for further research

Weird and wacky seeds. Look up seeds on the Australian Plant Image Index at Search Australian Plant Image Index - Australian Plant Information (anbg.gov.au).

Type 'nsb' (which stands for 'National Seed Bank') into the Class category and look at the diversity of seeds. Make a class poster.



Seeds from other parts of the world. Research different seeds from other parts of Australia and the world. How do seed types vary across different parts of Earth? Which plant species produces the biggest seeds on Earth and how do they disperse? Which animals help plants disperse their seeds in other parts of the world? How far can they travel?

Collect and test dispersal methods. Use a collection of different types of seeds to carry out an investigation on seed dispersal. Use a sock to test if any of the seeds can be picked up by an 'animal'. Use a fan to attempt to move the seeds by wind. Put the seeds in water to see which seeds sink and which float. Record your results try to link the outcomes with particular seed features.

How do we monitor seed dispersal by humans? Australia has strict import requirements for seeds entering the country. Seed of some species cannot be imported because plants grown from them are at risk of becoming a weed in Australia, and other seeds need testing and certification to ensure they are free from pathogens (diseases). Research the biosecurity measures taken to ensure seeds of concern aren't entering Australia. You could also research biosecurity measures between the states of Australia. Which states have different rules about what can be moved in or out? Why?

QUESTIONS AND ACTIVITIES FOR REFLECTION (EVALUATE)

Students review and reflect on their learning journey by:

- Revisiting the learning intentions and original inquiry questions:

  Are seeds moved away from the parent plant (dispersed)?

  How do you think they are dispersed?

  Are all seeds dispersed the same way?

  Can you tell how a seed is dispersed by looking at it?

  Why do seeds need to be dispersed?

  Are all seeds moved far away from the parent plant?

  What would happen if seeds could not be dispersed and stayed on the parent plant?

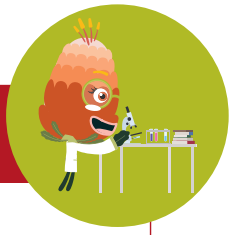
- Identifying further questions.

  What questions haven't I answered yet?

- Identifying what they learned from others and their own research.

  What new knowledge do I have about seeds I didn't have before?

RESOURCE – WORD BANK



dispersal	floaters	fliers	hitchhikers
tasty treats	travellers	ballistic	gravity
fruit	ovoid	reniform	globose
fusiform	irregular	lanceolate	cylindrical
sectoroid	pyramidal	cordate	cuneate
falcate	dormant	elaiosome	

RESOURCE – DISPERSAL METHOD FACT SHEET – ANIMAL DISPERSAL: TASTY TREATS

Animal Dispersal

Animals can disperse seeds by:

- Eating seeds and pooing them out (**Tasty treats**)
- Getting seeds stuck to their bodies and dropping them somewhere else (**Hitchhikers**)
- Collecting seeds and storing them for later (**Seed snack packs**)

Animals can often transport seeds for very long distances.

Tasty treats

Seeds that animals eat are often brightly coloured and have a tasty coating to attract animals to eat them. They are often contained in fruits that are sweet or otherwise attractive to eat.

The seeds can travel long distances in the animal's stomach and go through its digestive system before leaving its body in its poo. The poo is full of nutrients and can act as a fertiliser to help the seed to germinate.

Being eaten can also act as a germination trigger, which means it can stimulate the seed to grow. Passing through an animal's digestive system can remove the fruit around the seed or trigger germination by scratching the seed coat, known as scarification.

Cassowaries (*Casuarius casuarius*) are a keystone species in Queensland's tropical rainforests, which means that the rainforest relies on it. Cassowaries eat seeds and fruits from over 238 plant species and disperse (poo) their seeds throughout the rainforest, often called 'rainforest gardeners'. Cassowaries eat fruits that are toxic and too big for other animals to eat, so over 70 rainforest species rely on Cassowaries to disperse their seeds.

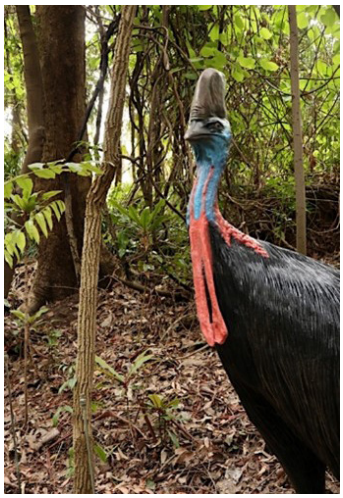


Image: ©M.Fagg, 2020

Emu poo with the seeds of Sandalwood (*Santalum spicatum*). This is similar to a cassowary eating and dispersing seeds in a rainforest.
Image: ©M.Fagg, 2005

RESOURCE – DISPERSAL METHOD FACT SHEET – ANIMAL DISPERSAL: SNACK PACKS

Animal Dispersal

Animals can disperse seeds by:

- Eating seeds and pooing them out (**Tasty treats**)
- Getting seeds stuck to their bodies and dropping them somewhere else (**Hitchhikers**)
- Collecting seeds and storing them for later (**Seed snack packs**)

Animals can often transport seeds for very long distances.

Snack packs

Some seeds have a tasty structure attached to their seed coat called an elaiosome that acts as a 'snack pack' for insects such as ants. The ant eats the elaiosome and leaves the seed near the entrance of their nest or discards it underground. Either of these places can provide an excellent site for seed germination.

Ants can help seeds to travel up to 180 metres from their parent plant. They can also scratch the seed coat and trigger germination.

Many wattle seeds have an elaiosome.

Acacia granitica
Image: B.Clinton

Acacia acuminata
Image: J.Fitz Gerald

Acacia oswaldii
Image: B.Clinton

RESOURCE – DISPERSAL METHOD FACT SHEET – ANIMAL DISPERSAL: HITCHHICKERS

Animal Dispersal

Animals can disperse seeds by:

- Eating seeds and pooing them out (**Tasty treats**)
- Getting seeds stuck to their bodies and dropping them somewhere else (**Hitchhikers**)
- Collecting seeds and storing them for later (**Seed snack packs**)

Animals can often transport seeds for very long distances.

Hitchhikers

Lots of seeds disperse by sticking to an animal as it brushes past. These seeds are usually covered in sharp spines, burrs, hooks or a very sticky substance. This helps them attach to fur, feathers or even clothes.

Have you ever found prickles in your socks or your dog's fur? That's a hitchhiking seed.

Seeds can hitchhike very far before dropping into a new environment to germinate.

Themeda triandra

Image: B.Clinton

RESOURCE – DISPERSAL METHOD FACT SHEET – ANIMAL DISPERSAL: WATER

Water Dispersal

Being able to float is important for water-dispersed seeds, so they are often small, lightweight, fluffy or have air pockets to allow them to do this.

Water-dispersed seeds can have a thick outer coat like a coconut (*Cocos nucifera*). This is to protect them from water.

Flooding

Some plant species need flood waters to disperse their seeds.

The River Red Gum (*Eucalyptus camaldulensis*) drops seed in spring and summer. This is often the same time as flooding that disperses the seed and warm conditions that help it to germinate.

Ocean currents

Plants that grow on tropical beaches are often dispersed by water. They usually have seeds inside woody, waterproof seed pods or coverings that let them float in salt water for a long time.

A coconut (*Cocos nucifera*) is a good example of a water-dispersed seed. A coconut has been known to germinate after floating on the ocean for 110 days.

Oceans and rivers

The Matchbox Bean (*Entada phaseoloides*) has seed pods that can be two metres long and the seeds inside them are the size of a matchbox.

The vines usually grow near water, and the seeds have a hard protective coating. The seeds drop into the water and are carried on the rivers out to the ocean.

Seed pod of a Matchbox Bean.

Image: ©CANBR, 1979

A coconut is dispersed by water.

RESOURCE – DISPERSAL METHOD FACT SHEET – GRAVITY

Gravity dispersal

Seeds sometimes fall straight from the parent plant to the ground. This is called gravity dispersal.

Gravity-dispersed seeds often grow in heavy fruits so that they aren't caught by the wind when they are falling to the ground.

Fruits with a hard outside might roll a long way from the parent plant before they release their seeds. Softer fruits might break open and scatter their seeds when they hit the ground.

Gravity dispersal means that seeds often germinate where the parent plant is growing as the habitat suits them. This means that they need to compete with their parent plant and other seedlings for light and nutrients. Only some seedlings win this competition.

Gravity-dispersed seeds germinate wherever they land or roll to, which can mean that there aren't many areas that the plants grow.

The weird and wonderful rainforest tree *Idiospermum australiense* is also called the Ribbonwood and Green Dinosaur. It has a seed about as big as an adult fist that is dispersed by gravity.

When the seed hits the ground, it can split into three or four parts and grow a number of different seedlings.

Green Dinosaur seeds are some of the largest seeds in Australia, weighing more than 200 grams, and are too toxic to be dispersed by animals.

Image: ©J.W. Wrigley, 1999

Green Dinosaur seeds rely on gravity for seed dispersal, which means they grow near the parent plant in small pockets of humid rainforest in northern Queensland.

Image: ©Neil Hewitt, Cooper Creek Wilderness, Daintree Rainforest.

RESOURCE – DISPERSAL METHOD FACT SHEET – WIND: PARACHUTES

Wind dispersal

Wind-dispersed seeds have parts that act as wings or a parachute. These wings and parachutes allow the seed to be caught by the wind and 'fly', as well as slowing them down so they fall gently to the ground.

Wind-dispersed plants produce hundreds or thousands of seeds, so some might land in a good environment to germinate.

Wind-dispersed seeds can be carried long distances.

Parachutes

Many species of daisy have wind-dispersed seeds. These seeds have a feathery parachute called a pappus that catches the wind and gives the seed a gentle ride.

Each seed can travel up to 100 metres away from the parent plant.

The seeds of *Microseris lanceolata* will be dispersed by the wind.

Image: A.N.Schmidt-Lebuhn©CANBR, 2012

Image: B.Clinton©ABRS, 2017

The Australian native seeds: a digital image library project which is supported through funding from the Australian Government's Australian Biological Resources Study (ABRS) Bush Blitz Program.), scale is in microns.

RESOURCE – DISPERSAL METHOD FACT SHEET – WIND: WINGS

Wind dispersal

Wind-dispersed seeds have parts that act as wings or a parachute. These wings and parachutes allow the seed to be caught by the wind and 'fly', as well as slowing them down so they fall gently to the ground.

Wind-dispersed plants produce hundreds or thousands of seeds, so some might land in a good environment to germinate.

Wind-dispersed seeds can be carried long distances.

Wings

Some seeds have papery wings to help them glide through the air.

Depending on the shape of the wing, they can help a seed to spin like a helicopter's rotors or to be blown like a leaf.

Waratahs (*Telopea* species) use the wind to disperse their seeds. Waratah seeds can 'fly' on the wind as they have a papery structure that looks like an insect's wing.

Image: M.Crisp©ANBG, 1984

Image: B.Hall©ANBG, 2018

Waratah (*Telopea* species) seeds are papery and winged to aid in their dispersal by the wind.

RESOURCE – DISPERSAL METHOD FACT SHEET – BALLISTICS

Ballistic dispersal

Some seeds explode out of their fruit! Sometimes, it even makes a 'pop' sound.

Plants can't use muscles to throw their seeds away from them. Instead, they have developed other ways of 'throwing' their seeds to disperse them.

The fruit of the Western Australian species *Baxteria* australis dries out when its seeds are ready to be dispersed. The fruit keeps some of its original flower parts and as these dry out they make a shape that is a bit like a catapult. The seeds sit in the catapult, ready to be launched, travelling up to one metre away from the parent plant when they are fired!

Fruits of the Quinine Tree (*Petalostigma triloculare*) explode after drying out, sending seeds up to 2.5 metres away from the parent plant.

Baxteria australis is endemic to south-west Western Australia and releases its seeds via ballistic dispersal. Structures of *B. australis* are shown as follows: (a) flowers, (b) fruit that has split open, (c) catapult mechanism for seed dispersal and (d) seed.

Images: ©Paula J. Rudall & John G. Conran (2012), Systematic Placement of *Dasypogonaceae* Among Commelinid Monocots: Evidence from Flowers and Fruits, Bot. Rev. 78:398–415. DOI 10.1007/s12229-012-9103-6

RESOURCE – DISPERSAL METHODS WORKSHEET

Write your own definition for each dispersal method written below. Include an example of each dispersal method, e.g. a type of seed or features that match these dispersal methods.

Animal dispersal

Tasty Treats

_____

_____

_____

Example: _____

Snack Packs

_____

_____

_____

Example: _____

Hitchhikers

_____

_____

_____

Example: _____

Wind dispersal

Parachutes

_____

_____

_____

Example: _____

Wings

_____

_____

_____

Example: _____

Water dispersal

_____

_____

_____

Example: _____

Ballistic (explosion) dispersal

_____

_____

_____

Example: _____

Gravity dispersal

_____

_____

_____

Example: _____

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Acacia granitica
Granite Wattle

Sclerolaena lanicuspis
Woolly Copperburr

Pappochroma bellidioides
Violet Fleabane

Daucus glochidiatus
Australian Carrot

Santalum acuminatum
Quandong

Brachyscome dentata
Lobe-seed Daisy

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Poa foliosa
Muttonbird Poa

(Note – many of these seeds ares less than 1mm long!)

Eucalyptus porosa
Mallee Box

Enneapogon nigricans
Pappus Grass

Allocasuarina media
Sheoak

All of the above images were sourced from the Australian Plant Image Index (anbg.gov.au)

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Acacia granitica
Granite Wattle

Dispersal method

Gravity and animal (snack pack)

- When the seed pod is ready, it splits, releasing the seeds to fall to the ground.
- They may grow where they fall or be carried away by animals such as ants.
- Ants eat the elaiosome (yellow part). The seed coat is scratched as the ant carries the seed back to its nest. This is called scarification and can trigger seed germination.

Sclerolaena lanicuspis
Woolly Copperburr

Dispersal method

Animal (hitchhiking)

- The bristles attach to the fur or clothing of passers-by.

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Pappochroma bellidioides
Violet Fleabane

Dispersal method

Wind

- The parachute feature enables it to be caught by the wind and float on the breeze.

Daucus glochidiatus
Australian Carrot

Dispersal method

Animal (hitchhiking)

- The bristles attach to the fur or clothing of passers-by.

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Note – these seeds were previously enclosed in a soft, fleshy fruit.
Santalum acuminatum
Quandong

Dispersal method

Animal (tasty treat)

- The fleshy fruit attracts animals that eat it, for example, emus.
- After eating the fruit and seed, the animal's digestive system helps to break down the hard outer seed coat.
- The animal then poos the seed out, and the poo acts as a fertiliser.

Brachyscome dentata
Lobe-seed Daisy

Dispersal method

Wind

- The tuft on the top and the light weight of the seed helps it to float through the air on the wind.

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Poa foliosa
Muttonbird Poa

Dispersal method

Animal (hitchhiking)

- The spikes attach to the fur or clothing of passers-by.

(Note – many of these seeds ares less than 1mm long!)
Eucalyptus porosa
Mallee Box

Dispersal method

Wind and gravity

- The seed pods mature and burst open.
- The tiny seeds are then carried by the wind or fall to the ground.

RESOURCE – NATIVE SEEDS

Pictures of native seeds

Which features do these seeds have that might make them suitable for a particular dispersal method?

Enneapogon nigricans
Pappus Grass

Dispersal method

Wind

- The lightweight seeds are lifted and carried by the wind.
- The shape of the fine hair-like protrusions aid in the seed being carried by the wind.

Allocasuarina media
Sheoak

Dispersal method

Wind and gravity

- The seed is inside a seed pod, which matures and then opens.
- As the seed drops to the ground, the wing helps to slow its descent so it can fly to a new location.
- Sometimes, the shape of the wing spins the seed like a helicopter and helps it disperse further.

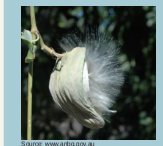
All of the above images were sourced from the Australian Plant Image Index (anbg.gov.au)

Seedy Tricks

Plants have developed various strategies to disperse their seeds.
For most young plants, the further away they are from their parent the better their chance of survival.

Here are some of their seedy tricks…

Fliers and Floaters



Source: www.anbg.gov.au

Some seeds have developed wind-catching structures, like papery wings or a feathery parachute-like attachment called a pappus.
These features allow them to float away from the parent plant, then slow their descent as they fall gently to the ground.

Hitchhikers

© Nathan Yuen. Source: http://hawaiianforests.com

Many seeds disperse by sticking to a passing animal or bird as it brushes past. The seed is covered in sharp spines, burrs, hooks or a super sticky substance which helps them attach to fur, feathers or even clothing. They may travel great distances before being dislodged. How many prickly seeds have you found on your socks after a day's bushwalk?

Tasty treats

Source: www.anbg.gov.au

Some seeds have a brightly coloured and tasty coating to attract animals to eat them. The digested seed passes quickly through an animal's gut and is deposited on the ground in its poo. The seed uses the nutrients in the poo to germinate and grow. The longer the seed is retained in the animal gut, the further it is likely to be scattered. However if they stay too long in the animal's digestive system the seeds can risk being broken down by the digestive fluids.

Travellers

© Bernat Guerard. Source: www.fsd2010.org

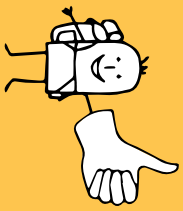
Insects like ants can also assist in the dispersal of plant seeds by carrying them for long distances away from the parent plant. Insects take seeds and store them for future food needs. Seeds that are dispersed and buried by ants have a number of advantages that make seedling growth more likely.
Cool Fact – seed dispersal by ants is known as 'Myrmecochory'.

Can you match each seed with its strategy and stick it below?
Did you know that Velcro was inspired by hitchhiking seeds in the fur of the inventor's dog?

RESOURCE – SEEDY TRICKS LABELS

Travellers

Hitchhikers



Fliers and Floaters

Tasty Treats

RESOURCE – SEEDY TRICKS CARDS

Note – these cards can be printed on two sides of a sheet of paper and cut out.

Hakea

Fliers and Floaters

Hakeas have a woody fruit, which often only opens after fire. When opened one seed can be seen in a small depression on either side of the open fruit.

The seed has a papery wing that allows it to travel on the wind.

Hakeas can be some of the first seedlings to emerge after a fire clears an area.

Photo: *Hakea tephrosperma*
© M.Fagg, ANBG

Allocasuarina
(Sheoaks)

Fliers and Floaters

Allocasuarina seeds have a papery wing. This type of winged seed is called a samara.

Once the cone has opened, the papery wing is caught by the wind and the seed is dispersed.

Photo: *Allocasuarina verticillata*
© R.Hill, ANBG

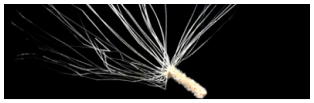
RESOURCE – SEEDY TRICKS CARDS

Doryanthes excelsa
(Gymea Lily)

Fliers and Floaters

Doryanthes excelsa or Gymea Lily grows a large red flower. The seeds of the Gymea Lily are fascinating. They are stacked inside a large woody capsule waiting for the wind. When the wind catches these seeds the whole stack can be blown away at once.

Photo: *Doryanthes excelsa*
© M.Fagg, ANBG



Senecio gregorii
(Yellow-tops)

Fliers and Floaters

Achenes are single-seeded fruits that have a feathery parachute-like attachment called a pappus. The seeds of the daisy genus *Senecio* are picked up on the wind and transported far away from its parent plant.

Can you think of other seeds that are soft and fluffy?

Photo: *Senecio gregorii*
© D.Skirrow, ANBG

RESOURCE – SEEDY TRICKS CARDS

Sclerolaena

Hitchhikers

Sclerolaena produce burr-like fruit. Each burr contains a seed which is dispersed through the movement of animals to other areas. The fruit have spines that can attach to the fur of unsuspecting animals and hitchhike far from the parent plant.

Photo: *Sclerolaena lanicuspis*
© M.Fagg, ANBG

Austrostipa
(Spear-grasses)

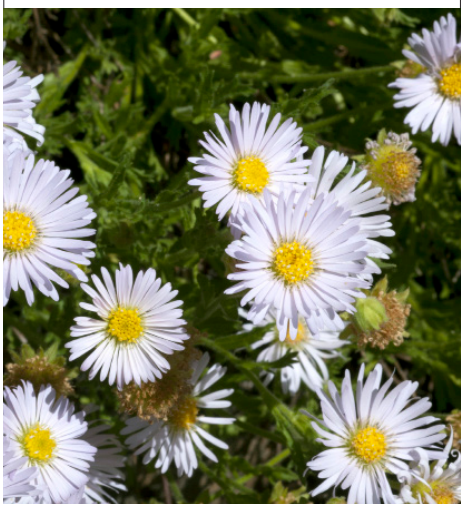
Hitchhikers

Spear-grasses have sharp-pointed seeds with a long ‘tail’ attached (called an awn), which help them hitch a ride in the fur of animals such as kangaroos. The awn also assists in twisting the seed into the soil where it can germinate.

Photo: *Austrostipa scabra* subsp. *falcata*
© M.Fagg, ANBG

RESOURCE – SEEDY TRICKS CARDS

Calotis
(Burr-daisies)



Hitchhikers

Burr-daisy seeds are round and covered with spikes. The seeds turn brown when ripe and the spikes attach to animals that are walking by. Farmers often find this seed caught in the wool of their sheep.

Photo: *Calotis glandulosa*
© M.Fagg, ANBG

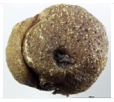
Santalum acuminatum
(Quandong)

Tasty Treats

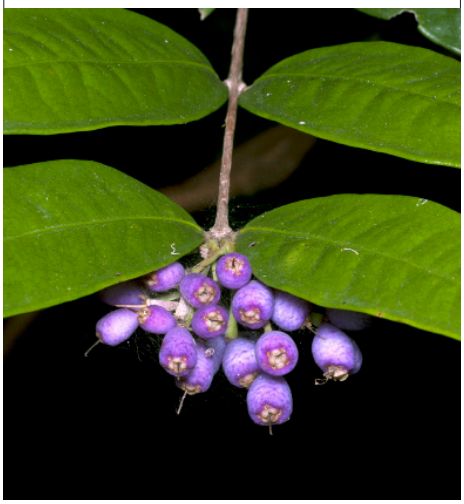
Emus are known to improve the germination rate from the seeds of the Quandong by swallowing its bright red fleshy fruit. The seed remains undigested and takes two or more days to pass through the emu's digestive system ensuring a successful dispersal.

Photo: *Santalum acuminatum*
© M.Fagg, ANBG

RESOURCE – SEEDY TRICKS CARDS



Syzygium
(Lilly pilly)



Tasty Treats

The colourful fruit of the Lilly pilly attracts birds. They not only eat the fleshy fruit, but often swallow the seed as well. The seed then passes through their gut and is deposited at another location, ready to grow into a beautiful new plant.

Photo: *Syzygium cryptophlebium*
© M.Fagg, ANBG

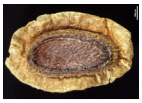
Acacia decurrens
(Green Wattle)

Travellers

Acacias and grevilleas produce seeds with a nutrient-rich appendage (called an aril) that ants find irresistible. This appetising treat acts as a reward for the ants that assist in dispersal by taking the seed back to their nest for safe storage underground. Protected from the drying heat of the desert sun, the seed still has the ability to germinate even after the ants have finished their meal.

Photo: *Acacia decurrens*
© M.Fagg, ANBG

RESOURCE – SEEDY TRICKS CARDS



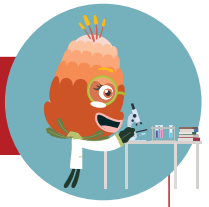
Grevillea

Travellers

Grevilleas, much like acacias, produce a seed with a nutrient-rich appendage called an elaiosome that ants love to eat. The ant will transport the grevillea seed back to its underground nest where the colony will consume the tasty treat. While being stored underground by the ants, the seed is in the perfect position to germinate.

Photo: *Grevillea beadleana*

RESOURCE: STUDENT REFLECTIONS



Consider displaying sentence starters or questions, such as below, in the classroom. Alternatively they could be turned into laminated thought bubbles that are directly passed to students. Students could choose two or three to complete in their journal then share their responses with the class.

End of lesson reflections	
Today I discovered ...	I am most proud of ...
I want to know more about ...	I feel confident about ...
Something new I found out was ...	I am enjoying ... because ...
I am excited about ...	I am confused by ...
Something I am finding interesting is ...	Today I asked ...
The most challenging thing was ...	A question I have is ...

Guiding students to reflect on their own thinking	
I am starting to think differently about ...	This idea is useful for ...
I got stuck when ... and I got back on track by ...	Some things I didn't understand are ...
I figured out that ...	To help me understand better I will ...
I solved a problem by ...	Before I didn't know ...
I first thought ... but then I realised that ...	Now I realise/know ...

Reflecting on stewardship and taking action	
This information can make a difference by ...	Something I will now help others understand is ...
It is important to know about this because ...	I can make a difference by ...
Something I will now do as a result of my learning is ...	An action I/we can take is ...
Something I want to do next is ...	If we don't ... the consequences could be ...
	It is important to ... because ...

End of unit reflections – where I was and where I am now	
I used to think ...	**Revisit** your first journal entry. What do you understand now that you didn't back then?
Now I know ...	
This causes me to (re)think/ wonder ...	
I didn't know how to ...	**Review** your work so far. What has been the biggest discovery/learning/ challenge?
Now I can ...	
In the future I will ...	**Reconsider** your initial ideas. Have your ideas changed? If so how?

Source: Adapted from the *Animal adaptations: year 5 Australian science curriculum focus, 2016, by the Great Barrier Reef Marine Park Authority, licenced under Creative Commons licence CC-BY-NC-SA from: http://hdl.handle.net/11017/2990'.*

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