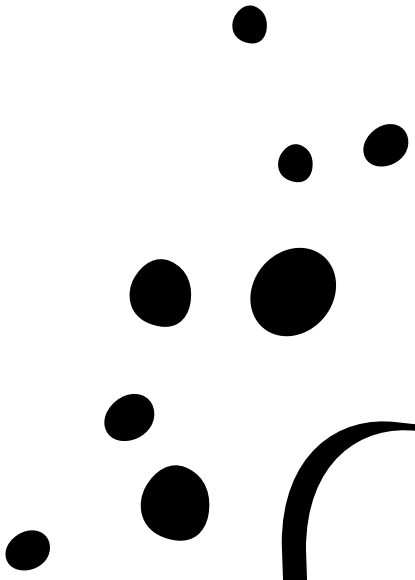

DUNGBUSTERS!



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Copies of this publication are available on CD from:
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Email: Sales@nrm.qld.gov.au
Web site: ‹www.nrm.qld.gov.au›

Illustration: Tony Drew
Design, editing and proofreading: Web and Publishing Services, Department of Natural Resources, Mines and Energy

QNRM03208
ISBN 0 7345 2485 4
27120

Natural Heritage Trust
Helping Communities Helping Australia

Queensland Government
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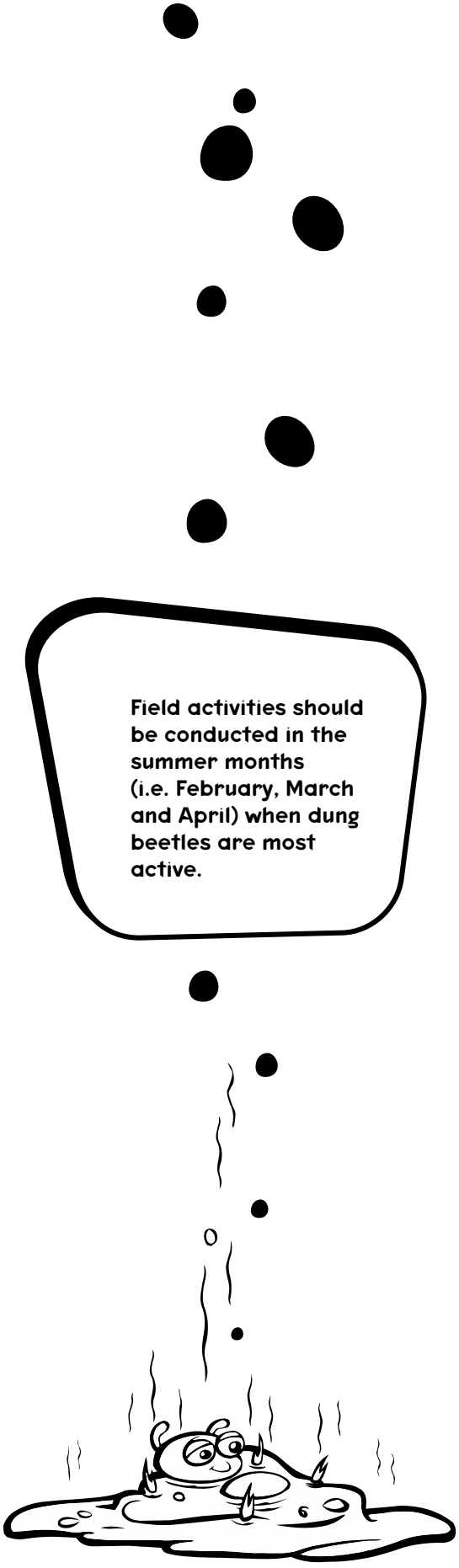
Acknowledgments

This module was written by Kirstin Kenyon on behalf of the Queensland Dung Beetle Project Management Committee.

Special thanks to those who provided assistance and support in the development of this module—Angus Macqueen, Mick Alexander, Dave Smith, Penny Edwards, Graeme Elphinstone, Christina Dwyer and Melva Hobson, and to the authors of *BioScan* (Department of Agriculture, Western Australia) for the use of some materials.

Funding and support has been provided by the Natural Heritage Trust, Department of Primary Industries (Agency for Food and Fibre Sciences), the Environmental Protection Agency, AgForce Queensland, the Department of Natural Resources, Mines and Energy, and Queensland landholders.



Using this module

From this module teachers can develop individualised units to demonstrate core learning outcomes in the key learning areas of Science and Studies of Society and Environment.

The activities are suitable for middle- to upper-primary and lower-secondary levels. While most are aimed at levels 3 and 4, some could be adapted easily for levels 2 and 5.

Rationale

The activities will:

- help students to understand the pivotal role of the dung beetle in the future health of Queensland's environment and beef industry
- encourage students to actively investigate the role of the dung beetle in natural resource management.

This module, which supports the NHT Queensland Dung Beetle Project, comprises:

- Background information for teachers and students
- Other supporting information and references
- Activities
- Resource sheets and background notes

Main ideas

This module introduces students to the important functions that dung beetles perform by rapidly returning animal manure to the soil, including:

- recycling nutrients
- promoting pasture growth
- improving the quality of run-off from pastures
- reducing fly breeding habitat.

Natural Resource Management Education Framework

Dungbusters! has been developed using the Natural Resource Management Education Program Framework, which promotes a balanced approach to the sustainable management of natural resources that takes environmental, social and economic factors into account. The framework (see figure 1) uses five phases in the learning process:

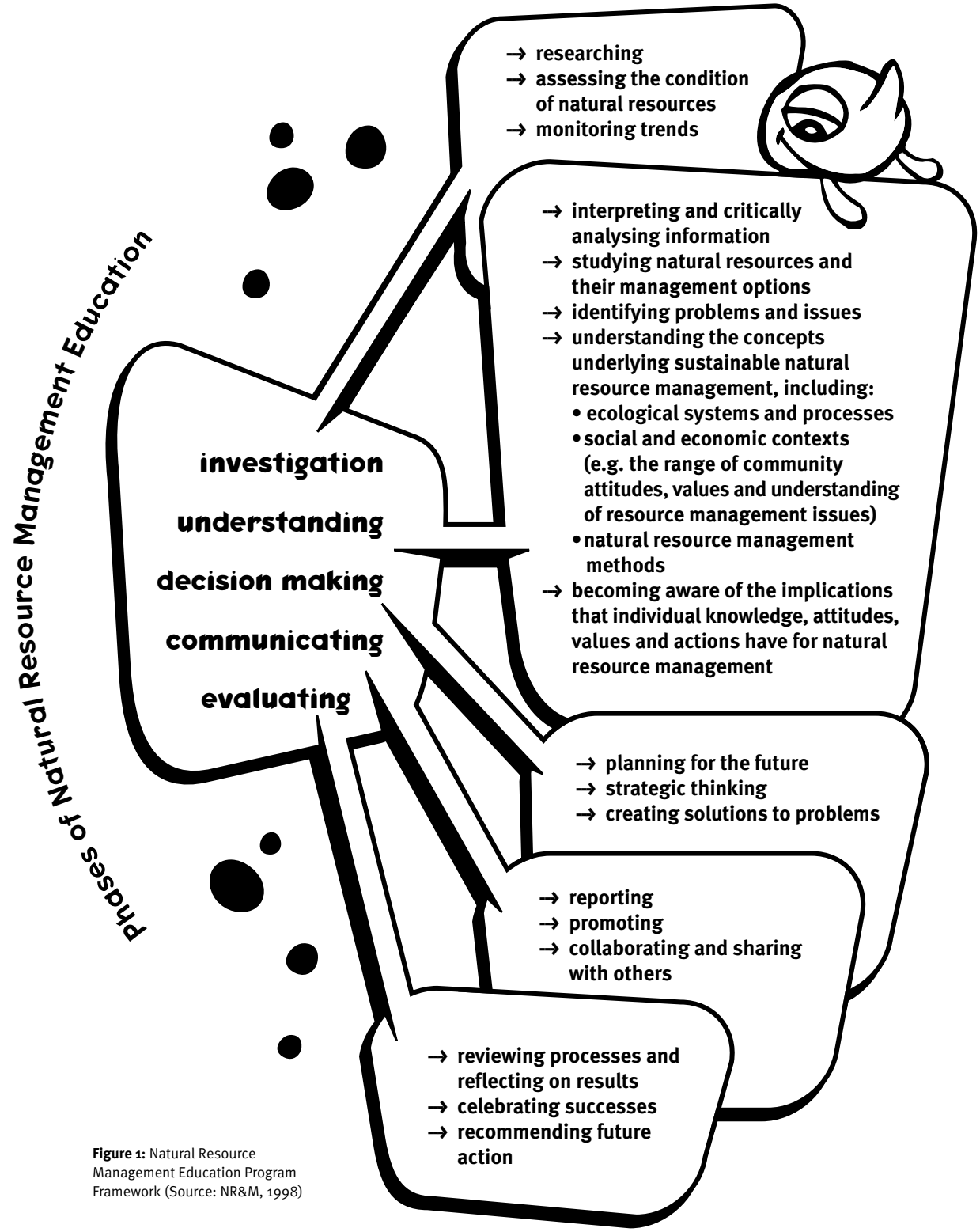


Figure 1: Natural Resource Management Education Program Framework (Source: NR&M, 1998)

Curriculum links

This module is linked to the key values and core learning outcomes identified in the *Queensland Science: Years 1–10 Syllabus* and *Studies of Society and Environment: Years 1–10 Syllabus* (Office of the Queensland School Curriculum Council 1999).

SOSE

Place and Space

2.2 Students predict possible consequences for an ecological system when an element is affected.

3.2 Students create and undertake plans that aim to influence decisions about an element of a place.

4.2 Students predict the impact of changes on environments by comparing evidence.

5.2 Students design strategies for evaluating environmental impacts of a proposed project, highlighting relationships within and between natural systems.

5.5 Students evaluate ideas concerning sustainability to identify who may benefit and who may be disadvantaged from changes to an Australian industry.

Systems, Resources and Power

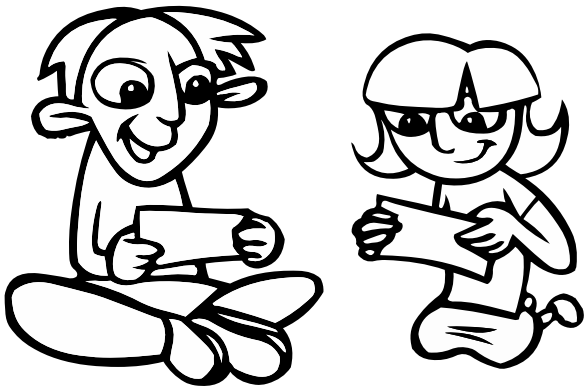
3.3 Students apply the principles of democratic decision making in cooperative projects

5.3 Students use a structured decision-making process to suggest participatory action regarding a significant current environmental, business, political or legal issue.

Time, Continuity and Change

2.4 Students describe cause and effect relationships about events in familiar settings.

3.4 Students organise information about the causes and effects of specific historical events.



Science

Science and Society

2.3 Students explain some of the ways that applications of science affect their community.

3.3 Students make predictions about the immediate impact of some applications of science on their community and environment, and consider possible pollution and public health effects.

4.3 Students present analyses of the short- and long-term effects of some of the ways in which science is used.

5.3 Students analyse relationships between social attitudes and decisions about the applications of science.

Life and Living

2.1 Students look for patterns and relationships between the features of different living things and how those living things meet their needs.

3.1 Students draw conclusions about the relationship between features of living things and the environments in which they live.

2.3 Students make links between different features of the environment and the specific needs of living things.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

4.3 Students make generalisations about the types of interactions which take place between the living and non-living parts of the environment.

5.3 Students evaluate the consequences of interactions between the living and non-living parts of the environment.

Background information for teachers and students.

(Source: Queensland Dung Beetle Project Training Notes 2002)

What is a dung beetle?

Dung beetles belong to the scarab family of beetles (Scarabaeidae). There are about 4500 species worldwide. Most are found in Africa, where they have evolved with large herbivores such as buffalo and elephants. There are over 300 native species in Australia.

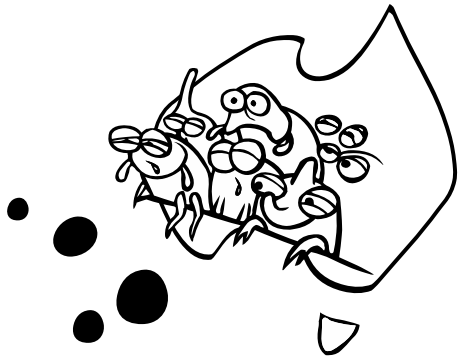
Dung beetles spend most of their time in dung. They feed on it. They grow up in it. The only time they aren't actually living in it, or working in it, is when they're flying around looking for more of it!

Although dung beetles are famous for making dung into balls then rolling it along, not all types do this. Some tear off chunks of dung and roll them away from the pat, while others make balls of dung within the tunnels that they dig under the dung pat.

Environmental benefits of dung beetles

Dung burial and dispersal provide agricultural and environmental benefits by:

- removing the breeding habitat of some fly pests and other parasites of livestock
- assisting nutrient recycling by exposing dung to soil microbes and earthworms
- improving water infiltration and soil aeration by generating a network of underground tunnels
- reducing pasture fouling and nutrient run-off into waterways.



Dung beetles in Australia

Most native Australian dung beetles don't cope well with the dung of introduced domestic animals and, as a result, cattle dung is not dispersed effectively.

The CSIRO introduced dung beetle species into Australia from Africa and Europe in an attempt to reduce numbers of bush fly and buffalo fly by improving dung burial. Forty-three species were released throughout Australia during the 1970s and early 1980s. Of the 29 exotic species released in Queensland, eight are widely established, seven have a limited distribution, and the remainder are presumed to have failed (see figure 2).

Some species released in Queensland are still spreading, with some potential climatic niches yet to be filled. Many areas require a greater diversity of species to achieve optimal dung burial. For maximum burial from spring to autumn it is desirable to have several species of dung beetle with complementary periods of activity.

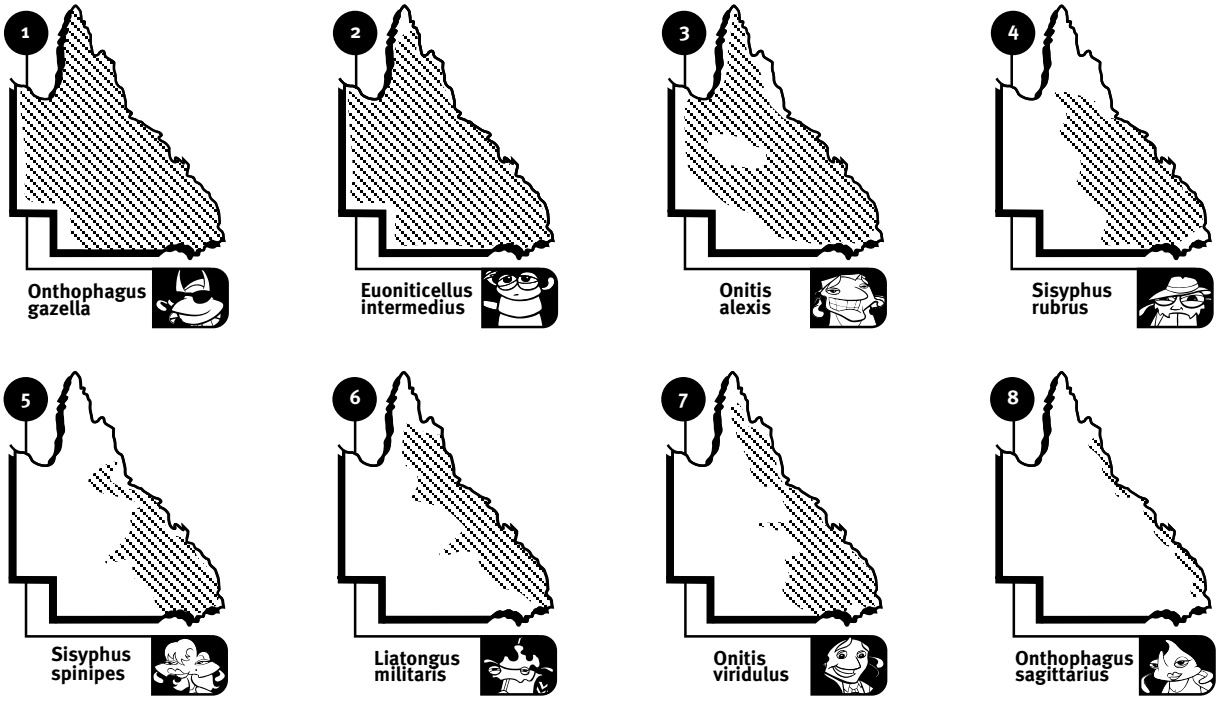


Figure 2: Distribution of common introduced dung beetles in Queensland (Source: Queensland Dung Beetle Project Training Notes 2002)

Flight

Dung beetles are strong fliers, able to travel up to several kilometres in one flight. Species fly either during daylight hours, at dusk and dawn, or at night. They can detect dung from a considerable distance by its smell, and fly upwind along an odour plume to it. They fly to fresh dung when their current supply is exhausted. When stocking rates are low, or cattle are regularly moved, dung beetles may need to fly considerable distances to find fresh dung.

Feeding

Dung beetles feed on the dung of vertebrates (i.e. animals that have spines). Adult dung beetles squeeze dung in their mouthparts to extract the fluid on which they feed. Dung beetle larvae feed on the whole dung (i.e. fluid and fibre), which they cut and chew with their mouthparts. Dung beetles do not require any other nutrients—not even water.

Young adult beetles always feed in dung for a week or more before they are ready to breed. This is known as the maturation feeding period.

Breeding

Dung beetles exhibit two main types of breeding behaviour:

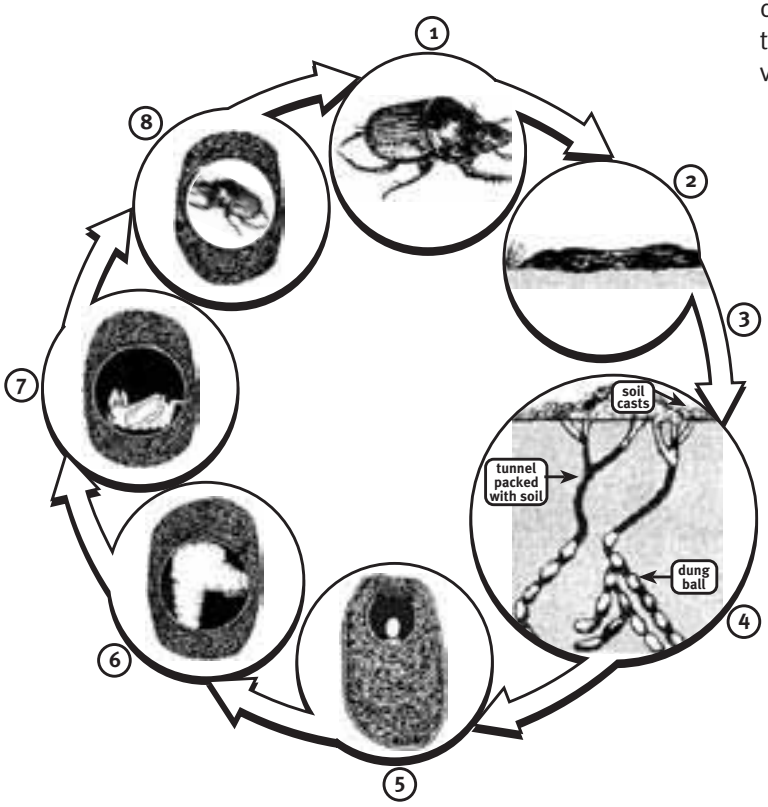
- 'Tunnellers' (most species) make tunnels under the dung pat (see figure 3).
- 'Rollers' make a ball of dung at the dung pat and roll it away (see figure 4).

Tunnellers

Tunnellers take the dung down into an underground nest, which they provide for their offspring. The male collects the dung and passes it down to the female, who constructs the nest and makes brood balls.

Most tunnellers lay one egg into individual brood balls moulded from dung, but some make a longer sausage of dung into which two or three eggs may be laid. A pair may work together in a single dung pat for several days, or even longer, while dung is available. The beetles then fly off separately in search of fresh dung.

Larvae hatch from the eggs and feed on the dung in the brood balls. When larval growth is completed, the larva pupates. Finally, the new adult emerges and digs up to the soil surface. Depending on the species, the time between egg laying and adult emergence can vary from one month to a year or more.



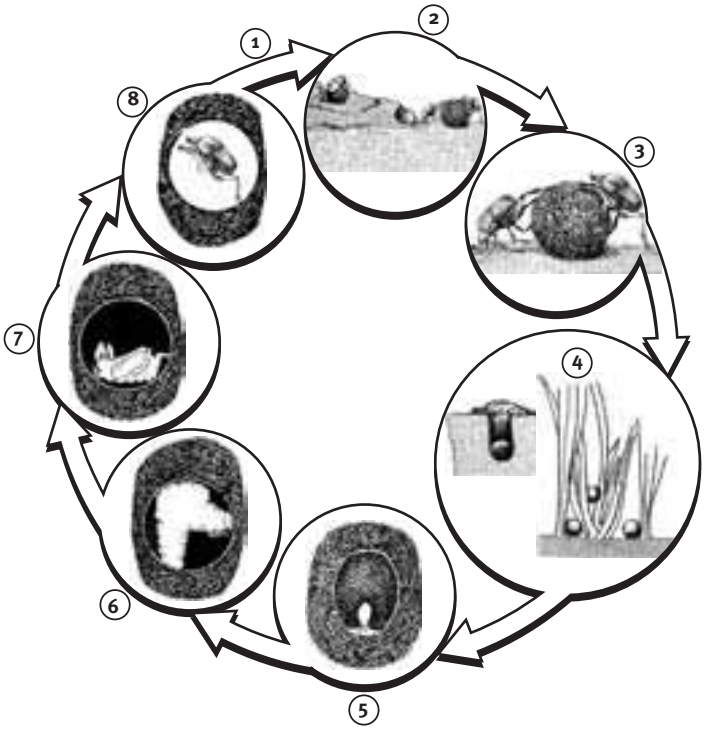
1. **Adult digs to soil surface and flies to fresh dung**
2. **Fresh dung**
3. **Male and female form a pair**
4. **Female lays an egg in each dung ball**
5. **Egg**
6. **Larva**
7. **Pupa**
8. **New adult**

Figure 3: Life cycle of tunnelling dung beetles (Source: Queensland Dung Beetle Project Training Notes 2002)

Ball-rollers

The male and female of the other group, the rollers, slave away, removing seeds and coarse fibres from the dung as they form it into a neat round ball. This is then rolled away by the pair, or by the female alone. Most (such as *Sisyphus rubrus*) bury the ball before laying an egg in it; however, *Sisyphus spinipes* lays an egg in the ball and leaves it propped up in a tussock of grass or other vegetation.

Some life cycle characteristics for the eight common species in Queensland (six tunnellers and two rollers) are shown in table 1.



1. **Adult digs to soil surface and flies to fresh dung**
2. **Dung balls made at dung pad**
3. **Male and female roll dung ball away**
4. **Dung ball buried or propped in grass**
5. **Egg**
6. **Larva**
7. **Pupa**
8. **New adult**

Figure 4: Life cycle of ball-rolling dung beetles (Source: Queensland Dung Beetle Project Training Notes 2002)

Species	Flight time	Development period (egg to adult)	Life span of adults	Number of eggs laid per day	Depth of tunnels
Tunnelling species					
Onthophagus gazella	dusk/dawn	4–6 wks	2 mths	1–2	20–30 cm
Onitis alexis	dusk/dawn	2–5 mths	›2 mths	2–3	10–20 cm
Onitis viridulus	dusk/dawn	6–8 wks	?	2–3	‹10 cm
Euoniticellus intermedius	day	5–6 wks	1–2 mths	2	5–15 cm
Liatongus militaris	day	?	?	?	5–15 cm
Onthophagus sagittarius	dusk/dawn	?	?	?	?
Ball-rolling species					
Sisyphus spinipes	day	7–11 wks*	2–4 mths*	1 per 2 days	no tunnel
Sisyphus rubrus	day	5–16 wks*	2–6 mths*	1 per 2 days	10 cm

Notes:
? = no information available
*** = laboratory data**

Table 1: Life cycles of common dung beetle species (Source: Queensland Dung Beetle Project Training Notes 2002)

Seasonal activity

Dung beetles are most active during the warmer months of the year, particularly after rainfall. The single exception to this in southern Queensland is *Onitis caffer,* which is active in autumn and early winter.

Breeding activity stops before winter. Dung beetles go underground during the cold months, either as adults or larvae. There is considerable adult mortality during this time. Some species simply become less active during winter, but others go into a state of diapause (which is similar to hibernation) and do not emerge until stimulated by environmental factors—such as a rise in soil temperature, or rainfall. In the case of *Onthophagus gazella*, the first good spring rain triggers pupation of larvae and the second good rain triggers the emergence of new adults.

Factors that affect dung beetle populations

Dung beetle populations can be adversely affected by factors including:

- dry weather
- cold weather
- predators—cane toads, ibis, crows, pigs, foxes
- dung from grain-fed animals
- chemicals—certain parasiticides used to control livestock pests can pass into the dung
- pasture quality—good quality pasture produces good quality dung (higher moisture and nitrogen content), resulting in higher rates of egg production by dung beetles and, hence, larger populations.

Managing to optimise beetle populations

Dung beetle activity is largely governed by seasonal conditions; however, there are several things that property managers can do to enhance dung beetle populations.

1. Use chemicals strategically:
    - When possible, use chemicals that have little or no impact on dung beetles.
    - Use hazardous chemicals only as necessary and at times of the year when beetle numbers are low (e.g. dry conditions, autumn and winter).
2. Reduce the amount of grain fed to cattle. The starch in grain produces an unnatural fermentation in the dung, lowering its quality and rendering it less attractive to dung beetles.
3. Manage the property to improve dung quality through better pasture quality—when the cattle are well fed, so are the beetles.

Dung beetles as competitors

(Source: Adapted from *BioScan*, 1995, Department of Agriculture, Western Australia, p. C3)

Dung beetles are not the only inhabitants of the dung pat; they share it with a range of other organisms, for example, predatory beetles, fly larvae, and mites. The dung beetles are interested in the dung pat for the bacteria-rich juices, which they extract and consume, and for the fibrous and colloidal components, which they take into their tunnels to feed to their offspring.

In search of nourishment for itself, each beetle removes some nutrients from the dung pat. The combined effect of many feeding beetles can quickly reduce one pat to fragments. Similarly, in a scramble for brood ball material, breeding beetles compete among themselves. Large numbers of breeding beetles are able to remove big pats completely within 24 hours by taking quantities of dung to their tunnels and brood chambers.

The beetles are affected little by other insects in the dung pat, apart from competition among themselves and some predation. In the scramble for dung juices and for dung for brood balls, however, the beetles render the pat unsuitable for some species (such as larvae of the bush fly and buffalo fly).

When dung beetle activity is intense, few suitable sites remain for flies to lay eggs and little suitable dung remains in which their maggots can develop.

Dung beetles and nutrients

One of the main macronutrients in cattle dung is nitrogen (N). When dung is left on the soil surface, some of the nitrogen is eventually converted to ammonia and nitrogen gas, and passes into the atmosphere—a process known as volatilisation. Some nitrogen is thus lost to the pasture system.

By rapidly burying dung in the soil, dung beetles help to preserve and recycle the nitrogen because most of it is retained below ground and converted into nitrates. These are absorbed by plant roots and used as building blocks for plant growth. The other nutrients in dung—phosphorus, potassium, calcium, magnesium and various trace elements—are not volatile and are recycled in the same fashion. These buried nutrients are located in the root zone of most pasture plants. After uptake by roots, they are locked up in plant tissue until consumed by livestock or liberated from decomposing plant litter. Recycling with the help of dung beetles makes nutrients available to plants much more rapidly than if the dung was left to decompose on the soil surface.

Dung burial also helps to reduce the problem of nutrient loss from pastures into water catchments.

identifying the eight common introduced dung beetle species in Queensland

The characteristics of the three main body segments:

- the head (at the front)
- the thorax (at the middle)
- the abdomen (at the rear)

are described and illustrated in this section. (See figure 5.)

Characteristics on the legs also are used to identify some species, especially:

- the femur, the large segment closest to the body on all legs
- the tibia, which is joined to the femur and bears teeth on one edge and claws at the end.

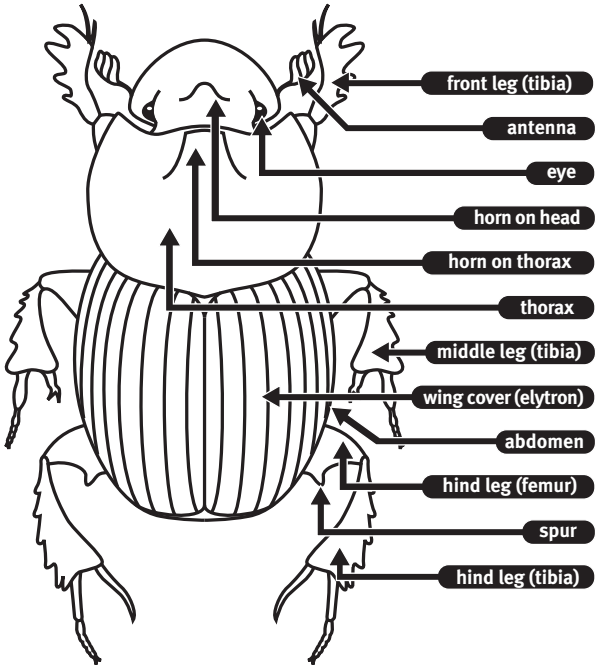
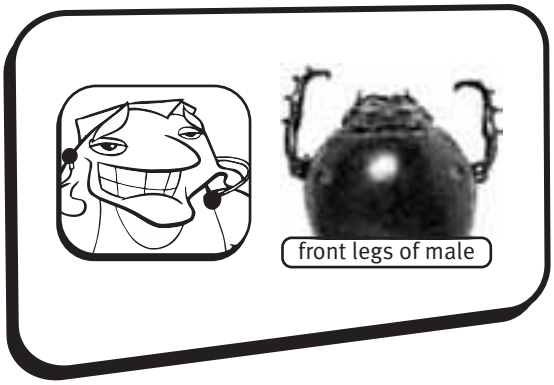
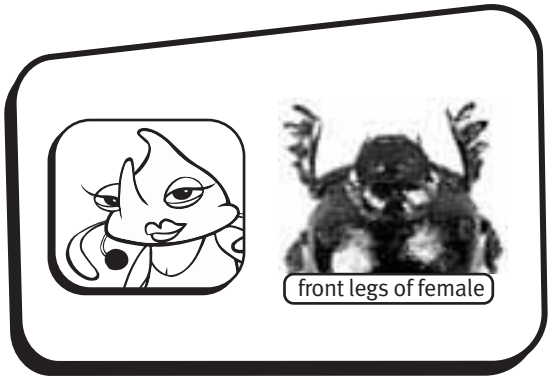


Figure 5: Body parts (Source: Queensland Dung Beetle Project Training Notes 2002)





Males and females

While the male and female of each species are usually quite similar, sometimes there are differences, and these have been noted. The terms 'major' and 'minor' are used respectively in referring to larger or smaller members of each sex within a species.

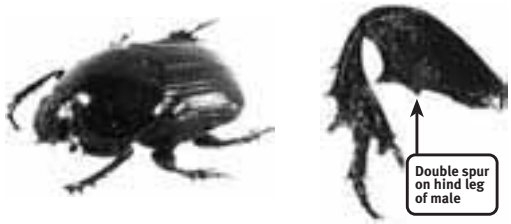
Males of tunnelling species—the majority of introduced beetles—generally have thinner tibiae than females do. The ends are slightly curved inwards and have smaller tibial teeth, more widely spaced than in females.

Females have shorter, stouter front tibiae, with the teeth well-developed for digging. The teeth may be worn or missing from hard work, or the tibiae even reduced to stumps.

These tibial differences are not present in the ball-rollers.

Tunnelling species

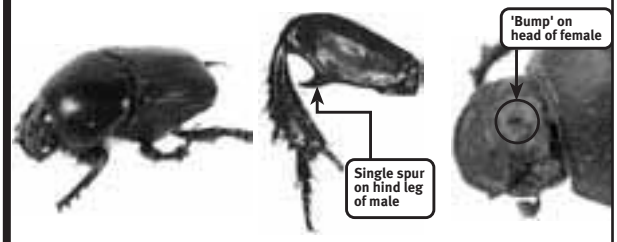
Onitis viridulus | dusk/dawn flier



- large (1.5–2.5 cm length)
- uniform dark metallic green or black on the thorax and wing covers
- males have a broad, thin, unequal double spur on the rear edge of the hind leg

1

Onitis alexis | dusk/dawn flier



- large (1.5–2 cm length)
- thorax with green or red hue and light brown wing covers, giving a two-tone effect
- males have a sharp, hooked spur, resembling a rose thorn, on the rear edge of the hind leg
- females have a small 'bump' at the rear of the head

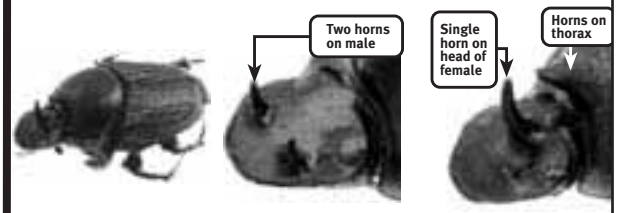
2

Onthophagus gazella | (dusk/dawn flier)

- medium-sized
- brown wing covers, often with small pale patches near the front and rear, and a darker brown thorax, giving a two-tone effect
- body shape is rounded (when viewed from above)
- males have a pair of horns at the back of the head, which are better developed in major males; females look similar, but are without horns

3

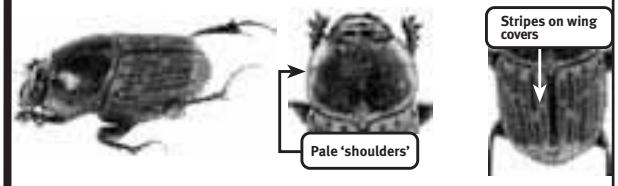
Onthophagus sagittarius | dusk/dawn flier



- small to medium-sized
- thorax and wing covers are uniformly bronze–brown (i.e. not two-tone)
- deeper through the body than *O. gazella* (when viewed from the side)
- males have two small horns near the front of the head
- females have one large horn on the head and one on the thorax (much reduced in minor specimens)

4

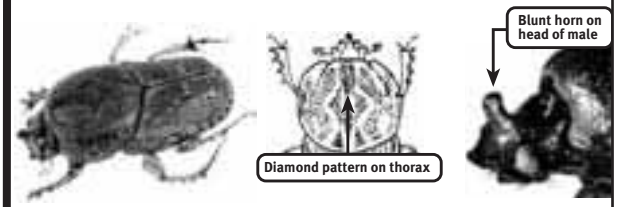
Liatongus militaris | day flier



- small, narrow and elongated
- dark brown or black, with pale patches on sides and 'shoulders' of thorax
- wing covers have broken black stripes running lengthwise
- major males have a small pointed horn on the head

5

Euoniticellus intermedius | day flier

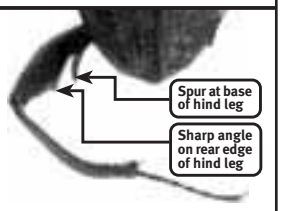


- small and narrow
- yellow–brown or straw-coloured with a faint diamond-shaped pattern on thorax
- males have a blunt horn on the head
- females are without horns
- undersides of legs are uniformly pale yellow

6

Ball-rolling species

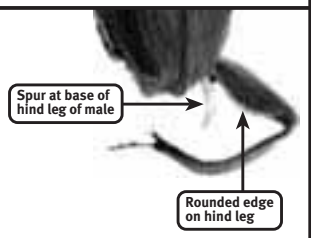
Sisyphus spinipes | day flier



- → long, thin middle and hind legs
- → entirely brown to matt black-coloured body
- → males have a dark-coloured spur at the base of the hind femur, which is small in minor males, and a sharp angle on the rear edge of the hind leg

1

Sisyphus rubrus | day flier



- → light brown to light yellow–brown body (smaller and lighter-coloured than *S. spinipes)*
- → long, thin middle and hind legs that are usually paler in colour than the body
- → males have a large, pale-coloured spur at the base of the hind leg, which is small in minor males (and not present in females)
- → rounded rear edge on hind leg of male

2

Other support information and references

These resources will be helpful both to teachers and students

Department of Natural Resources 1998, *Support for natural resource management education 1998–9,* Scientific Publishing, Brisbane.

Forge, K 1993a, *Pasture Watch Classroom Activities,* Department of Primary Industries, Queensland, Brisbane.
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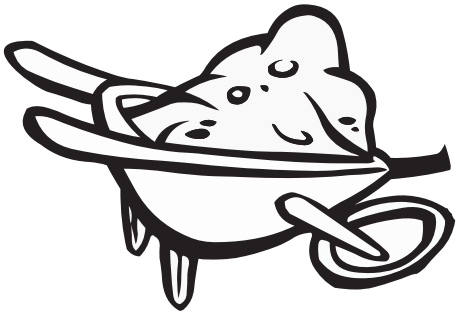
Tyndale-Biscoe, M 1990, *Common Dung Beetles in pastures of south-eastern Australia,* CSIRO Division of Entomology, Australia. (For enquires or orders, phone the CSIRO Bookshop on 02 6246 4001.)



Web sites

Department of Primary Industries
‹www.dpi.qld.gov.au›.
A search on 'dung beetles' will find a number of articles on this site with information on the Queensland Dung Beetle Project.

ABC Online
‹www.abc.net.au/science/k2/trek/default.htm›
Visit the Karl Trek page, which has a number of activities and interesting facts about dung beetles. See October and November 1997 entries for more details.

National Dung Beetle Program (site under development)
‹www.dungbeetle.uwa.edu.au›.

Contacts

Contact local landholders and landcare groups near you that might like to be involved in 'Dungbusters'. A listing of landcare and catchment management groups can be found on the Queensland Landcare web site at ‹www.landcareqld.org.au›.

Suggested activities

1. Why are farms important?
2. Where did all the dung beetles come from?
3. Effects of dung beetle activity on the environment
4. Sampling dung beetles
5. Identification of common introduced dung beetles
6. Making a dung beetle farm
7. Getting to know your dung beetles
8. Dung beetles and plant growth
9. Photosequence of dung dispersal
10. Debate: 'Introduced dung beetles are good for Queensland's environment'
11. Local area study
12. Where to from here?

Life and Living

2.3 Students make links between different features of the environment and the specific needs of living things.

1 Why are farms important?

Focus
Investigating, understanding

Aims
- To help students to understand why we have farms
- To introduce students to:
  - ➔ the concept of natural resource trends
  - ➔ the social and economic context and value of farms.

Materials
- Butcher's paper
- Pens

Sequence | 30 minutes
1. As a class, discuss farming in Australia and how much land is used for farming.

2. Ask students to break into groups of 3–4 and record their answers to the following questions on the butcher's paper provided. (Some suggested answers are included.)
   - What are farms and what types do we have in Queensland? *Cattle, sheep, pigs, crops, dairy.*
   - Why do we have farms? *So we can have food to eat, products to make clothes, and to provide jobs.*
   - Who needs them? *Everybody.*
   - What do we get from farms? *Food, leather, wool, cotton, jobs.*
   - Do you think farms are important? Why/why not?
   - What problems can affect farms? *Drought, flood, pests.*
   - What problems are farmers currently facing?

3. Ask students to report back to the class on their findings. Discuss the differences in their ideas.

Background notes

The Original CSIRO Dung Beetle Project (1966–86)

European settlement has permanently altered the nature of the Australian landscape. Key changes have included partial or total clearing of vegetated areas, and the introduction of pasture plants, undesirable plants, cattle, and other domestic animals. Cattle are quite unlike our native marsupials, particularly in their grazing patterns and in the type of dung they produce. A large proportion of the annual dry matter production of a pasture is consumed by cattle and converted into dung, increasing the need for efficient recycling of their faecal nutrients.

Australia has unique dung beetles. These evolved with our marsupials, which usually produce relatively dry and fibrous dung pellets. With some exceptions, these native insects are not adapted to using cattle dung effectively, nor to colonising it effectively in cleared open habitats. Consequently, prior to the introduction of exotic dung beetles, cattle dung in most areas of Australia was not dispersed (i.e. buried and/or shredded) to any notable extent, except in a few areas where certain native beetles were able to have an impact. This has given rise to various problems, with the main ones being that:

- cattle dung is the only breeding medium for the introduced buffalo fly, and is a major breeding site for the native bush fly and four species of *Culicoides* biting midges—some of which are known vectors of diseases such as ephemeral fever
- dung fouls pasture, obstructing plant growth and promoting rank, unpalatable growth around the edge of dung pats
- plant nutrients are immobilised in undecomposed dung pats, retarding the recycling process
- there is some loss of nitrogen to the atmosphere from unburied dung.

On the other continents (Africa, India and Europe) diverse dung beetle faunas evolved at the same time as large ruminants[1]. As these insects could use the dung for feeding and breeding, much of it was buried or dispersed during the growing season. There is considerable specialisation among these beetles as to dung preference, time of activity and reproductive strategy. There are also clearly recognisable functional groups: ball-rollers, large and small; tunnelling beetles of all sizes; and several other types.

Dr George Bornemissza of the CSIRO Division of Entomology noted that cattle arrived in Australia without dung beetles adapted to bovine[2] dung. Recalling that, in his native Hungary, it was commonplace to see dung beetles removing quantities of dung from cattle pats, he proposed that dung beetles be imported into Australia to disperse cattle dung and thereby reduce the problems associated with unburied dung.

(Source: Queensland Dung Beetle Project Training Notes 2002)

1. Any of various hoofed, even-toed, usually horned mammals of the suborder Ruminantia, characterised by the chewing of cud—such as cattle, sheep, goats and deer.
2. Of the ox family, comprising hollow horned ruminants—such as cattle.

Time, Continuity and Change

3.4 Students organise information about the causes and effects of specific historical events.

2 Where did all the dung beetles come from?

Focus

Understanding

Aims

To help students to understand why foreign dung beetles were introduced to Australia as a sustainable natural resource management option.

Materials

- Resource sheet 1—*Dung beetles arrive in Australia*.

Sequence | 30 minutes

1. Ask students to think about:
   - what Australia would have looked like before 1788 and the arrival of the First Fleet (i.e. before land clearing and the introduction of exotic plants and animals)
   - where farms are located.

2. Ask students to read resource sheet 1—*Dung beetles arrive in Australia*.

3. Ask students to think about what the consequences would be for Australia's natural environment if cattle dung were not dispersed by dung beetles—for example, what would our countryside look like?

4. Record a number of the words that students use to describe this scene.

5. Discuss how having a lot of undispersed cattle dung in pastures could affect our environment, and us.

6. Discuss water quality problems associated with run-off.

Science and Society

3.3 Students make predictions about the immediate impact of some applications of science on their community and environment, and consider possible pollution and public health effects.

Earth and Beyond

3.3 Students collect information that describes ways in which living things use the Earth and the sun as resources.

Life and Living

2.3 Students make links between different features of the environment and the specific needs of living things.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

Place and Space

2.2 Students predict possible consequences for an ecological system when an element is affected.

3 Effects of dung beetle activity on the environment: 'Woolly Thinking'

Focus

Understanding

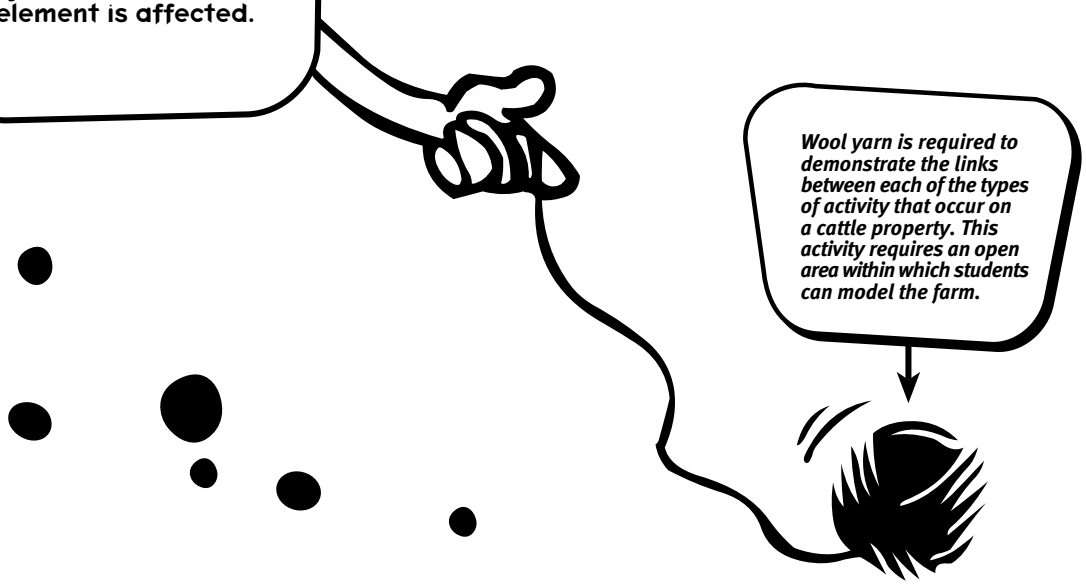
Aims

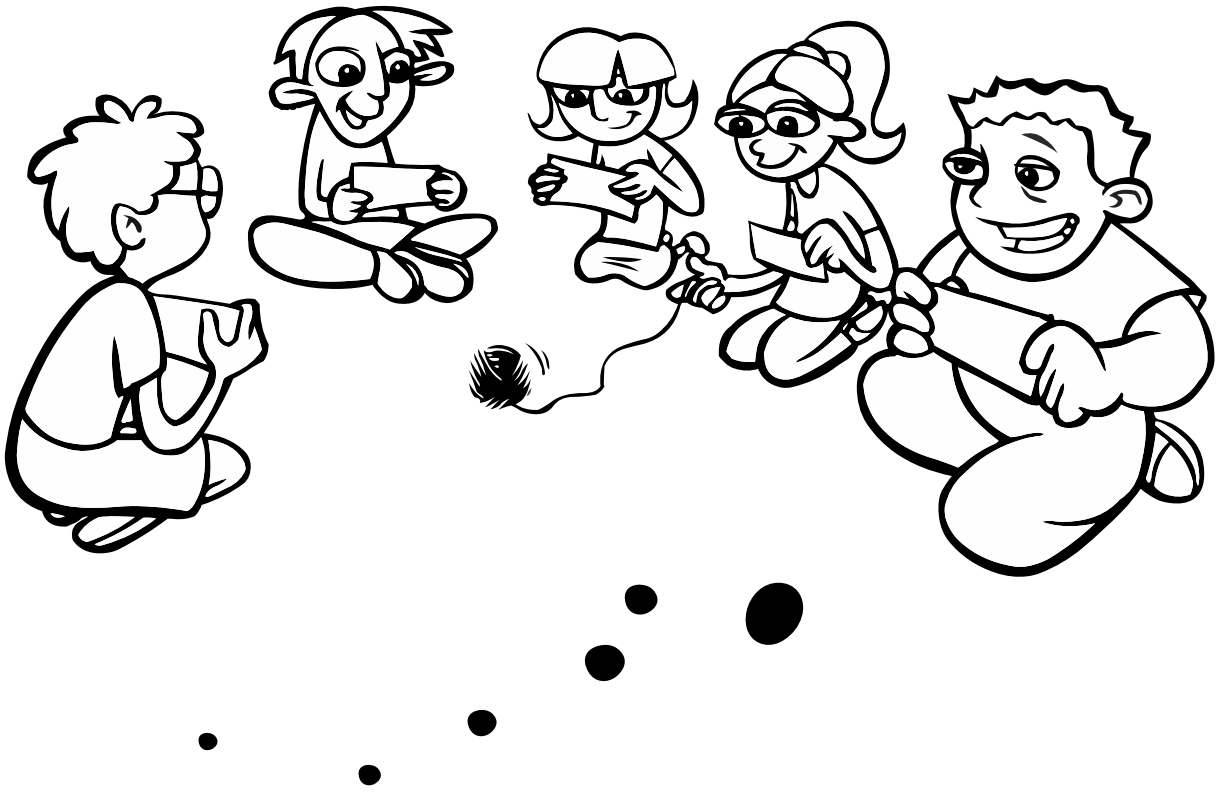
To prompt students to:

- think about the possible impacts, both good and bad, that the dung beetle may have on Australia's environment
- develop an understanding of the concepts underlying sustainable natural resource management.

Materials

- Eight balls of wool
- Labels, as follows:
  - cattle
  - fly pests
  - farmer
  - water
  - soil
  - pasture plants
  - other farm animals
  - dung beetles.
- Resource sheet 2—*Operation 'Dung Beetle'*





Sequence | 40 minutes

1. Make sufficient labels for each student to be allocated one. Pass them out at random and then ask all of those students whose labels are the same to join together in a group.

2. Ask students to think about how they (as described by their label) are affected by cattle dung and what links they have with the other (differently labelled) groups in the room. There are many different relationships that the students may identify with, some of which may be:
   - cattle drop dung → attracting flies → irritating people/animals→ harming the farmer and other animals → reduced when beetles bury sufficient dung
   - dung beetles disperse dung → cleaner water runs off the farm → better for people and other animals → improving water quality in dams and waterways
   - cattle drop dung on the soil → buried by dung beetles → puts nutrients back into the soil → allowing pasture plants to grow improving cattle nutrition.

3. Ask each group of students to stand in a different place in the room, or outside. All the 'dung beetles' will be together, but in a different place from the 'cattle'. Ask each group to demonstrate their relationships (as identified in step 2) by holding onto their ball of wool and walking to the next group in the relationship. As they get to each new group one of their group stays behind to keep hold of the wool and explain the relationship to the class.

4. Ask each group to do this until a very woolly web has been formed. When all the groups have had a turn, ask the students to remain sitting where they are to discuss the different types of relationships. (In doing so, discuss the positive effects that dung beetles have on farms.)

Science and Society

3.3 Students make predictions about the immediate impact of some applications of science on their community and environment, and consider possible pollution and public health effects.

Earth and Beyond

3.3 Students collect information that describes ways in which living things use the Earth and the sun as resources.

Life and Living

2.3 Students make links between different features of the environment and the specific needs of living things.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

Place and Space

2.2 Students predict possible consequences for an ecological system when an element is affected.

4 Sampling dung beetles in your local area

Focus

Investigating

Aims

To encourage students to:

- investigate dung beetles first-hand
- make inferences from their investigations.

Materials

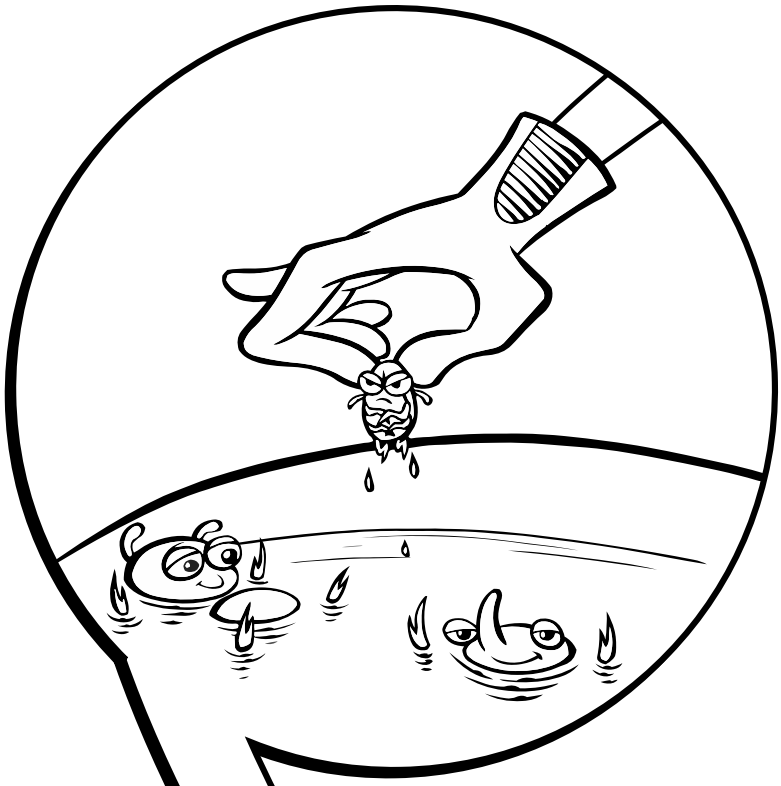
- Protective gloves (disposable rubber, vinyl or surgical gloves would be fine)
- Large open container filled with water (e.g. a 75 litre plastic rubbish bin)
- 10 litre bucket (for collecting dung and beetles before putting them in the larger container)
- Ice-cream container with lid and airholes
- Sharpened shovel
- Sieve
- Trowel
- Resource sheet 4—*Dung beetle data collection sheet*

Note: Students in some regional schools will have ready access to cattle dung and, hopefully, dung beetles; whereas city schools, and regional schools that aren't located near grazing land, may need to conduct a field trip to undertake this activity. (Refer to resource sheet 3—*Queensland distribution of common introduced dung beetles*) to determine which dung beetles are common in your area.)

For more information, it may be necessary to contact:

- your local Department of Primary Industries (DPI) office
- the DPI Call Centre—ph: 13 25 23
- a local landcare group ‹www.landcareqld.org.au›.

Discuss the safe handling and care of dung beetles with the students prior to commencing this activity.



Sequence | **Over a series of lessons**

1. Look for dung pats one- to two-days-old (where day-fliers, dusk/dawn fliers and night fliers might be present).

2. Approach quietly; dung beetles are sensitive to vibrations and will quickly descend into their tunnels.

3. Scoop up the dung pat with the shovel, if possible including about 10–20 mm of topsoil, and place it in the 10 litre bucket. Repeat the process so that you have two dung pats in the bucket.

4. Transfer the dung pats to the large container and stir well with the trowel to break up the dung. The dung beetles will float to the top. (Don't worry—they are good swimmers and won't drown.) Skim them off with a sieve. Stir again and skim again, continuing until there are no more beetles. You can collect more dung pats and repeat the procedure if you like—just keep a note of how many you sample. You may need to wash the beetles a few times, using a hose and the 10 litre bucket. (You can keep beetles in an ice-cream container half-filled with water while you sort through them. This will stop them from flying away.)

5. Pick out at least one specimen of each type of beetle. Release the remainder back into the paddock, or hold them overnight for use in activity 5.

Ensure that gloves are worn when collecting dung and beetles, and that hands are washed after the sampling is complete.

Dung beetles can be kept in the refrigerator overnight. First, empty the water from the ice-cream container, put in a couple of sheets of damp paper towel, and replace the lid (complete with air-holes).

Science and Society

3.3 Students make predictions about the immediate impact of some applications of science on their community and environment, and consider possible pollution and public health effects.

Earth and Beyond

3.3 Students collect information that describes ways in which living things use the Earth and the sun as resources.

Life and Living

2.3 Students make links between different features of the environment and the specific needs of living things.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

Place and Space

2.2 Students predict possible consequences for an ecological system when an element is affected.

5 identification of common introduced dung beetles

Focus

Investigating

Aims

To encourage students to:

- identify the introduced dung beetles in their area
- compare their result with the details recorded on resource sheet 3—*Queensland distribution of common introduced dung beetles.*

Materials

- Resource sheet 4—*Dung beetle data collection sheet*
- Resource sheet 5—*Common dung beetles in Queensland: colour identification sheet*
- Table lamp
- Magnifying glass(es)
- Trays (for sorting beetles)
- Disposable gloves
- Ruler

Ensure that students wear gloves and wash their hands after completing any stages involving the handling of dung.

Sequence | 60 minutes

1. Students should complete resource sheet 4—*Dung beetle data collection sheet.*

2. Divide the dung beetle sample among the class.

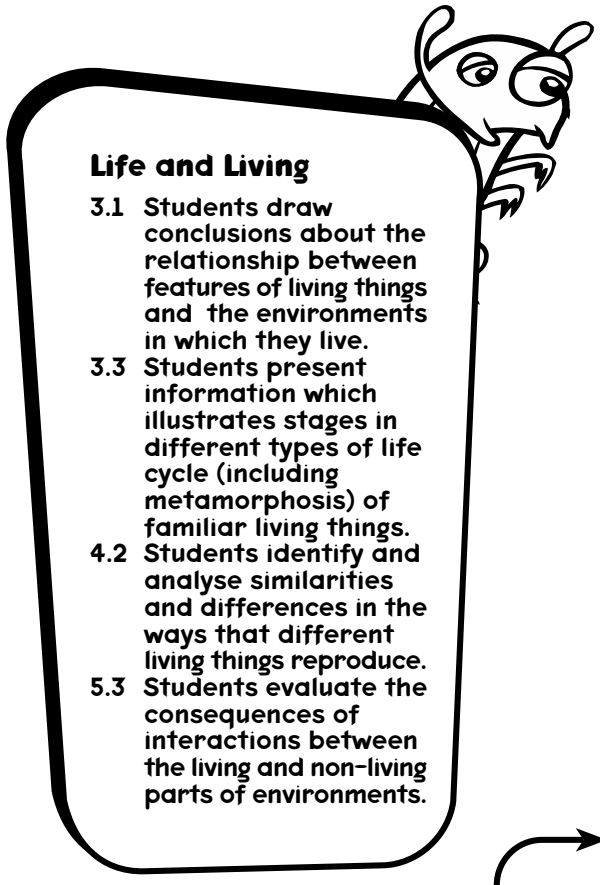
3. With reference to resource sheet 5—*Common dung beetles in Queensland: colour identification sheet,* ask students to examine the size, shape and colour of the beetles to distinguish between different types and determine the species.

4. With reference to resource sheet 4—*Dung beetle data collection sheet*, ask the students to tick off the beetles they think they have found and write down any comments that they would like to make about the beetles. They can then compare the number of introduced species they have found with those on resource sheet 3—*Queensland distribution of common introduced dung beetles*—to see whether they have collected all of the common species known to be present in their region.

5. Once the students are sure they have correctly identified their dung beetles they can move on to the next class activity—making a dung beetle farm. Students then will be able to observe dung beetle activity and interactions.

Students must be instructed not to harm the beetles in any way as they should be returned to a nearby paddock after the identification is done.

Remind students that not all the beetles they find will be on the identification sheet as some may be native dung beetles or among the seven less common introduced species.



Life and Living

3.1 Students draw conclusions about the relationship between features of living things and the environments in which they live.

3.3 Students present information which illustrates stages in different types of life cycle (including metamorphosis) of familiar living things.

4.2 Students identify and analyse similarities and differences in the ways that different living things reproduce.

5.3 Students evaluate the consequences of interactions between the living and non-living parts of environments.

If this activity is conducted after activities 4 and 5 students can use the beetles already collected. Before starting, students should be advised on the ethics of keeping dung beetles. They should be encouraged to think about the needs of the beetles (food, light, temperature—no sun), and who will be responsible for caring for them. (Perhaps a roster could be drawn up.)

6 Making a dung beetle farm

(Source: Adapted from *Bioscan*, 1995)

Focus

Investigating

Aim

To allow students who may not have access to a cattle property the opportunity to observe the tunnelling behaviour of dung beetles.

Materials

- An aquarium or a large plastic ant farm (available from pet shops), measuring about 30 cm high and 45 cm long, with the back and front about 1.5 cm apart.
- Fresh dung.
- Dung beetles (already collected for activities 4 and 5):
  - ➔ 6–8 *Onitis* (= 3—4 pairs of males and females)
  - ➔ or 8–10 *Onthophagus gazella* (4—5 pairs)
  - ➔ or 10–12 *Euoniticellus intermedius* (5—6 pairs).

  Fewer beetles should still give a result. Species can be mixed in lower numbers (e.g. two pairs of *Onitis* plus 3 pairs of *O. gazella*; or four pairs of *E. intermedius)*.
- Moist sand, packed firmly into the farm.

If your container is deeper (front to back) than that specified, cut a piece of glass or polystyrene to form the back so that the chamber has the correct depth, or build a container out of glass or Perspex. A suitable chamber can be made from two sheets of glass (30 cm x 45 cm) held apart at the edges of three sides by 1.5 cm x 1.5 cm wood strips cut to the required lengths. Use small woodworking clamps to hold the chamber together. A lid can be made from gauze or fly wire.

Dung can be kept in a container in a refrigerator for a few days so that more can be added if needed. Use a fridge that isn't used for food storage, (e.g. one that your school uses for science experiments).

This arrangement is not suitable for ball-rollers (Sisyphus).

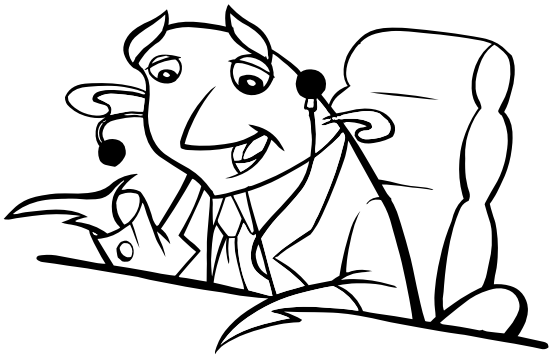
Plasterer's loam or brickie's loam also is suitable.

Sequence | Over a week or more to ensure that some dung beetle activity can be observed

1. Assemble the farm frame.
2. Place the sand/loam in the chamber, leaving room for the dung on top. Firmly pack the sand to a depth of 200–225 mm.
3. Add dung to the sand, leaving 5 cm of space at either side of the mass.
4. Add the beetles and replace the lid on the farm to stop them escaping.
5. The beetles must be fed when the dung dries out or is depleted by beetle activity.
6. Students should take daily observations of the dung beetles' activities, for example:
   - How many beetles are present?
   - How many different species are present?
   - What are the beetles doing?
   - Why do you think they are behaving that way?
   - What other behaviours have you observed (e.g. resting, hiding, feeding, mating, nesting, fighting)?
   - What conclusions can be drawn from these behaviours?
   - How many dung (brood) balls can you see?

Life and Living

2.3 Students make links between different features of the environment and specific needs of living things.
3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.
5.3 Students evaluate the consequences of interactions between the living and non-living parts of environments.



7 Getting to know your dung beetles

Focus
Investigating

Aim
To help students to identify the various species of introduced dung beetles in Queensland and to understand their behaviour.

Materials
- Resource sheet 3—*Queensland distribution of common introduced dung beetles*
- Resource sheet 5—*Common dung beetles in Queensland: colour identification sheet*
- Resource sheet 6—*Agent Doug the dung beetle and his dungbusters!*

Sequence | 60 minutes x 2

Part A

1. Ask students to compile a file on each dung beetle with reference to resource sheets 5 and 6, indicating what their special abilities are and how they work the dung. Ask students to analyse and compare the photos of the beetles and identify what makes each unique. (If you have conducted activities 4–6 already, the students could refer to the dung beetles collected when making their notations.) Their 'D' Files could be illustrated showing what tools and activities each dung beetle has at its disposal.

2. Ask students to choose **one** dung beetle to study further. It may be helpful to ask the students to choose a dung beetle which is found in your region. (See resource sheet 3—*Queensland distribution of common introduced dung beetles* and resource sheet 5—*Common dung beetles in Queensland: colour identification sheet* for more information.) Ask students to prepare a dossier on:
   - how this 'secret agent' operates
   - what its mission is
   - how it goes about 'dungbusting' on an average day.

Part B

Ask students to write a descriptive story or develop a picture book about their chosen dung beetle, highlighting an adventure it could be involved in. Activities of the dung beetle could include:
- collecting dung
- rolling dung
- attracting a female
- burying dung.

Other details could include:
- where in Queensland the beetle might live
- what the land looked like before your 'agent' came along
- how your 'agent' helps the environment
- how your 'agent' competes with the buffalo fly for dung.

Think about other characters who may be in the story such as the buffalo fly, cattle, a farmer, etc. Students might like to illustrate the story and make it into a picture book. This could be used to help educate the wider community about the benefits of introduced dung beetles.

Life and Living

2.2 Students illustrate changes which take place in the course of the life span of living things (including the growth of a plant and animal)

3.1 Students draw conclusions about the relationship between features of living things and the environments in which they live.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

Background notes

In a scientific experiment, scientists try to ensure that all conditions—such as soil type and moisture levels—stay the same. Then, by varying just one condition (a variable) at a time, they look logically at the effect of that one change upon the results. The variables are applied as a series of treatments.

To make sure that the result was not a freak occurrence, several copies, or replicates, of each treatment in the experiment are included. The more replicates, the more sure the scientist is of the validity of the results. In this activity there are 4 replicates of each treatment.

There is always one treatment, known as the control, in which nothing is varied. Here the control (treatment 4) consists of soil alone, without dung or beetles. The control group of pots allows you to measure the contribution that the soil alone makes towards plant growth.

8 Dung beetles and plant growth

(Source: Adapted from the Australian Dung Beetle Program and *Bioscan, 1995*)

Focus

Investigating

Aims

To investigate the effect that the activities of dung beetles can have on plant growth. (It can be linked to other activities that show how dung beetles are an effective tool for sustainable natural resource management.) The activity can be conducted in a classroom situation where there is good natural light.

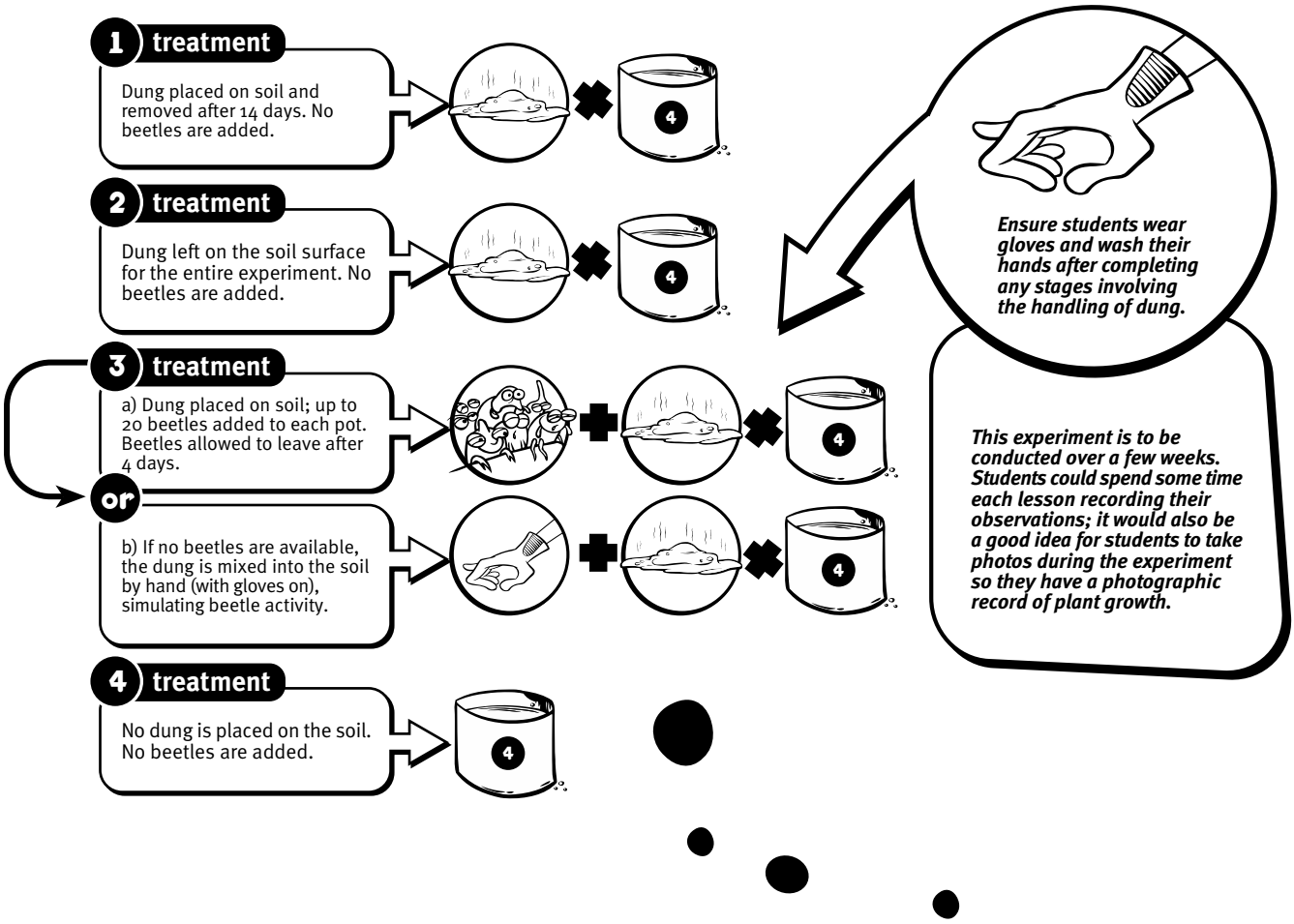
Materials

- 4 lots of 16–20 small dung beetles (e.g. *O. gazella*) (If you can't get dung beetles, conduct the alternative sequence in treatment 3.)
- 12 x 250 g of fresh cattle dung
- 16 plastic flower pots (20 cm diameter, 20 cm high—small squares of weed mat or fibreglass flyscreen in the bottoms will minimise soil loss and help to prevent beetles escaping during burial)
- 16 lids for the flower pots (use gauze and a rubber band to make a lid)
- 16 x 5 kg lots of sand or sandy soil (from the one location)
- 16 x 10 millet seeds (or 16 x 4 sweet corn seeds)
- 16 labels for pots
- Scales or top pan balance
- Disposable gloves
- Ruler or tape measure
- Paper bags
- Resource sheet 7—*Dung beetles and nutrient recycling*
- Optional—camera and film, or a digital camera

Sequence | Over a series of lessons

In the following experiment we will be looking at four different treatments, with four replicates of each.

Table 2: Treatments



Procedure

Day 1

1. Prepare 16 pots, each gently packed with about 5 kg of evenly moistened sandy soil. Leave room for the dung pat at the top, under the mesh cover. Pots in treatment 4 should be set up in the same way, although no dung is added.

2. Label each pot with the number and name of the treatment and the number (or letter) of the replicate.

3. Add 250 g of dung to all pots in treatments 1, 2 and 3.

4. Add the beetles to the pots in treatment 3(a); or mix dung in the soil by hand for treatment 3(b). (Beetles can be collected as for activity 4—*Sampling dung beetles in your local area*.)

5. Fit lids to all pots.

After 4 days

1. Remove the lids from all 16 pots. Do this outside so that beetles can escape from treatment 3 without invading your classroom! Make sure the soil in all pots is still moist. (The lids are not required again.)

2. Plant 10 millet seeds (or 4 sweet corn seeds) in each pot and water carefully, using equal amounts of water per pot. Carefully remove any dry dung from the surface of the pot while you plant the seeds. Remember to replace the dung after sowing, but not so that it will impede the growth of any of the plants.

After 14 days

1. Carefully remove and discard the dung from the surface of the pot used in treatment 1.

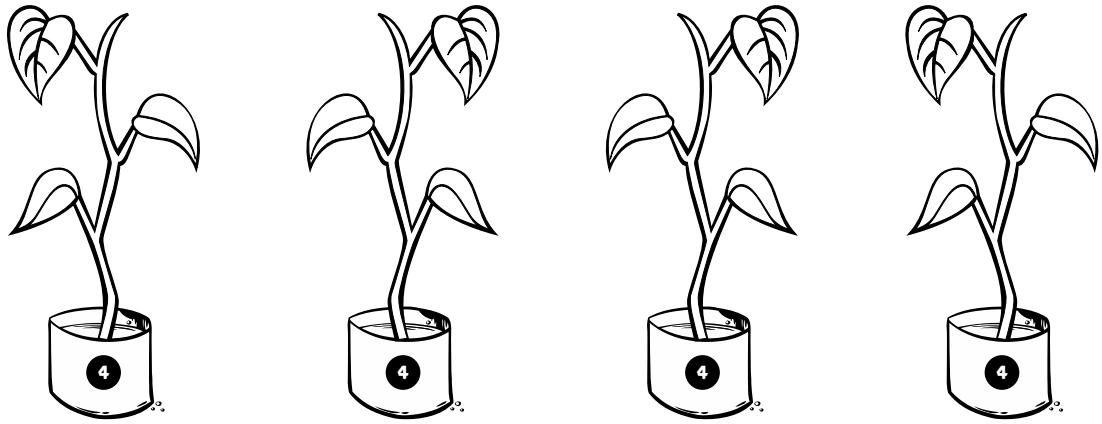
2. Record the germination or growth in all 16 pots and check that the soil is still moist.

3. Water carefully.

Every week

1. Make a record of the plant growth patterns for every pot (e.g. height, number of stems, general appearance) for up to eight weeks. (Remember to keep the pots watered in exactly the same way until the experiment is terminated.)

2. Water more regularly as plants grow.



Results

1. At the end of the experiment, measure the height of each plant (i.e. each stem) in each pot. (You could line the pots up grouped according to treatment and photograph them at this time.) The amount of plant growth can be determined by cutting the stems off at the soil surface.

2. Dry the plant material in paper bags (one bag per pot, with stems cut to fit) in a warm spot for a week. Weigh the total amount of dried plant material produced in each pot.

3. Prepare a table of results, grouping the results for each variable.

4. Work out an average for each treatment by adding the results for the four pots together and dividing by four. Do this for each variable.

5. Ask students if they can see any obvious differences between the treatments.

6. Consider the field situations that the different variables represent:
   - **Variable 1:** Represents a patch of soil on which cattle dung was dropped but removed after 14 days by harrowing so that only the dung fluids were absorbed by the soil.
   - **Variable 2:** Represents a dung pat on soil with no dung beetles about. It receives some added nutrients from dung during pot watering.
   - **Variable 3:** Represents a dung pat that is dispersed by dung beetles on soil.
   - **Variable 4:** Represents the actual soil without any dung or beetles.

7. Did the dung beetles have a noticeable effect on the amount of plant growth?

8. Ask students to break into groups and discuss the questions in points 5 and 7. When they have reached conclusions about the experiment, the results and photographs can be compiled into a class report.

Life and Living

2.3 Students illustrate changes which take place in the course of the life span of living things (including the growth of a plant and animal).

3.1 Students draw conclusions about the relationship between features of living things and the environments in which they live.

3.3 Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.

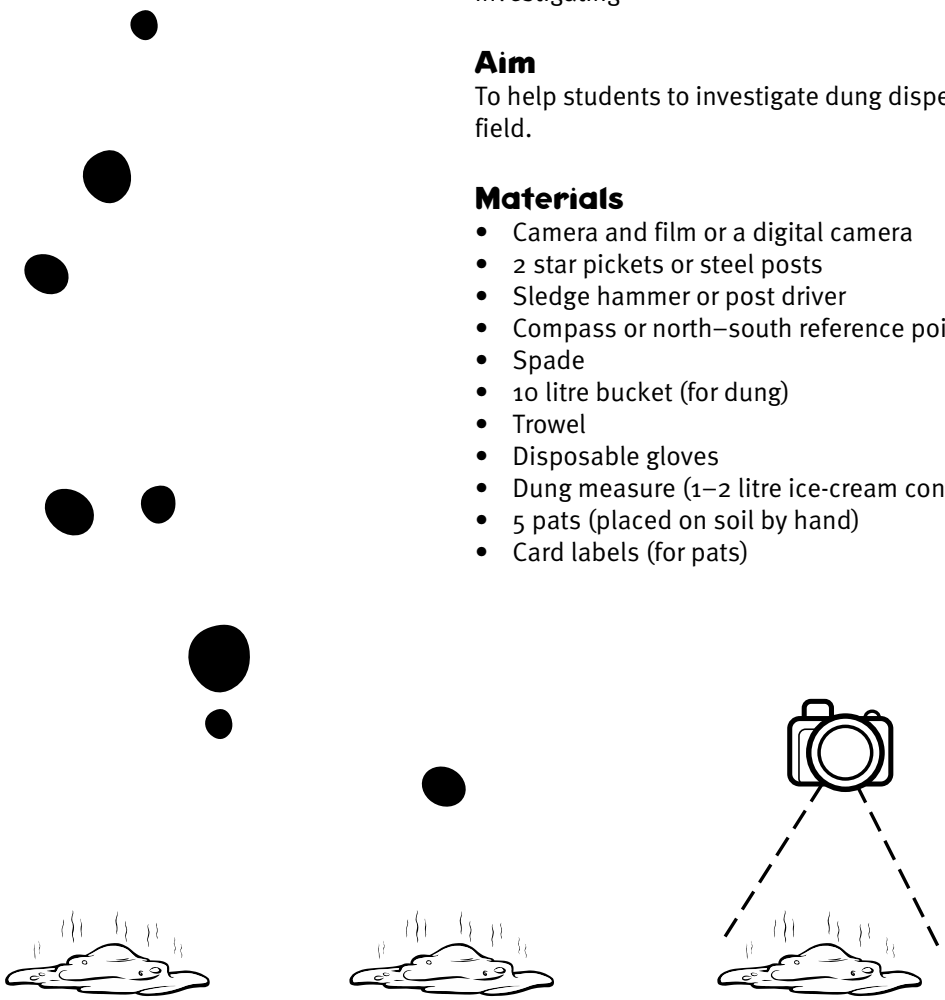
Students in a city area could use this activity to photosequence pots from activity 8. Photosequencing is better for recording sequential shots of dung dispersal (e.g. day of set up, one day after, two days after, three days after, etc).

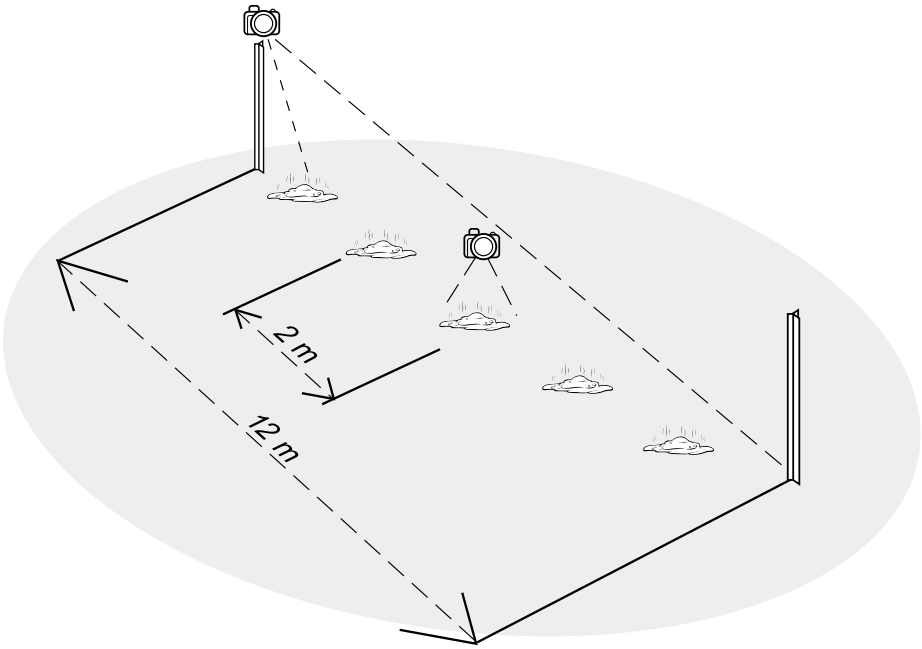
9 Photosequence of dung dispersal

Focus
Investigating

Aim
To help students to investigate dung dispersal in the field.

Materials
- Camera and film or a digital camera
- 2 star pickets or steel posts
- Sledge hammer or post driver
- Compass or north–south reference points
- Spade
- 10 litre bucket (for dung)
- Trowel
- Disposable gloves
- Dung measure (1–2 litre ice-cream container)
- 5 pats (placed on soil by hand)
- Card labels (for pats)





Sequence | Over a series of lessons in the summer months. (Time the activity to coincide with noticeable dung beetle activity in the field.)

To help monitor the activities of dung beetles—including how they help with plant growth in pastures—it is important to keep a record. One way you can do this is by taking a sequence of photographs over time. If your camera has a date feature on it this will help to keep the photographs in order; otherwise, record the date on a card and keep it with the photograph.

Photosequence procedure
(Source: Adapted from *PastureWatch Field Activities,* p.33)

1. Drive in two star pickets or posts 12 metres apart in a north–south direction on your chosen site in, or near, a cattle paddock. These posts should be permanent as they mark a standard site where pats are lined up and photographs are taken. Avoid areas with tall grass.

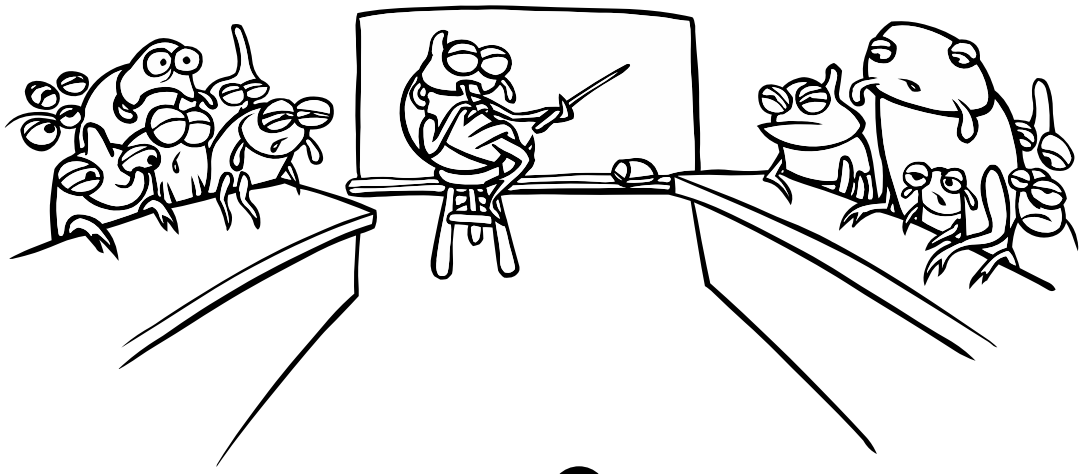
2. Use the spade to shave the grass off the soil surface (to 250 mm diameter) so each pat is 2 metres apart. This is to facilitate beetle activity. Use the trowel to fill the dung measure and then place five pats on the prepared sites.

3. Label pats for continuity (e.g. card with pat number and date for photographs).

4. Photograph each fresh dung pat close up, for detail, and the group of pats from a distance, with one of the pegs as a rest for the camera.

5. Conduct this activity over a number of days, weeks, or months, depending on the time available. In time, only close-up photographs may be possible due to pasture growth.

6. Compile photos in an album and record observations of the site over the course of the experiment. Observations could include:
   - the size of the pat or the extent of dung dispersal
   - any change in adjoining plant growth
   - other changes to the pats and surrounding area.



10 Debate: 'introduced dung beetles are good for Queensland's environment'

Place and Space

5.5 Students evaluate ideas concerning sustainability to identify who may benefit and who may be disadvantaged from changes to an Australian industry.

Systems, Resources and Power

3.3 Students apply the principles of democratic decision making in cooperative projects.

5.3 Students use a structured decision making process to suggest participatory action regarding a significant current environmental, business, political or legal issue.

Focus

Investigating, understanding, communicating

Aim

Students debate whether the introduction of dung beetles into Queensland has had a positive effect on our environment.

Materials

- Internet access
- Resource sheet 8—*Conducting a debate*

Sequence | 40 minutes x 3

1. Conduct this activity over a series of lessons to allow students to research their topic and prepare their arguments. Ideally, in the first session you would discuss how to conduct a debate, in the second session students would conduct their research, and in the third session the debate would be held.

2. Ask students to break into groups of nine. Each group should then break into three groups of three—one will be 'for' introduced dung beetles and the other will be 'against'. The three people remaining will be allocated the role of adjudicator, chairperson or timekeeper. If there are too many students, some could be researchers and then, later, the audience. Regardless of their specific role, all students should be involved in some aspect of the research.

3. Using the available research material, students should think of all the arguments for, or against, the statement: introduced dung beetles are good for Queensland's environment.

Note: In the case of secondary students, the results from their research and the debate could be compiled into a report that would highlight their research skills, methods of argument, referencing skills, etc.

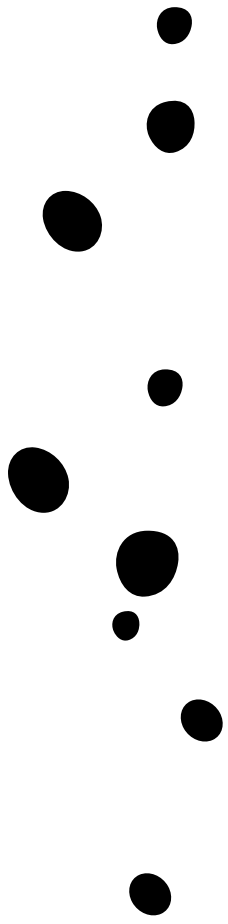
There are quite a few interesting sites that are fun to use and provide information about dung beetles. (See Other support information and references, p. 11.)

Such a debate also could be staged at a community meeting.

Systems, Resources and Power

3.3 Students apply the principles of democratic decision making in cooperative projects

5.3 Students use a structured decision making process to suggest participatory action regarding a significant current environmental, business, political or legal issue.



11 Local area study

Focus
Understanding, making decisions, communicating

Aim
Help students to plan:
- an investigation of land degradation in their local area (or an area they are familiar with)
- how the *Dungbusters!* program could be of use in tackling local land degradation issues
- programs which are based on valid decision making and sound management.

Materials
Resource sheet 9—*Developing a project plan*

Sequence | 40 minutes x 2
1. Working in small groups, students identify the relationship between dung, dung beetles (or other natural resource management issue) and environmental issues in their local area (or an area they're familiar with).

2. Students follow the steps outlined in the project plan (see resource sheet 9—*Developing a project plan*) to develop strategies to overcome the problem. Students should use their research from previous activities to ensure they have a balanced perspective of the social, economic and environmental factors in their solution.

3. At each stage of the problem-solving process students record their ideas under the headings given in the model. In a short oral presentation they then outline their problem and its proposed solution to the rest of the class.

Science and Society

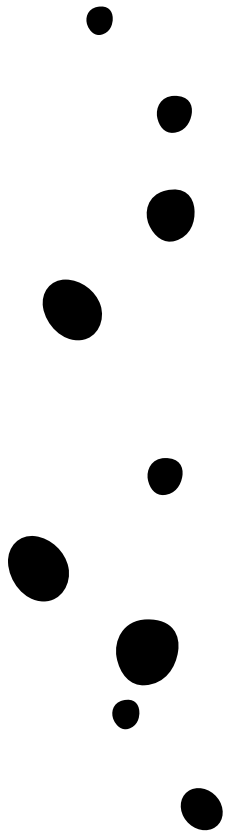
4.3 Students present analyses of the short and long-term effects of some of the ways in which science is used.

6.3 Students use scientific concepts to evaluate the costs and benefits of applications of science

Systems, Resources and Power

3.3 Students apply the principles of democratic decision making in cooperative projects

5.3 Students use a structured decision making process to suggest participatory action regarding a significant current environmental, business, political or legal issue.



12 Where to from here?

Focus

Communicating, evaluating

Aim

Students are to use the information they have gathered throughout the *Dungbusters!* module to report back to their local community or case study area, for example, to a local landholder or landcare group. (This may encourage the establishment of a *Dungbusters!* program in their community.) They are also encouraged to reflect on the program and the information they have found.

Sequence

1. Ask students to reflect on the information gathered during the investigating phase to identify what their results mean for a property management plan. (See resource sheet 10—*Property planning*.)

2. To generate initial discussion, ask students to identify ways in which dung beetles can be of help to landholders and what benefits they can bring to a cattle property.

3. Students should find out whether local landholders and/or landcare groups were involved in the Queensland Dung Beetle Project in their local area. (This information is available from their local Department of Primary Industries office or landcare representative.) If students find out that landholders and/or landcare groups in their local area have been involved, they could organise to visit them and report back to the rest of the class on what they have learnt.

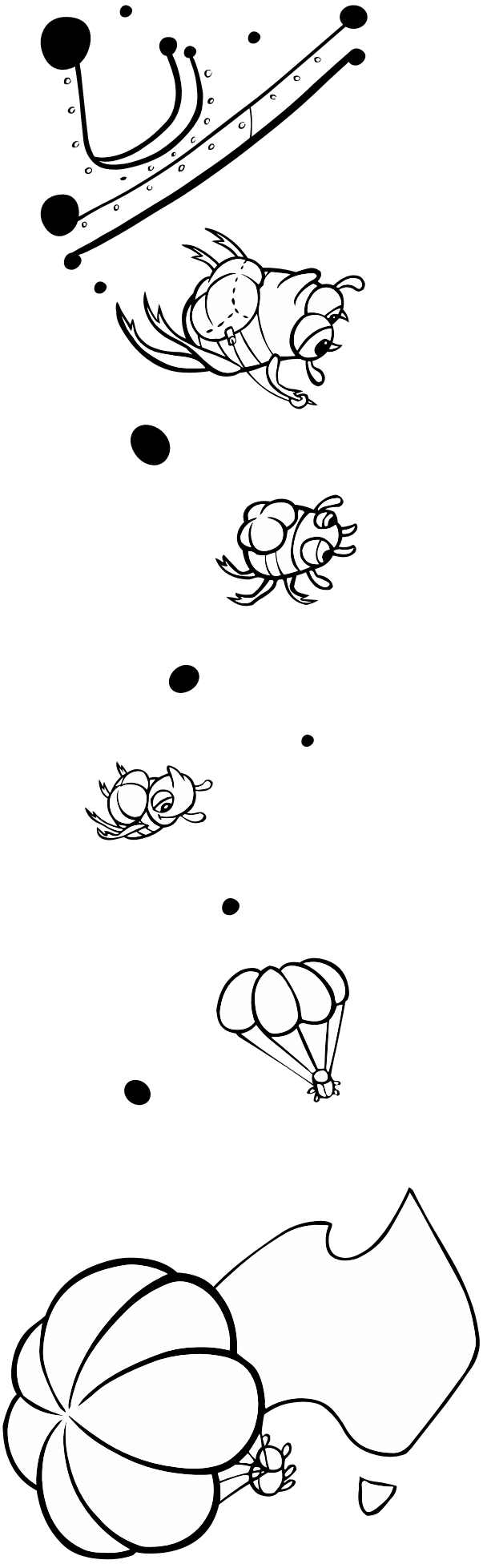
4. Students could survey local landholders to see how effective they believe the introduction of dung beetles on their property has been in controlling fly pests, preventing environmental problems and reducing costs. They should also ask about the associated social and economic impacts—both good and bad.

5. Students should evaluate their own actions when the program is underway in the community. They could survey local landholders or hold a forum at which community members are invited to express their views about the effectiveness of the program.

6. Students could also write accounts of what they have learnt from the *Dungbusters!* module and communicate these through local newsletters (e.g. school, P&C, local landcare group, local newspaper).

Resource sheets

1. Dung beetles arrive in Australia!
2. Operation ‘Dung Beetle’
3. Queensland distribution of common introduced dung beetles
4. Dung beetle data collection sheet
5. Common dung beetles in Queensland: colour identification sheet
6. Agent Doug the dung beetle and his dungbusters!
7. Dung beetles and nutrient cycling
8. Conducting a debate
9. Developing a project plan
10. Property planning



Resource sheet 1

Dung beetles arrive in Australia!

When the First Fleet arrived in Australia in 1788 they brought five cows, two bulls, seven horses and forty-four sheep, all of which started producing dung as soon as they arrived. The problem was that they forgot to bring the right kinds of dung beetles with them to get rid of all the dung that the cattle would produce.

Australia's landscape has changed a lot since that time. Trees have been cleared for farming and to make way for plants and animals that didn't normally live in Australia. Now, over 12 million cattle dung pats are dropped onto our soil every hour. On average, cattle 'poo' about 12 times per day, producing about 18 kilograms of dung. (This does not include all the dung made by sheep and other animals.)

We do have some dung beetles that belong to Australia (native beetles), but these mainly attack the dung of our native marsupials such as kangaroos and wombats. Although most native dung beetles can't disperse the huge pats that cattle produce they are attracted to cattle dung—sometimes in large numbers.

Since cattle arrived in Australia their dung has provided an abundant source of food for fly pests such as the introduced buffalo fly found in northern Australia and the native bush fly found throughout our continent. One undisturbed cattle dung pat can produce over a thousand bush flies under certain conditions.

What is the solution? Bring in the dungbusters—the dung beetles.

Resource sheet 2

Operation 'Dung Beetle'

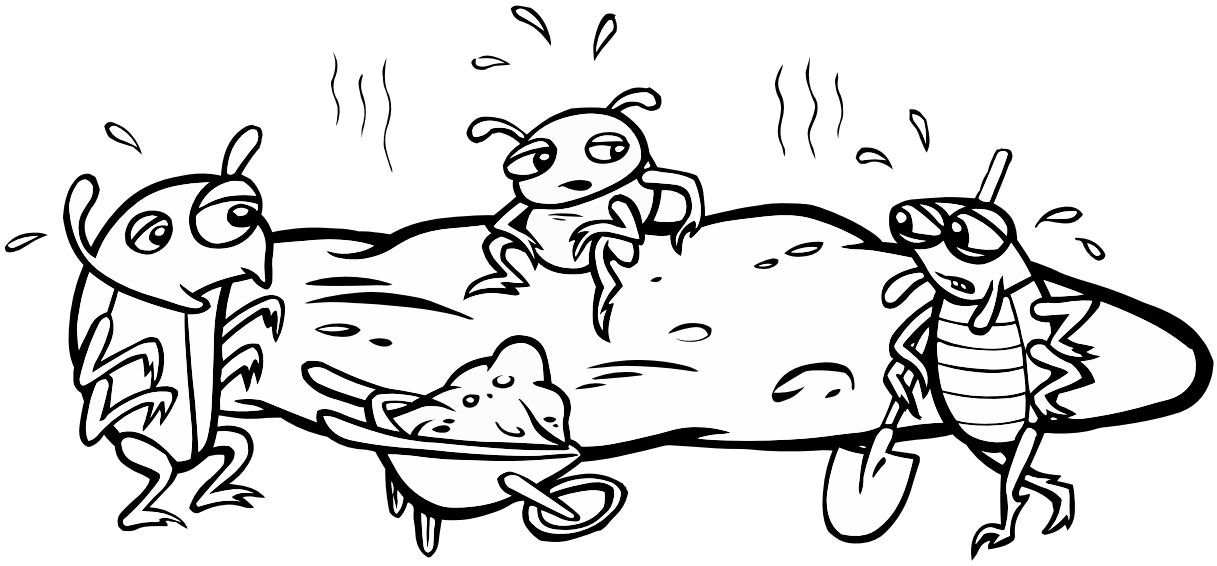
Dung beetles were introduced into Australia from Africa and Europe to bury and disperse dung. Forty-three species of dung beetle were released during the 1970s and early 1980s. By attacking the dung, these clever little beetles help to control the fly pests that breed in the pats, and provide other agricultural and environmental benefits.

The process of dung burial and dispersal:

- removes breeding habitat for some fly pests and other parasites of livestock, helping to reduce their numbers
- helps nutrient recycling by exposing dung to soil microbes, earthworms and plant roots
- improves water infiltration and aeration of soil by generating a network of underground tunnels
- reduces pasture fouling and nutrient run-off into waterways.

Some questions to think about:

- What happened to cow dung before dung beetles from overseas were released into Australia?
- What effect would having no dung beetles to attack dung in Australia have on our environment and on us?
- What are the benefits of introducing dung beetles into Australia?



Resource sheet 3

Queensland distribution of common introduced dung beetles

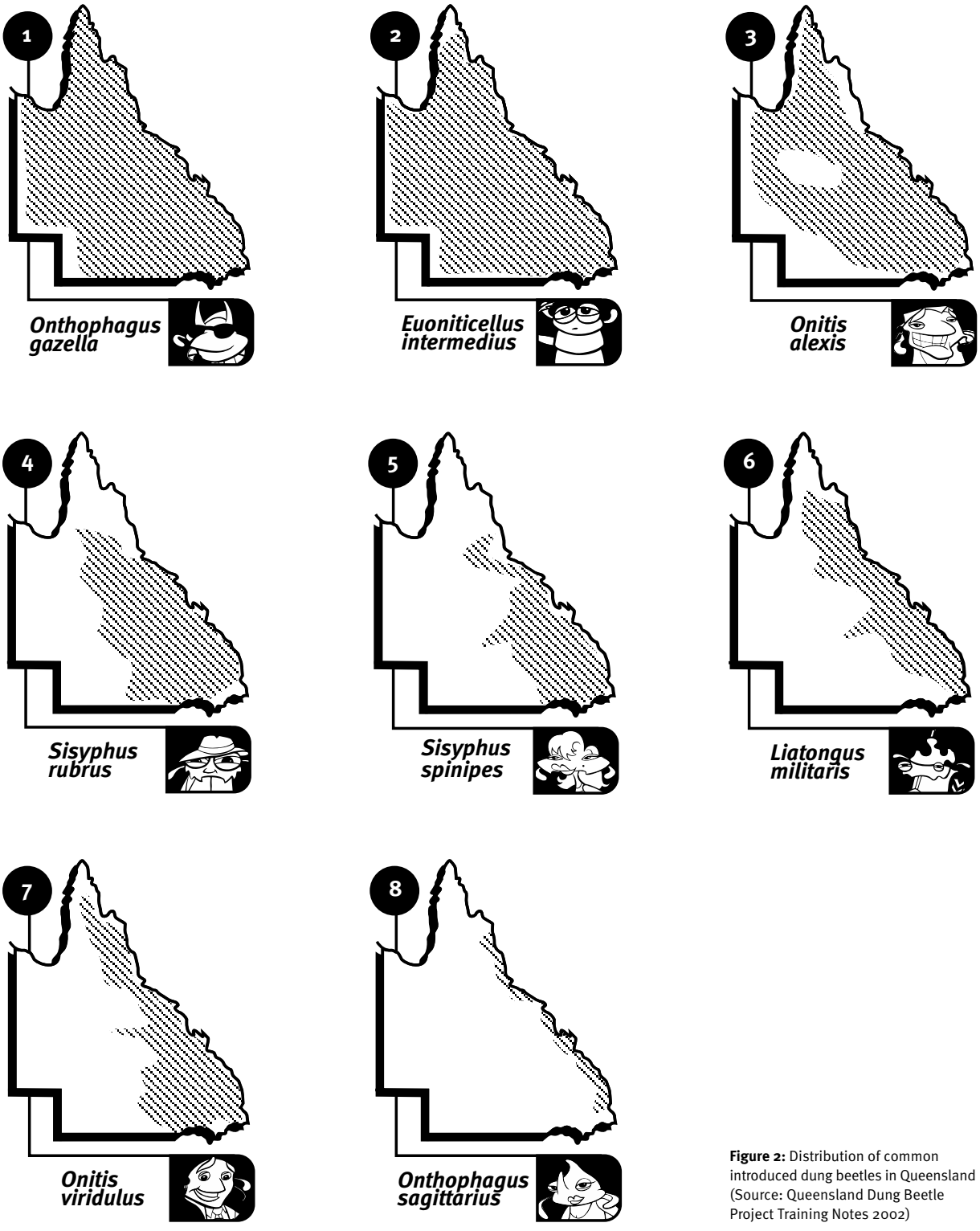


Figure 2: Distribution of common introduced dung beetles in Queensland (Source: Queensland Dung Beetle Project Training Notes 2002)

Resource sheet 4 Dung beetle data collection sheet

Your name:.....

Collected from:.....

Date of collection:.....

Collection details:.....

How many dung pats did you check for dung beetles?

Yes, I found this type	Name of dung beetle (species)	Comments (e.g. 'only found one'; 'lots in sample')
☐	*Onthophagus gazella*	
☐	*Onitis alexis*	
☐	*Onitis viridulus*	
☐	*Euoniticellus intermedius*	
☐	*Liatongus militaris*	
☐	*Onthophagus sagittarius*	
☐	*Sisyphus spinipes*	
☐	*Sisyphus rubrus*	

Did you find any other species of dung beetles?

Description (e.g. 'tiny brown one')	Comments

Resource sheet 5

Common dung beetles in Queensland: colour identification sheet

Onitis viridulus

- large (1.5–2.5 cm length)
- uniform dark metallic green or black on the thorax and wing covers
- males have a broad, thin, unequal double spur on the rear edge of the hind leg

Onitis alexis

- large (1.5–2 cm length)
- thorax with green or red hue and light brown wing covers, giving a two-tone effect
- males have a sharp, hooked spur, resembling a rose thorn, on the rear edge of the hind leg
- females have a small 'bump' at the rear of the head

Onthophagus gazella

- medium-sized
- brown wing covers, often with small pale patches near the front and rear, and a darker brown thorax, giving a two-tone effect
- body shape is rounded (when viewed from above)
- males have a pair of horns at the back of the head, which are better developed in major males; females look similar, but are without horns

Sisyphus spinipes

- long, thin middle and hind legs
- entirely brown to matt black-coloured body
- males have a dark-coloured spur at the base of the hind femur, which is small in minor males, and a sharp angle on the rear edge of the hind leg

actual size of beetles

Onthophagus sagittarius

- small to medium-sized
- thorax and wing covers are uniformly bronze—brown (i.e. not two-tone)
- deeper through the body than *O. gazella* (when viewed from the side)
- males have two small horns near the front of the head
- females have one large horn on the head and one on the thorax (much reduced in minor specimens)

Sisyphus rubrus

- light brown to light yellow–brown body (smaller and lighter-coloured than *S. spinipes)*
- long, thin middle and hind legs that are usually paler in colour than the body is
- males have a large, pale-coloured spur at the base of the hind leg, which is small in minor males (and not present in females)
- rounded rear edge on hind leg of male

Euoniticellus intermedius

- small and narrow
- yellow–brown or straw-coloured with a faint diamond-shaped pattern on thorax
- males have a blunt horn on the head
- females are without horns
- undersides of legs are uniformly pale yellow

Liatongus militaris

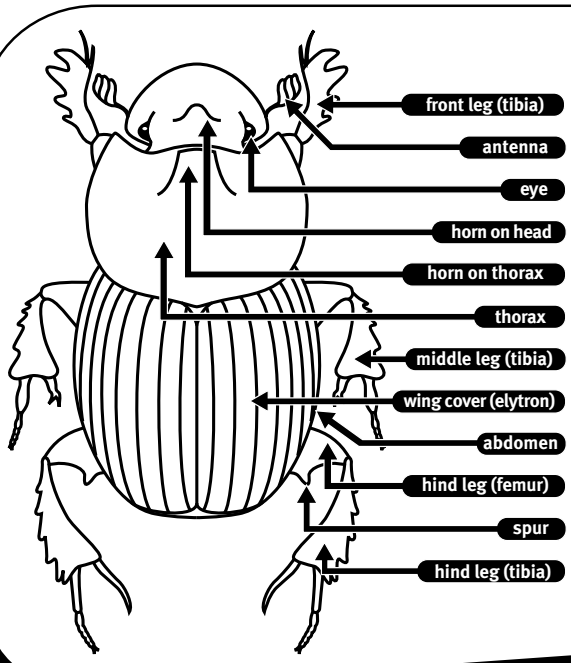
- small, narrow and elongated
- dark brown or black, with pale patches on sides and 'shoulders' of thorax
- wing covers have broken black stripes running lengthwise
- major males have a small pointed horn on the head

Resource sheet 6

Agent Doug the dung beetle and his dungbusters!

Secret weapons—The special features of the dung beetle which make 'dungbusting' possible

Refer to the diagram and list the characteristics of the dung beetle that would help with dungbusting. Identify why it would be an effective dung-fighting tool (e.g. feature: antennae; benefit: help to find dung or alert the agent to the presence of enemies).



Feature

Benefit

Agent Doug's 'D' Files—As part of your investigations complete iD cards for each 'secret agent'.

The Tunnellers

Secret Agent 1

Name | *Onitis viridulus*

Code name | Agent Viri

Statistics |

Special skills or features |

Secret Agent 2

Name | *Onitis alexis*

Code name | Agent Alex

Statistics |

Special skills or features |

Secret Agent 3

Name | *Onthophagus gazella*

Code name | Agent Gaz

Statistics |

Special skills or features |

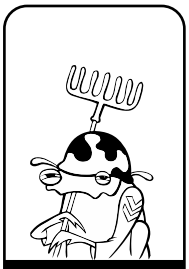
Secret Agent 4

Name | *Onthophagus sagittarius*

Code name | Agent Sagi

Statistics |

Special skills or features |



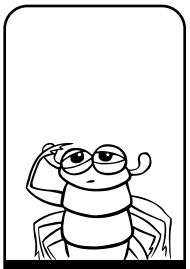
Secret Agent 5

Name | *Liatongus militaris*

Code name | Agent Mili

Statistics |

Special skills or features |



Secret Agent 6

Name | *Euoniticellus intermedius*

Code name | Agent Inter

Statistics |

Special skills or features |

The Rollers

Secret Agent 7

Name | *Sisyphus spinipes*

Code name | Agent Spines

Statistics |

Special skills or features |

Secret Agent 8

Name | *Sisyphus rubrus*

Code name | Agent Ruby

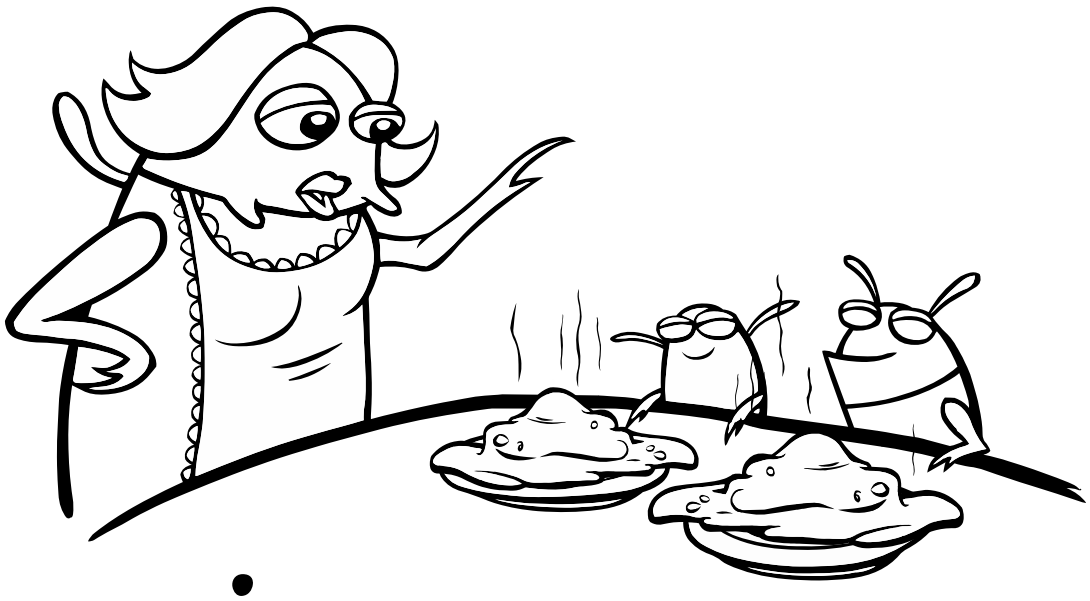
Statistics |

Special skills or features |

Resource sheet 7

Dung beetles and nutrient cycling

(Source: Adapted from *Bioscan*, 1995)



One of the main (macro) nutrients in cattle dung is nitrogen (N), which is also one of the building blocks used to make proteins. The other two are potassium (K) and phosphorus (P). Micro-nutrients in dung include calcium, magnesium, sodium, iron, manganese and copper.

Dung beetles digest the bacteria from dung fluids and then use these nutrients to maintain their strength so that they are able to dig and fly.

If dung is left on the soil surface, some nitrogen is converted to ammonia and nitrogen gas and is lost into the atmosphere. When dung is rapidly buried below the surface much of the nitrogen is eventually turned into nitrates, which are absorbed by plant roots and used as building blocks for growth. Thus, the beetles help to minimise nitrogen loss and recycle it by returning it through the soil to the plants, along with all the other nutrients in buried dung.

Resource sheet 8 Conducting a debate

Speakers

In a debating team speakers have specific roles to play in a specific order to fulfil their part in the team:

1st affirmative
Must:
- define the topic
- briefly outline what each speaker in their team will talk about.

1st negative
Must:
- present the negative team's ideas on the topic
- briefly outline what each of the negative speakers will say
- rebut a few of the main points of the first affirmative speaker (for approximately one quarter of their allocated time).

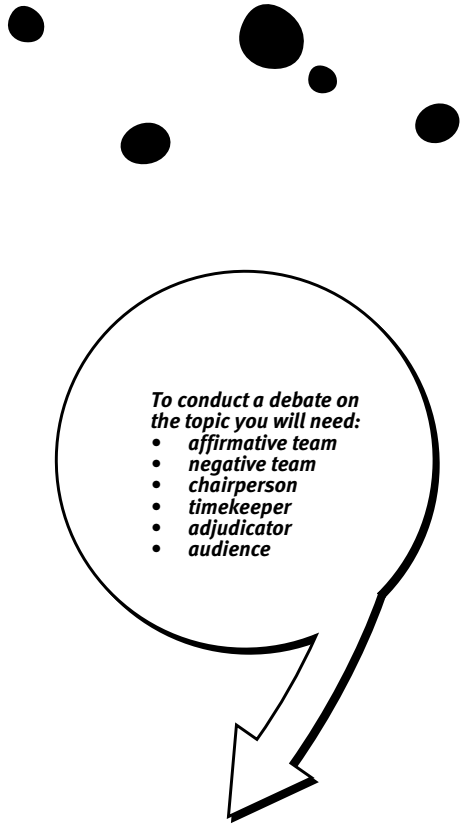
2nd affirmative
Must:
- tell the audience the affirmative team's main arguments again
- rebut the main points presented by the 1st negative (for approximately one third of their allocated time).

2nd negative
Must:
- reaffirm the negative team's arguments
- rebut some of the main points of the affirmative team's case (for approximately one third of their allocated time).

3rd affirmative
Must:
- reaffirm the affirmative team's argument
- rebut all the remaining points of the negative team's case (for approximately two-thirds to three-quarters of their allocated time)
- present a summary of the affirmative team's case
- finish off the debate for the affirmative.

3rd negative
Must:
- reaffirm the negative team's argument.
- rebut all the remaining points of the affirmative team's case (for approximately three-quarters of their allocated time)
- present a summary of the negative team's case
- finish off the debate for the negative.

Note: Neither third speaker is allowed to introduce new parts of their team's cases.

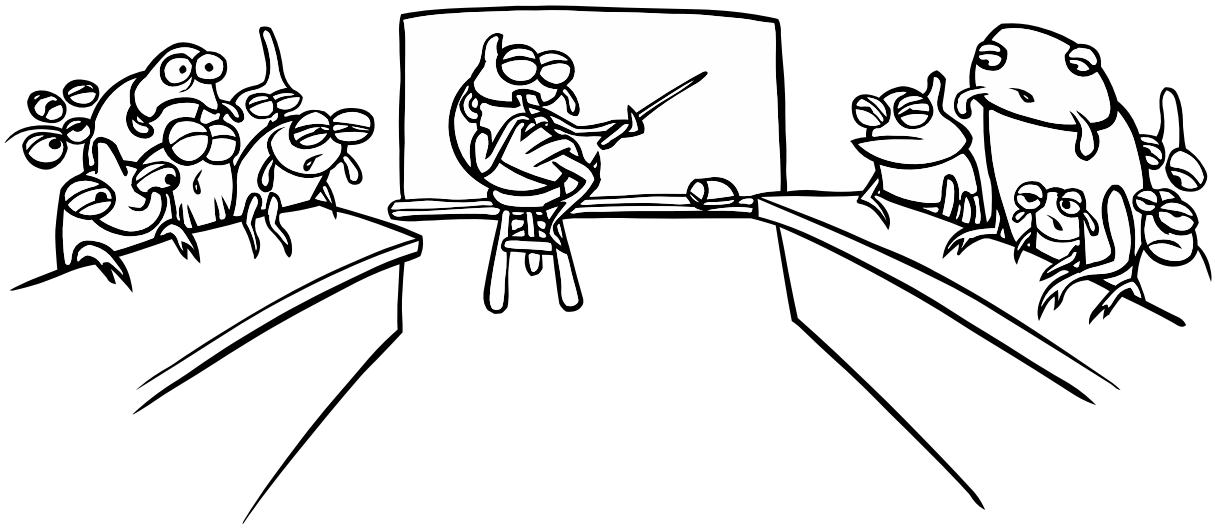


Affirmative team

The affirmative team will consist of three speakers whose job is to agree with the topic. The affirmative team will speak first in the debate. The team should sit on the right hand of the chairperson in order (from nearest the chair): 1st, 3rd, 2nd. This is to make it easier for the first and second speakers to pass rebuttal material to the third speaker. (Rebuttal is when you get to say why the other team's arguments are not correct and argue against them.)

Negative team

The negative team will consist of three speakers whose job it is to disagree with the topic. It will consist of three speakers. The negative team will speak last in the debate. The team should sit on the left hand of the chairperson in order (from nearest the chair): 1st, 3rd, 2nd. This is to make it easier for the first and second speakers to pass



Chairperson

The role of the chairperson is to control the debate. Their first duty is to call the debate to order and to welcome those present.

He or she should then announce the topic of the debate, the name of the adjudicator, and the names of the teams that are participating.

Next, she or he should tell the speakers and the audience how long each speech will be, giving the minimum and maximum times, and calling upon the timekeeper to demonstrate the sound of the bell.

The chairperson should then introduce the first speaker of the affirmative team to open the debate and then sit down.

After that speaker has concluded his or her speech the chairperson should wait for the adjudicator's 'okay' before announcing the first speaker of the negative team.

This process should continue throughout the debate, with the speakers called for in the following order:

1. 1st affirmative
2. 1st negative
3. 2nd affirmative
4. 2nd negative
5. 3rd affirmative
6. 3rd negative

A typical chairperson's presentation might go as follows:

> **Hello fellow students and welcome to today's debate. The topic for this debate is ‹topic›. Today, for the affirmative we have 'team name' and for the negative we have (team name). Our adjudicator is ‹name›.**
>
> **The speaking times today will be ‹minimum speaking time› to ‹maximum speaking time›. There will be a bell at ‹minimum speaking time› minutes [timekeeper demonstrates the bell] and a second bell at ‹maximum speaking time› minutes [timekeeper demonstrates the bell].**
>
> **I would now like to call upon the first speaker of the affirmative team ‹name› to open the debate.**
>
> **I would like now to call upon the adjudicator ‹name› to give the decision on today's debate.**

Timekeeper

The timekeeper times how long each speaker speaks and rings a bell to indicate that certain amounts of time have passed.

Adjudicator

The adjudicator decides who has won the debate. He or she marks the teams on how well they have developed their arguments and how well they have prepared the rebuttal against the other team. At the end of the debate he/she tells the audience who has won and why.

Resource sheet 9 Developing a project plan

Formulating a sustainable management plan for a natural resource management issue in your local area may seem like a huge task; however, breaking down your planning into stages will enable you to think about all the processes need to complete.

Project plan

Under the headings that follow, write down how you might complete each section of the planning process:

1. Identify the issue
2. Investigate the problem
3. Evaluate the facts
4. Evaluate the actions that could be taken
5. Predict outcomes—if we do that, what then?
6. Select the best action(s)
7. Implement the action(s)
8. Evaluate the actions—how did it go?

You may have only a few ideas at first and be able to fill out more later on. You might like to enlarge this sheet on a photocopier or copy it on to cardboard posters to put up on the wall of your classroom. This will help you to stay on track with your planning!

Resource sheet 10 Property planning

Property plans—When should they be prepared?

Property planning is a process whereby landholders can consider personal, financial and natural resource management issues involved in farm business management. (The Future*profit* program of workshops provides guidance throughout this process.)

Landholders also may need to prepare a property plan to fulfil a requirement of government or to be eligible for some forms of financial assistance.

By understanding the purpose of the various approval processes, landholders can avoid unnecessary duplication when collecting and presenting information. An integrated overall plan for the development and management of a property should also meet the needs of assessment and approval bodies.

Property plans include a map based on aerial photography or a satellite image, depending on property size.

Land and water management

Land and water management plans (LWMP) were introduced in 1996 to guide the sustainable use of water allocations. Their aim is to ensure that land and water management practices do not have an adverse impact on water resources or watercourses.

The *Water Act 2000* specifies that a LWMP is required before using new or additional water allocations for irrigation purposes, such as those purchased at auction or under permanent trading arrangements. A LWMP may also be required where specified in a water use plan (a plan relating to water use prepared in consultation with community and industry stakeholders).

A LWMP should show soils, topographic and flood-related information, wetlands, and saline areas. Planned improvements such as water storages, bores, pumping plants, channels, power lines, chemical and fuel storage, drains and levee banks should also be shown. The plan must include a report describing how the land and water resources will be managed sustainably.

Vegetation management

The retention and management of native vegetation requires careful planning. Clearing of vegetation on leasehold land is managed under the *Land Act 1994,* and on freehold land under the *Vegetation Management Act 1999*. Landholders are required to prepare a property vegetation management plan (PVMP) as part of an application to clear remnant vegetation on leasehold or freehold land.

A PVMP could include natural features or improvements, regional ecosystem types, areas of high nature conservation value or areas vulnerable to land degradation, stands of commercial timber, areas of land already cleared, and areas proposed to be cleared, the method of clearing, proposed land use after clearing, likely follow-up operation to control regrowth, any planned revegetation or rehabilitation and any other information prescribed under the *Land Regulation 1995* or the *Vegetation Management Regulation 2000*.

Soil conservation plans

Soil conservation plans show how measures such as contour banks and waterways coordinate run-off through one or more properties as part of a catchment. If a soil conservation plan affects upper or lower landholders, the *Soil Conservation Act 1986* provides a process through which the plan can be approved. Such plans are prepared with input from all parties affected, including road and rail authorities.

Land management and water conservation plans for taxation purposes

Land management plans are required when landholders wish to claim a tax deduction or a rebate for the erection of fences that improve the management of different land classes according to their capability.

Water conservation plans are required when landholders wish to claim a drought investment allowance for water storage and conveyancing equipment.

Assistance from QRAA

The Queensland Rural Adjustment Authority (QRAA) provides concessional loans for landcare-related activities. The application must include a plan indicating the location of the proposed activities and an outline of proposed strategies aimed at long-term management of the landcare activity.

Applicants seeking support through the Desert Uplands or South West Strategy schemes need to prepare a property management plan.

Nature conservation plans

Nature conservation plans help to identify areas of native vegetation to be retained for wildlife habitat, shade and shelter; timber and non-timber products; drought fodder; and honey production. Native vegetation improves the aesthetic appearance of a property can add to its market value, and contribute to a catchment or regional nature conservation strategy.

Advice and assistance for incorporating nature conservation in property planning can be obtained from the local Queensland Parks and Wildlife Service extension officer. The Land for Wildlife program also assists landholders to develop management plans through their local council.

Pest management plans

Landholders with significant pest problems should develop and implement a pest management plan. Some local governments are encouraging landholders to develop and implement pest management plans as a means of fulfilling their statutory obligations to control declared plants and animals. Such plans should normally be consistent with the Pest Management Plan for the local government area.

Environmental Protection Act—planning requirements

The *Environmental Protection Act 1994* places an obligation on everyone to care for the environment and to avoid environmental harm. To provide guidance to landholders in achieving this, the Queensland Farmers Federation has released the *Environmental Code of Practice for Agriculture*. More detailed codes have been, and are being prepared for specific rural industries.

A property plan would assist landholders in planning the use and management of their land and in demonstrating conformity with the relevant code of practice.

Under the Act, all 'environmentally relevant activities' (ERA) (such as feedlotting, and pig and poultry farming) need to be authorised by the issuing of a development approval and, for level 1 ERAs, an environmental authority. As part of the approval the applicant may be required to prepare an environmental management plan that addresses issues such as waste management, water resource management, noise, dust and odour.

Sugar cane assignments

Canegrowers wishing to expand their production area may be required to submit a plan of their proposed development to the local cane production board prior to obtaining approval to grow cane and supply a local sugar mill.

Local government needs

Under the *Integrated Planning Act 1997* and planning schemes prepared under the Act some local governments may require landholders to obtain development approval for changes in land use. Examples could include the conversion of grazing land to intensive agriculture (such as cotton, sugar cane or horticulture), harvesting of native forests, or establishment of timber plantations.

Property plans showing areas proposed for development and measures to protect environmental features may be needed as part of an application for development approval.

Further information

For more detailed information see the *NRM Facts* series available at ‹www.nrm.qld.gov.au›.