Level

F	1	2	3	**4**	**5**	**6**	B6

Consequences of interactions in the environment

Strands
Life and Living, Earth and Beyond

Key concepts
Environments are dynamic and have living and non-living components which interact.

Living things use the resources of the Earth, solar system and universe to meet their needs.

Purpose

Activities in this module are designed to help students understand that:

- there are consequences of the interactions that occur between living and non-living parts of the environment;
- applications of science have been influenced by changes in social attitudes;
- the Earth, the solar system and the universe are different types of resources which may be used for different purposes.

Students have opportunities to:

- investigate issues related to ecology and the management of ecosystems;
- understand the factors that may influence community decisions about the way science is applied in the management of ecosystems, and the consequences of these decisions;
- describe and justify preferred management options for ecosystems.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
Uses of forests — concept map	Biodiversity	Property planning
Interactions	Forest management	
	Protecting forest wildlife	
	Assessing waterways	
	Conservation planning	

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Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Life and Living

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 environments.

6.3 Students prepare scenarios to describe the potential long-term effects of changes in biodiversity caused by human action on ecosystems.

Earth and Beyond

5.3 Students prepare scenarios about the use of renewable and non-renewable resources of the Earth and beyond.

Core content

This module incorporates the following core content from the syllabus:

Life and Living

Components of environments — biotic/abiotic

Types of environments — aquatic/terrestrial

Features of different environments

Natural relationships

- interactions between living things
  - predator/prey
  - food chains/webs
  - competition for resources
- interactions between living and non-living things to meet needs
- interactions between non-living things
  - effects on environments

Human influence

- changes in biodiversity — conservation, preservation, introduced species
- modification of habitat
  - agricultural practices — grazing
  - urbanisation
  - tourism/ecotourism

Earth and Beyond

Using the Earth's environment

- to obtain needs — water
- for human recreation — waterways, roads, farms, built environment

Caring for the environment

- managing human impact on land, water and the atmosphere

Information as a resource

- for making predictions
- for considering ideas of futures and sustainability

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once satisfied that sufficient information has been collected, teachers may make judgments about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to give teachers an indication of the pattern of behaviour to look for when making judgments.

Life and Living

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

Students may:

- conclude that non-living things interact with each other — for example, water evaporates, water washes away soil when it rains and erodes creek banks;
- generalise about the interactions between living and non-living components of an ecosystem;
- use information from food webs to make inferences about changes to an ecosystem caused by changes in the numbers of one species;
- analyse the interactions between the living things in an ecosystem.

Life and Living

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

Students may:

- describe the interaction between human actions and changes in biodiversity;
- identify relationships between water quality and species living in a stream;
- identify relationships between the condition of riparian vegetation and the health of an aquatic ecosystem;
- infer the implications of management practices for forest ecosystems;
- evaluate ways of organising wildlife refuges.

Life and Living

6.3 Students prepare scenarios to describe the potential long-term effects of changes in biodiversity caused by human action on ecosystems.

Students may:

- describe the consequences of reduced biodiversity for ecosystems, local economies and communities;
- recommend methods of reducing the impact of human activities on native species.

Earth and Beyond

5.3 Students prepare scenarios about the use of renewable and non-renewable resources of the Earth and beyond.

Students may:

- evaluate the possible consequences of various patterns of natural resource use;
- recommend management practices for the sustainable use of ecosystems.

Background information

Current scientific conceptions

An **ecosystem** is a complex and self-sustaining natural system with interactions between the biotic (living) and abiotic (non-living) world.

Australia has a wide variety of ecosystems including desert, river, forest and grassland. Each has its own characteristic species and physical environment. Ecosystems are identified by their:

- major environmental feature — for example, dune or pond ecosystem;
- dominant growth form — for example, forest ecosystem, grassland;
- dominant species — for example, eucalypt forest.

Riparian vegetation is the vegetation on the banks of a waterway. The riparian zone extends approximately 30 metres from the water's edge.

The **habitat** of an organism is the environment in which it lives. An organism's **distribution** is its geographical range within its potential habitat.

Each ecosystem may contain a range of terrestrial and aquatic habitats. Ecosystems contain abiotic and biotic components. **Abiotic** components include sunlight, water, climate and soil; while the **biotic** components include plants, animals, fungi and bacteria.

A number of concepts and principles are associated with the functioning of ecosystems and the interactions of their components. The main ones are briefly outlined.

A **population** is a group of individuals of a single species of plants or animals living in the same area.

A **community** is formed when populations of different species interact. The species may come from different groups of living things — for example, plants, animals, bacteria, or fungi. Examples of communities include ponds, forests or grassland areas. When a community interacts with components of the abiotic environment, they form an **ecosystem**.

The individual organisms within the ecosystem not only live together but they also affect each other's chances of survival and reproduction. For example, plants compete for sunlight and moisture from the soil, while animals graze on them, causing their partial or total destruction. One of the ways that organisms in an ecosystem interact is the way in which they obtain their food. Herbivores eat plants, carnivores eat herbivores, and scavengers and decomposers feed on the dead parts of other organisms. These relationships can be represented by a food web. Where two organisms use the same food sources or other resources, they are called **competitors**. There may be competition between species, or between individuals of a species.

Food webs describe the feeding relationships between organisms. Organisms higher in the food web feed on some things lower in the web. This means that:

- changes in the population of one organism will affect an entire ecosystem;
- changes in the population of a herbivore will result in corresponding changes in producer organisms;
- changes in the population of one organism will affect other organisms in varying degrees.

Adaptation is a genetically determined characteristic of form, function or behaviour that makes an organism suited to live in its environment. Species adapt over long periods of time. The particular adaptations of different species enable them to occupy unique positions or **niches** in the habitat. This reduces inter-species competition for available resources, enables many organisms to coexist in the same habitat, and increases the chances of survival of a species in that particular environment.

Biodiversity refers to the number and variety of all life forms: the different plants, animals and microorganisms, the genes they contain and the ecosystems they form. Human management of natural resources may affect biodiversity positively and negatively. Negative impacts on biodiversity include loss of habitat for native species, competition or predation from introduced species, and pollution. Good management practices prevent, reverse or mitigate the negative effects (Environment Australia 1998).

Sustainable management is management of ecosystems that meets the needs of society now and in the future by implementing techniques to protect the environment and conserve natural resources. Sustainably managed ecosystems enable a range of human uses while protecting or improving biodiversity.

Decomposition involves the breakdown of organic matter into a range of simpler substances which may be in the form of solids, liquids and gases. Some of these substances are then taken in by living things and incorporated into the organic materials of their bodies. In this way matter is cycled through ecosystems.

Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Some students may think that:

- organisms higher in a food web eat everything that is lower in that web;
- changes in the population of an organism will only affect those directly related or interconnected through a food chain — that is, the predators and prey of that organism;
- some organisms are not important in an ecosystem and changes to that population will not affect others;
- changes in the population of a herbivore will not affect producer organisms;
- changes in the population of an organism will affect all other organisms to the same degree;
- the needs and roles of a species are general and typical of similar species;
- matter is 'lost' during the process of decomposition;
- species coexist in an ecosystem because they 'get along' — that is, their needs and behaviours are compatible;
- all human uses of ecosystems have negative impacts on biodiversity;
- nature reserves, which exclude all human land use, are the only effective method of protecting rare and threatened species, and biodiversity;
- fire is harmful to all plant and animal species and should be excluded from ecosystems.

Teachers can help students to build on their prior understandings by challenging students' understandings of ecology and the application of ecological principles in the management of ecosystems, particularly in relation to biodiversity conservation.

Terminology

Terms associated with the components of ecosystems and the ways in which they interact are essential to the activities in this module — for example:

abiotic	cycle	habitat
aquatic	decomposition	niche
adaptation	distribution	population
biodiversity	ecosystem	riparian
biotic	food chain	sustainability
community	food web	terrestrial

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module. Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to:

- field work;
- handling biological material, including plants and animals.

Support material and references

Additional resource material and activities related to this module are available from the Queensland Department of Natural Resources website: http://www.dnr.qld.gov.au/education (accessed December 2000).

Cronin, L. 1997, *Key Guide to Australian Mammals*, Reed Books, Vic.

Environment Australia 1998, 'The national strategy for the conservation of Australia's biological diversity', *Australia's National Report to the Fourth Conference of the Parties to the Convention on Biological Diversity*, Commonwealth of Australia, Canberra.

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Fingland, M. 1994, *Caring for Urban Fauna*, Queensland Department of Primary Industries, Brisbane.

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Forge, K. 1993, *Pasture Watch: Classroom Activities*, Queensland Department of Primary Industries, Brisbane.

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Glanznig, A. 1995, *Native Vegetation Clearance, Habitat Loss and Biodiversity Decline*, Commonwealth of Australia, Canberra.

Hauenschild, P. 1999, Forest Management Education Activity Series, Queensland Department of Natural Resources, Brisbane:

Casuarina Glade Forest Management Scenario (Years 9–12)

Forest Fires (Years 10–12)

Forest Management (Years 10–12)

Forest Waterways (Years 6–9)

Forest Wildlife (Years 6–9)

Multiple-use Management (Years 10–12)

Hale, P. & Lamb, D. 1997, *Conservation Outside Nature Reserves*, Centre for Conservation Biology, University of Queensland, St Lucia, Q.

Queensland Department of Natural Resources, *Natural Resource Management Catalogue* (produced annually).

Queensland Department of Primary Industries 1995, *Waterwatch Queensland Technical Manual*, Brisbane.

Queensland Department of Primary Industries and Queensland Department of Natural Resources, *Between the Leaves*, newsletter. Phone (07) 3234 0149 to be put on the mailing list.

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Simpson, K. & Day, N. 1996, *Field Guide to the Birds of Australia*, 5th edn, Penguin Books, Vic.

Smart, S. & Martin, J. 1994, *Living in a Catchment,* video*,* Queensland Department of Primary Industries, Brisbane.

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Strahan, R. (ed.) 1998, *The Mammals of Australia*, Australian Museum and New Holland Publishers (Reed New Holland), Sydney.

Tiggs, B. 1998, *Tracks, Scats and Other Traces — A Field Guide to Australian Mammals*, Oxford University Press, Melbourne.

University of Wollongong and NSW Dept of Land and Water Conservation 1996, *Exploring the Nardoo: An Imaginary Inland River Environment to Investigate, Maintain and Improve*, CD-ROM, Interactive Multimedia Pty Ltd, Wollongong.

Water Board (Sydney–Illawarra–Blue Mountains) 1997, *The Streamwatch Water Bug Detective Guide*, Sydney.

Students' alternative conceptions

Barman, C., Griffiths, A. & Okebukola, P. 1995, 'High school students' concepts regarding food chains and food webs: A multinational study', *International Journal of Science Education*, vol. 17, no. 6, pp. 775–782.

Leach, J., Driver, R., Scott, P. & Wood-Robinson, C. 1996, 'Children's ideas about ecology 2: Ideas found in children aged 5–16 about the cycling of matter', *International Journal of Science Education*, vol. 18, no. 1, pp. 19–34.

Leach, J., Driver, R., Scott, P. & Wood-Robinson, C. 1996, 'Children's ideas about ecology 3: Ideas found in children aged 5–16 about the interdependency of organisms', *International Journal of Science Education*, vol. 18, no. 2, pp. 129–141.

Munson, B. 1994, 'Ecological misconceptions', *Journal of Environmental Education*, vol. 25, no. 4, pp. 30–34.

ACTIVITY

Uses of forests — concept map

Introductory

Focus

This activity provides opportunities for students to make links between patterns of human resource use, issues that arise from this use, and management practices to deal with these issues.

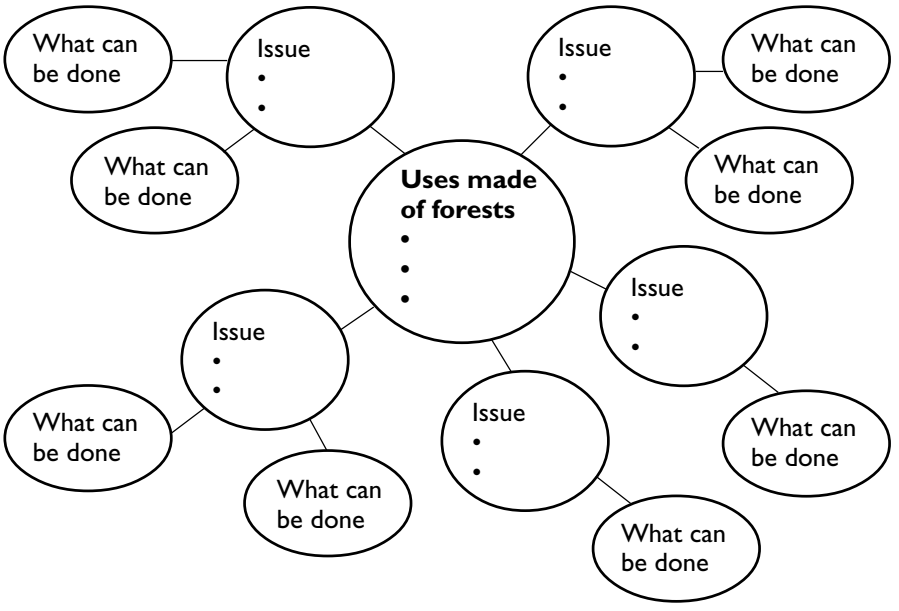
Materials

- butchers' paper and pens

Teaching considerations

This activity can be done as a class, or as an individual activity followed by the production of a shared class concept map. Teachers may wish to show an example layout for the concept map when introducing the activity.

Uses of forests — sample concept map layout



The structure of this activity could be used as a guide to study natural environments other than forests — for example, waterways, oceans, grasslands, wetlands.

The concept map produced by students should be kept and modified as students engage with other activities in this module.

Working scientifically

Time: 30 minutes; extended time for research

Clarifying and challenging

Formulating questions

▶ Students make a concept map consisting of a central list of uses humans make of forests, surrounded by issues relating to those uses and things that can be done to deal with the issues.

▶ Students discuss the issues that have been raised. They share the informa-

Making links
Clarifying ideas and concepts

tion they have about each one, decide what else they would like to know and formulate questions to clarify their ideas.

▶ Students record their questions and write answers to them as they obtain information through the other activities in this module.

Gathering information about student learning

Sources of information could include:

- students' concept maps;
- students' contributions to discussions;
- students' questions and answers.

ACTIVITY

Interactions

Introductory

Focus

This activity provides opportunities for students to clarify ideas and concepts about interrelationships between living and non-living parts of an ecosystem.

Materials

No particular materials are required.

Teaching considerations

This activity can be used to establish students' existing understandings of interactions between living and non-living components of a forest ecosystem. It provides an opportunity for teachers to structure activities and questions to clarify and challenge commonly held alternative conceptions related to ecosystem interactions (see 'Students' prior understandings', p. 5).

If a marine or freshwater ecosystem is more familiar to students, specific terms related to these ecosystems could be substituted in the first part of this activity.

Working scientifically

Time: 45–60 minutes, or longer if students are unfamiliar with the concepts examined in these activities

Accessing resources
Making links
Clarifying ideas and concepts
Creating diagrams
Summarising and reporting

▶ Students write the heading 'Forest ecosystem' at the top of a blank page. They then write the following terms, evenly spaced around the edge of the page: sunlight, water, oxygen, carbon dioxide, wind, rain, lightning, fire, soil, decomposers, leaf litter, trees, herbivores, carnivores, shrubs/grasses, humans.

▶ Students draw lines between terms that can be linked and on the line write a reason for linking them. The following are examples of phrases that might be used: is eaten by, competes with, is caused by, is needed by, is used by, is produced by, provides shelter for.

▶ Students then share their ideas in groups and produce a group diagram.

▶ In small groups, students research definitions of the following ecological terms to demonstrate understanding and to use as a reference during other activities: abiotic, adaptation, biodiversity, biotic, community, cycle, distribution, ecosystem, food chain, food web, habitat, niche, population, sustainability.

▶ Students share their definitions with the class and, following discussion, agree upon class definitions.

Gathering information about student learning

Sources of information could include:

- students' diagrams;
- students' contributions to discussions.

ACTIVITY

Biodiversity

Developmental

Focus

This activity provides opportunities for students to clarify ideas and concepts about biodiversity.

Materials

- print and electronic resources on biodiversity

Teaching consideration

Environment Australia has a range of free brochures about biodiversity. Their website (http://www.environment.gov.au) and that of the Queensland Environmental Protection Agency (http://www.env.qld.gov.au) are also useful resources.

Working scientifically

Time: 60 minutes

Accessing resources
Collecting information
Clarifying ideas and concepts
Creating presentations
Summarising and reporting

▶ Students discuss their understanding of the term 'biodiversity'.

▶ In groups, students refer to a variety of resources to collect information about the following topics:

- the benefits of biodiversity, and the consequences of reduced biodiversity in Australia;
- the main threats to biodiversity in Australia;
- what can be done to help protect biodiversity.

▶ They create a presentation of the information collected. The audience for the presentation could be other class members, students in other classes and year groups or the general public.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations.

ACTIVITY

Forest management

Developmental

Focus

This activity provides opportunities for students to observe differences in forests at different sites and relate these to management practices.

Materials

- Resource Sheet 1, 'Forest management walk'

Teaching considerations

This activity is designed as a walk in which students make their own observations and comparisons of a number of sites in plantations and native forests. A ranger accompanying students could assist in interpretation of the forest environment by providing information on aspects such as:

- the age of the trees;
- harvesting methods;
- reasons for constructing firebreaks;
- the effect of fire on the forest;
- management practices used at a range of sites;
- diversity of animal life.

Resource Sheet 1 suggests observations that could be made in the forest.

Background information relevant to this activity is included in the *Forest Management* booklet of the Forest Management Education Activity Series, available free from the Department of Natural Resources and from their website (http://www.dnr.qld.gov.au/education/).

Site selection

Ideally the site would have a plantation forest with two or three different stages of growth, evidence of management practices (for example, firebreaks, wildlife corridors or buffer zones along creeks) and a native forest within easy walking distance. If this is not possible, a bus could be used to transport students to a range of sites. Three recording sites should be chosen.

Number the sites for study to facilitate comparison of students' results from the range of sites. If appropriate, the class could also be split into smaller groups, with each group studying the sites in a different order.

Safety

Inform students of any potential hazard in the area and of safe practices for investigating a natural ecosystem — for example:

- Identify plants and animals that may be dangerous or cause allergic reactions.
- Minimise disturbance to animals and plants in the habitat.
- Do not stand too close to the edges of rivers or ponds.
- Do not feed or play with animals.

Working scientifically

Time: 90 minutes

Dealing in an orderly manner with the parts of a complex whole
Developing possible, probable and preferred options
Drawing conclusions
Inferring from data
Making comparisons
Selecting and justifying
Creating presentations
Describing

▶ Students discuss:

- characteristics of the forests they could observe, measure and use as a point of comparison;
- differences they expect to see between a native forest and a plantation forest;
- ways of making observations and measurements.

▶ Students draw up a table for recording their observations.

▶ Students undertake a forest walk. As the students proceed to each new site the ranger or teacher leads discussions on ways the forest is used and on forest-management issues.

▶ Students discuss:

- ways in which the living and non-living factors interact to create the differences between the forest types;
- the evidence of forest-management practices they saw and the influence these would have on the characteristics of each forest type.

They discuss criteria to use when comparing the forests.

▶ Students discuss forest management that would contribute to achieving sustainable use of the forests.

▶ Students create presentations that illustrate the observations they have made and explain their thinking on present and future management of forests. The presentation could be, for example, in the form of a feature article for a newspaper, an information pamphlet or poster for the general public, or the script for a documentary on the local forests.

Additional learning

▶ Students compare the forest community at the boundary between the plantation and the native forest.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations.

ACTIVITY

Protecting forest wildlife

Developmental

Focus

This activity provides opportunities for students to consider different ways of protecting wildlife and their habitats.

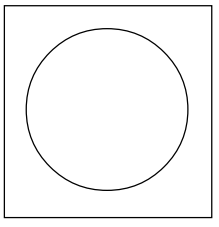
Materials

- Resource Sheet 2, 'Forest reserves'

Teaching considerations

A major threat to forest wildlife is the loss of habitat through clearing for agriculture and urban expansion. Forests provide important habitats for many plant and animal communities. Things that influence the value of a forest area for the conservation of native plants and animals include size, shape, location, connections, and diversity.

Size: In general, one larger area will contain a greater number of species than a number of smaller areas of the same type of forest which, together, cover the same area. Larger areas are also more likely to survive in the long term as they are less susceptible to damage by fire, wind or tree dieback.



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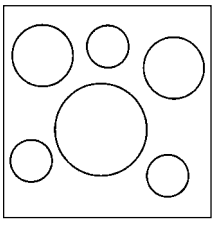
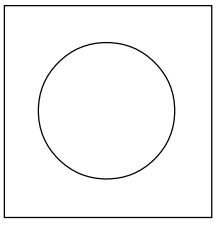


Shape: For a given area of forest, the shape with the smallest perimeter is least affected by disturbance from outside influences such as introduced diseases, pest plants and animals. A long, thin reserve will be more susceptible to disturbance at the edges than a round reserve of the same area.



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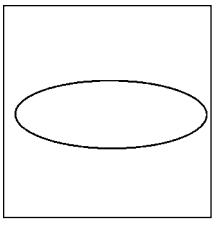
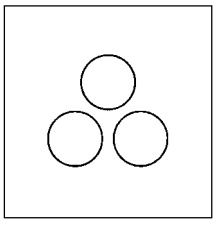


Location: Areas of forest close to other areas of natural vegetation are more likely to allow species to migrate for breeding and for repopulating areas after disturbances such as fire, drought or human activity. Small species in particular (for example, frogs, lizards and small mammals) are not able to cross large distances of unsuitable habitat.



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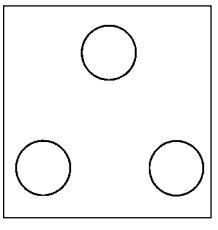
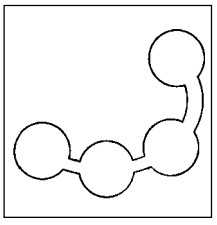


Connections: Corridors of vegetation linking areas of bushland are valuable as they allow movement of wildlife and provide useful habitat in themselves. Corridors are often used by young animals moving out seeking new territories. This avoids overcrowding of existing habitats and allows animals to recolonise areas from which they have disappeared.



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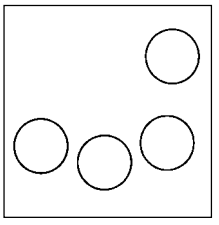
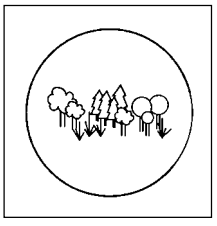


Diversity: Diversity within and between habitats is of major importance for wildlife conservation. A range of vegetation types will meet the needs of a greater range of wildlife than several areas of the same type. Areas with different soil types, aspects or topography are likely to have a range of habitat types. Diversity within habitats is often highest in areas with permanent water, rock outcrops, aged and mature trees, and an understorey of native shrubs and grasses.



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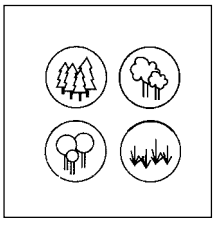


Working scientifically

Time: 45 minutes

Engaging with problems
Hypothesising
Seeking reasons
Drawing conclusions
Selecting and justifying
Discussing thinking
Explaining ideas and decisions
Supporting decisions

▶ Students discuss their current understandings of the topics of habitat loss, forest reserves, wildlife refuges and wildlife corridors.

▶ Students form small groups to engage with the scenario on Resource Sheet 2.

▶ Students share the main points of their group discussion with the class and compare the responses from each of the groups. They formulate questions that arise from their discussion and consider different ways of getting answers to the questions.

▶ Students, individually or in groups, collect information to answer the questions and share their answers with the class.

Resource Sheet 2

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions and formulation of questions;
- students' responses to Resource Sheet 2;
- students' answers to questions.

ACTIVITY

Assessing waterways

Developmental

Focus

This activity provides opportunities for students to draw conclusions about interactions between riparian vegetation, water quality, and the species living in streams.

Materials

For each group of students:

- Resource Sheet 3, 'Riparian environment survey'
- Resource Sheet 4, 'Riparian vegetation assessment sheet'
- Resource Sheet 5, 'Riparian assessment key'
- Resource Sheet 6, 'Water bug survey'
- dip net
- collection jars

Teaching considerations

Background information for this activity can be downloaded from the Department of Natural Resources website (http://www.dnr.qld.gov.au/education/).

Site selection

Select a waterway with ease of access for students and in which field activities can be conducted safely.

Safety

Inform students about safe practices for investigating a natural ecosystem — for example:

- Identify plants and animals that may be dangerous or cause allergic reactions.
- Minimise disturbance to animals and plants in the habitat.
- Minimise trampling to reduce risk of causing erosion.
- Do not stand too close to the edge of a waterway.
- Do not feed or play with animals.

Working scientifically

Time: 90 minutes

Drawing conclusions
Making and judging deductions
Making comparisons
Using ideas, theories and principles
Supporting decisions

Resource Sheets 3–6

▶ Students discuss their understanding of the term 'riparian vegetation' and why riparian vegetation is important to the water quality of a waterway.

▶ Students read Resource Sheet 3, 'Riparian environment survey'. They clarify their ideas about the task and familiarise themselves with some of the plant species they could expect to find in the area.

▶ In groups, students visit a waterway, where they:

- describe the area adjacent to a waterway, the types of land use in the area and the impact these could have on the water quality;
- complete the riparian vegetation assessment sheet (Resource Sheets 4 and 5) and the water bug survey (Resource Sheet 6). Resource Sheet 3 provides guidance for completing these tasks.

▶ Students compare the results between groups and discuss the significance of their findings. They discuss the need to protect the health of waterways. Discussion questions could include:

- What are the main uses of the waterway?
- What is the value of the waterway?
- Which of the land uses in the area would be most likely to adversely affect water quality?
- What additional information is needed before a decision can be made about the impact of types of land use? How can this information be collected?
- What management practices could be used to reduce the impact that human activities have on this waterway?

▶ Students write a short article for the local newspaper describing:

- the waterway and its immediate surroundings;
- any impact human activity has on the waterway;
- suggested management strategies;
- predicted short- and long-term effects of the strategies.

Gathering information about student learning

Sources of information could include:

- students' completion of resource sheets;
- students' contributions to discussions;
- students' newspaper articles.

ACTIVITY

Conservation planning

Developmental

Focus

This activity provides opportunities for students to produce a conservation plan for a plant or animal species.

Materials

- Resource Sheet 7, 'Casuarina Glade scenario: Background information'
- Resource Sheet 8, 'Casuarina Glade scenario: Maps of species distribution'
- Resource Sheet 9, 'Casuarina Glade scenario: Food web'
- a variety of print and electronic resources on conservation plans

Teaching considerations

This activity can be completed either as an individual or as a small-group task.

Information for species profiles could be collected from the Casuarina Glade booklet of the Forest Management Activity series or by entering the species name in an Internet search. The series is available free from the Department of Natural Resources and from their website (http://www.dnr.qld.gov.au/education/).

Working scientifically

Time: 90 minutes

Accessing resources
Collecting information
Engaging with problems
Assessing and reassessing
Developing possible, probable and preferred options
Drawing conclusions
Making and judging deductions
Selecting and justifying
Arguing a position
Creating presentations

Resource Sheets 7–9

▶ Students read the description of Casuarina Glade (Resource Sheet 7). From the distribution maps (Resource Sheet 8), they select one of the plant or animal species found in the area and collect information from a variety of sources to compile a description of the characteristics and habitat of the species.

▶ Students study the distribution map of their selected species. From the description of the natural values of the Casuarina Glade region, they identify the types of land use in the places where the plant or animal is found. Students identify any likely threats to the survival of this species in this area, using land-use information, the species profile they have compiled and the food web (Resource Sheet 9).

▶ Students draw up hypotheses about the direct and indirect impact of this species becoming extinct in the area. The impact may be to the biodiversity, to non-living aspects of the environment (that is, soil, water, climate and other natural features), or to the economy of the Casuarina Glade region.

▶ Students describe management methods that might help to reduce any threats to the species.

▶ Students develop criteria for determining the success of their proposed methods. They describe a research program to monitor the success of these methods. Points for consideration could include:

- ways of measuring the population of the species in this area;
- other aspects of the environment that have to be measured and how this could be done.

▶ Students create a presentation through which they share their information and ideas with others. Ways of presenting the information could include:

- a written report;
- an oral presentation to the class;
- an article in the Casuarina Glade local newspaper;
- a multimedia presentation — for example, using PowerPoint.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations.

ACTIVITY

Property planning

Culminating

Focus

This activity provides opportunities for students to produce a management plan for a property to minimise the impact of land uses on rare, vulnerable or endangered species.

Materials

- Resource Sheet 7, 'Casuarina Glade scenario: Background information'
- Resource Sheet 8, 'Casuarina Glade scenario: Maps of species distribution'
- Resource Sheet 9, 'Casuarina Glade scenario: Food web'
- Resource Sheet 10, 'Casuarina Glade scenario: Map of the area'

Teaching considerations

This activity could be carried out as an extension to the activity 'Conservation planning' (pp. 19–20).

Information for species profiles could be collected from the Casuarina Glade booklet of the Forest Management Activity series or by entering the species name in an Internet search. The series is available free from the Department of Natural Resources and from their website (http://www.dnr.qld.gov.au/education/).

Working scientifically

Time: 40 minutes

Developing possible, probable and preferred options
Drawing conclusions
Making and judging deductions
Selecting and justifying
Arguing a position
Creating presentations
Supporting decisions

Resource Sheets 7–10

▶ Students study the map of the Casuarina Glade area (Resource Sheet 10). From the distribution maps (Resource Sheet 8) they choose a plant or animal species which occurs in this area and which they wish to study. They collect information from a variety of sources to compile a description of the characteristics and habitat of the species. Students use the Casuarina Glade background information (Resource Sheet 7), to identify the types of land use on the property. From the species' description and the food web (Resource Sheet 9) they identify any likely threats to the survival of this species in this area.

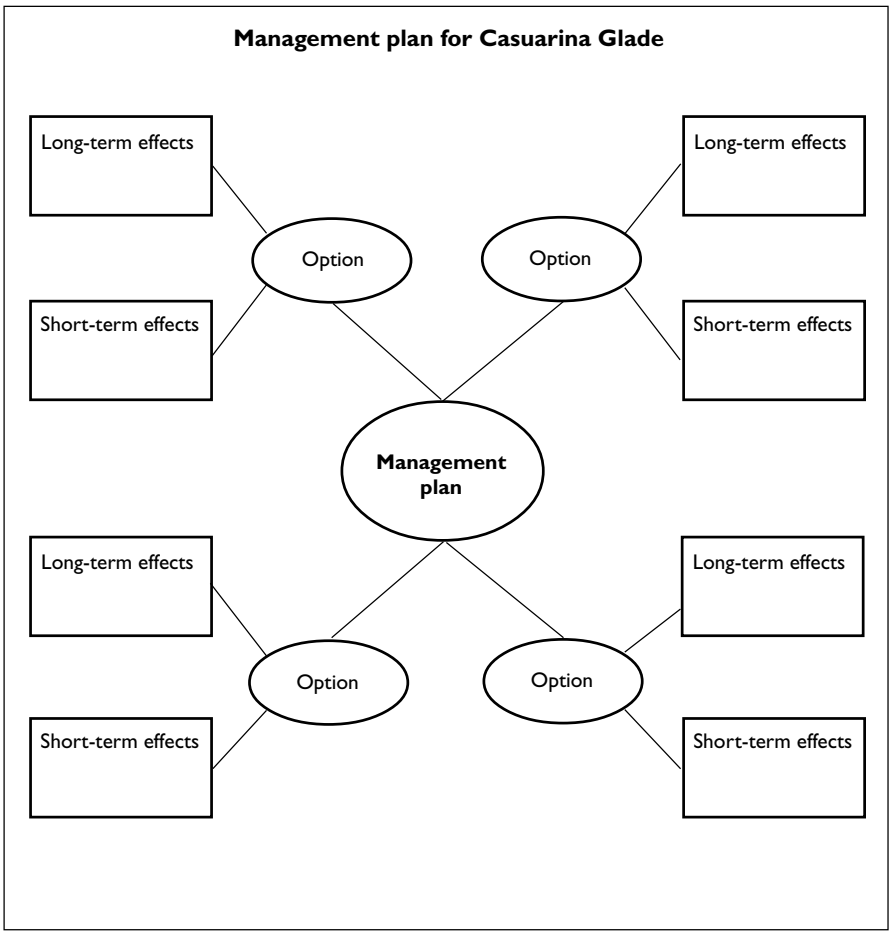
▶ Students summarise the possible threats to this species in this area.

▶ Students choose one of the properties A, B or C shown on the map of the Casuarina Glade area. They describe management methods they would employ if they were the owner of this land. These methods might include fire management, clearing controls, grazing controls, the control of feral animals, and controls on other specific activities.

▶ Students study the food web (Resource Sheet 9) and the description of the Casuarina Glade area (Resource Sheet 7). They develop hypotheses about the direct and indirect impact of this species becoming extinct in the area. The impact may be to the biodiversity, to non-living aspects of the environment (for example, soil, water, climate and other natural features), or to the economy of the Casuarina Glade region.

▶ Students create a cause-and-effect diagram which summarises what might happen if various options are chosen. They start with a circle in the middle of a page, labelled 'Management plan' and include the area to which the plan is relevant — for example, Property A. They write the range of management options in circles surrounding the central circle, connecting each by a single line to the central circle. Each of these circles is connected with other text that summarises the possible short-term and long-term consequences of each action. Students highlight a preferred option and give reasons for their choice.

Sample layout for a cause-and-effect diagram



Gathering information about student learning

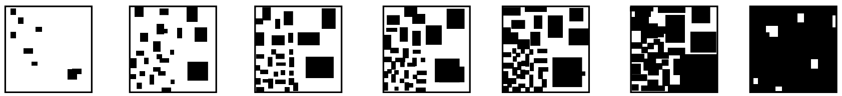
Sources of information could include:

- students' contributions to discussions;
- students' cause-and-effect diagrams;
- students' reasons for selecting their preferred option.

Forest management walk

Resource Sheet 1

At each of the sites visited, complete the forest survey. Record quantitative or qualitative data in response to each of the tasks.

	Site 1	Site 2	Site 3
Percentage canopy cover Percentage canopy cover has been used to assist in defining forest types. Look up at the canopy in the forest and decide which of the diagrams below represents it best.  10% 20% 30% 40% 50% 75% 90%			
Tree height The tallest trees in Australia are over 90 m tall. Estimate the height of the tallest trees in the sample area.			
Biodiversity The number of species in an area gives an indication of the biodiversity for that area. Identify and record the number of different tree species within a 10 m radius of a sample point. Look at the tree characteristics such as bark (colour and texture), leaf size and shape, fruit and growth form to classify it as a different species.			
Percentage groundcover Calculate the percentage groundcover, using the diagrams for canopy cover.			
Temperature (°C) Use a thermometer to measure air temperature in the forest.			

(continued)

Forest management walk *(continued)*

	Site 1	Site 2	Site 3
Depth of leaf litter/humus layer (cm) Leaf litter is dry or partially decayed leaves on the soil surface. Humus is decomposed or partially decomposed organic matter (plant and animal material) usually found in the upper layers of the soil. Humus darkens the soil. Measure the depth to which you can find obvious organic matter in the soil.			
Soil description Colour and texture are important characteristics of soil. Describe these qualities for the soil immediately below the humus layer.			
Evidence of invertebrates Record any evidence of invertebrate animals. This might include spiders, insects, leeches and worms.			

(continued)

Resource Sheet 1

Forest management walk *(continued)*

	Site 1	Site 2	Site 3
Evidence of vertebrates Record any evidence of vertebrate animals. Droppings, tracks or claw marks may be visible.			
Evidence of fire Record any evidence that a fire has been through the forest, such as blackened bark or trees that have been damaged or killed by fire. Estimate how long it has been since the fire went through and record the evidence you used to make the decision.			
Evidence of forest management Record evidence of forest management practices.			

Forest reserves

Resource Sheet 2

You are wildlife protection officers. Concern has been raised about the wellbeing of the wildlife in the local area and many meetings have been held in the community to discuss ways of protecting the remaining wildlife habitats. Many property owners have remnant vegetation on their properties. They are also willing to plant trees and other vegetation types to extend wildlife habitats in the future.

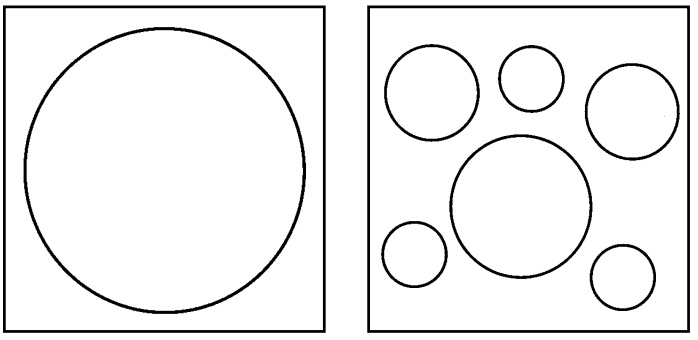
Argument has centred on the size and shape of the reserves. Some community members suggest many small, isolated pockets of vegetation can protect animals from their predators. Others favour larger areas or having corridors joining small areas so that animals can move over a more extensive area.

Your task is to evaluate the different scenarios for forest reserves that have been prepared.

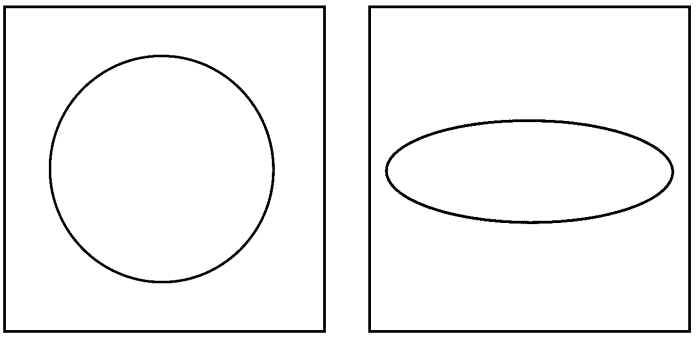
1. For each situation shown below list the benefits or disadvantages of the shape as a wildlife habitat reserve. (Assume that the area covered in each situation is the same.)
2. Decide which option would be the preferred shape and organisation for a wildlife habitat reserve. Provide information to support your decision.
3. Based on your evaluation of each scenario, compile a set of criteria that could be used to evaluate the usefulness of any area, or areas, of vegetation as future wildlife habitat reserves.

Which one is preferable?

One large section or many small sections, both of which cover the same overall area?



A round area or a long, thin area?

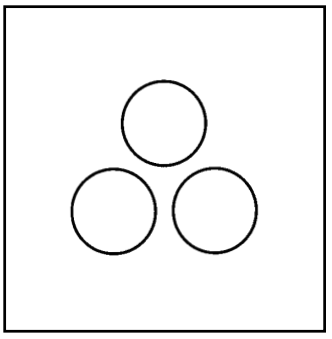


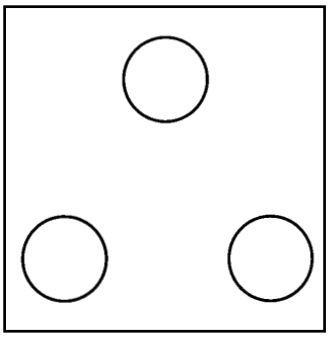
(continued)

Forest reserves *(continued)*

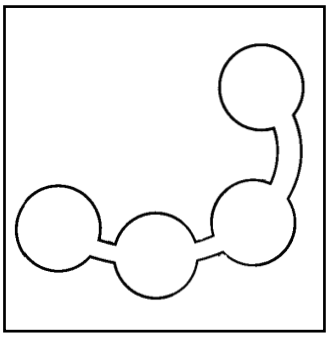
Resource Sheet 2

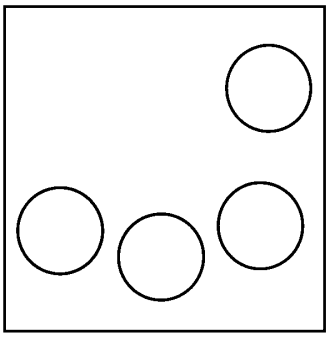
Small areas close together or far apart?



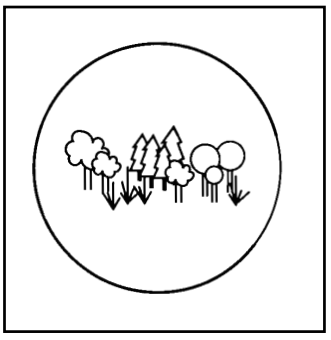


Small areas that are linked together or separate small areas?





A large area with a range of vegetation types or many areas each with one vegetation type?



Riparian environment survey

The riparian environment is the environment on the banks of a waterway. The width of a riparian zone is approximately 30 metres each side of the waterway.

The riparian zone as part of the catchment environment

Riparian environments function within a more extensive environment in three ways:

1. They influence the ecology of both the aquatic environment and the surrounding terrestrial environment.
2. They contribute to soil stability.
3. They contribute to water quality by acting as a buffer against sediment carried in catchment run-off.

The level of disturbance found in the riparian zone will affect the water quality. The disturbance can be categorised into four different levels:

- very low disturbance;
- low disturbance;
- high disturbance;
- very high disturbance.

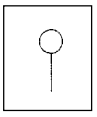
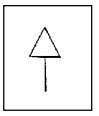
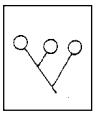
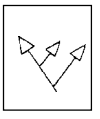
When assessing an area, consider the level of disturbance both upstream and downstream. The place that provides access to the waterway may be the only disturbed area along the waterway.

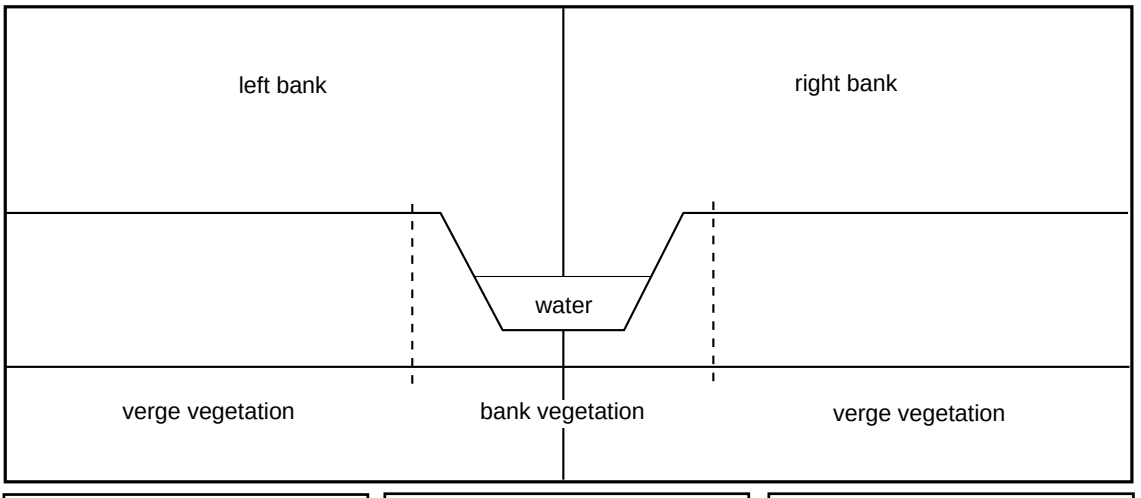
Surveying a riparian zone

- To assess the riparian zone, complete the diagram on Resource Sheet 4 as a way of recording the vegetation present. Use the symbols to represent different plant types, and tick the boxes below the diagram if exotic plants are present. Your diagram should represent an average 40-metre stretch of waterway.
- Having completed your diagram, select the category from the 'Riparian assessment key' (Resource Sheet 5) that is most like it. Allocate the categories for both the bank and the verge vegetation in the riparian environment and record them on Resource Sheet 4.
- Next, complete Resource Sheet 6, 'Water bug survey'.

Source: Adapted from Queensland Department of Primary Industries 1995, *Waterwatch Queensland Technical Manual*, Brisbane.

Riparian vegetation assessment sheet

Symbol	Meaning	Symbol	Meaning
	Tree More than 2 m high Only one stem *Native* to the area		Tree More than 2 m high Only one stem *Exotic* to the area
	Woody shrub Less than 2 m high One or more stems *Native* to the area		Woody shrub Less than 2 m high One or more stems *Exotic* to the area
	Herbs and grasses Not woody More than one stem Short *Native* to the area		Sedge and rushes Herbaceous Tufted perennial



erosion and bank stability	verge vegetation	bank vegetation
(Describe the stability of the banks and any sign of erosion.)	(Choose a category from Resource Sheet 5.)	(Choose a category from Resource Sheet 5.)

Common exotic plants found on waterways in Queensland

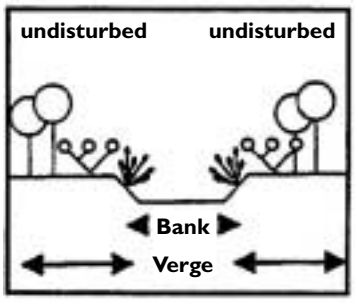
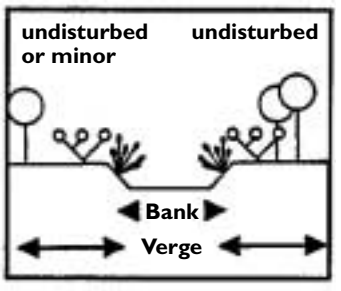
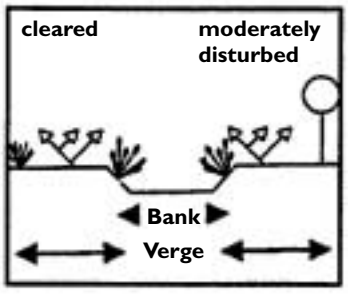
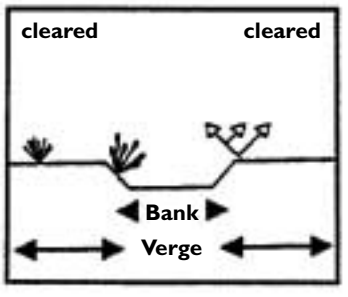
Tick if present:

- ❑ camphor laurel
- ❑ Chinese elm
- ❑ exotic pines
- ❑ groundsel
- ❑ lantana
- ❑ para grasses
- ❑ poplars
- ❑ rubber vine
- ❑ weeping willows

Source: Adapted from Queensland Department of Primary Industries 1995, *Waterwatch Queensland Technical Manual*, Brisbane.

Riparian assessment key

Select the diagram which is most like yours, and read the section next to it. If this information does not match, try another category.

Category	Description	Sketch
Very low disturbance	*Verge vegetation*. Native vegetation present on both sides of the river with an intact canopy. Introduced species are absent or insignificant. No evidence of outside interference. Representative of natural vegetation in excellent condition. *Bank vegetation*. Native vegetation on both sides of the river in an undisturbed state. Introduced species are rare or insignificant. Representative of natural vegetation in excellent condition.	
Low disturbance	*Verge vegetation*. Native vegetation clearly disturbed or with a high percentage of introduced species present. *Bank vegetation*. Native vegetation on both sides of the river generally in good condition with few introduced species present. Any disturbance is minor.	
High disturbance	*Verge vegetation*. Native vegetation clearly disturbed or with a high percentage of introduced species present. *Bank vegetation*. Bank vegetation moderately disturbed by stock or through the intrusion of introduced species, though native species remain. Note: Sites with verge vegetation in good condition (for example when it is fenced off) should be included in this category.	
Very high disturbance	*Verge vegetation*. Cleared land on both sides (agriculture or urban development). Plants present are virtually all exotic species (willow, pines, etc.). *Bank vegetation*. Some native vegetation present, but it is severely modified on both sides by grazing, human access or the intrusion of introduced species. Native species are severely reduced in numbers and cover.	

Source: Adapted from Queensland Department of Primary Industries 1995, *Waterwatch Queensland Technical Manual*, Brisbane.

Water bug survey

The number and variety of water bugs found in a stream can give an indication of the relative levels of water pollution. (Note that the term 'water bugs' is a common name which refers to macro-invertebrates — animals without backbones which are large enough to be seen with the naked eye. This includes animals that are not true 'bugs' — a type of insect.)

Calculating a stream pollution index

- Use a dip net to collect as many water bugs from the stream as you can.
- Look at the water bug identification chart. The water bugs are split into three groups — sensitive, tolerant and very tolerant. Each illustration has a number next to it in brackets. Identify all of your water bugs and take a note of the identification number.
- When you have completed your collection and identification, add the numbers together and you have a 'stream pollution index'. Only count each type of animal once. The higher the total, the cleaner the water.
- Use the table below to estimate a stream quality rating.

Pollution index	Stream quality rating
20 or less	Poor
21–35	Fair
36–50	Good
51 or more	Excellent

Pollution index _____

Stream quality rating _____

After you have recorded your results, carefully return all water bugs to the place you found them.

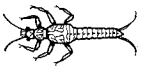
(continued)

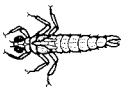
Source: Adapted from Water Board (Sydney–Illawarra–Blue Mountains) 1997, *The Streamwatch Water Bug Detective Guide*, Sydney.

Water bug survey *(continued)*

Identification chart

Sensitive

(8) Stonefly nymph — 30 mm 

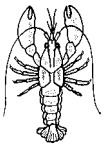
(6) Dragonfly nymph — 40 mm 

(7) Mayfly nymph — 30 mm 

(5) Water mite — 4 mm 

(6) Caddis fly larva — 20 mm 

Tolerant

(4) Freshwater crayfish — 25–200 mm 

(3) Leech — 25–50 mm 

(4) Freshwater mussel — 50 mm 

(3) Lesser water boatman — 15 mm 

(3) Water flea — 8 mm 

(3) Water strider — 8–12 mm 

(3) Fairy shrimp — 30 mm 

(3) Whirligig beetle — 12 mm 

(3) Planarian — 15 mm 

(3) Water tiger beetle — 30 mm 

(3) Pond snail — 25 mm 

Very tolerant

(2) Midge larva — 12–14 mm 

(2) Mosquito larva — 12 mm 

Note: This chart can be used as a simple guide to estimating water quality. More detailed identification charts, including up-to-date sensitivity ratings specific to Queensland, are available from Waterwatch Queensland, tel: (07) 3896 9737.

Source: Based on Gould League 1984, *Ponding*, Melbourne.

Casuarina Glade scenario: Background information

Casuarina Glade is an imaginary area in south-east Queensland, north-west of Brisbane. The Casuarina Glade region depicted in this case study is rural, with the nearest town located 20 km to the south. All species information in this case study is factual, and the land-management issues are based on real examples from other areas.

Natural values of the Casuarina Glade region

Topography

The area is surrounded by the scenic peaks of Mount Cockatoo, Mount Wattle and Mount Monitor. Ironbark Ridge extends to the south from Mount Monitor. The two main waterways of this area, Monitor Creek and Cockatoo Creek, drain these hills.

Geology

The geology of the area is quite varied and includes a range of volcanic and sedimentary rock types. In some areas of limestone rock, caves are present in cliffs and hills. While the soils are generally poor and suited mainly for grazing for beef production, small pockets of more fertile volcanic soil exist, and this is suitable for the small-scale production of fruit and vegetables.

Flora

Most of the Casuarina Glade State Forest is dry open sclerophyll forest. The dominant species include ironbark (*Eucalyptus crebra*) and spotted gum (*Corymbia variegata*). Casuarina (*Allocasuarina littoralis*) species are also common in this forest. They are the predominant tree species in some areas along Cockatoo Creek and Monitor Creek and are mid-storey species in other parts of the forest along with shrubs including wattles (*Acacia* species) and some bottlebrushes (*Callistemon* species) along the creeks. The forest groundcover contains a range of herbs and grasses.

Dry sclerophyll forest is also the main forest type in the area surrounding Casuarina Glade State Forest. In many areas this forest type has become more open (i.e. trees are spaced wider apart) in the last 50 years due to clearing or the frequent use of fire to encourage the growth of pasture on grazing properties. In open woodlands and grasslands, native grasses such as kangaroo grass (*Themeda triandra*) are common. A rare and vulnerable herb called *Stemmacantha australis* (which has no common name) occurs in patches in some grassy areas and open woodlands. The forest has been cleared for small-scale agriculture in some areas outside the state forest.

Plunkett mallee (*Eucalyptus curtisii*), a rare species of eucalypt tree, occurs in some small patches in Casuarina Glade State Forest. This species was once more common outside the state forest, but is now found on only one grazing property.

Fauna

Fauna species include many common species found in dry sclerophyll forests and woodlands. Species of special interest include the large pied bat

(continued)

Casuarina Glade scenario: Background information *(continued)*

(*Chalinolobus dwyeri*), a rare insectivorous bat which roosts and breeds in three small caves in this area. Three fauna species in this area are considered vulnerable to extinction: the glossy black cockatoo (*Calyptorhynchus lathami*), the Hastings River mouse (*Pseudomys oralis*) and a legless lizard, the collared delma (*Delma torquata*). The yellow-bellied glider (*Petaurus australis australis*) is common in this area. However, land managers have listed it as being 'of concern' (of becoming rare or dying out) because of its specific habitat needs. This includes the need for large continuous areas of uncleared forest in order to sustain a sufficient breeding population.

Common introduced fauna species that are likely to play a significant role in the ecology of the area are domestic cattle and cats. Domestic and feral cats are regularly seen preying on small birds, mammals and reptiles. It is also possible that native fauna are the prey of domestic dogs, which are likely to have interbred with local dingo populations.

Usage of the Casuarina Glade region

Timber

Timber is an important industry in the area. Selective harvesting of trees has occurred in parts of the Casuarina Glade State Forest for the past 60 years. Trees from this state forest and several others in the region have provided sources of wood for a timber mill in the town 20 km to the south.

Other forest products

The local landscaping-supply industry is interested in collecting small logs and bush rocks from properties in this area and has applied for a permit to collect these materials from the state forest, in areas adjacent to the existing logging roads.

A local florist would like a permit to collect flowers of the plunkett mallee from the state forest as he envisages much demand for this flower in native flower arrangements. A nursery supplier would also like to collect the seed of this species from the state forest. She plans to germinate the seed on a large scale and sell this plant to nurseries in south-east Queensland in the belief that there will be great demand for this species as an attractive small native tree for gardens.

Beef production

Beef-cattle grazing has been a successful industry in this area for more than 100 years. The three large properties on the map are used for this purpose. Some graziers with properties near Casuarina Glade State Forest have leases to graze cattle in most parts of the forest. The picnic area is fenced to keep cattle out.

Small-scale fruit and vegetable production

Hobby farmers have been moving into the area over the past 10 years, attracted by the scenic beauty of the region and the development of a number of acreage subdivisions. Some of these farmers have small-scale permaculture

(continued)

Casuarina Glade scenario: Background information *(continued)*

gardens and some livestock, with the aim of being self-sufficient in food production. Some hobby farmers live in the city and use their land as a retreat from the city on weekends and holidays.

Catchment protection
Cockatoo Creek is part of the catchment of a large dam supplying water for drinking and irrigation for towns and farms in this region. The vegetation of the Casuarina Valley helps filter rainwater run-off and prevent soil erosion. This protects water quality in rivers downstream. The forest also reduces the frequency of floods by increasing infiltration of rainwater and reducing run-off.

Climate protection
People are attracted to the cool shade of the forest along Cockatoo Creek in Casuarina Valley. Similar vegetation in many other valleys in this area has been cleared, causing generally higher local temperatures in the valleys.

Scientific study
The ecology of this area is of great interest to researchers, especially since a number of rare and vulnerable species occur here. These species seem to have coexisted with a variety of human land uses in this area for a considerable period. However, researchers are interested in determining if the populations of these animals and plants are declining with the increasing human population and changing land uses in the area.

Recreation, education and tourism
The Casuarina Glade State Forest is a popular area for recreation. Activities include picnicking and swimming at the Casuarina Glade picnic area and taking the hiking trails along Cockatoo Creek. Bushwalkers regularly use the Mount Monitor hiking trail, camping overnight at Monitor Falls and returning along Ironbark Ridge to the Casuarina Glade picnic area.

Driving along the logging roads is another popular weekend recreational activity.

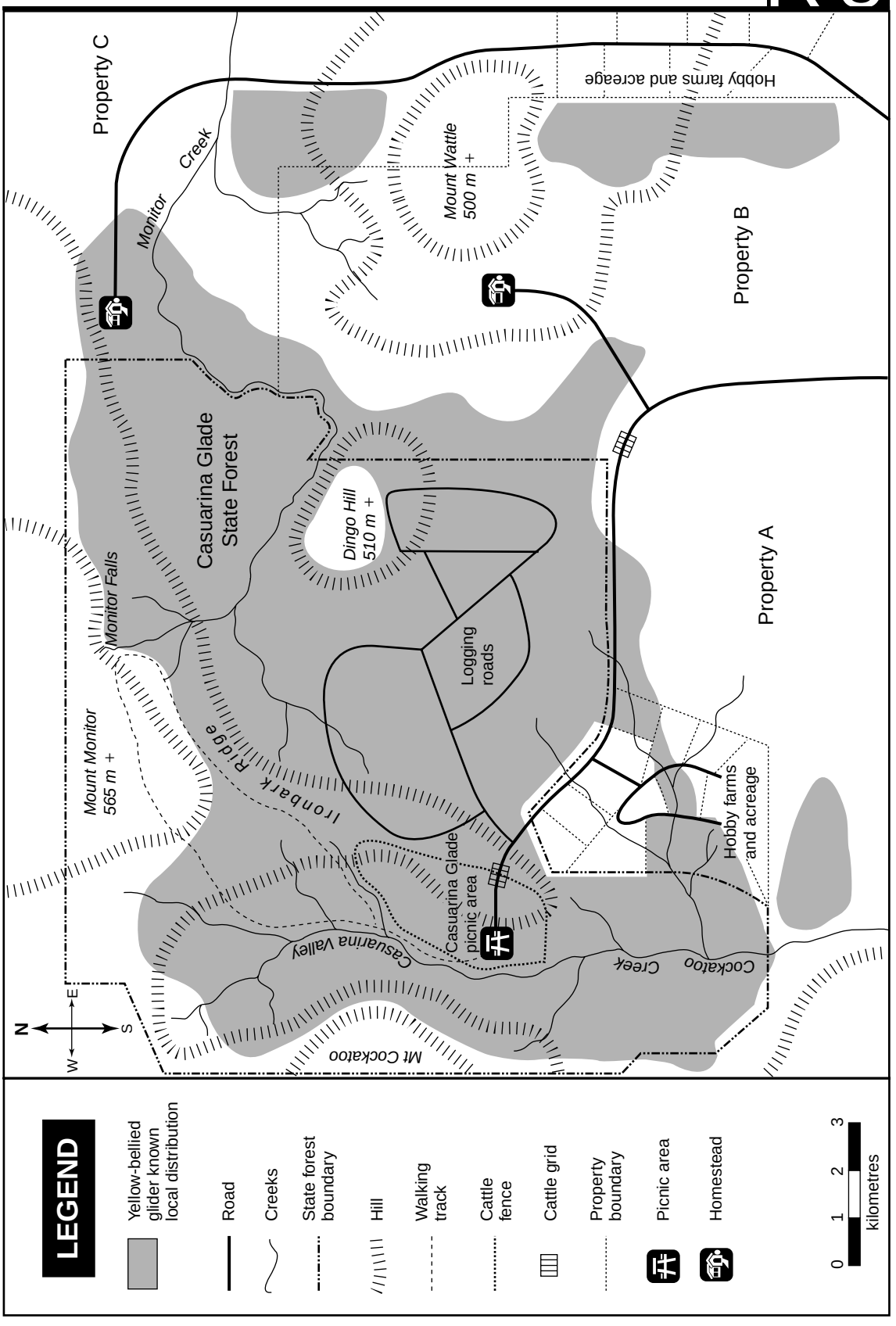
A grazing property (Property C) has recently opened a small ecotourism business, with cabin accommodation near the homestead on Monitor Creek. The owner has applied for a permit to conduct bushwalking, horse-riding and driving tours in Casuarina Glade State Forest and has already opened some walking trails on her own property. The owner is a member of the local Aboriginal community and plans to involve her community in demonstrating to visitors the sustainable land-management practices used by her people for many thousands of years. This will include fire management by burning patches of forest each year, traditional food gathering of local wild foods and hunting small mammals and reptiles.

A local natural history club has regular bush walks, birdwatching trips, and spotlighting tours to observe nocturnal animals in the state forest and surrounding areas. Primary and secondary schools from the surrounding region often undertake educational excursions to Casuarina Glade State Forest.

Casuarina Glade scenario: Maps of species distribution

R 8

Resource Sheet 8



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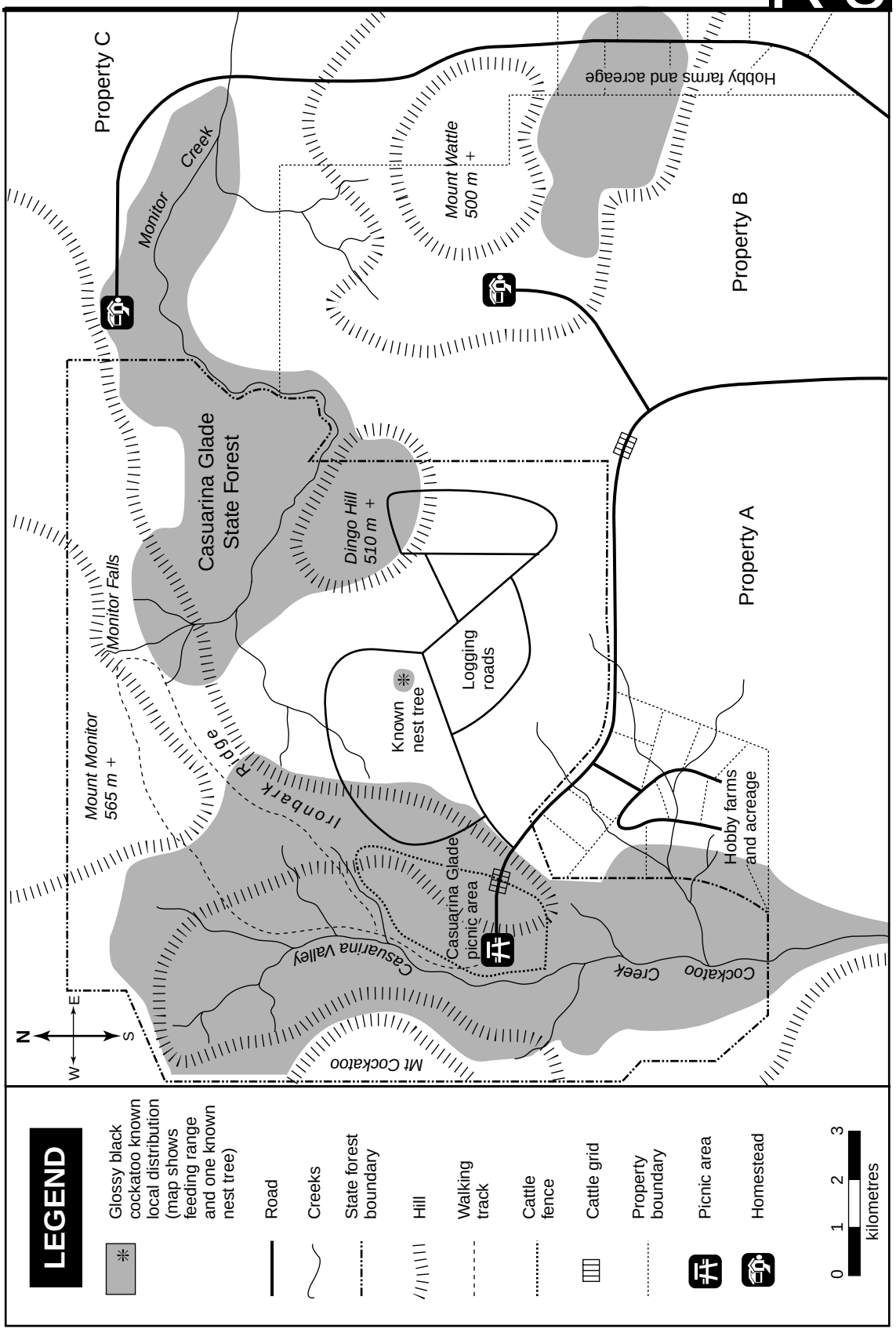
Casuarina Glade scenario: Maps of species distribution *(continued)*

R 8

Resource Sheet 8



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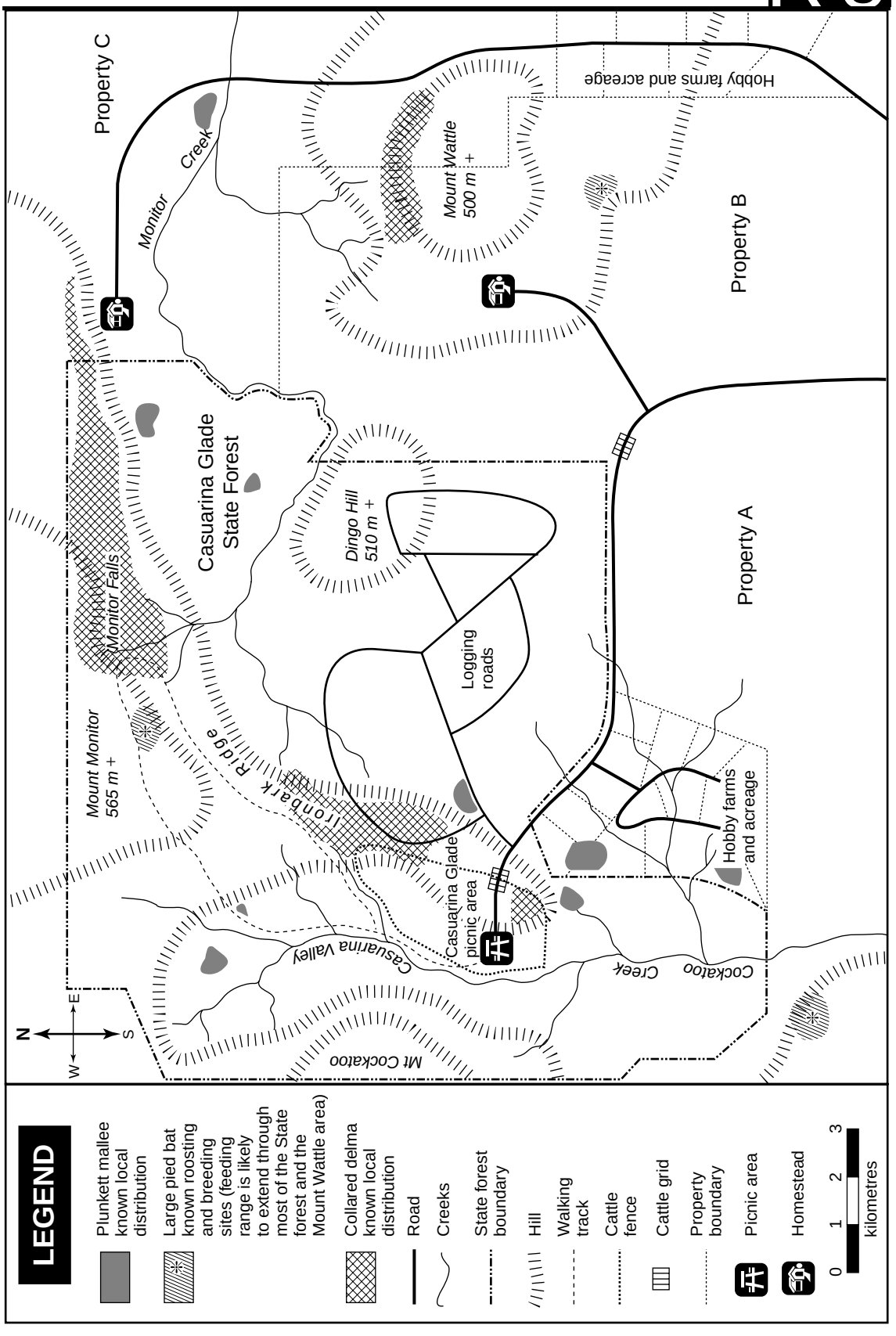
Casuarina Glade scenario: Maps of species distribution *(continued)*

R 8

Resource Sheet 8



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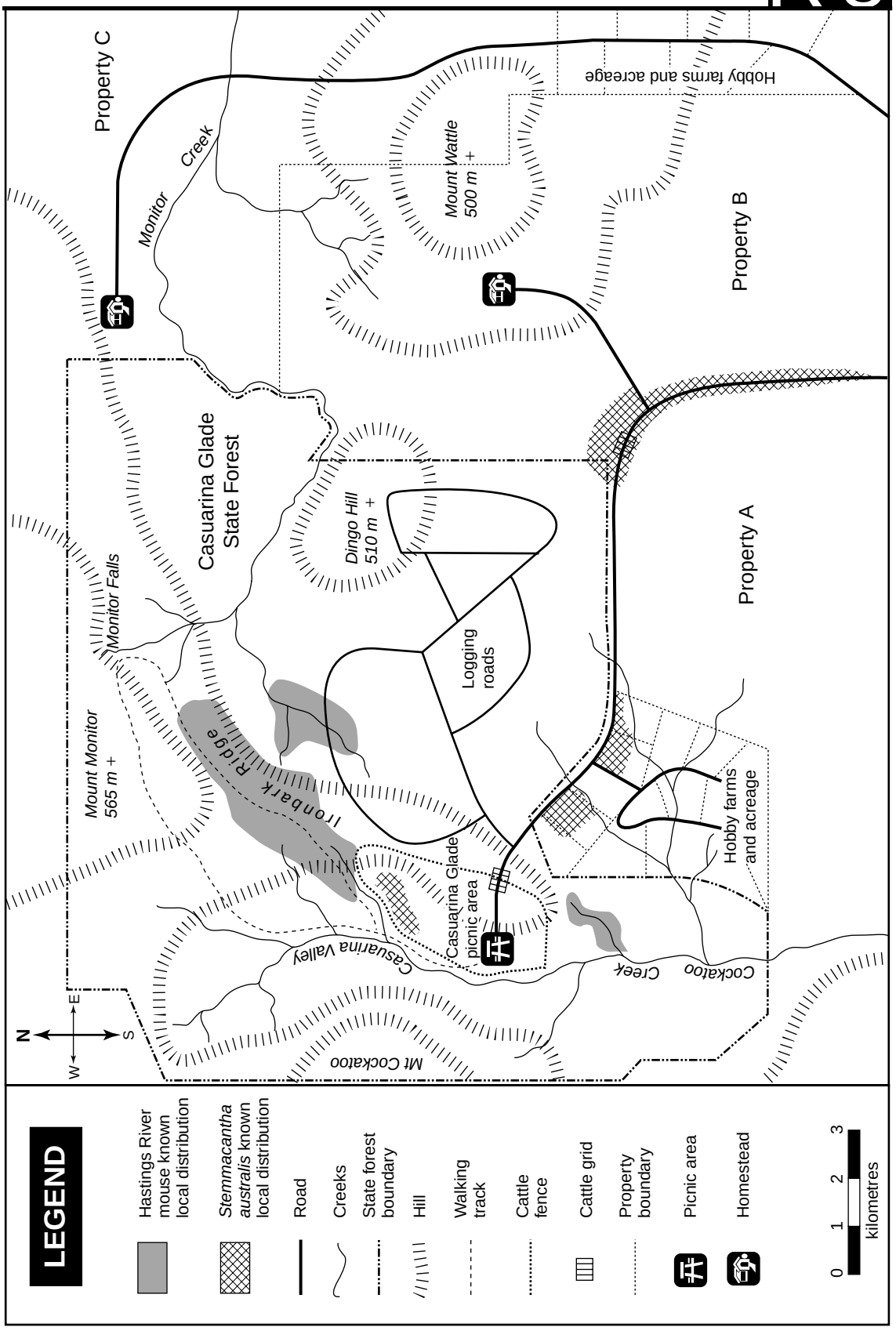
Casuarina Glade scenario: Maps of species distribution *(continued)*

Resource Sheet 8

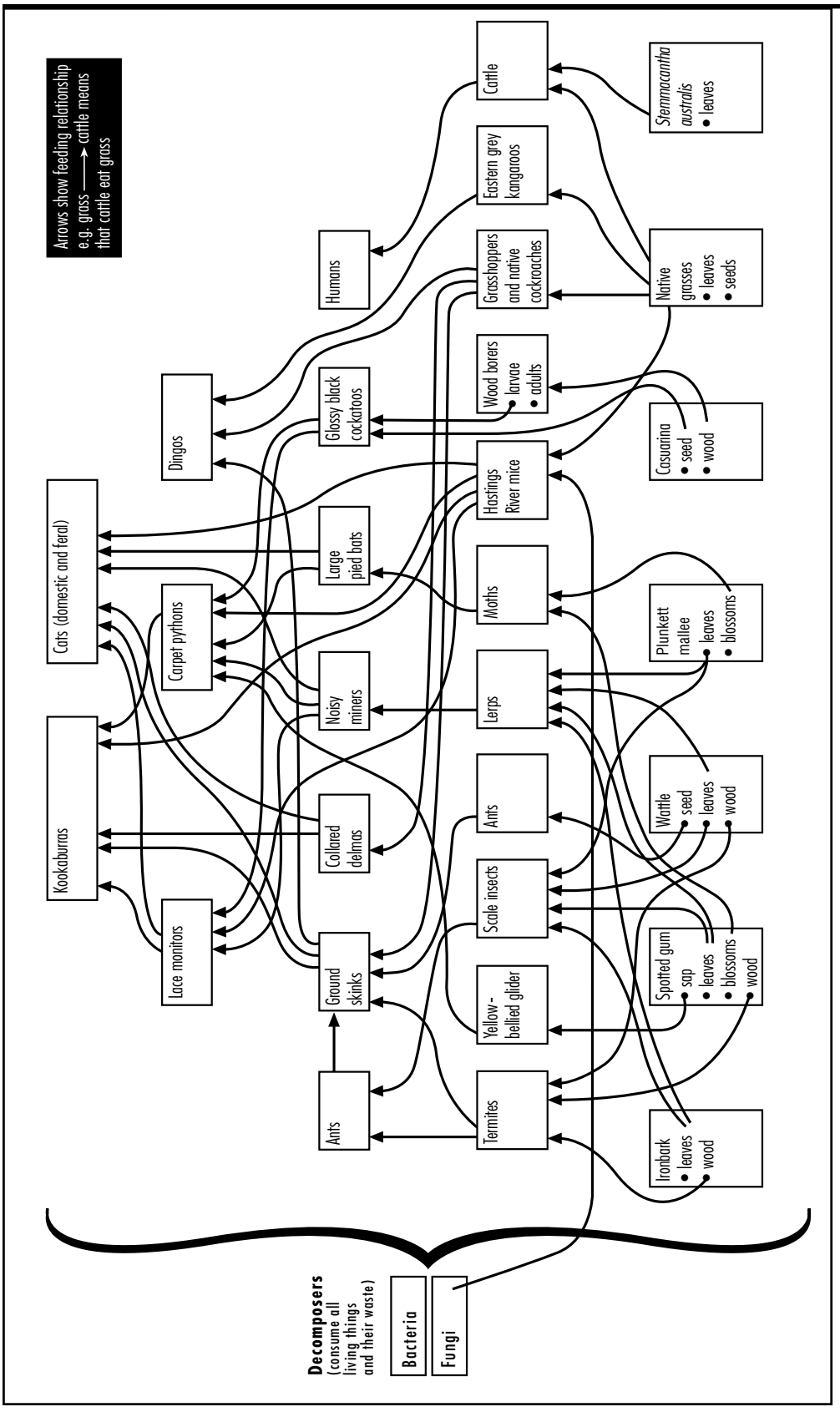
R 8



Casuarina Glade scenario: Food web

Resource Sheet 9

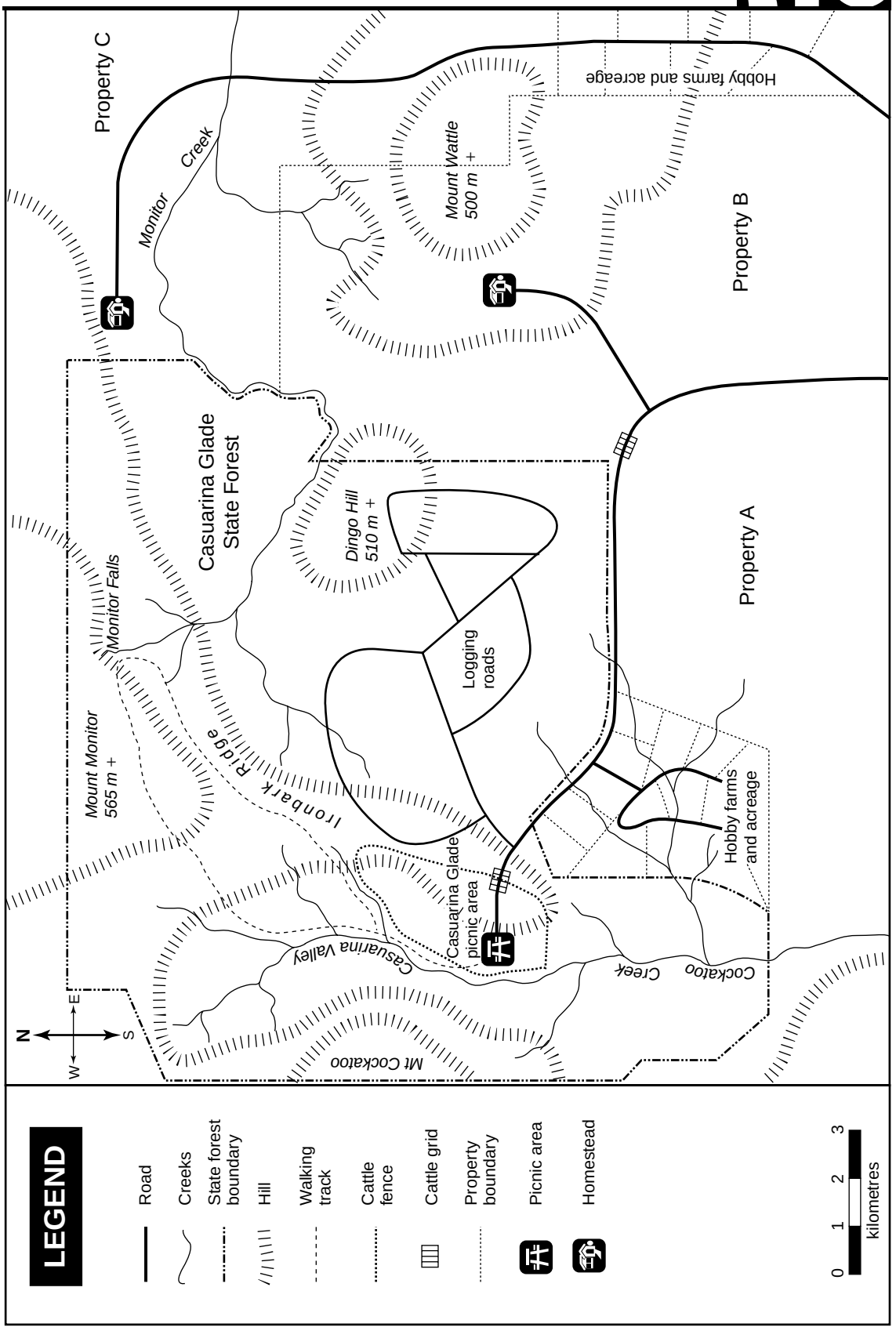
Prepared by students of Casuarina Glade State High School



Casuarina Glade scenario: Map of the area

R10

Resource Sheet 10



Acknowledgments

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Sydney Water for material from *The Streamwatch Water Bug Detective Guide*.

This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

ISBN 0 7345 2144 8

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