FREE CD INSIDE

Exploring BIODIVERSITY

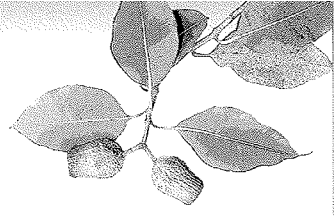
AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

asta 50

FIFTY YEARS 1951 - 2001

A resource book of ideas for National Science Week 2001

Foreword



Exploring Biodiversity

A resource book for National Science Week 2001

Exploring Biodiversity is a resource book of activities and information, designed for teachers and students, and provides many interesting and exciting activities for use at school and at home. The book can be used during National Science Week right through to Biodiversity Month in September and throughout the rest of the year.

National Science Week, supported by the Commonwealth Government, is a partnership program between the Australian Broadcasting Corporation, the Australian Science Festival Limited, the Australian Science Teachers Association and the Department of Industry, Science and Resources. National Science Week helps to focus community attention on science and its importance in the school curriculum and promotes the image of science.

The ideas and suggestions in this book are written for students from K to 12. Some you may find too difficult for your students and others may not be advanced enough. They are there to trigger your own ideas.

Each State and Territory has an ASTA National Science Week Coordinator. Contact details are below. There is also a National Science Week Coordinating Committee in each State and Territory.

National Science Week is one of many programs that ASTA organises to enrich school science education for students and teachers in primary and secondary schools. Please contact the ASTA office or your State/Territory Science Teachers Association for further information. A free copy of this resource book is one of the many benefits of membership.

ASTA is pleased to have received funding for this project from the Department of Industry, Science and Resources. ASTA Council thanks and congratulates the authors and designers of *Exploring Biodiversity*, the National Science Week Coordinators in each State/Territory of Australia and all the teachers and students who become involved in activities during National Science Week.

We have included a questionnaire at the back of this book to gauge its value to teachers and students. Please take a few minutes to complete and return it and be in the draw for a wonderful prize donated by Newton Graphics.

Marj Colvill

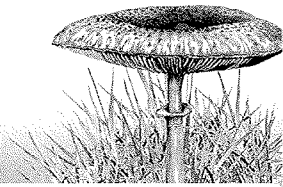
Marj Colvill
President

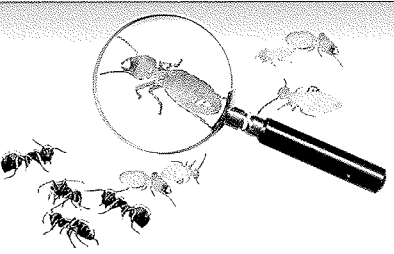
ASTA Secretariat
Australian Science Teachers Association
P.O. Box 334
Deakin West ACT 2600

Ph: (02) 6282 9377 Fax: (02) 6282 9477
email: asta@asta.edu.au
website: www.asta.edu.au

State/Territory Science Teachers Associations

ACT	NSW	Northern Territory	Queensland
SEA*ACT GPO Box 1205 Canberra ACT 2601 Ph: (02) 6205 6344	STANSW C/- PO Homebush West Homebush NSW 2140 Ph: (02) 9746 3210	STANT PO Box 1168 Nightcliff NT 0814 Ph: (08) 8941 2699	STAQ, C/- School MSTE QUT Kelvin Grove Campus Victoria Park Road Kelvin Grove, Qld 4059 Ph: (07) 3864 3340
South Australia	**Victoria**	**Tasmania**	**Western Australia**
SASTA 1st Floor, 211 Flinders Street Adelaide SA 5000 Ph: (08) 8224 0871	STAV P O Box 109 Coburg Vic 3058 Ph: (03) 9386 6677	STAT Launceston Delivery Centre Launceston TAS 7250 Ph: (03) 6233 5677	STAWA P O Box 1099 Osborne Park WA 6919 Ph: (08) 9244 1987





Contents:

Publisher:
Australian Science Teachers Association
PO Box 334, Deakin West, ACT 2600

ISBN: 0-9586618-8-X

Author: Bob Winters, Gould League
Scientific and educational authorisation: Gaye Hamilton, Dr Annette Gough, Dr Adrian Daniell
Graphic design: Trish Hart
Illustrations: Sharyn Madde

Winters, Bob.
Exploring biodiversity.
ISBN 0-9586618-8-X
1. Biological diversity – Study and teaching (Primary).
2. Biological diversity – Study and teaching (Secondary).
3. Biological diversity – Study and teaching (Primary) – Activity programs.
4. Biological diversity – Study and teaching (Secondary) – Activity programs.
I. Madder, Sharyn, 1949.
II. Australian Science Teachers Association.
III. Title.

ASTA acknowledges the following for their valuable input during the drafting of this book: Andreas Glaznig, Community Biodiversity Network; Judy Freeman, STAT; Donna Bennett, STAQ; Anne Forbes, STANSW; Niels Hider, SEA*ACT; Jan Brooks, SASTA.

Safety warning: All student activities included in *Exploring Biodiversity* have been designed to minimise hazards. However, there is no guarantee expressed or implied that an activity or procedure will not cause injury. Teachers selecting an activity should test it with their own materials before using it in class and consider the occupational health and safety requirements within their State or Territory. Where physical activity is involved the teacher should be qualified to conduct that activity.

Any necessary safety precautions should be clearly outlined by the teacher before starting the activity. Students must also be provided with all safety equipment prior to commencement.

How to use this book

This book is designed to provide real-life scientific challenges for students. The book does not provide many step-by-step procedures, because it focuses on students designing their own scientific procedures. Teachers can include more rigorous activities from other sources. It caters for a wide range of experience and knowledge. A series of ***challenges*** for students, built around real-life investigations of local biodiversity are presented on pages 8 to 12. The large range of challenges ensures that all school environments around Australia are catered for.

These challenges can be modified to suit students' interests, ages and abilities.

The problem-solving approach of the challenges is supported by many methods for ***discovering and measuring biodiversity*** on pages 13 to 32. These provide classes with a wide range of scientific methods for exploring biodiversity.

Students should be encouraged to modify these activities and invent their own ways of discovering local biodiversity.

As part of the challenges, students are encouraged to use their new understanding of biodiversity to design and create projects to increase local biodiversity.

A final section, ***Restoring biodiversity*** suggests some achievable ways for schools to increase biodiversity in their grounds.

Introduction – What is Biodiversity?

The Earth supports an astounding variety of plants, fungi, animals and microorganisms. Organisms are found living over the surface of the land, in soils and in fresh and salt waters. Some microorganisms can grow in the air, some on rocks, some close to boiling volcanic water and some in ice.

Biodiversity is the variety of all living things. It includes the obvious large animals and plants, the smaller plants and creatures and millions of microorganisms. Scientists can only guess at how many different types of living things occupy the Earth.

Biodiversity describes more than the gross number of kinds of living things. It includes:

- Species diversity
- Genetic diversity
- Ecosystem diversity

Species diversity is the total variety of all the species in a given region. There are estimates of up to a million species in Australia, most of them not named. A species is a group of organisms that naturally interbreed producing healthy reproducing organisms. Some organisms don't interbreed but reproduce asexually. The individuals of a species reproducing asexually will have very similar genes.

Genetic diversity is the variety of genes within a species. Humans have about 100,000 genes, bacteria about 1000 genes but some plants have up to 400,000 genes. Differences in the genes determine the different attributes of an organism. Genes vary between individuals within a species. This variation is genetic diversity.

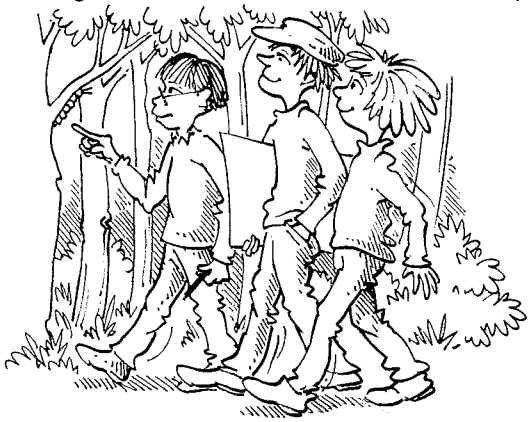
Ecosystem diversity is the variety of ecosystem types. An ecosystem includes the living organisms in a community plus the non-living factors with which they interact. It is thought that there are hundreds of ecosystem types in Australia.

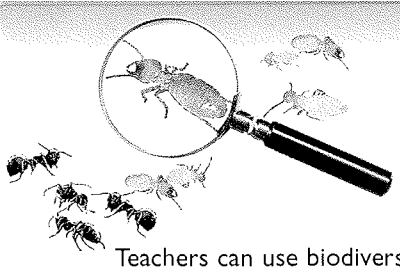
An indigenous species is an organism belonging to, and found in, a certain location. Its genetic diversity at the location is unique. Many populations of a species must be protected to maintain overall genetic diversity. When re-establishing habitat, indigenous plant and animal stocks are used for propagation and breeding to protect genetic diversity.

Teaching biodiversity

The study of biodiversity provides students and the community with a more complete explanation of the dynamic living environment than the study of isolated topics and issues related to ecology or endangered species. The theme of biodiversity includes rainforests, the Great Barrier Reef and endangered species, school grounds, local parks and back yards. A unit on biodiversity includes many of the environmental and biological topics taught already and provides a richer context.

Over the past 200 years there has been a significant loss in Australia's biodiversity. While students can not hope to tackle issues covering large areas of Australia, they can make a significant contribution to local biodiversity issues.





Teachers can use biodiversity to engage students with real scientific challenges and dynamic debates about current issues. The theme can empower students to take action in their local environment to protect and restore biodiversity.

Using this book to explore and increase biodiversity

This book aims to enable students to discover and record as much biodiversity as possible. From their investigations students are encouraged to implement biodiversity projects to increase the school's biodiversity by up to 50%. A range of challenging biodiversity explorations is suggested. Each challenge focuses its attention on one aspect of biodiversity.

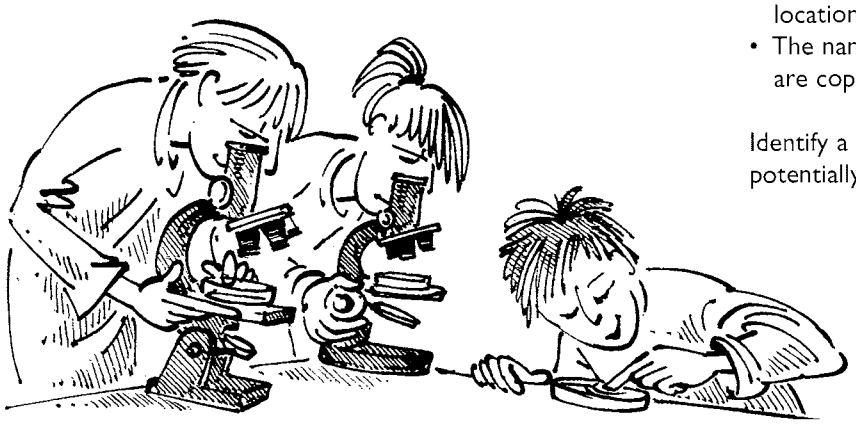
Students will:

- decide what should be monitored and recorded
- investigate relevant monitoring models
- choose or develop methods for monitoring
- monitor and record biodiversity
- discuss related issues
- identify ways of increasing biodiversity
- implement projects that will increase biodiversity.

To assist this process, *Exploring Biodiversity* has a large selection of biodiversity monitoring activities for students to choose from. This is followed by a section of projects designed to increase the school's biodiversity. A wide choice of activities will provide all schools with some methods for measuring biodiversity whether the school is urban or rural based.

Teachers may use this publication to introduce students to biodiversity by selecting the activities most relevant to their school grounds.

Teachers may want to make the activities more challenging and allow students to work independently. They can provide students with a challenge, allow them to select and modify activities found in this book or create their own activities having shown them what equipment and other resources are available.



Measuring biodiversity

The species diversity of an area is a measure of the number of species of plants, fungi, animals and bacteria living in the region. Generally, natural and untouched areas have higher biodiversity than cleared or built-up areas.

There are numerous techniques for measuring biodiversity. In South America scientists use pyrethrin fogging guns to spray the canopy of a single rainforest tree. The dead insects fall onto large tarpaulins laid out below the tree. The insects and other invertebrates falling from the tree are then compared to the invertebrates from other trees. It is not necessary to actually name the insects. This is impossible, as most of the invertebrates have never been scientifically named. Scientists compare the number of species living on each species of tree. Even though each species cannot been identified, a measure of the species diversity for each tree can be measured.

It is possible for students to complete many valuable biodiversity investigations without scientifically identifying all the organisms found.

Keeping records

Keeping records and identifying changes in the local biodiversity enables people to more effectively protect and even improve the local environments. Making measurements and keeping records also assists people to judge the success of wildlife projects. The measurements can be taken again at a later date and biodiversity comparisons can be made.

The following information helps to make realistic comparisons:

- Time and date
- Location or place
- Weather at the time the data was collected
- What kind of data was gathered
- How the data was gathered
- The names of the people who gathered and recorded the data
- Any special comments that could be relevant about the location or data
- The name of the school in case the records are copied and sent to another school.

Identify a place where the data can be safely stored, potentially for some years.

Importance of Biodiversity

The demands made on the Earth's resources are constantly increasing. People are using much of the land for farming and are fishing most of the oceans. There is less space than ever for natural ecosystems to survive without major impacts from humanity.

There are two interlinking views of why biodiversity is important:
1. People who care about the environment feel strongly that other living things have a right to survive alongside people. To them, other living things do not need to benefit humanity directly to have a right to exist.
2. Environmental experts and others see many compelling benefits to humanity by protecting the Earth's biodiversity. Among these is humanity's very own survival. As people learn more about the amazing complexity of the Earth's biodiversity, they will discover more and more direct benefits.

The ecosystems of the world have evolved over a billion years. They make the planet livable. The plants and bacteria even help to clean up some of our pollution. We are starting to understand that when the environment becomes badly 'damaged' people also suffer as a consequence.

Many ecosystems are magnificent and attract many visitors. Such places in Australia as the Great Barrier Reef, Uluru, Blue Mountains, Kakadu, Flinders Rangers, Kimberley Plateau, Stirling Range, Warrumbungles, Great Ocean Road and Cradle Mountain National Park support large tourist industries. People visit these places to view spectacular landscapes, experience areas rich in biodiversity, enjoy and relax in beautiful environments.

Only a fraction of biodiversity's full potential has been discovered. Scientists have an endless resource for new discoveries in chemicals produced by millions of different kinds of organisms. many of these will provide many new medicines. Through breeding, people can use the genetic diversity of plants and animals to produce new foods. One of the most exciting things about biodiversity is that nobody knows what the next discovery will be. Humanity will never know what has been lost when biodiversity is destroyed.

Threats to Biodiversity

The Earth is presently experiencing its highest rate of extinction since the period of the dinosaur. Over the past 10,000 years this rate has progressively increased and has become extraordinarily high in the past 100 years. Besides species extinction many other species have lost a significant pool of genetic diversity, having been driven away from many of their former habitats.

Habitat loss People often think of forests when habitat loss is considered. There are many other ecosystems that are suffering major losses in Australia besides forests. Natural grasslands throughout Australia and much of the world have been destroyed by modern agricultural practice. Ploughing, fertiliser use and grazing can greatly reduce grassland biodiversity. Once destroyed, it is almost impossible for the grassland to fully recover its original biodiversity. It is not surprising that the largest number of endangered and extinct mammals in Australia are from grasslands and woodlands.

Other impacts on ecosystems are not obvious at first glance. For example, the volume of logs removed from the forest floor, roadside and farmland for burning in wood stoves is greater than the quantity of woodchips that are exported. This can have a devastating impact on ground-dwelling animals.

Habitat fragmentation Many ecosystems have been fragmented and reduced in size. Sometimes the fragments are not large enough to support the original species diversity. The species that remain are isolated from the large gene pool. When a disaster occurs and such populations are wiped out, others of their species can no longer migrate back to the isolated ecosystem. Small populations of animals living in small fragmented locations are at risk. One of the greatest risks could come from climate change. Animals and plants in fragmented habitats may not be able to migrate to suitable climates if global change occurs as forecasted by some scientists.

Weeds These are unwanted plants living in places where they do not naturally occur. In some parts of Australia there are almost as many weed species as there are indigenous species. Some weeds were deliberately released and spread, albeit ignorantly. In their country of origin they were used as food, feed for stock or garden plants.

Many escaped from farms and gardens. Many more were accidentally brought into Australia. Weeds can also be Australian plants growing wild outside their natural range.

Introduced weeds take the place of indigenous species. They cannot be eaten by indigenous animals and fungi and usually make poor homes for animals. Introduced weeds can be successful for a number of reasons: their natural enemies are not present to eat them; they grow quickly and take over whenever people, domestic or feral animals change the natural vegetation.

Feral animals Many of Australia's mammals became endangered when rabbits and foxes entered their habitat. Rabbits and foxes now live over the southern part of Australia where they have changed many ecosystems, particularly grassland and woodlands. The re-introduction of small mammals to their original ecosystem is only successful in fox-proof habitats. For many species their only chance of survival is on islands with no foxes, in fox-proof environments and in zoo-like enclosures being cared for by people. A more recent feral infestation is the cane toad. Poison from its glands kills any wildlife trying to eat it. It also eats smaller creatures. The population of cane toads is still expanding.

Feral ants and cockroaches invade houses. Sparrows nest in buildings. Indian mynas attack native garden birds and take over tree hollows. Today, Australian authorities take many precautions to prevent the release of any more feral animals.

Over exploitation Over thousands of years many cultures have understood that they must exploit nature's resources in a sustainable way. This means there is a natural replacement of the resources that have been taken leaving minimal long-term impact on the biodiversity of an area.

With modern fishing and forestry techniques people can exploit natural resources at a faster rate than in the past. Sometimes the resource is being used faster than it can be replaced. For example, modern ships powered with engines and armed with exploding harpoons were able to hunt many more whales than sailing ships. Many whale species were almost hunted to extinction before they were protected.

There seems to be a lot of forest in Australia but it takes a long time for trees to grow back to a large size after logging. An increasing demand for timber from our forests creates pressure to use the remaining large old growth trees. The challenge for forestry is to develop a sustainable industry while protecting biodiversity.

Changed fire regimes Since the arrival of Europeans, there has been a large increase in the number of fires in Australian forests, woodlands and grasslands. In a few specialised habitats the fires have decreased. Changing the natural occurrence of fires can have a dramatic impact on many Australian ecosystems. People light control burns in forests to reduce the fuel loads and potentially reduce the impact and spread of a wildfire. This type of burn has the potential to prevent some species of plants from regenerating.

We require a great deal of scientific research to fully understand how best to manage forests, woodlands and grasslands using fire.

Pollution Many of Australia's waterways, creeks, rivers, lakes, inlets and seas are exposed to water pollution. This takes many forms including solid litter, fertiliser, chemicals and nutrient run-off. Extra soil particles in the water reduces the penetration of light and reduces plant growth. Extra nutrients will change the kinds of organisms growing in the water. Some pollutants can cause reduction of oxygen in the water and affect the survival of many organisms.

Climate change Scientists have carefully investigated the change in climate over time and are making predictions about the impact of the extra carbon dioxide we are releasing into the air. Many scientists predict that over the next 100 years the air and the sea will get warmer. This may impact on many ecosystems. For example, much of Australia's alpine ecosystem might disappear. Some of the corals which have built the Great Barrier Reef may die as the temperature of the sea water increases by only a few degrees.

Disease International transportation means that animal and plant diseases can move between countries. It's likely that some endangered mammals such as the Eastern Quoll disappeared from some areas due to disease. The disappearance of frogs throughout Queensland may also be due to disease.

Restoring biodiversity

As part of a real-life science experience, students can be encouraged to restore local biodiversity in their school grounds. Through their research, students will develop considerable understanding about biodiversiy and will be motivated to explore the section called *Restoring Biodiversity* (pages 33-37).

Before increasing biodiversity, measure the school's current biodiversity. Consider starting with some small projects before creating larger plans. Set down some goals for what can be achieved. Use and modify the suggested goals below to identify and plan the school's biodiversity restoration program.

Suggestions for biological indicators to measure the success of biodiversity projects:

These goals are a suitable starting point for rural, suburban and urban-based schools.

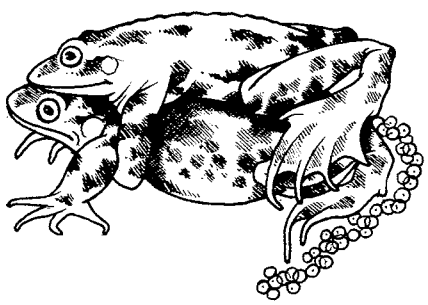
1. Possible goals for habitat modification:

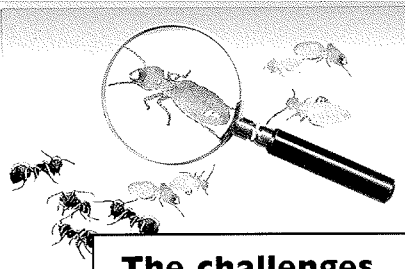
- up to 10% of the school ground will be transformed using native and indigenous plants to provide habitat for wildlife
- the completed projects are maintained
- tripling the number of indigenous species of plants in the school grounds
- doubling the types of natural objects in leaf litter in a 900 sq cm area.

2. Increase in wildlife:

- 50% increase in the types of invertebrates in the soil, grasses and vegetation
- 25% increase in the types of birds visiting the school
- 35% increase in the types of honeyeaters visiting the school
- 50% increase in the sighting of parrots feeding in the school grounds
- small skinks observed on site
- frog calls heard on site.

Increasing biodiversity requires the creation of new habitat. Indigenous plants should be extensively used. It is much cheaper to plant forests than it is to landscape. It costs from $5 to $10 a square metre to plant habitat.





The challenges

This section sets out some interesting challenges for students relating to biodiversity. It provides a starting point for students who, in collaboration with teachers, can modify these challenges to suit their interests. It also highlights some relevant issues and suggests specific action. Students can use investigation methods from the ***Discovering and measuring biodiversity*** section and should try to invent some methods of their own.

Not all challenges will suit every school's environment, but the broad range of challenges should help every school explore their local biodiversity.

Teachers should try to:

- Help students choose appropriate challenges for the school environment.
- Investigate the challenges using activities from the ***Discovering and measuring biodiversity*** section.
- Encourage students to invent their own experiments.
- Use the students' discoveries and the ***Restoring biodiversity*** section as a guide to increasing the school's biodiversity. It should be possible to increase biodiversity by 50% in most schools over 12 months.

Classroom biodiversity

The scenario: A classroom may be home to over 20 types of organisms.

The challenge: Use a range of techniques to find as many types of classroom organisms as possible. See how many can be found.

The plot: It may not be obvious what living things occur in a classroom, but most of the species diversity is in microscopic form. Discuss what types of life can inhabit a room. Where might invertebrates live? Are some nocturnal? How can bacteria and fungi be detected in the room?

The issues: Does classroom biodiversity pose a threat to people's health? Are all bacteria harmful? Do dust mites or cockroaches create problems? Do all or some spiders have a right to live in the classroom?

The action: Manage a healthy classroom and maintain appropriate biodiversity.

Air biodiversity

The scenario: Microscopic life floats in the air. Some of the life is so small that individual organisms cannot be seen under a microscope that uses normal light.

The challenge: Find living things in the air in the classroom.

The plot: The air holds many surprises. It is full of microscopic organisms. As many of these cannot be seen under a normal microscope, it may be necessary to grow some of the smaller organisms.

The issues:

- If there are so many organisms in the air, why are people healthy most of the time?
- Find out about Legionnaires Disease. How do people get sick from Legionnaires? What must we do to prevent the disease?

The action: Maintain the classroom so it has clean air.

Tree and shrub biodiversity

The scenario: Many organisms depend on specific trees and shrubs.

The challenge: Record as many organisms as possible that live or feed on the leaves, trunks and branches of shrubs and trees. Find out about, and grow, the plants required to attract more biodiversity.

The plot: Discuss what animals need to survive. How might shrubs trees and grasses in school grounds help some animals? How can students find out if some types of plants are better homes than other plants? Which plants in the school make the best homes: indigenous (species of plants which are genetically from the local area), native (grow naturally somewhere else in Australia) or introduced (not native to Australia)? Are significant parts of some animal homes missing in the school grounds e.g. tree hollows? Can animals migrate through the school grounds?

The issues: Is it better to log eucalypts or pines? People who grow pines say pine trees are better for the environment because native forests are not logged. People who log eucalypts, say their logging is better for the environment because native animals live in eucalypt forests but there is little biodiversity in pine forests. Is it better to grow pines or eucalypts? What kind of information is required for students to come to a satisfactory conclusion? Try investigating pines and eucalypts in the school grounds or local park.

The action: Identify some kinds of animals that people at the school would like to attract to the school grounds. Find suitable plants to grow. What other projects may be necessary for this to be successful?

Soil biodiversity

The scenario: Soil is created by weathering of rock, rotting leaf litter and soil and leaf litter organisms.

The challenge: Find out what soil conditions produce the greatest species diversity. How can soil biodiversity be increased?

The plot: Soils, leaf litter and compost bins in warm, moist conditions support large numbers of small organisms including insects and fungi. In the drier regions of Australia, ants rather than earthworms are responsible for turning over the soil and leaf litter. There are many methods for extracting soil life. Which are the most effective methods in the school's conditions?

Find the best location in the school for soil life. What conditions contribute to the greatest soil biodiversity? How does soil compaction from constant walking and running on the ground affect soil biodiversity?

The issues: Cattle, horses and sheep have much harder feet than people. No native animals have hard feet. How might these hard hoofed animals affect soil biodiversity? Can soil biodiversity be protected from hoofed animals?

The action: Create ideal conditions for increasing the biodiversity of soil animals.

Grassland biodiversity

The scenario: There is a lot of grass around most schools. Is the grass in the school grounds like a desert, with little biodiversity?

The challenge: Are any areas of grass around the school rich in species diversity? Can students find any conditions that increase species diversity in grass? How do native grasses compare with introduced grasses for biodiversity? Do the same invertebrates live in parks and on sports ovals?

The plot: Large areas of grass surround most schools. Examine the condition of the ground. Is it compacted and as hard as rock? Are some areas very dry? Are some areas heavily shaded? Is the grass long or short? Design a survey that will indicate if any specific conditions increase species diversity in grassy areas. Graph biodiversity against the height of grass.

Investigate how grassy areas can be improved to provide habitat for small lizards.

The issues: Should native grasses be planted? Should special areas be created for lizards? Would snakes be attracted to these areas?

The action: Plant an area with native grasses and monitor the changes in biodiversity.

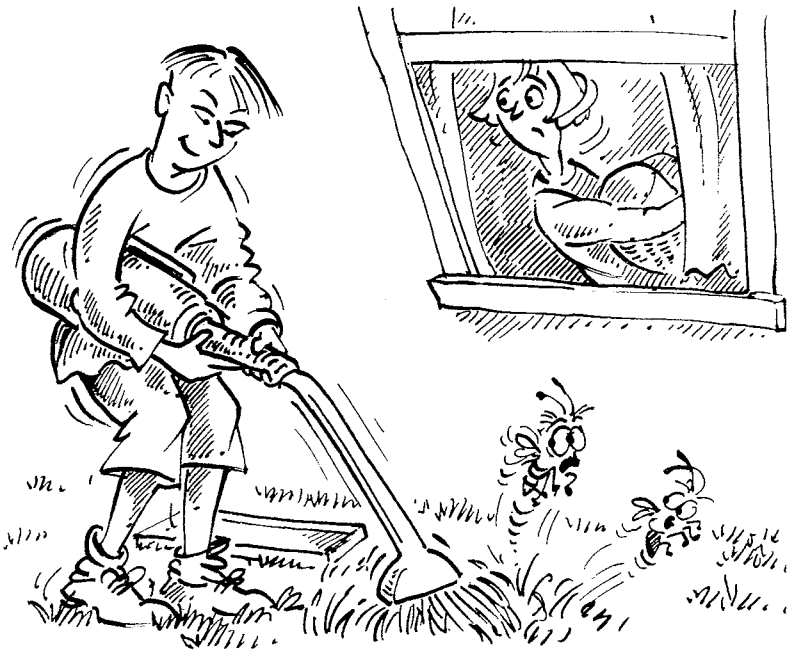
Fallen log biodiversity

The scenario: Animals, fungi and bacteria live in and under fallen logs. These logs are slowly broken down and returned to the soil.

The challenge: Most schools do not have fallen logs. Design an experiment to find out what kind of organisms can live in fallen logs. How can fallen log habitat be introduced into the school?

The plot: Fallen logs and branches are cleaned out of gardens, parks and school grounds to keep them tidy. They are also taken from forests, roadsides and farmland for firewood. Is this having an impact on species diversity? What kinds of organisms live in rotting logs? Can alternatives to fallen logs be used to make animal homes?

More information can be found on:
www.ea.gov.au/firewood



The issues: Debate whether the school should or should not acquire some rotting logs from a nearby forest to be placed in the school grounds.

How does the removal of fallen logs affect biodiversity? Explore the implications of this issue by asking students to write an imaginative story about an animal or fungus that has its log removed. Identify some of the organisms effected by the removal of fallen logs from the forest. Each student can choose an organism and write a story entitled 'The case of the missing log' Students should describe the following:

- What is the life in or under the log like?
- What other organisms share the log?
- Why was the log removed?
- What happened to the organism?
- What happened to the log?
- What happened to the other organisms left behind?
- What happened to the organisms that remained in the log?
- If lots of other logs are removed what is the impact on the forest?

The action: Discuss with the school maintenance committee their policy on removing fallen tree limbs. Find out if there is an area in the school where fallen limbs can be left to rot. Ask students to think of other ideas to make homes for animals that would normally live in or under fallen logs. Test these ideas in the school grounds.

Pond biodiversity

The scenario: Ponds are beautiful examples of small, dynamic ecosystems. They are fascinating places to explore for wildlife and become highly valued features when built in school grounds.

The challenge: How many kinds of organisms can be found in pond water?

The plot: It is easy to collect a wide diversity of pond animals from some ponds. Rivers and creeks are more difficult to sample because most animals are attached to plants or rocks, so they are not swept away. Some ponds will have many plants, while others have almost none. A farm dam with no visible plants may contain a wide variety of invertebrates. The basis of the food web is nutrients from farm animal manure washed into the dam. Bacteria consume these nutrients. Many large lakes have few nutrients and low biodiversity. Explore local ponds for invertebrates and plants. What factors in a pond increases species diversity? When a pond is established in the school, record the changes in biodiversity. Which organisms colonise the pond first? How do they get to the pond? Which organisms eventually dominate the pond?

The issues:

- What must students do to protect ponds and wetlands when they visit them?
- Why are people prohibited from removing frogs, tadpoles and their eggs from wetlands? How might the removal of frogs etc. effect species diversity and genetic diversity?
- How do feral mosquito fish threaten the biodiversity of ponds? Why should feral fish not be released into waterways? What can students do if mosquito fish are caught while sampling a pond?

The action: Construct a pond or marshland in a secure area of the school. (Railway sleepers and a sheet of plastic can form a temporary pond on bitumen or concrete.)

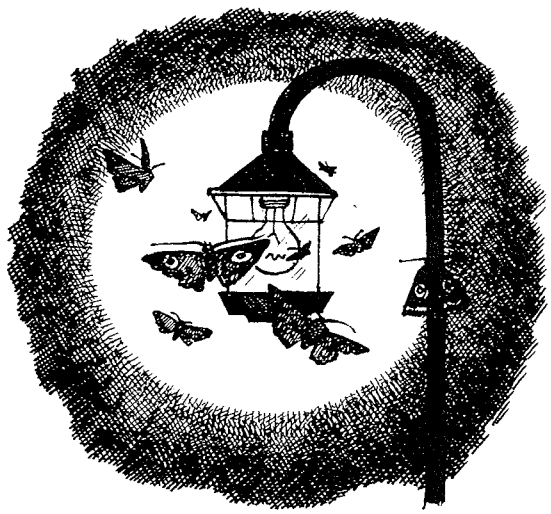
Nocturnal biodiversity

The scenario: Many Australian animals are nocturnal. They are often secretive and very challenging to find.

The challenge: Detect as much nocturnal and early morning wildlife as possible in the school grounds. Use as many methods as possible. Use imagination and technology.

The plot: Organise students into groups. Design an investigation to find out what animals come out at night and in the early morning in the school grounds. Some groups may want to modify their challenge.

The issues: In some States in Australia, the only way people are allowed to remove troublesome possums from their property is to catch them and take them to a vet who must kill them with a lethal injection. Why do some possums cause problems? Why should people not catch and release possums somewhere else? What do students think is a reasonable way to deal with 'pesty' possums?



The action: Grow native plants that flower throughout the year to feed many nocturnal insects. Provide enough vegetation for nocturnal animals. Find out what kind of homes nocturnal mammals sleep in and build and install new homes.

Genetic diversity

The scenario: A species is the sum of its genetic material (genes). When genetic diversity is lost, the species variation and viability is reduced. Schools and communities can make a significant contribution to preserving local genetic diversity.

The challenge: Find different types of genetic diversity in organisms. Identify the difference between genetic diversity and variation caused by environmental factors. Create habitats that preserve genetic diversity.

The plot: There is often a large amount of genetic diversity within a species, but people can only see and measure a small amount of this diversity. Humans provide opportunities for the study of genetic diversity because people are skilled at recognising subtle differences between each other.

Examine a range of organisms. Find and measure features that represent genetic diversity. Which variable features are good measures of genetic diversity and are easily distinguished from variation caused by environmental factors? For example, in humans which features are effected by environmental factors: eye or hair colour, weight, number of fingers?

The issues: Some students intend to build a forest or grassland to attract wildlife. What are the important genetic diversity factors in choosing the plants? Where will they start looking for the plants they need? Should they remove plants from natural areas of bush? Should they remove and propagate seed?

The action: Grow indigenous plants with stock that has originated close to the school's location.

Ecosystem diversity

The scenario: In cities, suburbs and rural areas, many ecosystems have been removed, reduced or greatly modified.

The challenge: Find as many different kinds of natural and artificial ecosystems in the school's locality as possible. Identify how local ecosystems have changed. How great are the changes? Complete a project that re-creates an ecosystem or protects an existing ecosystem.

The plot: Compare how the local area has changed over the past 200 years. What kind of ecosystems dominated the area 200 years ago? Have any ecosystems been lost? Have the remaining ecosystems undergone many changes? Where are the remaining natural ecosystems? What are the threats to these ecosystems? What can be done to protect them?

The issues: Propose to the students that they build a pond ecosystem to increase freshwater biodiversity. The school council is apprehensive about a pond in the school. List a range of concerns the school council might have about a pond. Try to find a suitable location and create a design for a pond that will address the concerns of the council.

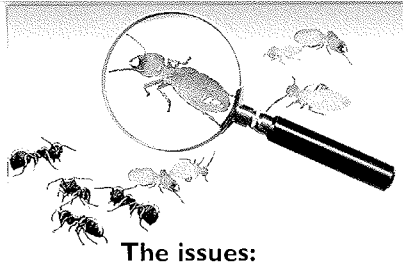
The action: Build or grow an ecosystem that closely represents a past ecosystem.

The importance of biodiversity

The scenario: People have a range of beliefs about the environment. Only a few people have opinions about why biodiversity is important.

The challenge: Find out how biodiversity improves people's lives.

The plot: Examine a range of foods, medicines and pets. Which of these have used the organisms' genetic diversity to breed new strains? Find some examples of plants and animals that have many breeds/varieties. Why might protecting the world's biodiversity be important in the discovery of new medicines? Ask everyone in the class to contribute at least one reason why biodiversity is important to them.



The issues:

First discussion

Students are to reply to a newspaper article that states: 'Plants and animals should only be protected if people can clearly demonstrate they have some benefit for humanity.' Ask students to respond to this statement and provide views that will change the writer's mind.

Second discussion

How to effectively deal with feral and stray cats is an unresolved issue. Some people have strong feelings for the protection of feral cats and other feral animals due to their relationships with their domestic counterparts. This topic is likely to bring out some strong views about the issue. Can students find ideas they can agree on for the control of feral animals? Their proposals must have a realistic chance of being implemented.

The action: Write letters to local politicians explaining why it is important to protect local biodiversity.

Threats to biodiversity

The scenario: Individual schools cannot do much to save exotic endangered species but a significant contribution can be made to reducing threats to local biodiversity.

The challenge: Find out how locally threatened organisms can be saved. Embark on an activity to protect local biodiversity.

The plot: Examine the major threats to biodiversity described in the teacher notes. Which of these apply to local biodiversity? Find examples of how some of these threats have changed local biodiversity. Identify methods for reducing or removing these threats. Which of these methods can be implemented by the students?

The issues: Discuss issues that are significant in protecting local biodiversity. Examine some of following issues that affect the marine environment:

- Is there excessive clearing of land in Australia? What must be done to establish sustainable land management that protects biodiversity and maintains the soil and the farmers' income?
- Albatross are often hooked and killed when they take fish caught on very long fishing lines. Is long-line fishing endangering the albatross?
- For every tonne of prawns hauled into a trawler, ten tonnes of other marine creatures (by-catch) are killed or injured. Can anything be done to reduce the by-catch?
- How can rare and endangered turtles be protected from being caught and drowned in fishing nets?

Most of these issues are hundreds or thousands of kilometres from where students live. Can students do anything to help solve these issues?

The actions:

- find ways to connect fragmented areas of habitat
- remove weeds from natural areas
- prevent weeds from spreading
- make a list of products that people should not buy because the products reduce biodiversity.

Discovering & measuring biodiversity

These activities are examples of methods students can use to address the challenges. They will help students to discover and measure the biodiversity of their school environment. Students can modify these activities or invent their own.

The wide range of activities will enable students in urban and rural surroundings throughout Australia to investigate many aspects of biodiversity. Not all the activities are appropriate to all schools.

Help students choose activities from this section that suit the challenges they have selected and that are appropriate to the local environment.

Activities are roughly grouped into the following order:
- Species diversity
- Genetic diversity
- Ecosystem diversity
- Importance of biodiversity
- Threats to biodiversity

First 100 invertebrates

Measuring invertebrate species diversity using a graph of Petri dishes

This activity is used to explore species diversity without needing to identify animals. Use this technique to compare the diversity of two environments or the same environment over time.

Equipment: 100 Petri dishes, a large piece of paper to record the results.

Precautions: Students should not catch spiders, bees or wasps, as these may be dangerous.

Procedure: Discuss how species diversity can be measured. What might a team of biologists do? What can students do? With this method high and low species diversity can be measured. When put on a graph, tall, narrow graphs represent low species diversity and flat, wide graphs represent high species diversity.

Steps:
- Explain to students they will catch invertebrates and place a single animal in each of the 100 Petri dishes. The class is to catch the first 100 invertebrates found.
- Each student will use three to four Petri dishes.
- Survey any area in the school or beyond.

On returning:
- Look closely at the animals. Some animals such as beetles will belong to different species.
- Sort the Petri dishes into species.
- For each species stack the Petri dishes one on top of the other and then rank them from the tallest stack to the smallest stack. The row of Petri dishes should look like a graph.
- Give each stack a name such as beetle type 1, worm, beetle type 2, fly type 1, beetle type 3 etc.
- Make a bar graph labelling the animals to replicate the pile of Petri dishes.
- Ask students to release the animals into the area from which they were collected.

This technique can be repeated to compare habitats or changes due to seasonal or environmental change. What conditions produce high species diversity? Keep the records in a safe place where they can be referred to at a later date.

Indicator species

Linking the presence of habitat with particular species and creating an artificial but comparable score

The presence of particular species will indicate the presence of their habitat. The following chart is designed for school grounds and identifies some species that indicate a high species diversity for this kind of environment. General groups of animals are used so the chart can be used around Australia.

Equipment: Pencils and copies of the 'Indicator species chart'.

Procedure: Divide the students into groups. Some students are very optimistic and will tick almost anything they are asked to find, so ask them to be accurate. Students can use the chart below as a model to develop a chart that reflects the locality. This task is best undertaken over a week.

Discuss the students' findings. Were there any surprise sightings? Would the record change if the activity was done at a different time of year? Why? Discuss with students what may be required to attract more species.

Indicator species chart

Species	Good species diversity score 1	High species diversity score 2	
	Number of species	Number of species	Score
Ground orchid		1	
Frogs	1	2	
Small skinks	1	2	
Blue-tongue lizard		1	
Possums	2	3	
Echidna		1	
Cockatoos	3	4	
Lorikeets	2	3	
Other parrots	3	4	
Black and white birds	3	4	
Blue wrens (Fairy-wrens)		1	
Owl, falcon, hawk etc.	1	2	
Ants	3	5	
Butterflies	4	7	
First 100 invertebrates experiment	18	25	
Score (maximum score of 30)			

Dust crawling with life

Record microorganisms in dust

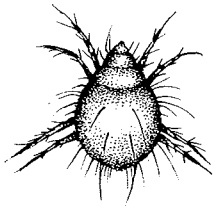
Most students have seen the commercials, can they find the culprits? Mites are very common in the environment. They can be carnivorous, herbivorous or omnivorous. Many are parasites or eat rotting materials. Some mites live in people's beds eating shedded flakes of skin.

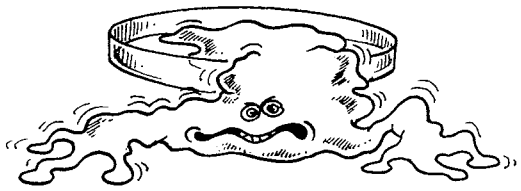
Equipment: Monocular microscopes, vacuum cleaner, sticky tape.

Procedure: Discuss television commercials advertising products that remove dust mites. What information do these commercials provide? Where do students expect to find these mites? Provide students with the challenge of finding mites. Pose the following questions:

- How can mites be found in the dust?
- Will mites stick to things?
- Can mites be separated from dust by placing the dust in different solutions?
- How small are dust mites?

Ask students to explore their ideas and experiment to find different ways of finding dust mites.





Something in the air?

Record microorganisms in the air

Equipment: In secondary schools ask the Laboratory Technician to prepare agar plates. Primary schools may need to ask for assistance from a Laboratory Technician possibly from a secondary school or purchase pre-made plates. Writing materials and a permanent marker are also required.

Precautions: Check your State/Territory legislation to ensure safe handling and conduct with agar plates. Do not remove covers from live cultures. Never attempt to smell a culture. In primary schools, unless there is access to a Laboratory Technician, dispose of the Petri dishes in the sharps container stored in the first aid room.

Procedure: Use a permanent marker to label the lid of each plate. Expose each plate to the air for periods of one to 30 minutes recording the period for each plate and where it is exposed. Leave the agar plates in a warm place and check them each day. Individual bacteria and fungi spores landing on the plates will slowly form observable colonies. Some species of bacteria form different looking colonies. Record the number of colonies over time and the number of different looking colonies.

Use fresh plates to find bacteria and fungi from skin and breath. Human bodies support up to 300 species of micoorganisms.

Bird diversity

Record the types of birds in their habitat

Equipment: Writing material, bird identification resources/books/posters, binoculars if available.

Procedure: Spend equal amounts of time recording the number of bird species in the school grounds and in natural bushland.

Record:

- the number of species of introduced birds, native birds and the native birds that commonly eat garbage
- record where each species feed
- record the size of each bird.

Most birds are active during the day. They are more active early in the morning. Natural habitats will support populations of mostly native birds. European style gardens, cities and farmlands will support populations of many introduced birds. Some native birds like ravens and seagulls turn up to feed on rubbish.

Classify birds generally into:

1) Introduced non-native birds
2) Native birds that take advantage of garbage
3) Other native birds.

Different types of land birds spend most of their time feeding in one of these three locations:

1) Tops of trees
2) In shrubs and understorey
3) On the ground
4) Feeding in the air.

Define the size of birds as:

1) Small – same size or smaller than a sparrow
2) Medium – between a blackbird and a magpie
3) Large – larger than a magpie.

Make a chart to record the findings. Compare a natural area with a built-up area such as the school grounds. Look for differences between the number of species of native birds in the two areas. Are there differences in the number of kinds of introduced species of birds?

What would need to change in the school to increase the number of native birds? Can anything be done to reduce the number of introduced birds? Are birds like seagulls (silver gull), ravens or crows having an impact on other birds? How can students find out if large numbers of these birds keep away other birds?

Parrot monitoring

Record the frequency of parrots using the school

Parrots are common throughout Australia and even visit the gardens in city centres. In this activity students will discover whether parrots regularly spend time at the school.

Procedure: Before the start of morning recess spend ten minutes looking for different species of parrots. The parrots must be feeding, resting or using the area. Parrots flying overhead and not landing are not counted. This needs to be repeated each term. The records will provide trends of how common parrots are in the school. Later, once projects designed to enrich biodiversity are underway at the school, students can monitor whether the projects are attracting parrots.

Parrots include cockatoos, lorikeets and normal parrots like rosellas and budgies (page 19).

You've got a gall

Discover the types of galls occurring on plants and the animals responsible

Galls are growths found on the leaves, stems and branches of plants. Insects and other invertebrates mostly cause them to grow by injecting chemicals into the plant tissue. Sometimes they are caused when insects feed on leaves and stems. Often galls are caused by chemicals on eggs when they are injected into the plant by insects. The eggs hatch and the grubs live inside eating the contents of the galls. When they pupate they crawl out and are ready to reproduce.

Equipment: Plastic bags, wire ties, marking pen, stereo microscope.

Procedure: Find galls on native plants. Take two of each example to inspect under a microscope. Cut one of each gall and search for a hollow with a white grub inside. Place the other galls in separate containers for future reference. Return outdoors to find galls. Take plastic bags and place the bags over different galls on branches and leaves. Label the bags. Use wire ties to secure each bag to the branch. Inspect at least once a week. Look for very tiny flying insects or grubs. Most insect groups have gall forming species, but the most likely are to be wasps or flies. Find out the difference between a wasp and a fly.

Super slick soil sampling

Separating some invetebrates from soil

Scientists analyse organisms in soil samples to find out how soil is made and maintained. These are some estimates of the numbers of organisms that live in soil:

Per gram	Bacteria	1,000,000,000
	fungi (actinomycetes)	5,000,000
	Protozoa	500,000
	Algae	200,000
	Moulds	200,000
Per sq. metre	Round worms	20,000,000
Per hectare	Snails and slugs	150,000
	Millipedes and centipedes	2,000,000
	Earthworms	2,000,000
	Insects, mites, spiders etc.	< 2,000,000

Equipment: Jar, salt, water, spoon.

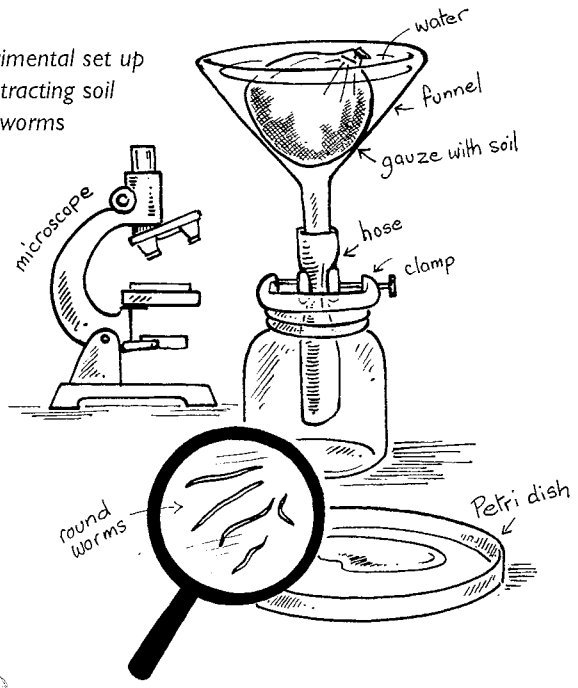
Procedure: This is a very quick method to sample soil animals. Some insects float on the surface of salty water. In a glass jar, stir two or three teaspoons of salt in about 30 mL of water. Place a couple of teaspoons of soil in the solution, but do not stir. It may be necessary to prod the sample with the spoon to allow the sample to get wet. After 10 minutes some types of organisms like springtails will float on the surface. These can be scooped off the surface and observed under a microscope or flex video camera.

Living soil

Measuring soil invertebrate diversity

There is often an amazing diversity of life in soil, leaf litter and compost. If the soil in the school is dry for long periods during the year, it may be difficult to find soil creatures.

Experimental set up for extracting soil roundworms



Equipment: Hand trowel, plastic bags, low power microscopes or flex video camera if available, Berlese funnel (instructions below) desk light, large two litre PET bottle, two litre plastic milk bottle, four wooden skewers, fly wire (so the animals can fall through) and scissors.

Procedure: A Berlese funnel is an instrument with a light at the top. Underneath is a soil sample lying on a fly wire. This then sits on a large funnel. The drying heat of the light encourages the soil animals to move to the bottom of the soil, leaf litter or compost. The animals fall through the funnel and can be easily collected at the bottom. If the school does not have a Berlese funnel, these are some instructions for making one:

- cut the top from a two litre PET bottle to make a funnel
- cut the top from the two litre plastic milk container and use the bottom to make a large cup
- place the funnel in the cup
- use the four wooden skewers to stretch the plastic flywire
- put the soil sample on the cloth
- place the light over the soil.

Obtain soil samples from a damp garden bed. Take a sample of leaf litter from under a eucalypt. Take a sample of rotting kitchen waste from the top of a compost bin.

The samples need to be placed in the Berlese funnel for 24 hours. The animals can be identified and where possible, the numbers counted. Compare the invertebrates found in each of the samples.

Worms

Separating roundworms from soil

Roundworms are very simple long round creatures. They are not segmented like earthworms. Roundworms are extremely common but they are mostly very small and inconspicuous. Soil, plants and animals are the homes of different kinds of roundworms.

Equipment: Jar, funnel, rubber hose to fit over the end of the funnel, clamp to block the hose, gauze, Petri dish and microscope.

Procedure: Soil roundworms will swim downwards when placed in water. This technique separates roundworms from soil. Place a short length of rubber hose over the end of a funnel. Tightly clamp the hose preventing the leakage of water. Take a soil sample and wrap it in gauze, tying it into a neat parcel so it fits into the funnel. Place the funnel, clamped hose and soil sample in a vertical position in a jar or rack so it cannot tip over. Fill the funnel with water. Leave undisturbed for 24 hours.

The next day open the clamp to allow no more than 1 mL of water to flow into a Petri dish. Observe the tiny roundworms under a microscope. Explain that these are only some of the types of roundworms. It is claimed that if all the roundworms remained in the position they occupy in their host plants, but the plants were removed, the shapes of all the plants would remain.

Vacuum the grass

Measuring invertebrates living among grass

Use a battery operated vacuum to vacuum lawn and grass invertebrates. It is surprising what a quick vacuum of the lawn will pick up. What conditions are required for the greatest species diversity in grass?

Equipment: A clean battery-powered hand vacuum, white tray.

Precautions: Avoid catching bees or wasps. Use gloves and beware of spiders.

Procedure: Thoroughly clean a battery-operated vacuum. Test the vacuum on some lawn. Tap the contents into a large white tray. The flies will be gone in seconds, so be very observant. To count the flies, empty the contents into an insect net. Develop a recording sheet to record observations. Test various grass areas. Take notes of the distinguishing features of each area. Find out which grassed areas around the school have the greatest biodiversity.

Instant rotting log?

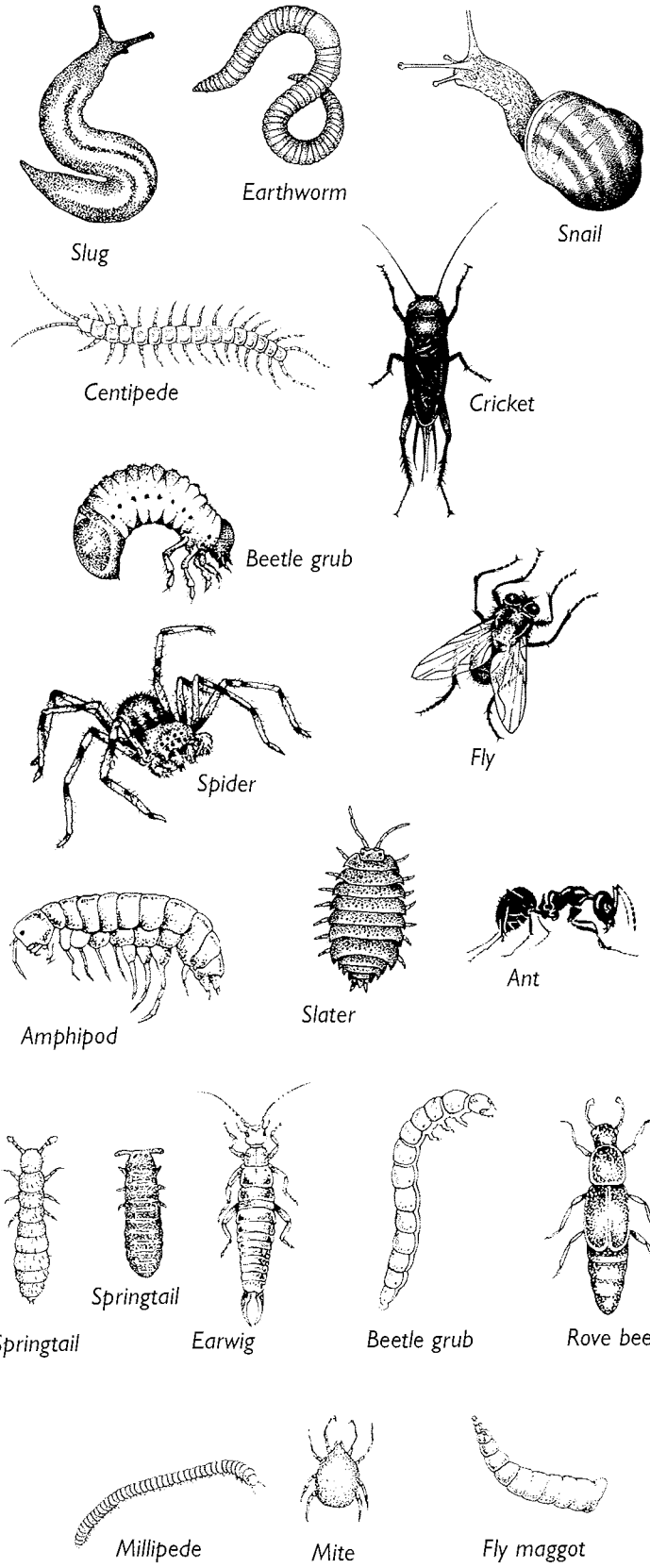
Making alternative rotting logs to attract and measure biodiversity

Find the best places in the school for a rotting log habitat. Fallen trees and branches are cleaned from gardens and school grounds. What kinds of animals might live in rotting logs? Rotting logs can be simulated by using a new roll of toilet paper. What types of animals invade and eat the cellulose in the roll? For some animals a damp roll of toilet paper on the ground is gourmet food or five star accommodation.

Equipment: New rolls of toilet paper, thick sticks, large, plastic plant pots, tent pegs, white tray, collecting jars or Petri dishes, stereo microscope.

Procedure: Identify a range of different places around the school where rolls of toilet paper can be lodged. Place short thick sticks in the centre of the toilet rolls. The protruding stick is used to anchor the rolls onto the ground. Pour half a cup of water over the roll to make it damp. An upside down flower pot can be placed over the roll and secured by a tent peg. After four weeks collect the rolls one by one. Slowly dismember each roll extracting the invertebrates. Record the type and number of each animal. Carefully examine the surface of the paper for fungi and record the number of different fungi.

Soil invertebrates



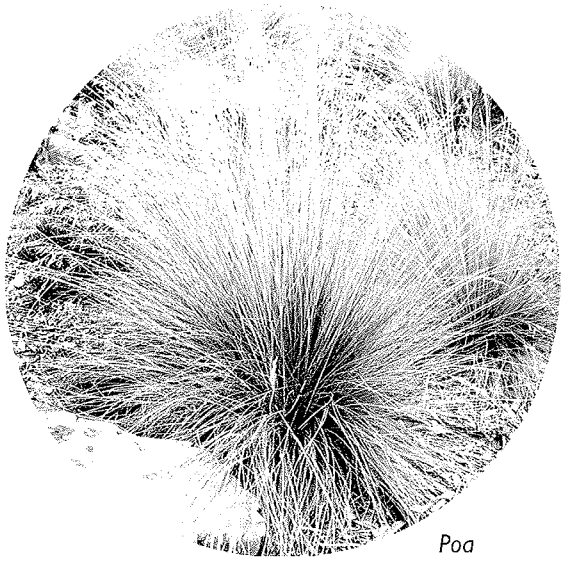
Native grasses versus the lawn

Comparing the biodiversity of native grass with lawn grass

Native grasses like poa become very large and one tussock can be home to almost a thousand visible invertebrates.

Equipment: Fresh poa grass complete with soil and roots, at least 100 Petri dishes, microscopes.

Procedure: Ask the local council or indigenous nursery where a poa grass can be extracted from the ground. Have 100 or more Petri dishes. Catch the animals as the poa is pulled apart. Compare the range of species living in the poa with those found in the school's grass. (Small lengths of poa with roots can be potted making up to 60 tubes from a single plant.)



Poa

The ultimate bug catcher/attracter

Make traps to measure larger invertebrates

Equipment: A collection of empty plastic bottles, saucer, sticks, scissors, tape, stapler, vinegar, flat beer, rotting fruit etc.

Precautions: Do not handle or release live European wasps or bees. If caught, kill them with fly spray.

Procedure: Design the ultimate bug catcher trap. The invertebrate must be able to get in and then find it difficult to get out. Think about which invertebrates are active at night, e.g. moths and cockroaches. The trap can be designed and hung to attract flying insects. It may be placed on the ground. It may work like a pitfall trap. Make several identical traps and place different kinds of bait inside. This can include rotting fruit, sugar water, vinegar and even flat beer. Place the traps both inside and outside.

Ring around plant diversity

In the gounds of a school there will be many different types of ground cover. There may be grass, creepers, leaf litter, earth or pavement. How diverse are these areas? Is the ground covered with native plants or is it covered by weeds and introduced grasses?

Equipment: One hoop per team of four to five students (a hoop covers an an area approximately 60 cm in diameter), magnifying glasses, writing and recording materials, tennis ball and racquet (or cricket bat).

Precautions: Try not to disturb any bees or wasps. The student who is to hit the ball must stand well clear of the rest of the group.

Procedure: One student with a tennis racquet stands clear of the group. Another student throws the ball up to be hit by the racquet. The aim is to hit the ball high in the air and observe where it lands. This becomes the starting point for the plant survey.

- Place the hoop over the spot where the ball first bounced.
- Be careful not to move the hoop once it is down.
- On paper, draw a circle to represent the hoop.
- Draw the different types of plants, earth, leaf litter etc. seen in the hoop.
- If the names of the plants are not known, label the items as grass 1, grass 2, weed 1, weed 2, native plant, earth, leaf etc.

Make a chart to record the findings. Compare the types of plants that grow in each of the hoops.

900 square centimetres of soil litter

Measurement of loose plant material fallen onto the ground

Equipment: A small rake, large plastic shopping bag, 30 cm ruler and recording materials.

Procedure: Measure an area of ground cover, 30 cm by 30 cm. With a small trowel or small rake, remove the surface litter from two separate areas in the school grounds and two separate areas in a natural forest, woodland, semi-arid coastal, semiarid habitat or other natural place. Rake all the leaves, twigs and seeds that have fallen from trees, shrubs etc. and place them in a plastic bag. Record the location and date of each sample. Take the samples back to class. In class, place some old newspaper on a table and tip the contents of one bag onto it.

- Sort and classify material
- Distinguish known leaves, seeds etc.
- Write numbers of materials onto a chart.

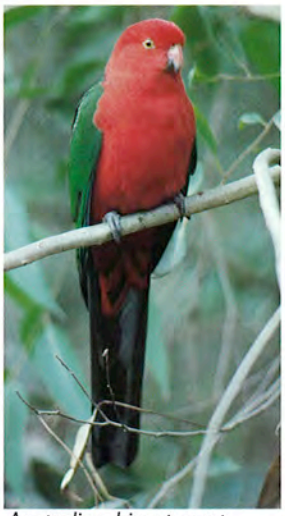
Once completed, remove the material and repeat the classification for the other bags one at a time. Make a single bar graph that compares the different samples. Which area seems to have greater biodiversity?

Parrots

Red-winged parrot

Sulphur-crested cockatoo

Galah



Australian king parrot

Western rosella

Rainbow lorikeet

Cockatiel

Budgerigar

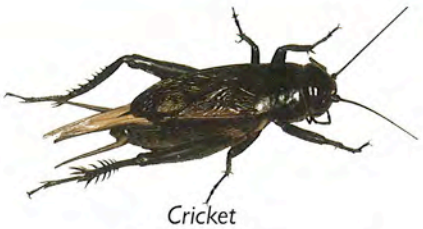
Australian ringneck

Purple-crowned lorikeet

Eastern rosella

Ant

Millipede



Cricket

Spider

Worm

Emperor gum moth

Sawfly wasp

Cockroach

Fly

Centipede

Weevil

Slater

Slug

Scorpion

European wasp

Examining a pond

Measure the biodiversity of a pond

The biodiversity in a pond is very dynamic and can quickly change in response to environmental change.

Equipment: Fine mesh nets (aquarium nets), or nets made from a coat hanger and pantyhose, white plastic containers, e.g. ice-cream container, pond life identification materials.

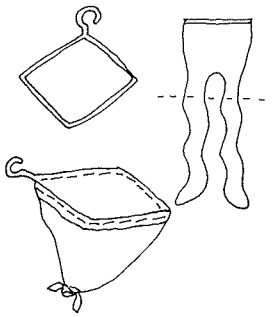
Precautions: Using a net, sample the pond before the excursion to make sure there is adequate biodiversity. Many artificial, crystal clear lakes lack biodiversity. Take care of student safety around wetlands. Be careful not to erode the banks. Never remove frogs, tadpoles or their eggs. Never allow feral fish like mosquito fish to spread to other ponds or waterways.

Procedure: Organise a student visit to a pond environment. Revise safety and behaviour codes. Water sampling: Use nets to sample the life found in water. Place 2 cm of clean pond water in the bottom of a white container. Demonstrate how to wash the contents of the net into the tray. Once this is done, hold the container still so the small animals can be seen moving against a white background. Emphasise the need to look for tiny animals (and sometimes plants) swimming. Use identification materials to find out which groups of animals the pond life belongs to.

Ask students to experiment with their nets to find the best procedure to catch animals. Record the types of animals found in the pond. Find out if one part of the pond has more animals than other parts of the pond. Make a chart to record plants.

Growth habit of plant	Number of species found
Floating on the surface (no roots)	
Floating under the surface (no roots)	
Roots, leaves submerged	
Roots, leaves floating on the surface	
Roots, leaves exposed above the surface	
Plants covering the surface of rocks	

Return all organisms to their homes. To obtain 48 pages of curriculum materials on pond life, go to www.gould.edu.au and click on school programs and find ponding.



Fit pantyhose over a wire coathanger to make a pond net.

Pond-slime hangers on

Discovering microscopic plants and animals associated with pond-slime

Pond-slime is an algae known as spiragyra. It is a slimy green mass consisting of long threads of algae only a single cell thick. The threads are matted together giving it a blob-like structure. Under a microscope it is easy to observe the cells' spiral chloroplasts. Many simple animals and plants are attached to the algae or swim among its large cells. Many small single cell plants have the ability to swim. Simple multicellular animals like rotifers create currents to filter the water for food. The better and cleaner the optics on a monocular microscope the more small creatures, plants and animal cells can be seen. A drop of glycerol will slow down the microorganisms.

Equipment: Monocular microscopes, pond-slime, flex video camera and television if available. (Many normal video cameras can focus up close to an object and are an alternative to a flex video camera. Place the camera on a tripod facing down onto a Petri dish.)

Procedure: Obtain some fresh pond-slime. Keep the slime in pond water and in a cool place. Demonstrate to students how to use a monocular microscope. Take careful note on how to focus the microscope, methods of light adjustment and the need to prevent the objective lens from getting wet. If available use a flex camera to view the pond-slime through the eyepiece of the microscope.

As a rule-of-thumb, if the microorganism is a different shape, it is a different species. Observe the different kinds of microorganisms, their shape and the way they move. Look for mobile single cell microorganisms and creatures attached to the pond-slime.

How many different types of organisms are observed? Are there ways of distinguishing animals from plants? Which organisms are multicellular? Try to create a classification system for the organisms observed. If possible, observe fresh pond-slime every two months for seasonal changes.

Discuss whether or not pond slime is desirable in a pond, a lake, a fish pond or an aquarium.

Catching mammal hairs

Discovering nocturnal mammals

Can the occurrence of nocturnal mammals be confirmed by the presence of their hair? In Australia it is possible to distinguish the hairs of almost all species of mammals. This is achieved by making a latex impression of the surface scale-like texture of hair and also examining thin cross sections under a microscope. A book of photographs is then used to identify the species. This is a complex and skillful process requiring much practice and is only used by a few specialists. As schools have only a few species of mammals, students can distinguish how many types of hair they have found.

Equipment: A range of adhesive materials.

Procedure: Design a process or procedure for collecting mammal hair samples. Can the hair be collected without interfering with the natural behaviour of the mammals? What materials might the hairs adhere to? Where can these materials be placed for the best chance of obtaining hair samples? E.g. on a tree trunk? Around holes going under the school? Students can place baits on trees. Hammer nails into a tree trunk and push cut pieces of fruit onto the ends. For small mammals they can use cardboard tube with bait and adhesive inside.

Dead invertebrates in light fixtures

Measuring invertebrates trapped in light fixtures

How many types of invertebrates get trapped when attracted to the school's security lights? Many nocturnal insects are attracted to lights. For security purposes most schools leave external fluorescent lights on at night.

Equipment: Adult, screwdriver, white tray, specimen bottles, stereo microscope, marking pen, cleaning materials, rubber gloves.

Precautions: Turn off the lights. Ask an adult to dismantle the plastic casing around the lights.

Procedure: Obtain permission from the appropriate people in the school. Ask an adult to unscrew the plastic casing around external fluorescent lights. Be careful not to lose the screws. Tip the contents of the light into a white tray. Examine the contents and tip the insects into a labelled specimen jar. Examine the contents in detail under a stereo microscope. Make a table of the types of organisms found.

Ultraviolet light attracting

Counting species of invertebrates attracted to ultraviolet light

Equipment: Ultraviolet light.

Procedure: Place an ultraviolet light in a secure outdoor situation against a suspended white sheet. The light shines against the sheet. Fold the bottom of the sheet to make an open pocket for insects to fall and hide in. Many nocturnal insects will be attracted to the light and chose to rest on the white sheet. Collect the insects in the morning. This can be set up for the entire year, and changes due to seasonal changes can be recorded.

Mosquito zappers use ultraviolet light. What insects are attracted to ultraviolet light? What insects get killed by mosquito zappers? Is there any evidence that mosquitoes are attracted to ultraviolet light?

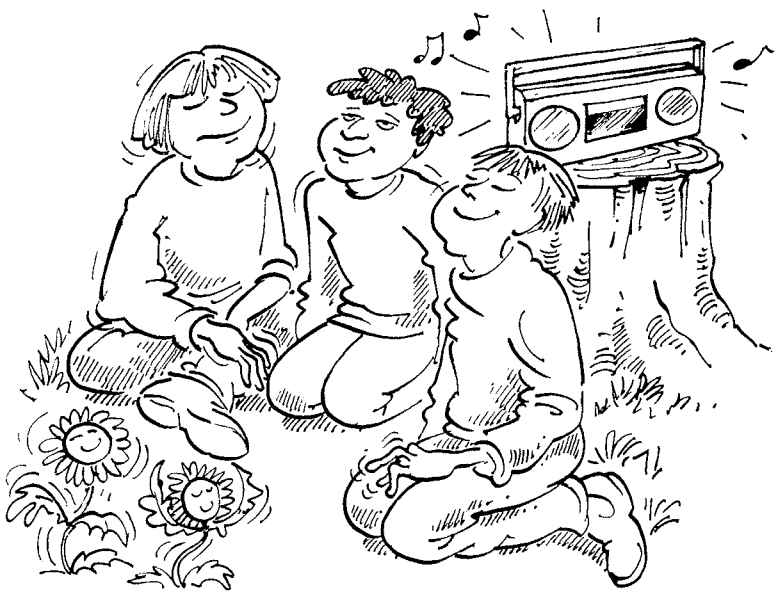
Dawn chorus of birds

Measuring bird biodiversity in different seasons

Many species of birds in the early morning seem to call in a chorus. This behaviour is called the dawn chorus. Under what conditions are birds most likely to join in a dawn chorus? For how long does it go? Is it affected by weather or seasons?

Equipment: Tape recorders, microphone, timers.

Procedure: Design a method to record the bird chorus early in the morning while students are not at school. Once students have the recording they can listen to the tape and develop a method for identifying the number of species of birds calling each day. This can be compared to other areas where the tape can be set up.



Who dropped that poo?

Measuring biodiversity by observing scats

Can the presence of animals be confirmed by the finding of scats (animal poo)? Many mammals have characteristic scats. The ones most likely to be found are:

Possum	shaped like small chocolate bullets
Rat	very small long thin twisted scat
Mouse	very small long thin twisted scat
Dog	large sausage like blob
Fox	finger size with a twisty curl at the end
Cat	they always bury their droppings
Kangaroo	heart shaped balls
Bird	white uric acid (pee) is part of the dropping

Use a copy of *Mammal Tracks and Signs* by Barbara Triggs published by Oxford University Press (1984).

Equipment: Digital camera.

Precautions: Never handle droppings. Dog, fox and cat scats contain many parasites that can infect humans.

Procedure: Make a photographic record of all the scats found around the school. Possums will drop most of their scats near where they feed. Can any plants or other features be identified with the scats? Are dogs common in the school ground after school hours? Also look out for small piles of feathers. The only animals in Australia that pluck their prey are cats. Foxes and cats have a habit of biting the head from their prey and leaving the body.

Footprints

School grounds are one of the most difficult places to find footprints. Students will need to invent methods for recording prints. In arid and semi-arid areas footprints are easily detected in dusty places.

Equipment: Digital camera and whatever the imagination has to offer, a copy of *Mammal Tacks and Signs* by Barbara Triggs published by Oxford University Press (1984).

Procedure: Discuss the ways that detectives find evidence at crime scenes and how they find fingerprints. A quick inspection of the school may find some dog prints in mud. Find materials that can be spread on the ground that will possibly record animal prints, including bird, mammal, reptile and invertebrate prints. Students may wish to include some baits to attract animals to the location.

Video monitoring of a possum nesting box

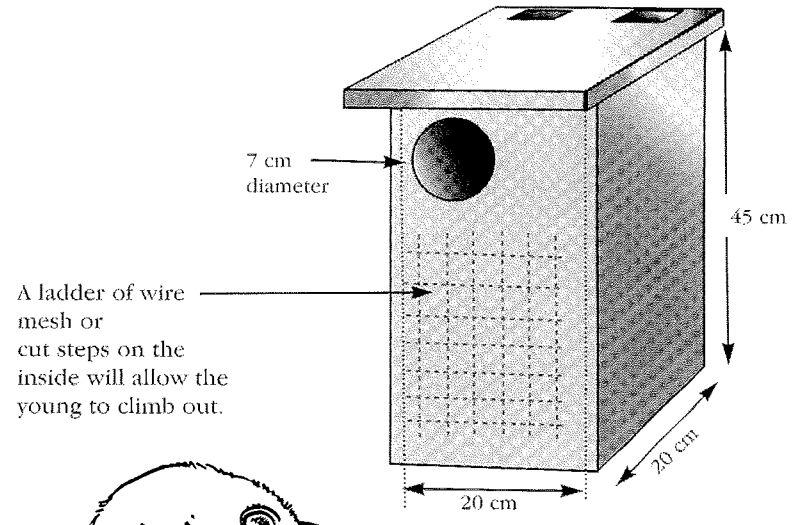
Is it possible to use video to record the activity in a nesting box?

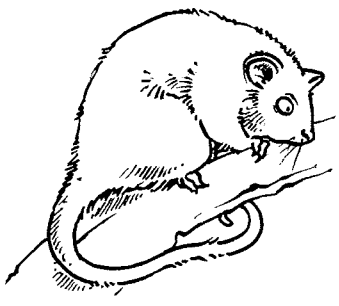
Equipment: Small security video camera, video recorder, nesting box placed near a suitable building.

Precautions: Only an adult should work on nesting boxes above the ground. All Health and Safety procedures must be followed. Do not try to handle or get close to any animals in the nesting box as most will attempt to defend themselves.

Procedure: Use thick timber (treated pine is OK) to build a nest box. Do not use chipboard. The nestbox plan below is suitable for possums and parrots. Further nesting box designs can be found in the Gould League publication *The Nestbox Book*. Have the box installed where wires can be run from a room to a video camera. If there is a tree against a window, a box without a back can be installed against the window. The inside of the box can be seen from inside the room. Make a cardboard cover to go over the glass. Use a room that is not used much by students, e.g. a prep room. Set up a camera to observe the entrance or inside the box. Experiment with ways of recording the activity around the box.

Identify potential needs of nocturnal animals, e.g. do possums need nesting boxes?





Diversity Index

Calculating species diversity

Species diversity can be calculated mathematically. There is no requirement to actually name the species, just to be able to group them.

Equipment: Writing material, calculators, computer spreadsheet program.

Procedure: The following is an example of using a diversity index using shells:
The first 100 unbroken shells (could have been any number but the maths is simpler using 100) were picked up from a beach and sorted into groups. These shells are named, but naming is not necessary.

Simpson Index
This formula enables different size samples to be compared. Diversity indices are applied to group composition data. One of the simplest is the Simpson Index that uses the following formula:
Diversity = N (N-1)/ Sum n (n-1)
Where N = total number of individuals and n = number of individuals of each species

Example of the Simpson Index
On a survey, these species of shells were found: 20 warreners, 30 ribbed tops, 10 blue mussels, 10 black nerites, 15 rainbow kelp shells, 5 Adelaide tops, 8 horse mussels and 2 knotted abalones. The maths is as follows:

D = 100 X 99/ (20x19)+(30x29)+(10x9)+(10x9)+(15x14)+(5x4)+(8x7)+(2xl)

D = 9900/ 380 + 870 + 90 + 90 + 210 + 20 + 56 + 2

D = 9990/ 1718

D = 5.814

The larger the diversity indices, the greater the diversity of animals.

Finding the seasons from a database

Measuring seasonal change

It seems that our seasons are not correct! Autumn, Winter, Spring and Summer has limited relevance to the Australian environment. Aboriginal calendars that still exist often have six seasons. Aborigines base their seasons on the activity of animals, growth and flowering of plants and changes in weather patterns. Local seasons can be rediscovered in the same way Aborigines viewed them. Scientists now have the power of computers to sort information.

Equipment: Computers, database software (or the Gould League Timelines Database CD-ROM which also includes information about Aboriginal calendars, or the Dataworks Green Database).

Precautions: If using spreadsheet, have a good system of backups to protect information from being scrambled.

Procedure: Choose a number of biodiversity measuring techniques to be taken at regular intervals. These will need to be done at least six times during the year to find seasonal trends.

Make a database for the local area or use the Gould League Timelines database. Explain the purpose of using fields to store information. Fields can include:

- Name of observer
- Date
- Month
- Time
- Name of the organism
- What it is doing
- (may also want to record location)
- (may also want to record numbers)

Discuss what happens when a species is given different names, if spelling mistakes are made etc. It will be necessary to make a common key for 'What it is doing' so the information can be sorted properly. The Timelines database kit comes with a teacher's resource book. It provides activities explaining how databases are set up to extract the information required.

Once the information has been logged in for the year, sort the information and search for trends.

Human differences

Measuring human genetic diversity

How many people can individual students recognise, ten, one hundred or a thousand or more?

Equipment: Digital camera, measuring instruments, Internet.

Precautions: Observations and records should be neither of a personal nature nor embarrassing to students.

Procedure: Discuss how humans are a single species. What are some of the differences between people? How can these differences be measured? Can these differences be used to distinguish each member of the class? How can eye, skin or hair colour be measured? List the features to be measured, make a chart and measure each student. If the class has a buddy on the Internet (preferably from overseas), ask them to make the same measurements and compare results. Match up students with similar measured features. Exchange digital photographs. Why do they not look like each other?

Ask students to list relations including aunts, uncles and cousins. Record how closely the student resembles each relation, e.g. no resemblance, a little resemblance and a lot of resemblance. Discuss how people derive most of their features through genetics. Discuss how much genetic variation there is among people.

Annuals

Measuring plant genetic diversity

The environment has a large influence on plant growth. Looking at fully grown plants, it is difficult to know how much of the difference is due to the environment and how much is genetic.

Equipment: Measuring instruments including callipers and measuring scales, small plant trays, potting mix, annual seeds (mixed poppies) or purchase a punnet of seedlings from a nursery.

Procedure: Either grow or purchase a tray of annual seedlings. Extract each seedling and measure as many features as practical. This should include the length of stems, leaves and roots, total weight, shape of leaves etc. Plants that germinate earlier will probably be larger. Can students find differences in the plants that are genetic and not due to some germinating earlier than others? Can they think of methods to improve the experiment?

Greengrocer

Discovering the potential of genetic diversity

Humans are able to use genetic diversity to their advantage. Plants and animals are bred to have special characteristics to suit the needs of people.

Procedure: Visit a greengrocer to investigate the varieties of fruit and vegetables. Which fruit or vegetable has the greatest number of varieties? Cabbage and cauliflower are the same species of plant. Does any vegetable or fruit have a greater visual difference than cabbage and cauliflower? Can more than one variety of apple be grown on an apple tree?

Red gums

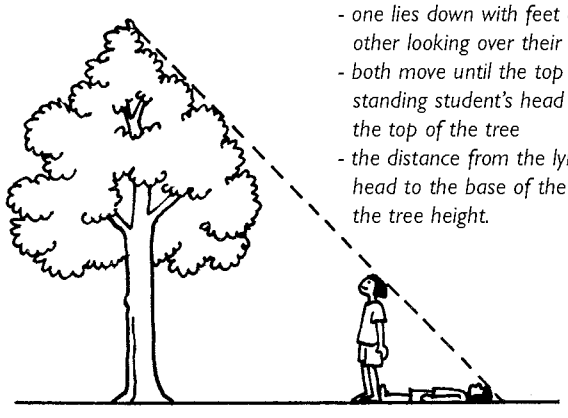
Measuring genetic diversity in gum trees

River red gums have the widest distribution of any eucalypt. Tall massive red gums line the rivers and spread over the flood plains of eastern Australia. Broad, leaning red gums dot the Victorian volcanic plains. Spreading red gums line the snaking creeks of inland South Australia, NSW, southern Queensland and central Australia.

Equipment: Measuring instruments to calculate the height, circumference and canopy of a tree.

Procedure: Use a plant identification book to find the closest river red gums. Most river red gums have smooth bark. The base of the trunk (butt) has rough bark from two to five metres above the ground. The shape of the leaves and the shape and features of the fruit (gum nuts) will distinguish most of the 600 species of eucalypts described in botanical publications. Calculate the height of the tree (refer to the diagram). Measure the circumference at one metre above the ground. Estimate the diameter of the canopy. Make a fraction of height to canopy diameter. Measure the height of the rough bark from the ground. Estimate the angle of the trunk from the vertical position. Compare the local red gums with students' measurements from other parts of Australia via the Internet.

Measuring tree height (equilateral triangle)
- *two students the same height*
- *one lies down with feet against the other looking over their head*
- *both move until the top of the standing student's head lines up with the top of the tree*
- *the distance from the lying students head to the base of the tree equals the tree height.*

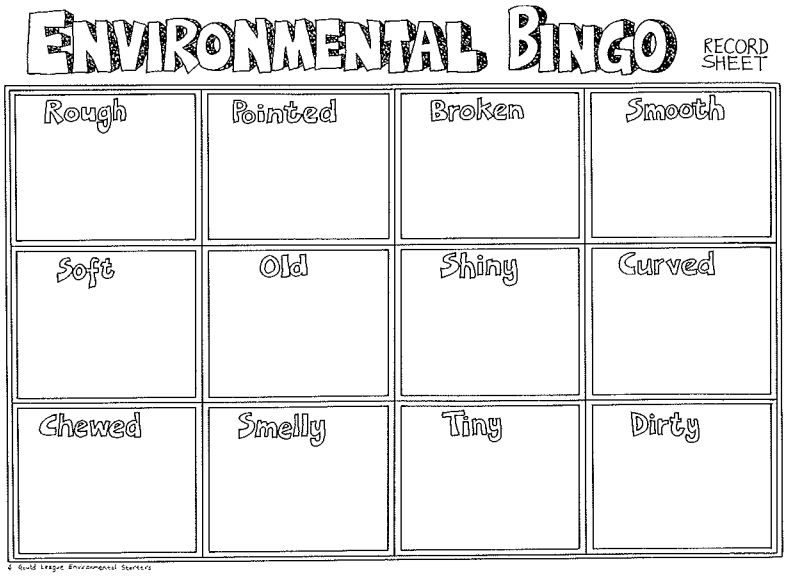


Environmental bingo

Comparing ecosystems

This is a simple tool for identifying some features that distinguish different places.

Equipment: Plastic lunch bag, photocopies of Environmental Bingo sheet or make an equivalent work sheet like the one below divided into 12 squares each with one of the following words:



Precaution: Students must not damage plants. They may only take things that fit into their bag.

Procedure: Provide each student with a plastic lunch bag and a bingo sheet. Explain they need to find 12 objects to meet the 12 criteria on the sheet. Send an equal number of students to the following areas, e.g. classroom, garden bed, lunch area, lawn and under trees.

When the students have returned, combine the four or five bags for each area.

- Extract the objects that have been made or modified by people.
- Which area had the most objects made by people?
- Do these objects help describe the area?
- Which area had the second most objects made by people?
- Are the objects different?
- Explain the different ways people use these areas.
- Which area had the most natural objects?
- Are they from plants or animals?
- Which of the objects is part of a decomposition process?
- Observe all five piles of objects.
- What information do they provide about the nature of each area?
- Do they accurately represent each area?
- Is more information needed to describe the differences between the areas?

Differences

Comparing ecosystems

There are over 100 different ecosystems in Australia. It is easy to see the contrasts between a desert and a coral reef. It is more difficult to see the differences between some of the wetlands.

Equipment: Reference books, CD-ROMs and Internet links that describe Australian ecosystems.

Procedure: Brainstorm with students the wide range of Australian environments they are already familiar with. Make a list on the board. Ask them to choose three of these and describe what makes each one of the three distinctive from the others.

Ask students to describe each environment. Start to classify the distinguishing features into:

1. physical conditions (non-living)
   - climate
   - water
   - minerals
   - sunlight
   - soils, physical structures etc.
2. biological community (living)
3. log onto IBRA bioregions photographs to view Australia's major terrestrial ecosystems: www.environment.gov.au/bg/nrs/ibraimcr/ibrapics/index.htm

The school's ecosystem

Discovering the school's ecosystem

Even though people dramatically modify the ecosystem they live in, it may still function, but often with less biodiversity.

Equipment: Computer and digital camera.

Procedure: Make a representative photograph of the school. Paste the picture into a word program and describe the ecosystem in the photograph. How far does this ecosystem extend? Does it have distinctive boundaries in some places? Is there a gradual change in some places? From the photograph describe how the area has changed in the past 200 years. Which elements of the ecosystem have people changed? When did these changes occur? Are there continuing changes to the ecosystem?

Habitat and ecosystems

Discovering animals' homes in an ecosystem

A habitat is the place that an animal or plant lives within. In this activity students will create a visual representation of a habitat and an ecosystem.

Equipment: Paper, colour pencils, craft material, research materials, access to the Internet.

Procedure: This activity can be completed as a coloured drawing or a three-dimensional diorama in a shoebox.

1. Ask students to bring a shoebox and a plastic animal to school. Discuss what each animal requires in its home (habitat). Provide craft material for students to make their diorama.

2. Begin with a discussion about what kind of animals are native to Australia. Introduce words like indigenous, adaptation, competition and predators. (The school may have a foodweb computer program or the Gould League *Foodweb Kit*, with magnetic animals and plants to help with the introduction.)

It may be useful to organise the class into groups representing different habitats. For example, freshwater, coastal sea area, grassland, and soil, forest canopy and understorey. So that students get a sense of the variety within each habitat, it may be useful to encourage students to choose animals of differing size, from tiny beetles to large marsupials. Each student chooses an animal native to Australia that lives in a specific habitat . As a group they can pool information about their habitats.

Each student then researches some information about his or her animal, finding interesting facts, pictures and information about the animal's preferred habitat and adaptations the animal has evolved to survive in its ecosystem.

Each student should find out the following about his/her animal:

- Its name
- Its size, shape and colour
- Where it lives in Australia
- What it eats
- How it moves
- How it feeds
- How it protects itself and other adaptations
- How it has young
- Whether it is rare or endangered
- Whether it requires protection or help from people.

Discuss whether feral animals affect the ecosystem or the other animals that live in the ecosystem.

3. A rotting log is like a small ecosystem. A large range of animals, fungi and bacteria depend on rotting logs in the forest. Ants, cockroaches, termites, centipedes, amphipods and small skinks are just some of the animals that call a log their home. If possible show the students a rotting log and the process it goes through. Ask students to describe in words and drawings a rotting log ecosystem. Discuss the different environments found in and around the rotting log. Where is it going to remain damp and cool? Which part will dry out and get very hot in summer? Which part of the log rots fastest? Draw and describe the rotting log environment. Place animals and fungi into homes.

Lost but not found

Discovering changes to ecosystems

How much of the local environment is regarded as natural?

Equipment: Street directory, writing materials, highlighter.

Procedure: Find the page in the local street directory or map that shows the school. Copy the page for each student. Discuss with students those areas on the map that are not heavily developed. Use a highlighter to colour the areas that have some natural vegetation. Try to estimate what percentage of the page this represents.

Discuss whether students think these natural areas retain the same biodiversity as they once had. Is it important to protect the biodiversity that is left? Why?

The local pharmacist

Biodiversity provides people with medicine

The local chemist shop is full of weird and wonderful chemicals extracted from thousands of obscure plants and some animals. Chemicals that are difficult to refine from plants are made from engineered bacteria. Most medicines are derived directly from plants that are specially grown for the purpose. New medicines are constantly being discovered by chemically examining newly discovered plants and animals. Bacteria and fungi have provided people with life saving medicines.

Precautions: Get permission through the appropriate school authority to leave school. Talk to the Chemist and arrange a time to visit.

Procedure: Inspect some of the jars of herbal medicine to find what they are made from. Take some notes and look for more information about them in the library. Ask the Chemist to explain how penicillin was discovered. Find out what the newest drugs are and if the drugs were discovered in living things.

What's eating you?

Threats to biodiversity

Evidence of animals grazing on leaves can be easily found on some trees. Leaf damage is caused by local species eating or infecting the leaves. Indigenous plants have more local browsers and thus are likely to show more evidence of being eaten.

Equipment: Magnifying glass, notepaper and pencils, video flex or video camera.

Precautions: When students go outside ask them to be careful of bees, wasps and large spiders. Bees are the most dangerous animals in Australia.

Procedure: Divide the class in half. Each group collects 100 leaves. Half the class collects leaves from native eucalypt trees and the other half collects leaves from introduced trees. The leaves must be mature and fully grown.

Students can quickly sketch the trees from which they collected their leaves. Note the shape of the tree and the shape and thickness of the leaves. Many introduced species have leaves that are much thinner than eucalypt leaves and can be either broad or long. Many introduced species of tree lose their leaves in winter but the natives rarely do.

Outside or back in the classroom examine each leaf using a magnifying glass or videoflex camera. Are the leaves perfect? Is there evidence that an animal has eaten the leaf? Usually any small blemish indicates that animals have been feeding or fungi or viruses are present.

Students can make a bar graph of how many of their leaves are eaten and how many are not. Make a comparison between eucalypt trees and introduced trees.

Gardeners are often worried about blemishes on the leaves of their introduced plants. Discuss whether people should be worried about animals eating indigenous plants? Should they be concerned about indigenous animals eating local plants? Is there a concern about rabbits eating local plants?

Bandicoot valley

Threats to biodiversity

This Internet game demonstrates how fragmented habitat is unable to support populations of bandicoots. The game can be found on www.gould.edu.au – click on wildscape and find kids activities. The game has also been published in a board game form in the Gould League *Endangered Species Kit.*

Habitat fragmentation in a jar

Threats to biodiversity

Collecting and keeping pond creatures in a tank is not always straightforward! People often collect large numbers of animals. Some of the larger animals are carnivorous and by the next morning many of the creatures will be dismembered.

Equipment: Large glass jars or plastic containers with screw lids, pond net with fine mesh, large white tray.

Procedure: To collect pond creatures, first place a few centimetres of water in a white tray. Sweep the net a few times through the pond water and then rinse the net into the tray. If the collection of animals is suitable gently pour it into a jar.

What to collect:

- Some floating pond plants – but do not cover the surface of the water with floating plants as they will restrict oxygen exchange with the air. Also, too many plants will use all the oxygen at night.
- Many tiny creatures.
- Only a few larger creatures, because most are savage hunters and will soon perform a 'gladiator's fight to the death' if there are too many packed together.
- Only take clear water samples. Never place mud in the water as the bacteria putrefy the contents of the jar. If mud is needed, place some mud and pond water in a separate container.

Avoid collecting the following:

- introduced mosquito fish as they may accidentally spread to other waterways
- tadpoles or frogs.

Set up three large jars or small aquariums for the pond water. Count the number of species of plants and animals placed in each jar. Label the jars and record the number of species. Do not place lids on the jars. Do not place the jars in the direct sun. Every three or four days, examine the jars and record the species.

There will be a progressive reduction in the number of species. Often each jar is dominated by a different small species. This process is a form of habitat fragmentation. A small part of the habitat has been isolated. The number of species that can be supported is reduced. Return the remaining animals and plants to their pond after two weeks.

Local ecosystem time line

Threats to biodiversity

How much has the local ecosystem changed? What was it originally like? How long did it take for it to change? What might happen to the area in the future?

Equipment: Writing materials, maps of the local area, history of local area, past aerial photographs.

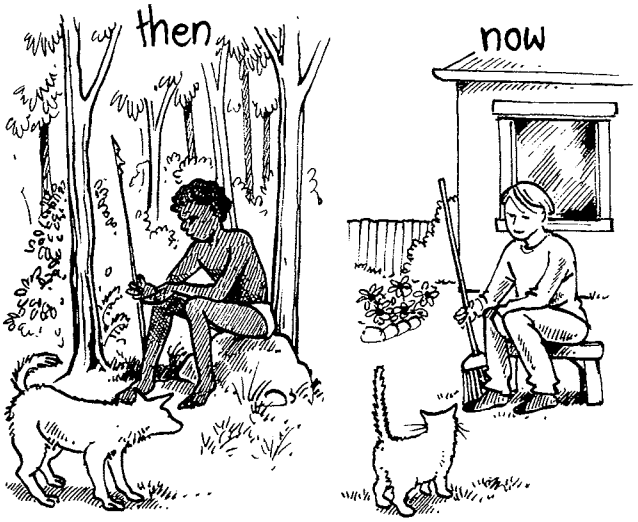
Procedure: Use many methods to find out about the changes in the local area. Speak to some of the oldest people in the community who have lived in the area for many years. The local council may have a collection of old maps showing subdivisions. Local historical societies may have completed relevant research and may be willing to speak to the class. In the past, were there any special animals or plants living in the area?

Find out:

- what settlers lived in the area
- what they did for a living
- if they needed to clear forest from the area for farms
- if they grazed their cattle or sheep on the native grasses
- if there have been changes in farming
- when the area was developed for housing and over what period the farms were transformed into a suburban or urban area
- if factories are in the area, when they were built.

Use this information to construct a time line. Mark down the changes over the past 200 years in 10 or 20 year intervals.

From the information obtained describe what changes have occurred to the local biodiversity. What types of organisms have become locally extinct? Predict what the local environment will be like in 20 years if residents take care of it. Predict what the environment will be like if they do not look after it.



What's legal?

Protecting biodiversity

Each State in Australia has wildlife laws. The world's first wildlife laws were to prevent people poaching animals on other people's land. Australia had some of the first conservation wildlife laws to stop the hunting of the platypus and lyrebird. Most laws either cover the total protection of certain fauna and flora or include regulations that allow them to be hunted, harvested, gathered or kept in captivity. The only protected invertebrates are some butterflies and marine species.

Procedure: Gather regulations from the appropriate authorities from the State/Territory government about the protection of wildlife. What regulations are there about hunting and fishing? Can permits be obtained to take plants such as ferns out of forests? Are wildflowers protected? What native animals can be kept in captivity? What kinds of permits are required? Will the State/Territory allow a farmer to kill parrots or kangaroos? Are emus or crocodiles farmed in the state? Does the local city or council require a permit if trees are cut down on private property? Are these laws adequate to protect biodiversity? Are the laws intruding on people's rights?

Fish market survey

Protecting biodiversity

Only some fishing practices are sustainable. The rate of flathead fishing is not changing the population so it is a sustainable form of fishing. Other fish are being harvested faster than they can reproduce. These populations progressively decrease over time and it becomes more difficult to catch the remaining fish. When this happens the fishing is unsustainable and the fishing resource begins to run out. For example, the fishing of orange roughy is probably not sustainable. Orange roughy grow slowly and the fish being sold are at least 50 years old and too many fish are taken each year. They start breeding at 30 years and can live for 150 years. It will take a long time to replace the fish being taken.

Bugs like Aussie plants

Threats to biodiversity

Pine plantation trees originate from North America. The pine needles are thick on the ground because Australian invertebrates have not evolved ways to deal with the poisons in the leaves. In America the same is true for the eucalypt trees. American invertebrates have not evolved ways to deal with the poisons in eucalypt leaves.

Equipment: Berlese funnel (see page 16), identification material (see page 17) and the Gould League *Compost Creatures* Poster.

Procedure: Use the activity living soil on page 16 to survey the invertebrates in a sample of leaf litter from under a gum tree and under a pine tree. What is the difference? Does this demonstrate the problem that introduced plants are not edible for most Australian animals? Try to find a buddy school in California. Ask them to do the same experiment and share the results.

Do not chuck it!

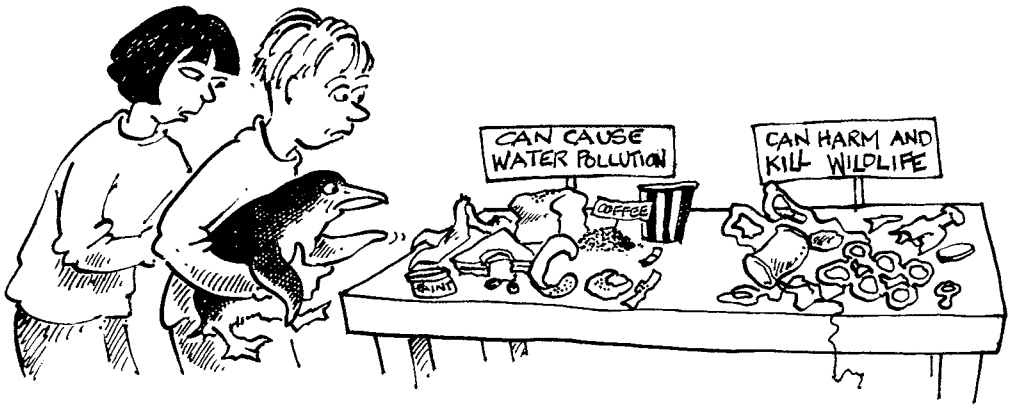
Protecting biodiversity

Many forms of pollution enter our waterways mostly from people's daily activity rather than from dirty factories or mining. Cars dripping oil, people throwing litter, poor farming practices, leaking sewage are some of the ways in which Australian creeks, rivers, lakes and oceans are polluted.

Equipment: Aquarium, items of school ground litter, rubber gloves.

Precautions: After the experiment, place the solid materials into the school waste system and pour the liquid into a toilet. Do not use car oil in this experiment as there is no easy method for disposing of the liquid.

Procedure: Half fill an aquarium with water. Find a number of items of litter and record each one. Ask students what they think will happen to each item of litter after two weeks in the water.



After two weeks find out which items rotted and which did not. Could fish or tadpoles live in the water after some of the rubbish has rotted? Some items like plastic and metal will not rot. How can these items injure wildlife? Are students aware that over 10% of urban platypuses are scarred from litter injuries?

The action

As part of the challenge, students are encouraged to find ways to increase the school's biodiversity. This part of the book is designed to help students create biodiversity projects. It describes how to prepare and plant parts of the school grounds with indigenous and native species. The range of simple procedures will suit schools around Australia and cover small to large projects.

Refer to page 7 for background information about establishing goals for restoring the school's biodiversity. Some teachers may want to learn more about revegetation. Organisations like Greening Australia provide excellent courses.

Biodiversity project

Teachers are very good organisers, so they have the most important skill for completing successful biodiversity projects. The following provides a strategy for creating habitat.

Initial planning:

1. Develop a school ground plan. The resource kit *Enviro Smart* published by the Minerals Council of Australia can assist schools in developing an environmental management plan (see inside back cover).
2. Make a scaled map of the area that is to be planted.
3. Mark any features including changes in topography (most school grounds are flat).
4. Draw to scale any paths or tracks that will be part of the garden.
5. Use colour pencils to contour the proposed planting on the map. The types of planting are as follows:

- heavily treed with a thick understorey
- heavily treed with no understorey
- lightly treed with a thick understorey
- lightly treed with some understorey and thick ground cover
- open area with a couple of trees and shrubs with a thick ground cover.

Choosing plants for a forest Students can only manage two plants per square metre, although four plants are probably better.

When using indigenous species avoid larger pots. In almost all situations young seedlings in long narrow tubes are desirable because:

- Tubes are much cheaper
- They actually grow faster and will overtake larger, more expensive plants within a year
- They establish themselves much better and the trees have a better chance of growing strong root systems.

The local indigenous nursery may only have a small percentage of local species in stock. A realistic strategy is to visit the local indigenous nursery with a general list of types of plants, and they can fill this from their stock. To assist with future maintenance, ask for grasses that students can easily distinguish from weeds.

For every 16 square metres of ground purchase 32 plants. Only one or two trees and a few shrubs are needed. The rest needs to be ground cover and native grasses. To establish a ratio of trees, shrubs and ground cover, plan the project using the wildscapes landscape planner on www.gould.edu.au. The plan of the project can be designed online and the software will provide an image of what it will look like.

Acquiring plants for a forest If planting can be planned three months in advance, many indigenous nurseries will specially grow larger orders.

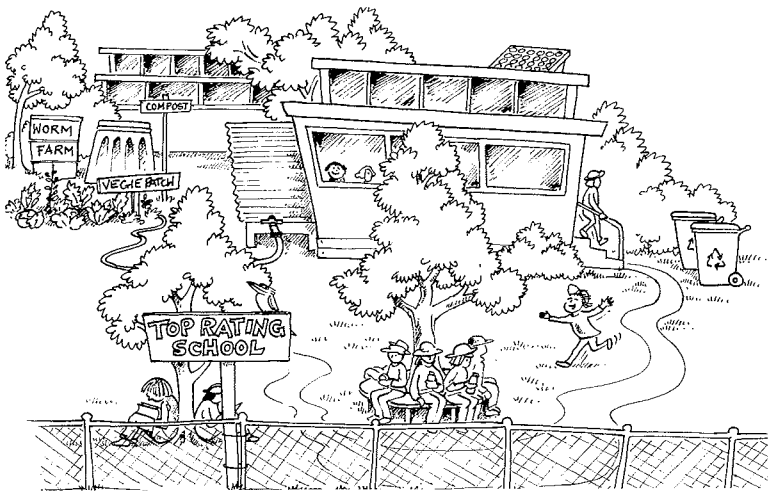
Arrange to visit an indigenous nursery when an appropriate person has time to assist you.

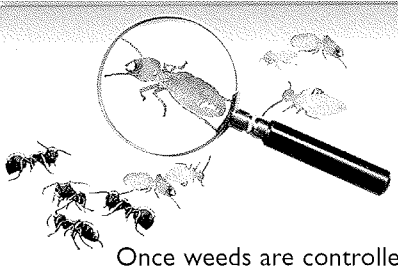
- insist that their assistance is required
- explain how many trees are required
- explain that students should not confuse the plants with weeds, the plants need to be tough, and small species are not desirable
- provide a description of the effect required
- provide a list of the types of plants needed
- when buying current stock, put the plants to one side and order them on the spot, otherwise some of the plants will be sold.

Preparing a site for native and indigenous plants

Schools will need to address two key issues in preparing their site for planting:

1. How will the weeds be controlled?
2. What is the best solution to overcome hard compacted soils?





Once weeds are controlled, many new tubed plants will grow quickly producing stunning results. Unless the weeds (that include introduced grasses) are controlled, any new plants will struggle and any results will take a long time.

The most common method for controlling weeds and grasses is a herbicide spray called Roundup. This product is used because once the chemical touches the soil it becomes inactive and will not damage the environment. Only adults must perform the spraying of chemicals and children should never be present. The school holidays when students are not around is a good time to spray. The area will need to be sprayed twice two weeks apart. The spray needs two or three dry days to work. It works best when the weeds are growing. Two weeks need to pass from the second spray before the area can be planted.

Rock hard ground due to many years of compaction is very difficult for children to dig. Rotary hoeing or ripping the area will loosen the soil but will bring unwanted weed seed and roots to the surface. Only dig the ground if it is really necessary.

Mulch will retain the moisture in the ground, slow down the invasion of weeds and make the pulling of weeds much easier. Mulch should cover the area to a depth of 10 cm. Commercial mulches will not create any problems. Roadside mulching services prune trees. Some of these may contain unwanted seeds and berries. Be cautious when using this source of mulch.

Students are excellent spreaders of mulch. Shovels, wheelbarrows and rakes are required. Just keep rotating the jobs. Hand shovels used as part of shovel and broom sets are very effective for smaller children to move mulch. Moving the mulch always seems to be the best fun.

Students are unable to mulch an area after it has been planted as the plants get buried and walked over. Mulch the area first, it is easier for students to be careful while planting.

Planting procedures The following is needed for planting:

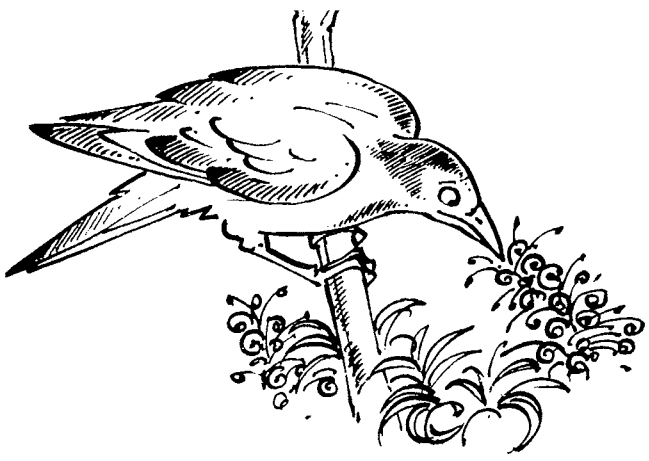
- Buckets to water the plants (hoses if not used carefully present a number of problems including damage to plants in the ground and in tubes).
- Hand trowels or other implements to dig holes so the plants can be put in the ground.
- An adult who understands the plan and the plants to distribute the plants over the mulch. The plants need to be distributed in a fashion that reflects the 16 sq formula.
- Demonstrate to students how to plant the seedlings.
- Do not plant too close to paths, or plant trees under other trees or under powerlines.
- Students need to provide each plant with at least half a bucket of water.
- Discuss with students where they need to start and how they can avoid stepping on plants or tubes.

Directions for planting:

- Scrape an area of mulch forming a large hollow and exposing an area of the ground the size of a saucer.
- Make sure students work progressively and do not step or kneel on other plants.
- Dig a hole that is a little deeper than the tube. Do not mix the soil with the mulch.
- Soak the tubes beforehand. Squeeze the tube to loosen the soil. Turn the tube upside down and carefully extract the plant.
- Some roots may need to be gently teased out or cut off if they are tightly bound in circles.
- Place the plant vertically in the hole.
- Gently pack the soil around the plant. Avoid pushing mulch into the hole.
- Move some of the mulch back but leave a hollow like a crater around the plant to collect water. Beware of piling mulch deeply around the stem of the plant as it can get collar rot.
- Place the empty tube upside down next to the plant so that others know not to step on the plant.
- Gently pour a bucket of water into the crater around the plant.

Maintaining the projects At regular intervals, the weeds need to be extracted from the forest. If the preparation is adequate, the task will be easy but should be done two to four times a year so there is no chance of the weeds taking over and becoming a major maintenance issue.

Before weeding with students make sure they know which plants are weeds. Often it is easier to show students one species of weed and ask them to extract that one throughout the area before moving on to the next species of weed.



Wildlife corridor

Most schools have at least four boundaries. It is usually possible to plant two of these boundaries as wildlife corridors. A wildlife corridor is a long stretch of plants that enables animals to migrate between two areas and can be built along a fence line. Birds, possums, insects etc. are able to move through the trees, shrubs or ground cover as they move through the school. The corridor consists of large trees with a thick canopy, e.g. eucalypts and an understorey of smaller trees and shrubs with dense foliage for small birds to hide in. The ground is mulched and many thickets of native grasses and other ground covers are grown for ground-dwelling animals. A few rotting logs are also desirable.

Preparation: See preparation instructions for indigenous plants on pages 33 and 34. The area will need to be mulched. The corridor needs to be at least three metres wide. Use mostly indigenous grasses and ground cover plants. Choose poas, lamandras, kangaroo and wallaby grasses. These should be planted on average two per square metre. For every 10 metres, plant one large tree, two small trees and four to six bushes. Clump the bushes together, so there are gaps under the tree canopy.

Habitat islands

Many birds including parrots and magpies feed on grasslands, but prefer to have trees close by. They need the trees as safe resting-places and to retreat when there is danger. Habitat islands can be grown where large areas of grass like lawn, ovals or paddocks occur. Some of the smaller honeyeaters will be able to feed without being chased by larger honeyeaters. Habitat islands are also attractive for galahs and sulphur-crested cockatoos.

Preparation: When choosing shrubs and trees, both native and indigenous plants are suitable. Purchase indigenous grasses. Choose the types of grasses students can easily distinguish from weeds, e.g. poa, lamandra, kangaroo grass.

A habitat island only needs to be about 16 square metres. The structure of the island can be:

- big trees – (1 to 2) one or two large trees (eucalypts) for large birds to perch in
- small trees – (2 to 3) several small trees (wattles) for smaller birds to hide and sleep
- dense bushes – (3 to 5) some dense bushes for small birds to escape from larger birds
- ground cover – (12 to 20) many ground cover plants including native grasses for birds to scratch around for insects.

Native flower calendar

In this project, the aim is to provide animals with a series of native plants that flower in sequence throughout the year. This will attract and sustain nectar feeding birds and insects.

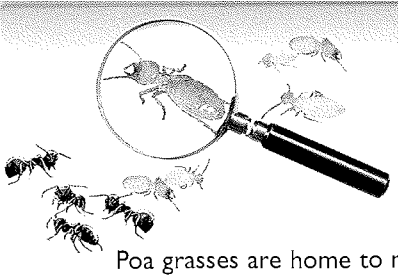
The nectar in flowers is a form of sugar and is an inducement to animals to visit the flower. In the process of feeding, the flowers' pollen is spread to other flowers. Australia has a large number of honeyeater bird species. These specialist feeders lick nectar and pollen from flowers. Besides introduced bees, many flies, wasps, moths, some ants and beetles feed on nectar. Native gardens have become an important habitat for these animals.

Preparation: Develop a calendar that records the number of native flowering plants growing in the school for each fortnight. The chart should record the number of species of trees and large shrubs in flower. When there is a noticeable gap in the flowering of plants, visit a nursery and choose native plants on display that are flowering. Specifically look at the larger growing grevilleas, banksias and callistemons.

Lizard garden

Students can build lizard gardens in the hope that small skinks can re-establish themselves. People tidy everything in their gardens, leaving very few homes for lizards. Lizards are disappearing from the suburbs. By simply planting indigenous poa grasses, small skinks can re-establish populations in some school grounds. Small skinks eat tiny invertebrates. They require a wide selection of hiding places. They need rocks to warm themselves in the sun and like to hide under logs and rocks.

Preparation: Locate an area of garden in the school that receives morning sun. The ground should not be rock solid.



Poa grasses are home to much of the skinks' food and the skinks are very happy to hide in the poa. Other homes can be provided. These can include rotting logs and thick planks of wood. The lizards hide underneath them. They will also hide under rocks and large pavers, but make sure there are some small gaps between the pavers and the ground. Native shrubs and trees can be grown above the area as long as there is an exposed sunning platform that captures the sun all morning.

Students can make their own concrete rocks. These look natural, are good for sunning and the lizards can hide under the flat surface. To make a rock:

- Dig a hole in the ground and create the desired shape for the rock.
- Mix cement, sand, stone and concrete colouring.
- Pour the cement into the hole and allow it to cure.
- After a day remove the concrete from the hole and position it in the garden.

No mater what kind of sunning structures are used, plant some poas next to the sunning spots so the lizards can quickly escape when there is danger.

Insect grassland

Students can cheaply grow a grassland. Native grasslands look spectacular and children find them great fun to play in. A grassland is nothing like a lawn or an oval. Natural grasslands are rich in plant and invertebrate species. Many native grasses are easy to maintain. Councils and road authorities are planting these grasses in large areas along major roads and freeways. Many plants and small animals need the native grasses for food or shelter. These plants provide homes for many more types of animals than the lawn grasses and weeds that grow in schools and gardens.

Precautions: Do not encourage play in the grassland if snakes live in the area.

Preparation: See preparation instructions for indigenous plants. The area will need to be mulched. At least two grasses per square metre are required. It is suggested that over 60% of the grasses are poas or danthonias. In any hollow damp areas plant lamandra. These have thick, dark green, strappy leaves. Patches of kangaroo or wallaby grass can be planted among the poa or danthonias. Many of the other grasses are also good habitat plants, but are easily confused by students as weeds and are likely to be pulled out during maintenance. If the nursery can supply wildflowers, make sure the students can distinguish them from weeds.

Pond or marsh habitat

Many small water creatures are able to find temporary ponds to lay their eggs and complete their life cycle. This even includes frogs. Garden ponds are very important, as most of the natural ponds no longer exist or introduced mosquito fish are found in many of the remaining ponds and these fish kill most of the water life.

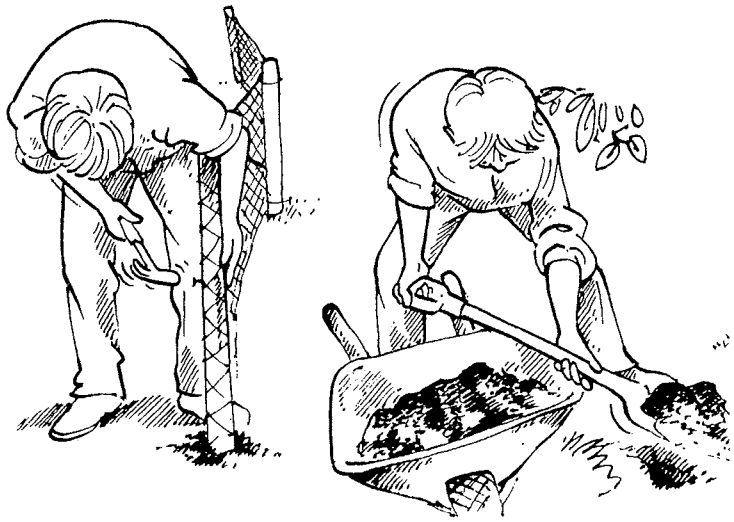
Examine and clarify the following issues:

- Where will the pond be constructed?
- Will the pond need to be in a secure place and are additional fences required?
- How will the pond be lined, with concrete or a plastic liner? (Farm dams are constructed out of a thick lining of clay. This form of construction in a school is probably unrealistic.)
- Develop a strategy for keeping the pond clean and free from litter, and have a system for emptying the pond if this is required.

Precautions: Fence the area from young children.

Preparation: Before work starts, organise the materials for the pool:

1. If a plastic liner is to be used, get advice from the supplier about how the hole should be lined, e.g. with sand.
2. If the pond is to be lined with concrete, ask the supplier the following:
   - Can the concrete be purchased with reinforcing fibre so steel reinforcement is not required?
   - Can a water proofing additive be incorporated into the concrete?
   - The thickness the concrete needs to be.
   - Can they recommend a coating that stops lime leaching from the concrete into the water?
3. Ask the local council about regulations concerning ponds.



The pond does not need to be deep. An average depth of 30 cm will meet the needs of aquatic animals. When making the depression or hole, take into account the following:

- the thickness of any material like packing sand lining the hole
- the thickness of the concrete
- the slope of the land.

If the land has a significant slope, a number of smaller ponds may be necessary. Use a string and level to find the gradient. If the land falls away by 30 cm, one end of a 30 cm deep pond will be dry. Use the soil extracted from the hole to create mounds and slopes around the pond. Once the pond is constructed purchase aquatic plants from an indigenous nursery. These plants will be appropriate for wildlife and will not include unwanted weeds. Some of the plants should float while others grow tall out of the water. Ask for instructions about planting. While water lilies are excellent habitat plants they do require deeper water.

Large native grasses like poas and lamandras need to planted as close as possible to the pond edge. Ideally the leaves from these grasses should droop over the edge. Frogs hide underneath these grasses. Plant some native or indigenous shrubs around the pond. However do not plant melaleucas as their roots can damage the pond. Logs can be introduced into the pond and among the adjoining bush plants.

Once the pond is established:

- Never place fish in the pond as they will drastically reduce the pond's biodiversity.
- Resist the temptation of having a fountain in the pond as the pump can damage the small creatures passing through it.
- Never feed the pond creatures.

As soon as the pond is established, start to sample the creatures in the water. You may be horrified in the first few weeks to see thousands of mosquitoes. Usually they become an excellent food source for your first predators. In a few weeks they will be hard to find. If for some reason this does not happen, you may like to introduce some pond creatures to your pond. There are two notes of precaution:

1. Do not introduce mosquito fish into the pond.
2. In most States it is illegal to capture, keep or transport frogs, tadpoles or frog eggs. If frogs are in the area, they are likely to find the pond if it has the appropriate conditions.

Soil creatures habitat

Gardening, mowing lawns and farming reduce the types of animals found in the soil. Leaf litter and other rotting plant material are habitats for a wide range of small invertebrates, lizards and frogs.

Preparation: Identify an area that can be turned into a soil creature haven. The area can be open, it can be an old garden bed but it is best if it is located under some large eucalypts. The area needs to remain damp through the year so it should not be under the eaves of buildings. Then do the following:

- Loosen the soil.
- Place some logs and large rocks on the ground. Carpet and bricks also make good homes for animals to hide under.
- Press some upside down terracotta pots into the soil
- Place 10 cm of mulch on the soil. It is desirable to have a large content of gum leaves.
- Scatter rotting branches and bark over the mulch.
- If necessary, lightly water the mulch to keep the area damp.

Use the soil invertebrate survey to measure the increase in biodiversity of soil creatures.