BY-NC-SA

5.1 What do you know about ecology?

Lesson outcomes

At the end of this activity students will be able to:

- explore and share ideas about the living and non-living components of ecosystems
- identify key terminology relating to ecosystems.

Key vocabulary:

Ecosystem, environment, habitat, abiotic, biotic, predator, prey, carnivore, herbivore, omnivore, parasite, specialist feeder, opportunistic feeder, plant, animal, fungus, decomposer, detritivore, food chain, food web

Equipment list:

The CLASS will require:

- internet access

Each STUDENT will require:

- ***e-Notebook***
- *Student Guide*

Things to consider:

- View the three videos of Australian ecosystems. Choose one best suited to your context. Identify the abiotic and biotic factors in your chosen video and prepare questions to probe students' ideas.
- This lesson provides a **diagnostic assessment** of students' current understandings of ecosystems. This information allows you to better plan for Parts 5 and 6 by teaching to students' weaknesses.
- Consider creating a classroom ecology display with definitions and examples of all the ecological terminology in this unit. As new terminology is introduced, invite students to research the best definition. Encourage students to discuss different definitions and resolve confusion. As a class, form a consensus and define each term to add to the display. Make use of the glossary. As the unit progresses, ask students to find concrete examples to add to each term; e.g. adding an image and text about fungi under the term *decomposition*.
- Consider playing the four sound files of various ecosystems as students enter the classroom. Ask if they can identify what they are hearing, where it is and the time of day. Give the answers at the end of the class and invite students to use their own recording devices to record sounds in their local environment or backyards.
    - **Sound 1:** Daytime, rain forest with a creek, birds, frogs and insects can be heard.
    - **Sound 2:** 50 cm-high waves crash onto a sandy beach at Palm Cove, Queensland.
    - **Sound 3:** Australian box eucalypt forest at dawn, recorded near a dam, hence the frogs.
    - **Sound 4:** Flying foxes jostle for position in the trees at night at Palm Cove.

BY-NC-SA

Teacher content information:

This activity is designed to arouse curiosity in the topic and to identify students' current ideas about ecosystems.

There can be confusion between the words environment, habitat and ecosystem.

1. The *environment* specifically describes the conditions or surroundings organisms live in.
2. *Habitat* categorises the type of environment in which organisms live. Habitat is dictated by such things as the type of plants that grow there, climate and geography. Habitats can be grouped as freshwater, terrestrial or marine. Examples include rainforest, desert, urban, river and reef habitats. For examples and descriptions see: http://www.bbc.co.uk/nature/habitats
3. An *ecosystem* (e.g. rainforest, desert, urban, river or reef ecosystem) describes the system within habitats; i.e. the interaction between communities of interdependent organisms (biotic) and the non- living components (abiotic) of the environment. These aspects of an ecosystem link together through nutrient cycling and energy flow.

Lesson plan:

Step 1: Remind students of what they have explored in the first four parts of this unit; the components of a system, how living systems respond to stimuli, how living systems respond to disease and how living systems respond to change. Invite students to now consider the local environment in which they and other organisms live as a system and to draw on their knowledge of ecosystems from Year 7.

Step 2: Direct students to the *Student Guide*. All of the terms in the *word map* should be familiar from their Year 7 studies.

Step 3: Play each of the sound files to students and see if they can describe the various ecosystems.

Step 4: Organise students into ***Learning Partners***. Explain that the class will watch a video about an Australian ecosystem. One student in each pair will record a list of the living things seen in the video, while their partner lists the non-living things. Inform students they will share their lists with their partner after the video.

Suggested question/s:

- What is an ecosystem? How is it a system?
- What sorts of organisms are living here?
- What do you think biodiversity means?
- What non-living things are in this ecosystem?
- Why are non-living factors in an ecosystem important?
- Are these living things and non-living things interacting in any ways? What ways?
- Did anyone note any microorganisms?
- What about dead things? Where do they fit into this picture?
- Are humans a part of this ecosystem? How?

BY-NC-SA

Step 5: During discussions introduce any scientific terminology arising from students' observations and ideas. Display new terminology and identify or co-create definitions for each. Examples include ecosystem, environment, abiotic, biotic, species, predator, prey, carnivore, and herbivore.

Step 6: Download and show the students the *Soil PowerPoint*. Click Slide Show/From Beginning and present it as a slideshow. Show the class the video *Microorganisms in abundance*. Discuss answers to the question *What is the significance of all the small forms of life?*

Step 7: Conclude by asking all students to complete the tasks in their ***e-Notebook***. Discuss students' answers. This **diagnostic assessment** exercise will alert you students' strengths and weaknesses and allow you to better plan for future lessons. During class discussion students will begin to appreciate the links between simple systems, living systems and more complex ecological systems.

BY-NC-SA

5.2 What can we observe in our local ecosystem?

Lesson outcomes

At the end of this activity students will be able to:

- use different techniques and tools for gathering abiotic data in a local ecosystem
- observe an ecosystem and accurately record qualitative information.

Key **vocabulary:**

Abiotic, biotic, erosion, topography.

Equipment list:

The equipment used in this activity will depend on the local ecosystem explored and the techniques and tools used to gather abiotic and biotic data. See **Things to consider** for more details.

Each STUDENT will require:

- ***Notebook***
- *Student Guide*

Things to consider:

- It is recommended that you first plan the **summative assessment** task in **Activity 6.5** and then identify the skills and techniques students can practise in **Activities 5.2** and **5.3**. As you plan the summative assessment task in **Activity 6.5**, view the **Teacher Content Information** (below) for practical ideas and resources for preparing ecological studies.
- Practical issues should be considered when planning fieldwork. Consider the following questions as you plan for **Activities 5.2**, **5.3** and **6.5**:
  - What ecosystem could students study in your area?
  - Is there an ecosystem within walking distance of school?
  - What, practically, can we achieve in a lesson if we leave the classroom?
  - Would it be more effective to combine **Activities 5.2** and **5.3**?
  - Should we consider planning a variation to routine in this unit i.e. organising one or more field trips?
  - What are the alternatives if a field trip is impossible?
- Ensure you understand health and safety requirements and risk assessments for student field trips.
- It is essential that you and your students are aware of the ethical issues and requirements when studying living organisms. Consult the animal ethics guidelines for your state and jurisdiction.

Teacher content information:

The aim of **Activities 5.2** and **5.3** and the **summative assessment** task at **Activity 6.5** is to get students out of the classroom and into the field in order to study ecosystems in an authentic way. The resources listed below provide ideas and practical support for engaging in three different ecological studies:

BY-NC-SA

1. A biodiversity or bio-health study of terrestrial ecosystems
2. Soil safari
3. A water quality monitoring study of a freshwater ecosystem.

1. A biodiversity or bio-health study of terrestrial ecosystems

Biodiversity study using a pitfall trap.

Summary:

Teacher and student resources, including videos on sampling techniques, identification guides, data sheets and handouts for a biodiversity or comparative bio-health assessment of terrestrial sites in your local area. http://www.qm.qld.gov.au/microsites/wild/plan-study.asp

Select and view the resources at '**Plan a study'**, '**Collect Insects'**, '**Identify Insects'** and '**Summarise data'**.

Hints and ideas:

Some web links or identification guides are specific to Queensland. Refer to **Further Resources** for some locally relevant links.

Keep it simple. Adapt, refine and focus on the ideas provided to suit your students' learning and context.

Always check the ethical requirements for your state when you begin field-based studies.

Further Resources

Sampling techniques:

Peter Macinnis, author of Australian Backyard Explorer, showing how to make a Pooter for catching small insects: http://www.youtube.com/watch?v=DHv7ur8Yoks

Peter Macinnis, author of Australian Backyard Explorer, showing how to collect insect using an umbrella and pooter: http://www.youtube.com/watch?v=g94hO5U6KyM

A lesson on random sampling using quadrats in a school oval: http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard

A lesson using line transects and quadrats to assess abundance of organisms: http://www.hawaii.edu/gk-12/opihi/classroom/measuring.pdf

BY-NC-SA

Identification guides and links:

CSIRO online key for invertebrates (downloadable): http://www.ento.csiro.au/education/key/couplet_01.html

Online identification key for ants: http://www.antwiki.org/wiki/Welcome_to_AntWiki

A guide to Australian Insect families: http://anic.ento.csiro.au/insectfamilies/

Identification for birds: http://www.birdsinbackyards.net/finder

For purchase: The Michael Morcombe eGuide to Australian birds (available as an App for mobile devices including audio calls): http://www.michaelmorcombe.com.au/

Simple guide to Land organisms: http://www.climatewatch.org.au/get-involved/land

Atlas of Living Australia: http://www.ala.org.au/

Australian weed identification: http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weedidtool.pl

Toad scan: resources for identifying and recording cane toad sightings on interactive maps: http://www.feralscan.org.au/toadscan/default.aspx

2. Soil safari

Safety note

Consider the use of safety glasses and/or masks during the following procedures, particularly if the soil or compost is dry.

Notes on advanced preparation of bait bags and/or compost heap

Trials have shown that students quickly engage with this topic when they have plenty of soil fauna to examine. Unfortunately some Australian soils yield few animals from an extraction. For this reason we strongly recommend showing students samples rich in fauna before they go outside to collect their own soil samples for extraction. This can be achieved through a combination of bait bags, compost and compost extractions.

Bait bags are a great way of attracting soil fauna, especially when ‘planted’ in moist warm soil typical of late autumn or early spring. They’re best examined when half-decayed, typically after three weeks.

BY-NC-SA

During their initial exploration of compost/soil/bait bag extractions students could be posed the following questions.

- How easy is it to find and count soil animals among compost and soil?
- Where did they find the most soil animals? (They're unlikely to find much in soil, but there should be some in compost and bait bags, especially when they tease apart clumps of organic matter.)
- Where should they take soil samples in the school ground to find lots of soil animals? (Use their suggestions to plan a sampling program, for example half the class samples the school vegetable plot, the other half samples grassland.)

Notes on *Soil safari* – Taking a soil sample

The best results are obtained by sampling first thing in the morning when the ground is cooler and fauna are nearer the surface (the sun's heat will drive many deeper).

The sampling rings used in the procedure sheet *Soil safari* need to be a standard size so that students can compare their results. You can use PVC drainage pipe (7.5 cm diameter) cut into 5 cm lengths as this size fits inside the funnel (drink bottle neck) used in the procedure sheet.

Notes on *Soil safari* – Extracting soil animals

Plaster of Paris and charcoal recipe

The plaster of Paris and charcoal base used in the collecting containers should be made at least a day before the extraction.

- 8 parts plaster of Paris (approximately a tablespoon per container)
- 4 parts activated charcoal
- 5½ parts water (or more, to make a soupy consistency)

Mix dry plaster of Paris and charcoal together, then sieve into water. Allow to stand for five minutes before stirring into a thick, soupy consistency. Pour into a container to a depth of 1 cm. Smooth by tapping on the workbench and swirling, then allow to dry. When setting up the extraction re-wet the plaster of Paris base so that it's just damp.

Extraction apparatus

Once extractions are running the equipment will need regular checks to ensure soil fauna doesn't cook! Ideally the soil should reach 30-35 °C, with the extraction running for up to five days. As long as the plaster of Paris base is slightly damp then soil fauna should still be alive when students examine their containers.

There's always a danger in leaving an incandescent globe on in an unoccupied area. Make sure the lamp has metal rather than plastic fittings, and if you're concerned about leaving the light unattended, switch it off at the end of each day and run the procedure for longer.

If students find the extracted soil fauna too mobile to identify, they can kill them by tipping them into a Petri dish containing a thin film of 70% alcohol.

Students may be posed the following questions.

BY-NC-SA

- Can they think of any drawbacks to the extraction method? (It's good for mobile animals that can move through the soil, but poor for immobile stages or those that dry out quickly, such as nematodes.)
- If the soil extraction yields low numbers of soil animals does this mean there weren't many in the soil? (Not necessarily – it means that the extraction technique didn't yield many, but other extraction techniques might be different.)
- Why can't they see fungi or bacteria? (Discuss scale – these micro-organisms are far too small to be seen with a stereomicroscope. A mushroom kit may be used to show filaments of hyphae massed into mycelium.)

Notes on the learning object *Soil life* explorer

For the purpose of this sequence decomposers and detritivores are given the following definitions:

- 'Decomposers' refer to bacteria and fungi. These microbes possess the necessary enzymes to break down certain organic compounds (eg sugars, cellulose and chitin) in dead plant and animal material.
- 'Detritivores' refer to animals that ingest both dead organic matter and their associated bacterial and fungal populations. Most detritivores lack enzymes to break down cellulose and lignin. Instead they make use of enzymes produced by decomposers when they ingest decomposing organic matter and its associated microflora. The chewing and grinding action of detritivores feeding breaks organic matter into smaller pieces, increases the surface area that decomposers can attack, and thereby speeds up the decomposition process. Their partially digested faeces may in turn pass through the guts of several more detritivores and be colonised by various decomposers, before finally reaching an inorganic or mineral form.

Dietary descriptions in the virtual microscope have been simplified. For example, certain soil animals are microbivores – animals that specialise in feeding directly on bacteria or fungi, without ingesting detritus. It can be difficult to distinguish between detritivores and microbivores. Where a group of organisms, such as springtails, contains both feeding groups, we have classified them as detritivores.

Further Resources

Sampling techniques:

- If you do not have a pH probe consider obtaining a soil pH testing kit or garden monitoring kit from a garden centre

Identification guides and links:

- CSIRO online key for invertebrates (downloadable) http://www.ento.csiro.au/education/key/couplet_01.html
- CSIRO online identification key for ants: http://anic.ento.csiro.au/ants/
- A guide to Australian Insect families: http://anic.ento.csiro.au/insectfamilies/
- Great Insect-Related Websites: http://www.bugsed.com/extras_teachers/insect_website.html
- Atlas of Living Australia: http://www.ala.org.au/

BY-NC-SA

- Australian weed identification: http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weedidtool.pl

Local Contacts:

- Get in touch with state government agencies, local council or environmental community groups that may be able to assist with local identification guides or even individuals that can assist in the field.

3. Resources for studying a freshwater ecosystem

Sampling techniques:

A low cost water quality kit has been developed by GREEN USA and La Motte. The kit contains equipment, chemicals and simple instructions to test for such things as dissolved oxygen, nitrates, phosphates, turbidity, pH and temperature. The kit is available through Oz Green and costs approximately $66 including GST (subject to exchange rate variations).

Contact details:

Oz Green

Email: ozgreen@ozgreen.org.au

Internet: www.ozgreen.org.au

Identification guides and links:

- Create laminated posters from StreamWatch Water Bug Guide and NSW Department of Land and Water Conservation Bug Survey. http://www.streamwatch.org.au/cms/resources/manual_pdfs/BugGuide.pdf

  http://www.wagga.nsw.gov.au/__data/assets/pdf_file/0020/44183/Water-Bug-Identification-Sheet.pdf
- The Waterbug Book, a guide to the freshwater Macro invertebrates of Temperate Australia by John Gooderham and Edward Tsyrlin. See: http://www.publish.csiro.au/pid/3148.htm
- Atlas of Living Australia: http://www.ala.org.au/
- Australian weed identification: http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weedidtool.pl
- A simple online guide and exploration of pond life: http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/collect.html

Local Contacts:

Explore resources from local or state museums. Get in touch with state government agencies, local council or environmental community groups e.g. Water Watch that may be able to assist with local identification guides or water quality parameters and even individuals that can assist in the field:

- **New South Wales:** http://www.nswwaterwatch.org.au/ for downloadable resources select *Resources* in the top menu.
- **Victoria:** http://www.vic.waterwatch.org.au/ for downloadable resources select *Education Resources* in the top menu
- **Western Australia:** https://www.dpaw.wa.gov.au/images/documents/get-involved/n2n/20160231_nearer_to_nature_schools_programs_for_2017.pdf for Nearer to Nature Schools Program.

BY-NC-SA

- **South Australia:** http://www.sawater.com.au/sawater/ for resources select *Community/Schools/Education Resources* in the top menu.
- **Northern Territory:** https://denr.nt.gov.au/land-resource-management/water-resources/educational-resources/waterwatch-kit for Waterwatch Education Kit.
- **ACT:** http://www.act.waterwatch.org.au/ for resources select *education* on the left.

Lesson plan

Step 1: Explain to students that they will visit a local ecosystem to explore and observe a site in detail. They will form groups to gather a variety of information about the site's physical aspects. They will use different tools to gather abiotic data and will practise observing biotic and abiotic aspects.

Step 2: Facilitate a class discussion about the types of physical characteristics of the site and abiotic data for collection.

Suggested question/s:

- What could we observe?
- What could we measure? How could we measure it?

Step 3: Ask students to record their data and observations in a ***Notebook***. Demonstrate the use of tools and equipment. Explain what will occur at the site. Discuss any safety requirements.

Step 4: Form groups. Allocate group and/or individual responsibilities, such as using certain equipment, gathering and recording certain data, and sharing information with the class.

Step 5: Visit the site. Help students gather and record information about its physical aspects.

Examples include:

- An annotated sketch of major features e.g. vegetation zones or profiles, position of roads, topographical aspects and the location of waterways. This sketch may include approximation of scale for some features.
- Identification of dominant plant types and the habitat type.
- Information about specific features such as widths and lengths, slope of banks, evidence of human interference e.g. erosion.
- A series of photographs complementing sketches and information gathered.
- Other points of interest e.g. evidence of recent rainfall or human impacts.

BY-NC-SA

Step 6: Help students gather such quantitative data as:-

- direction of North.
- longitude and latitude (via GPS).
- date and time of day.
- recordings at different locations of:
- air and soil temperature
- relative humidity
- soil moisture content
- soil pH
- light levels
- wind speed.
- soil type
- water quality parameters - e.g. turbidity, pH, dissolved oxygen, temperature, salinity/conductivity, and rate of flow.
- recent, local weather and climate data from the Bureau of Meteorology (BOM).

Step 7: Help students use their observational skills to identify and record information about the site's general biotic aspects. No sampling or handling occurs yet. Examples include:

- photographing major vegetation or plant types
- sketching or photographing potential aquatic or terrestrial weeds
- photographing living organisms e.g. vertebrates, macro invertebrates
- silently observing and listening e.g. counting or tallying bird calls or sightings
- observing under rocks or substrate
- using hand lenses
- photographing other organisms e.g. lichen, visible fungus.

Step 8: Return to the classroom and conclude by sharing interesting or unusual observations and identify ways to improve methods for using tools and collecting data. If required, complete any analysis of abiotic features in the class e.g. soil analysis.

Suggested question/s:

- How might we improve our methods of collecting data?
- How could we explore this ecosystem in more detail?

Follow up:

- Consider using latitude and longitude to find and display a satellite map of the site using a program such as Google Maps.
- Encourage students to sit in their backyards or favourite outdoor location and observe it in detail, using a similar process. Suggest they sit silently for five minutes and take notes and tallies of any organisms seen or heard; sketch the site and take photographs; generate a story to describe the site. For example see:

  http://www.qm.qld.gov.au/microsites/wild/wild-backyards.asp

BY-NC-SA

5.3 What organisms live in our local ecosystem?

Lesson outcomes

At the end of this activity students will be able to:

- use a variety of sampling techniques to collect living organisms
- observe and identify a range of living organisms in an ecosystem and make a biodiversity record.

Key vocabulary:

Biodiversity, invasive, macro invertebrates, native, organism, quadrat, transect.

Equipment list:

Equipment will depend on the local ecosystem and sampling techniques for collecting organisms. See **Things to consider**.

Each STUDENT will require:

- ***Notebook***
- *Student Guide*

Things to consider:

- Consider combining **Activities 5.2** and **5.3**.
- Consider your plan for **summative assessment** in **Activity 6.5** as you explain this lesson.
- Use photographs of organisms taken in **Activity 5.2** in the biodiversity record to be created.
- Organisms should be identified in the field with minimal handing and, afterwards, living organisms returned to their exact location. If impossible, consider how some organisms e.g. in soil or water samples, may be collected in advance and identified in the classroom.
- Some sampling techniques (e.g. pitfall traps) need time. If possible, set up before students arrive.
- Consider inviting community groups or scientists to help identify organisms.
- Collect posters, charts and books for identification in the field and/or the classroom.
- Ensure you understand health and safety requirements and risk assessment for student field trips.
- Ensure you and your students understand ethical issues and requirements when studying living organisms. These will directly affect the type and manner of interactions with different organisms.

As you teach:

Step 1: Explain students will return to the ecosystem they have explored and will use techniques to sample for living organisms. They will also use identification guides.

Step 2: Facilitate a class discussion about the types of living organisms they might observe and/or collect.

BY-NC-SA

Suggested question/s:

- What organisms might we observe?
- How could some of these organisms be collected?

Step 3: Demonstrate sampling techniques and explain the process that will occur. Discuss safety requirements and ethical responsibilities when working with organisms.

Step 4: Form groups. Allocate group and/or individual responsibilities. Some may be responsible for certain sampling processes. All students should observe and identify organisms. Consider your students' abilities to identify organisms in the field.

Step 5: At the site, help students sample and identify living organisms. Encourage most identification; e.g. plants and vertebrates, to occur via observation *in situ*, without removing or handling organisms. Photograph and sketch all organisms, for follow up or later research. Use hand lenses for identification. Note relevant information e.g. is the organism native or invasive? Is it sensitive or tolerant of certain environmental conditions?

Step 6: In the classroom, conclude by gathering information for a class display or digital record of the site's biodiversity. Encourage students to share interesting or unusual observations and identify how to improve methods and identifications. If required, complete any final identification processes e.g. using microscopes to observe organisms in soil or water samples.

Suggested question/s:

- How might we improve methods to sample organisms?
- What other information about the site's biotic aspects could we obtain? How?

Follow up:

- Create a digital space e.g. a wiki, to develop the class biodiversity record. Include photographs and information about all observed organisms. Assign roles and responsibilities for adding to or altering this record e.g. adding website links, identifying feeding relationships, reproductive strategies and other information about each organism. Encourage students to add questions to the wiki, a blog or discussion forum e.g. unidentified organisms. Invite local scientists to join digital discussions.
- Consider your students using or contributing, as science citizens, to the Atlas of Living Australia; a collaborative, national project making biodiversity information accessible and useable. Scientists, academics and the community contribute biodiversity data to the atlas. Your students can search for species observed in the field. Atlas of Living Australia: http://www.ala.org.au/

BY-NC-SA

5.4 What are the relationships in our local ecosystem?

Lesson outcomes

At the end of this activity students will be able to:

- describe the relationships between living and non-living components of an ecosystem
- identify and use key terminology to describe these relationships.

What ideas might your students already have?

This activity provides an opportunity to build upon students' prior knowledge about relationships in ecosystems e.g. food chains and webs.

Key vocabulary:

Carnivore, competition, consumer, herbivore, omnivore, parasite, pollinator, predator, prey, producer, resources, scavenger, decomposer.

Equipment list:

The CLASS will require:

- chalk
- scissors
- marker pens
- **Activity sheet 5.4 Ecosystem components**
- **Activity sheet 5.4 Possible ecosystem relationships**

Each STUDENT will require:

- ***Notebook***
- *Student Guide*

Things to consider:

- The lesson occurs on a concrete surface where chalk marks can easily be made.
- Label 10-15 cards, each with a single biotic or abiotic component from a local, familiar ecosystem. Use green card for biotic and brown for abiotic components. **Activity sheet 5.4 Ecosystem components** contains some generic examples with enough empty spaces for you to add site specific components. Students can use the marker pens and write them.
- This activity is an opportunity for a class discussion about the relationships in ecosystems. Students may need help defining these relationships. Consider displaying **Activity sheet 5.4 Possible ecosystem relationships** when creating the physical model.
- When labelling and planning this activity:
  - use examples students have explored from the biodiversity record in **Activity 5.3**.
  - choose labels with the most potential to identify relationships
  - include two biotic cards that are the same to discuss concepts such as species, population, and reproduction
  - include human as a label to discuss our interaction in ecosystems

BY-NC-SA

- include a parasite or organism with a symbiotic relationship to another.

- Alternatively, labels could be drawn from any of the videos in **5.1 What do you know about ecology?**

Lesson plan

Step 1: Remind students of aspects explored in **Activities 5.2** and **5.3**. Refer students to **Activity 5.4 What are the relationships in our local ecosystem?** in the *Student Guide*.

Suggested question/s:

- In what ways do organisms interact with each other?
- In what ways are abiotic components important for organisms in an ecosystem?

Step 2: Explain that students will create a physical model to identify and discuss the relationships in an ecosystem. Move to the site and arrange the class. Choose 10-15 students to each hold a labelled card. They form a medium-sized circle and sit down. The remaining students form pairs and stand or sit in a larger circle outside the inner circle.

Step 3: Pass chalk to one student who has a label. This student chooses another student whose label has some relationship to their own (in any direction). The first students says or describes out loud the relationship, while standing up and drawing a chalk line from their position to the new student's. They pass the chalk to this student and return to their seat, holding their label in view. The process is repeated by each student who receives the chalk. They can choose any label and may return to the same one more than once.

Step 4: Explain the role of the outside circle. Student pairs will record in their ***Notebooks*** each relationship revealed in the activity and any new terminology. These notes can be used in future analysis. The students can represent relationships in different ways, for example:

Arrow may be single headed in either direction or double headed depending on the relationship

OR

'_____ has a relationship with _____ because _____'

BY-NC-SA

Step 5: During the activity, facilitate a class discussion and suggest relationships. Invite all students to give ideas if anyone is stuck. If need be, move the chalk to a new student and continue the process.

Step 6: Finish the activity at a natural stop point, depending on time available. Consider photographing the 'relationship-web' for later analysis. Students with labels stand back to observe the connecting lines. Identify and discuss relationships that involve multiple steps e.g. a food chain. Have a volunteer 'walk and talk' along some lines. Identify components e.g. the sun, with multiple connections to others in the system.

Suggested question/s:

- Why is the sun so important in the ecosystem? What is its role?
- Are there more herbivores or carnivores in this system?
- What is the prey for X?
- What might happen if we removed Y?
- Can anyone identify the following?
- herbivore
- carnivore
- omnivore
- parasite
- decomposer
- scavenger.

Step 7: Conclude by prompting students to share questions about the relationships observed. Display and define new terminology in the classroom.

Follow up:

Invite students to read this description of a complex and interesting ecological relationship between a plant and parrot. Ask them to identify all biotic and abiotic relationships: http://blogs.scientificamerican.com/extinction-countdown/2012/10/03/dung-endangered-kakapo-parrots-save-plant/

BY-NC-SA

5.5 How does energy flow through an ecosystem?

Lesson outcomes

At the end of this activity students will be able to:

- identify and describe producers from different ecosystems
- explain why the collective biomasses of each trophic level form a pyramid shape
- explain how energy flows through an ecosystem.

What ideas might your students already have?

Students' prior knowledge and ideas about the roles of producers and energy flow may be evident during discussions in **Activity 5.4 What are the relationships in a local ecosystem?** Students may think of energy as being destroyed when exploring energy flow through an ecosystem. The *law of conservation of energy* is pertinent in this activity.

Key vocabulary:

Algae, consumer, cyanobacteria, diatom, food chain, food web, photosynthesis, phytoplankton, producer, scavenger, trophic level, biomass, biomass pyramid.

Equipment list:

The CLASS will require:

- internet access

Each STUDENT will require:

- ***Notebook***
- (Optional) **Activity sheet 5.5 Pond organisms**

Things to consider:

- Remind students to bring in their decomposed toilet rolls next lesson for the following activity, **Activity 5.6 What causes a roll of toilet paper to decompose?**
- Determine if students have encountered the law of conservation of energy and, if so, adjust your planning.
- Preview the digital resources and *Student Guide* to decide how best to support learning and manage internet access.
- The digital activity *Flow of energy: pond* is housed in Scootle. You (as educator) will need to register on Scootle (https://www.scootle.edu.au/ec/p/home) in order to access this resource for your students. Once registered you can search for it using its ID code (L11713) and add the resource to your own learning path. Click on the 'Add to' button, and choose 'Create new learning path'. Click on 'Learning paths' at the top of the page, open your learning path and copy the six letter PIN number that you can share with your students. Your students need to go to the Scootle home page (https://www.scootle.edu.au/ec/p/home), click on 'Student login' at the top of the page and enter the PIN number.

BY-NC-SA

- Explore the diagram creator for the pond ecosystem in the *Find out more* section. Identify opportunities in this resource for students to create and save diagrams (e.g. uploading images, using text and saving their completed diagrams as JPEGs.) **Note:** this resource can also be used by students in the optional **formative assessment** task in **Activity 5.9 How can I communicate ecosystem components to others?** This *Find out more* resource is an opportunity to practise using the diagram creator before this task.

Lesson plan

Step 1: Ask the class the question:

Where is the energy in an ecosystem and where does it go?

Use a ***Think-Pair-Share*** strategy to help students think of and share ideas.

Step 2: Show the *Energy Flow* video to the class. Discuss the main points. Invite students to explore in the *Student Digital* how different producers capture energy in different ecosystems. Students then complete the ***Notebook*** task.

Step 3: Refer students to the *Student Guide* and explain the diagrams showing energy flow through a food chain and then the energy flow through a consumer (koala). Prompt them to complete the *Student Guide* discussion questions in their ***Notebooks***.

Step 4: Conclude by asking students to share their answers with the class and prompt them to link their new understandings to the relationships explored in **Activity 5.4 What are the relationships in our local ecosystem?**

Follow up:

Refer students to *Find out More* section *Building an energy flow diagram*. Step students through the development of a diagram of energy flow in the pond ecosystem. Download **Activity sheet 5.5 Pond organisms** and prompt students to read the information about each organism and decide on the relationships they wish to represent. Instruct them to locate, save and upload an image of the sun to this system. Display the text you wish students to add to their diagrams e.g. *'Sunlight energy', 'Energy lost to the environment as heat', 'Producer', 'Consumer', 'Herbivore', 'Carnivore', 'Omnivore', ' Decompose', ' Scavenger'.*

BY-NC-SA

5.6 What causes a roll of toilet paper to decompose?

Lesson outcomes

At the end of this activity students will be able to:

- observe and identify organisms involved in decomposition
- describe optimal conditions for decomposition to occur.

Key vocabulary:

Decomposer, decomposition, macro invertebrate, micro-organism, microscopic, mould, organic matter, recycling, scavenger.

Equipment list:

Each GROUP will require:

- a decomposed roll of toilet paper in a plastic zip lock bag
- white or light coloured tray
- protective gloves
- hand lens
- dissecting microscope
- forceps
- pooter (if available, or see **Teacher Content Information** below)
- specimen jars
- identification guides

Each STUDENT will require:

- ***Notebook***
- *Student Guide*

Things to consider:

- Prepare identification guides for students. Guides for terrestrial organisms are in Teacher Content Information in **Activity 5.2 What can we observe in our local ecosystem?**
- Check for latex allergies before students wear gloves.

Teacher content information

Detritivores (scavengers) break down dead or decaying organic material into smaller pieces which aids decomposition. Examples of detritivores range from cockroaches and earwigs to vultures.

Decomposition of dead plants and animals occurs by microorganisms, such as fungi and bacteria. These organisms feed on dead matter. The process of decomposition leads to the recycling of nutrients, such as carbon and nitrogen, back into the soil, air and water.

Peter Macinnis, author of Australian Backyard Explorer, shows how to make a Pooter for catching small insects.: http://www.youtube.com/watch?v=DHv7ur8Yoks and how to collect insect using an umbrella and pooter: http://www.youtube.com/watch?v=g94hO5U6KyM

BY-NC-SA

As you teach:

Step 1: Refer students to the *Student Guide*. Step them through the appropriate method for an in-class exploration of the rolls.

Suggested questions:

- What happens to dead and decaying things?
- What do you think you will find in and on your toilet roll?

Step 2: Organise small groups and the materials. Remind students how to properly carry and set up a microscope. Remind them of safety precautions when observing and extracting organisms from the toilet roll. Do not touch centipedes, scorpions or spiders and ask for assistance.

Step 3: Interact with groups and pose questions to assist students' observations and annotated drawings. Help them use guides to identify organisms found. Encourage photographic records.

Suggested question/s:

- What type of organism is this?
- What body structures can you see under the microscope?
- Can you identify this organism?
- Where do you observe this organism in/on the toilet roll? What do you think it was doing?

Step 4: After the investigation, a spokesperson from each group shares their observations and findings.

Step 5: Conclude with a class discussion about organisms involved in the process of decomposition. Discuss the difference between scavengers and decomposers.

Suggested question/s:

- What environmental factors promoted the greatest growth of mould and decomposition in the toilet rolls?
- Can you think of other living organisms that you cannot observe under the microscope that may also be at work?
- What do you predict you would see if this toilet roll experiment was continued for several months?

Follow up:

- Show students the following time-lapse video of a dead rat decomposing (Scootle resource R11856 - *Returning nutrients to the soil*). Ask students to identify the different organisms involved. Discuss the difference between scavengers and decomposers.
- Show students a video about the role of fungi in decomposition. A suggested video is The Private Life of Plants (2 disc set, by David Attenborough) Disc 2, The Social Struggle 23:20m - 28:22m. Ask students to find out more about fungi, particularly any observed on the toilet roll.

BY-NC-SA

5.7 The carbon cycle

Lesson outcomes

At the end of this activity students will be able to:

- generate a flow diagram to represent the carbon cycle
- list some of the carbon stores in the carbon cycle
- describe the route that carbon can take through the carbon cycle and relate this to ecosystems.

What ideas might your students already have?

Where do trees get their mass from? Your students might not know the answer to this question. If so they are not alone. Watch the MIT graduates answer the same question - https://www.youtube.com/watch?v=JhCHb6xtqeY

Key vocabulary:

Carbon cycle, carbon store, fossil fuel, photosynthesis, respiration.

Equipment list:

Each PAIR will require:

- butcher paper
- Blu-Tack™, sticky tape
- pencils, markers
- scissors
- **Activity sheet 5.7 The carbon cycle.**

Each STUDENT will require:

- ***Notebook***
- *Student Guide*

Things to consider:

- Identify to what extent students understand from previous study the processes of *respiration* and *photosynthesis* and adjust your planning to suit.
- The digital activity is housed in Scootle. You (as educator) will need to register on Scootle (https://www.scootle.edu.au/ec/p/home) in order to access this resource for your students. Once registered you can search for it using its ID code (M008906) and add the resource to your own learning path. Click on the 'Add to' button, and choose 'Create new learning path'. Click on 'Learning paths' at the top of the page, open your learning path and copy the six letter PIN number that you can share with your students. Your students need to go to the Scootle home page (https://www.scootle.edu.au/ec/p/home), click on 'Student login' at the top of the page and enter the PIN number.
- Preview the *Carbon Cycle* digital activity and decide how to incorporate it to support learning and how to manage internet access.

BY-NC-SA

Lesson plan

Step 1: As a class watch the video '*Where do trees get their mass from?*' Stop at pertinent points and question students to probe prior understanding and ideas about where trees come from. Direct students to the graphic novel showing Jean Baptista van Helmont and his famous tree growing experiment.

Step 2: Refer students to the image of the snail and plant in a jar of water in the *Student Guide.* ***Brainstorm*** the following statement and guide their ideas with the questions:

Statement:

In a sealed tank is a large sprig of pond weed and a snail. The tank is kept for several weeks on window sill with indirect sun. Both the plant and snail appear healthy. Why does this happen?

Guiding questions:

- What do the plant and snail need to survive?
- What processes are occurring in the jar to keep them both alive?
- Where do animals and plants get carbon? What about aquatic plants and animals?
- What are the possible outcomes for the carbon in these plants and animals?

Step 3: Provide student pairs with **Activity sheet 5.7 The carbon cycle**. Explain they will work in pairs to create a visual diagram of the carbon cycle. Step students through the methods in the *Student Guide*. Ask questions to probe students' thinking and challenge their ideas.

Consider sentence starters such as:

- Can you explain to me …?
- Why do you think that …?
- Have you considered …?
- What would happen if …?

Step 4: Ask pairs to join another pair and compare their cycles. Prompt students to add to and refine their cycles. Discuss students' completed cycles and identify different approaches. Students may then photograph (or copy a simplified version of) their completed cycle into their ***Notebooks***.

Step 5: As a class or in groups, students can explore the interactive diagram representing the global carbon cycle. Prompt them to complete the ***Notebook*** tasks. Discuss different students' responses to these tasks.

Follow up:

- Invite students to watch the video '*Carbon and the origins of crude oil'* at abcspla.sh/m/30888
- Have students create a cartoon strip with the title '*A 300-million-year life story of a C atom*'.

BY-NC-SA

5.8 The nitrogen cycle

Lesson outcomes

At the end of this activity students will be able to:

- identify the key processes and components in the nitrogen cycle.

Key vocabulary:

Decomposer, decomposition, denitrification, denitrifying bacteria, leguminous plants, nitrate, nitrogen cycle, nitrogen fixation, nitrogen fixing bacteria, root nodules.

Equipment list:

Each STUDENT will require:

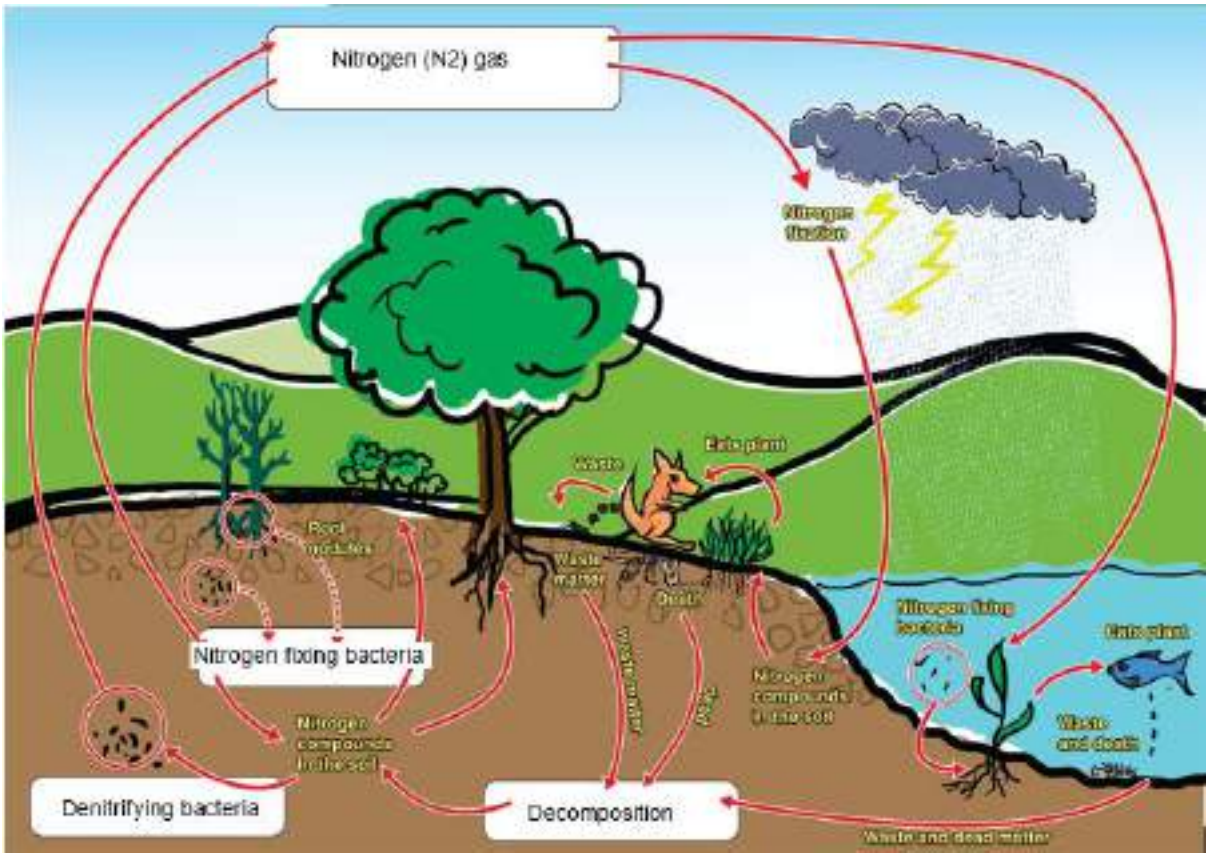
- ***Notebook***
- *Student Guide*

Things to consider:

- This activity is a literacy exercise. Familiarise yourself with the reading in the *Student Guide* and plan how your students can better understand the text.
- View the follow-up activities and possibly plan to include them.

Teacher Content Information

The correct labelling for the Nitrogen Cycle Diagram is shown below.



BY-NC-SA

Lesson plan

Step 1: Remind students of the carbon cycle in **Activity 5.7 The carbon cycle** and the percentage of the atmosphere that is carbon dioxide. Ask students the following question:

Suggested question/s:

- What gases make up the atmosphere on Earth? Do you know what percentage each gas comprises in the atmosphere?

Step 2: Use a physical prop e.g. a full balloon or the classroom, to represent the atmosphere. Draw lines on a balloon or lay out dividing lines in the classroom to represent the amount of 'space' or 'slices' some of the gaseous components of air have, e.g. 78% nitrogen, 20% oxygen and 0.03% carbon dioxide.

Step 3: Ask students to breathe in and out. Explain that the amount of nitrogen gas they breathe in and out is the same. It is not taken in by our bodies. Ask and discuss with students the following questions:

Suggested question/s:

- Is nitrogen a clear gas? Does it have smell or taste?
- Why do organisms need nitrogen?
- So how do we get the nitrogen we need to survive if we cannot access it from air?

Step 4: Refer students to the *Student Guide* and delegate students to read aloud. Stop and explain each new term in the text and add it to a word wall. Link each new term to its place on the diagram. Ask questions to clarify the students' understanding of the cycle.

Consider sentence starters such as:

- Can you explain …?
- What is the role of …?
- What happens to …?

Step 5: To conclude, students complete the discussion questions in their ***Notebooks***. Facilitate a class discussion to explore their answers.

Follow up:

- Consider watching as a class the following animation to reinforce the stages of the nitrogen cycle.

  http://www.classzone.com/books/ml_science_share/vis_sim/em05_pg20_nitrogen/em05_pg20_nitrogen.swf

- **Nodulation activity:** Explore and view nodules on the roots of legume plants (e.g. clover, soybean). Split the nodules open with your thumb nail to reveal the pink Rhizobia bacteria inside. The colour is due to leghaemoglobin, an iron-containing protein (just like haemoglobin in our blood) that binds with oxygen for the bacterium. The redder the colour, the more active is the nodule at fixing nitrogen. Consider this option if time permits.
- Invite students to watch the video Western Waves to see how nutrients like nitrogen and phosphorus, trapped in under-sea sediments, get circulated by the physical action of waves: http://www.abc.net.au/catalyst/stories/2856351.htm

BY-NC-SA

- Refer students to the short article ‘For Antarctic food webs, penguin poo is the gift that keeps on giving’ (https://cosmosmagazine.com/biology/for-antarctic-food-webs-penguin-poo-is-the-gift-that-keeps-on-giving) where soil productivity kilometres inland on the Antarctic Peninsular coast benefits from windblown ammonia from penguin and seal droppings.

BY-NC-SA

5.9 How can you communicate parts of an ecosystem to others?

Lesson outcomes

At the end of this activity students will be able to:

- create a visual poster to communicate to an audience about relationships, flow or cycles in an ecosystem.

Equipment list:

Each GROUP will require:

- internet access
- poster paper, pens and markers
- scissors, glue
- (Optional) **Activity sheet 5.9 Grassland organisms**
- (Optional) **Activity sheet 5.9 Seagrass organisms**
- (Optional) **Activity sheet 5.9 Poster checklist**

Each STUDENT will require:

- *Student Guide*

Things to consider:

- Familiarise yourself with the task in the *Student Guide*. View **Activity sheet 5.9 Poster checklist** to assess the task for peer and/or student self-assessment.
- The two digital resources are housed in Scootle. You (as educator) will need to register on Scootle (https://www.scootle.edu.au/ec/p/home) in order to access these resources for your students. Once registered you can search for each resource using their ID codes (R11957, L11714) and add each resource to your own learning path. Click on the 'Add to' button, and choose 'Create new learning path'. Once you have curated all the resources you need in a learning path, click on 'Learning paths' at the top of the page, open your learning path and copy the six letter PIN number that you can share with your students. Your students need to go to the Scootle home page (https://www.scootle.edu.au/ec/p/home), click on 'Student login' at the top of the page and enter the PIN number.
- Consider photographing public information boards for national parks and other areas to use as a stimulus.
- Explore the content options students can use to complete this task:
  - **Option 1: Pond ecosystem**

    Online via the interactive in the *Find out more* section of **Activity 5.5**. Use **Activity sheet 5.5 Pond organisms** to learn about individual pond organisms.
  - **Option 2: Grasslands ecosystem**

    Online via the interactive in **Activity 5.9**. Use **Activity sheet 5.9 Grassland organisms** to learn about individual grassland organisms.
  - **Option 3: Seagrass ecosystem**

    Online via the interactive in **Activity 5.9**. Use **Activity sheet 5.9 Seagrass organisms** to learn about individual organisms in the seagrass ecosystem.

BY-NC-SA

- **Option 4: Local ecosystem**

  Use information gathered in **Activities 5.2**, **5.3** and **5.4** to complete this task.

- Explore the options for the visual format students can use to complete this task according to resources and computer availability e.g. physical poster, PowerPoint, Publisher, or for the pond and seagrass ecosystems, using the diagram creator tool.
- This task could run over two lessons; one to research and one to prepare the poster for presentation and voting.

Lesson plan

Step 1: Begin by introducing students to the task as described in the *Student Guide*. Discuss or view examples of public information boards with visual information on ecosystems in national parks and other areas. Give each student **Activity sheet 5.9 Poster checklist** and explain the task components' criteria for success.

Step 2: Form pairs and allocate each a component of the ecosystem to present.

Step 3: Allocate time for pairs to research, design and create their posters. Interact to refine ideas and prompt them to use the checklist. Ensure all students contribute.

Step 4: Organise a ***Gallery Walk*** of the completed posters. Group posters into categories and number them. Ask students to vote for the most effective poster in each category using a voting card. For example:

- The most effective poster of feeding relationships in the ecosystem
- The most effective poster of energy flow through the ecosystem
- The most effective poster of the carbon cycle in the ecosystem.

Step 5: View all posters and give an assessment to each pair. This is an opportunity to discuss with the class strengths and strategies to improve communication skills and the use of scientific terminology.