Pathfinder Honour:
Trainer's Notes

Ecology 1

Instructions to Trainers / Instructors of this Honour

Thankyou for being involved with this Honour. These notes have been developed to assist in teaching / instructing this honour. We recognise that there is much more information available and we are grateful that you should share your expertise.

Please remember that Honours are designed to develop our Pathfinders in many ways; their interests, their knowledge and their relationship with their Saviour and Creator. Your enthusiasm and creativity will have a huge impact on those doing the honour.

To complete an Honour, the following (where applicable) must be completed satisfactorily:

- Physical and Practical Requirements.
- Honour Workbook.
- Honour Assessment Sheet. *(On SPD Honour Website but Leader's level access is required)*

Additional Reference Material

Please refer to following Trainer's Notes for useful websites

Acknowledgements

Ecology, Earl . Lathrop, Loma Linda University
Ecology, Milliken Publishing Company, St. Lousis, Missouri, 1984
Australian Social Trend 2007 – Article: Household Waste, Susan Linacre, Commonwealth of Australia, 2007.
Other contributions are acknowledged in the text of these Notes.

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Before you start

These notes can be applied to all of the South Pacific Division. Because of space considerations, the examples in the following notes relate to Australian conditions

REQUIREMENT 1. Construct a diagram of a fresh-water pond ecosystem.

The forest pond illustrates a series of food chains that are interwoven into food webs. The pond is filled with many forms of life.

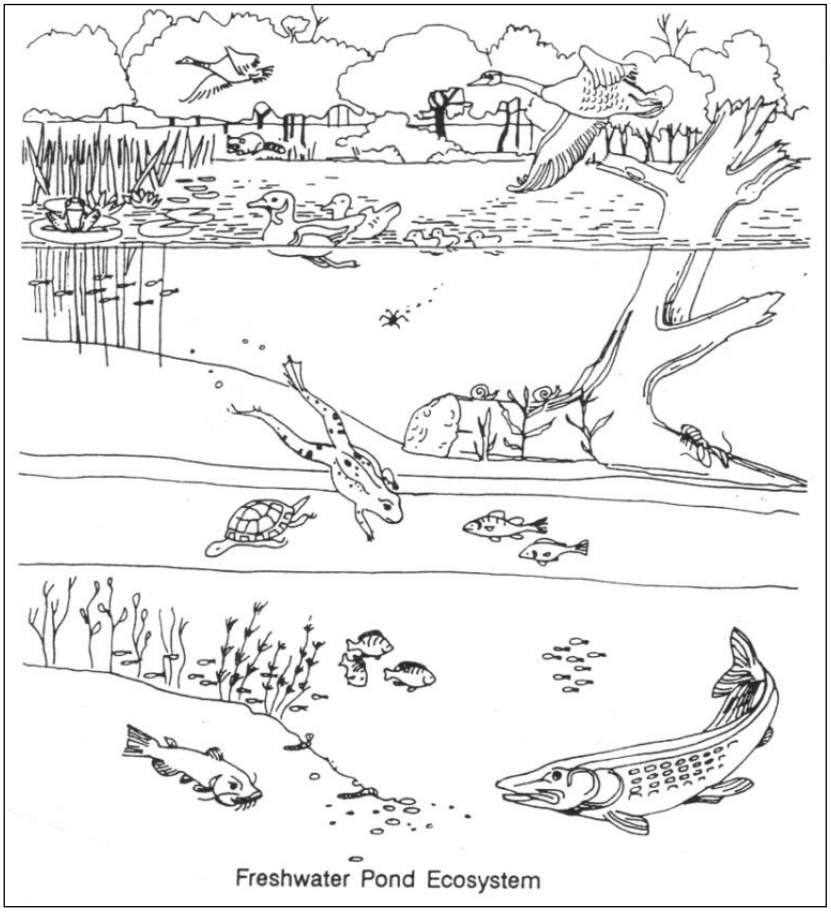
A single drop of water contains many microscopic single-celled plants and animals. These microscopic plants and animals provide food for much of the pond life.

Plants near the shore and those floating on the water whose stems reach down to root in the soft bottom of the pond provide food for insects. The plants also provide a natural hatchery for insect larvae and eggs. In and among the stems lurk small fish looking for food. Frogs and turtles blend with the floating leaves and patiently wait for a meal to fly or swim by.

In deeper water of the pond, larger fish hunt and feed on smaller fish, frogs, insects and each other.

Animals living in and around the pond, such as snakes, water rats and birds consume the larger fish and plants.

Everything alive in the pond is eaten at one time or another. Even the broken bits and pieces of the plants and animals do not go untouched. From the very smallest to the very largest form of life in the pond, it is the same – eat and be eaten.



Freshwater Pond Ecosystem

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REQUIREMENT 2. Pick one mammal, one bird, one reptile, and one amphibian from your home environment and for each construct a diagram of its ecological pyramid.

Key points in regard to ecological pyramids:

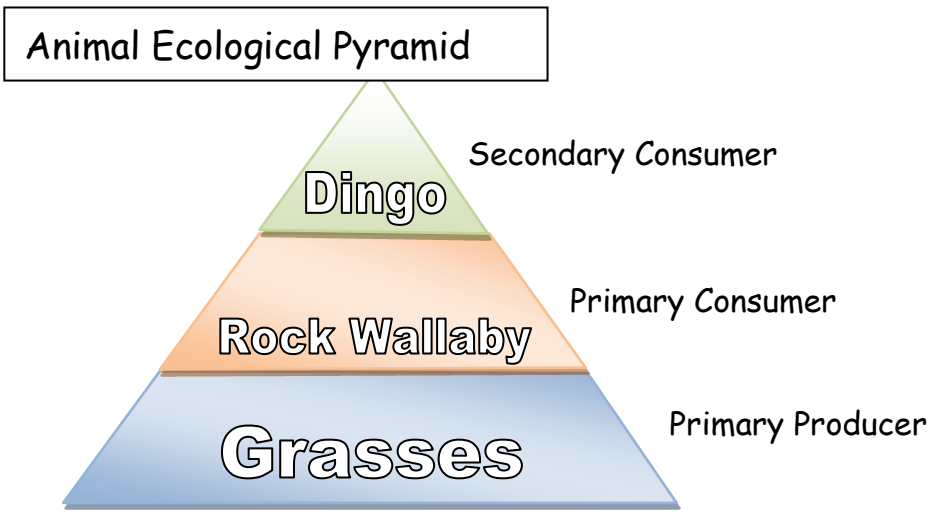
- The different layers in an ecological pyramid are known as the *trophic levels*.
- Almost all ecological pyramids start with energy from the sun.
- All ecological pyramids start with a *primary producer*.
  - Eg. plants that convert energy sun energy into stems, leaves and seeds.
- Animals that eat the primary producers are called *primary consumers*.
- Animals that eat primary consumers are called *secondary consumers*.
- Animals that eat secondary consumes are called *tertiary consumers*.
- Each consumer is typically larger than the prey being consumed.
- The higher the trophic level in the pyramid, the fewer organisms will be present.

Additional information in regard to ecological pyramids

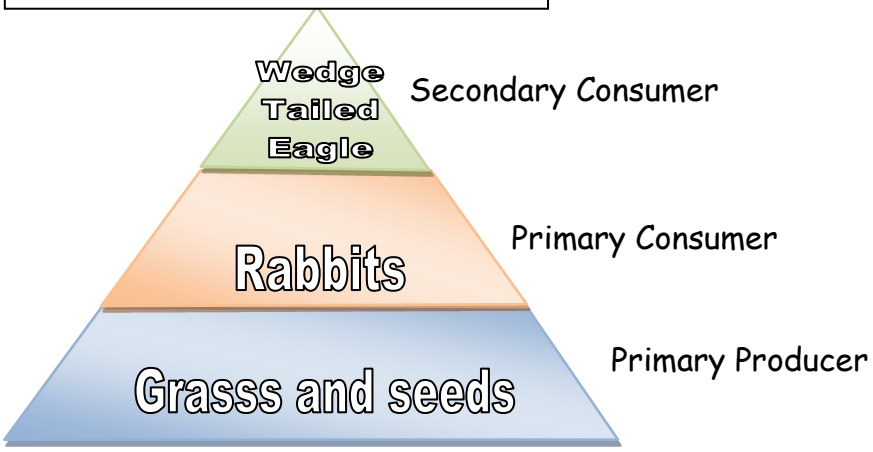
Trophic levels transfer the energy of the sun through organisms of the community up to a practical limit beyond which there is insufficient energy for the support of further trophic levels. This reduction of energy through the various trophic levels until the energy runs out forms what is known as an energy pyramid. This reduction of energy can also be demonstrated indirectly by the reduction in numbers and in biomass (living weight) for each succeeding trophic level.

The consumer at each trophic level is usually larger in size than the trophic level being consumed. Predators, for example, are usually larger than the prey they feed upon. Such increase in size of the individual organisms strictly limits the number of successive trophic levels in a food chain. This larger size means that each successive trophic levels will support fewer numbers of organisms. The total biomass each succeeding level can support is also reduced. Thus ecological pyramids of trophic levels can be expressed in three ways: energy, biomass and numbers.

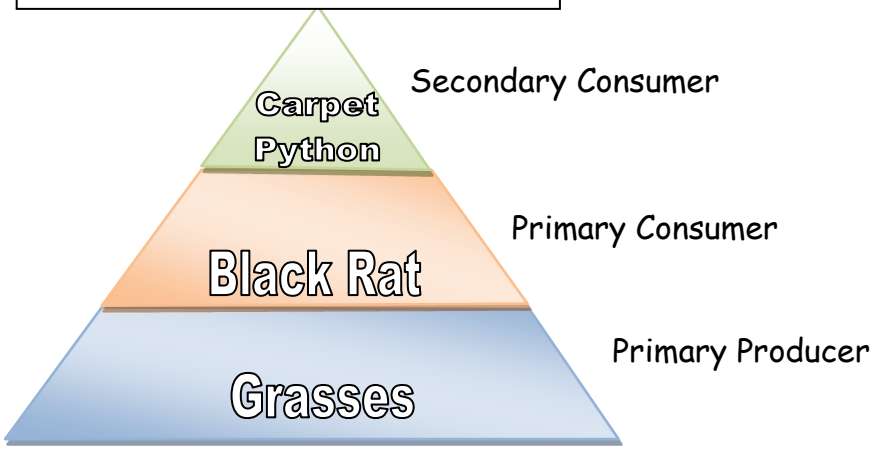
The purpose of an ecological pyramid is to demonstrate the reduction in biomass or energy as the food chain moves between primary producers to the different levels of consumers.



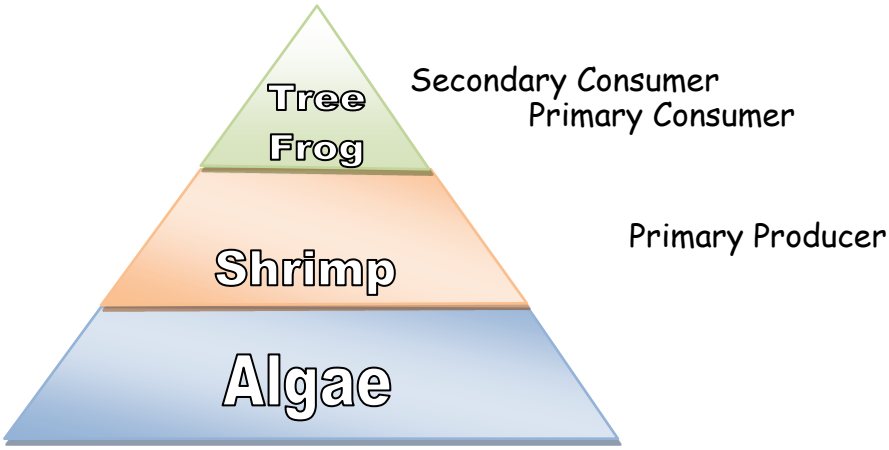
Bird Ecological Pyramid



Reptile Ecological Pyramid



Amphibian Ecological Pyramid



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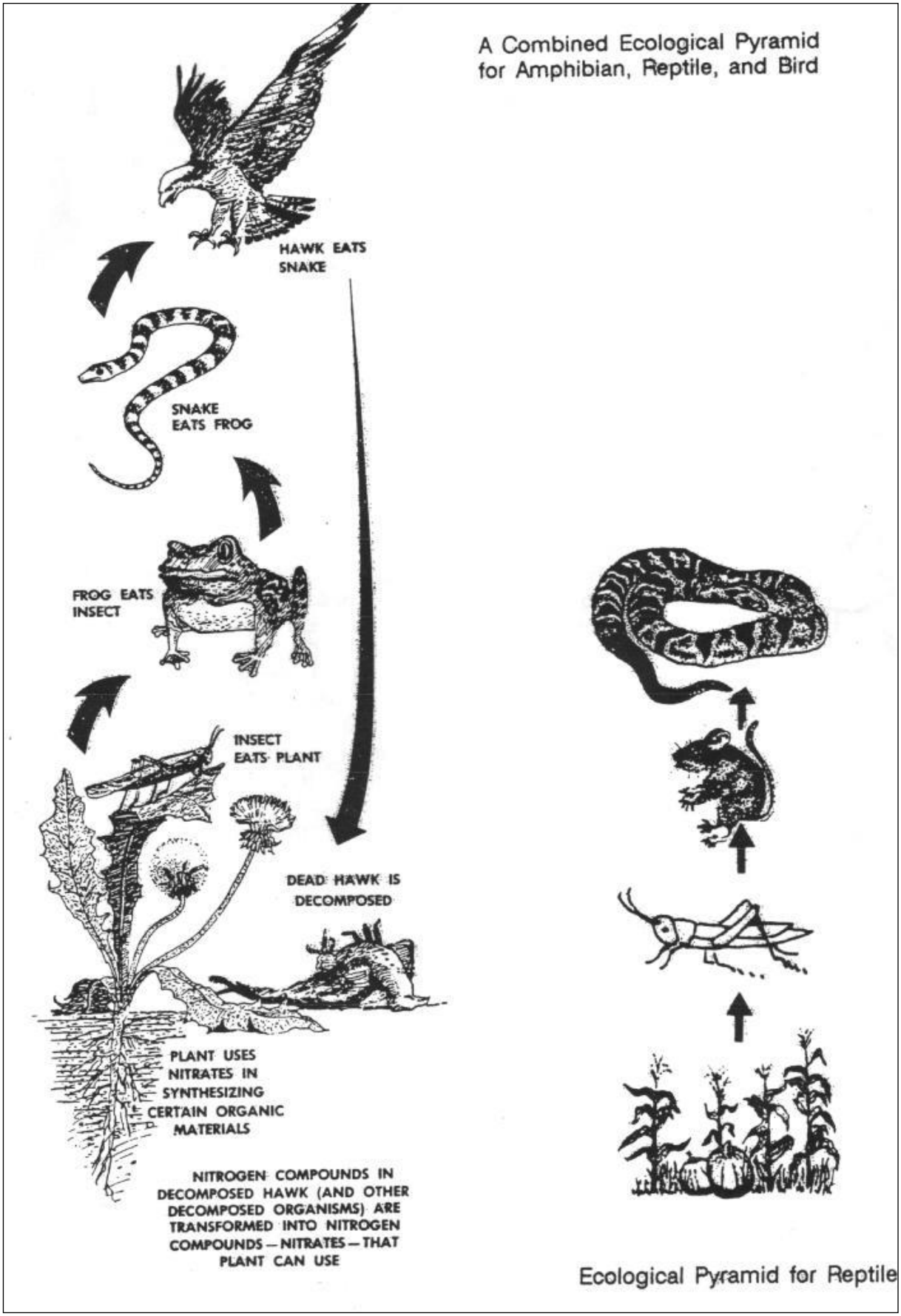

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REQUIREMENT 3. Know the meaning of the following terms:

a. Ecology

The study of plants and animals in relation to each other and to their physical surroundings.

Example: *Ecology may be the study of a single organism (the study of a single turtle including what it eats and where it eats)*

It may also be the study of an entire species (the study of all turtles in freshwater pond including how they breed and rise and fall in numbers)

Ecology can also be the study of an entire ecosystem (the study of all organisms in a freshwater pond including how they interact with each other.

b. Plankton

The microscopic animals and plant life found floating in bodies of water which are used as food by fish and water mammals.

Example: *Although Plankton is microscopic, it is in such abundant supply that it is the sole diet of the largest whales (Blue, Humpback and Right).*

c. Community

A total of living organisms having mutual relationships among themselves and to their environment.

Or,

Groups of organisms in an area that interact or depend on each other for survival.

Example: *An area of a river or creek may be considered are a community. All of the algae, crustaceans, fish and sea mammals that live in the area and rely or interact with each other do so in a community.*

d. Conservation

The wise use of natural resources.

Example: *Conservation is about using resources in a best possible way to prolong their supply and maximise use.*

e. Food chain

The transfer of food energy from one organism to another

Example: *Grass → Small Marsupials → Birds → Snakes*

Removing any of the organisms in the chain will cause an imbalance that may affect all of the other organisms. If the Grass is removed the Small Marsupials die of starvation which will lead to the loss of Birds and Snakes

f. Climax community

Not required by the South Pacific Division.

g. Commensalism

The relationship between two organisms where one benefits and the other neither benefits nor is harmed.

Example: *The remora suckerfish attaches itself to sharks and eats the scraps missed by the shark. The remora gets a free ride and meal but the shark is not affected.*

Barnacles attached to the sides of whales. Barnacles are filter feeders waving feather appendages in the water to collect small food. Barnacles only attach themselves to whales but do not feed on the whale. The whale is not positively or negatively affected by the barnacles.

Staghorns and orchids (Epiphytes) growing on the branches and trunks of trees. The Staghorns and orchids gain access to support, shelter, sunlight and water while the tree is not affected

h. Eutrophication

The process by which a body of water, as a lake, matures and ages, characterised by an environment growing progressively richer in mineral and organic nutrients, resulting in a seasonally recurring depletion in oxygen that is ultimately incompatible with animal life.

Example: *Eutrophication is when then number of plants in a water body become so numerous that they start to remove more oxygen from the water than they can produce. Without sufficient oxygen the animal species begin to die allowing even more plants to grow. This generally occurs when large amounts of nutrients (nitrogen and phosphorus) enter the system through runoff (eg. agriculture). A symptom of Eutrophication is an algae bloom.*

i. Ecological Succession

Members of a community, by their very activities, tend to change the environment. After a period of time, they often make the habitat unfit for themselves. The organisms then die out or migrate elsewhere. But they have made the environment fit for other kinds of plants and animals. A different kind of community develops in place of the old one. This kind of gradual but continuous change is called ecological succession

The ecological succession is the process by which a natural community moves from a simpler level of organisation to a more complex community. Succession is a natural process that occurs after some form or disturbance which simplifies the system.

Example: *In the Australian outback where forest fires regularly destroy the forested areas. After only a few days small plants take advantage of the absence of the forests to grow. When further time has passed they are replaced by shrubs which are replaced or are eventually joined by regrown or new trees to restore the community to its original state.*

j. Biome

Not required by the South Pacific Division.

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REQUIREMENT 4. Make detailed field observations and library-book / internet study of the habitat of some small animal in your own environment. Write a report; one-half from your field observations and one-half from your book / internet study. Length about 500 words.

Field Observations

Tips in making field observation records:

- Record the date/s, location/s and time/s observed
- Records may include:
  - How the animal finds food
  - What the animal eats
  - Where the animal does its foraging
  - How the animal interacts with animals of the same species
  - How the animal interacts with animals of other species
  - How the animal communicates
  - Where the animal does its foraging
  - Drawings / photos of any particular markings

Simple Field Observation Example

Observation Log	**Animal Observed:**			**House sparrow**	
Date:	26 Aug 08	26 Aug 08	26 Aug 08	26 Aug 08	26 Aug 08
Time:	1:00 pm	1:30 pm	2:00 pm	4:00 pm	5:00 pm
Location:	Outside my bedroom	Outside my bedroom	Outside my bedroom	Outside my bedroom	Outside my bedroom

Notes on Observations
There are 9 house sparrows in the observation area.
The sparrows spent most of their time in the small trees and on the ground
They were eating bread crusts on the ground
The sparrows did not interact with any other animal. All of the sparrows kept away from us.
There was a pecking order in the sparrows. Some of the sparrows would chase the other sparrows away. The sparrows with the brightest markings chased the other sparrows away from food. Sometimes they would chase the other sparrows for no particular reason. This appeared to be a sign of dominance.
The sparrows appeared to chirp continuously. They kept in constant communication the whole time during the observation.
Some sparrows appeared much darker in colour than others.
The markings on their chest varied in size between the sparrows.

Book / Internet Study

A study could include library books, videos or websites. An example is the following on House Sparrows: http://www.sialis.org/hospphotos.htm

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REQUIREMENT 5. Define an ecosystem and state what the basic biological and physical factors are that keep it a balanced system.

Key points in defining an ecosystem:
An ecosystem is a community of living things and the environment in which they live.
Examples of ecosystems are:

- Coral Reefs
- Deserts
- Rainforests
- Inland lakes or dams
- Grasslands

How an ecosystem works
Almost all ecosystems gain their power from the sun.

Green plants use sunlight to covert carbon dioxide and water into plant material (leaves, stems, roots and seeds) through a process called photosynthesis.

Green plants also need sufficient temperature, nutrients and minerals.

Plants are therefore the basis of almost all ecosystems. They provide the input energy for all other organism in the community.

Primary consumers gain energy by eating the photosynthetic plants. Secondary consumers gain energy by eating the Primary Consumers. In this way energy, nutrients, minerals and biomass is transferred between organisms in the ecosystem.

When an organism dies, the nutrients and minerals return to the environment. These once again become available to the photosynthetic plants to utilise.

The number of organisms in an ecosystem is largely dependent upon the amount of resources available to the photosynthetic plants (water, nutrients, temperature). Locations with large amounts of water, temperature and nutrients have a greater diversity of animals in their ecosystems (e.g. Tropical Rainforests).

A balanced ecosystem has steady numbers of producers and consumers. Predators keep the prey populations in check without killing them all.

What keeps an ecosystem in balance?
Animals and plants have a range of physical conditions to which they are suited. This typically is some physical requirement such as shelter, food, water or air. (e.g. penguins and emus are both birds but live in very different ecosystems).

When one of these conditions is beyond the tolerance of an organism it is said to be limiting factor.

A balanced ecosystem is comprised of a community of organisms all interacting in an environment that suits their range of tolerance.

When the physical conditions of an ecosystem change either through natural or human intervention, the new conditions may not meet the range of tolerance of some species.

If the species are mobile they may move to a more suitable area. However, organisms that do not leave may die.

The removal of single species from an ecosystem can have a huge impact on the entire community.

The pollution of streams, rivers, oceans, and other disturbances by man to natural communities will, of course, change some conditions to the point that is may be beyond the tolerance of some organisms.

Additional information on ecosystems:
The vast assemblage of plants, animals and their non-living environment makes up what is known as an ecological system or ecosystem.

Ecosystems are composed of biotic and abiotic elements. The biotic element is formed from groups of similar and related organisms, the populations. These are linked together by organism relationships among themselves and to their physical surroundings to form communities. The abiotic element is involved in processes of energy absorption and released by the biotic elements, energy input and utilisation, and nutrient input and cycling are all vital activities in an ecosystem.

How does the ecosystem work? How does it keep in balance? The power of the system is the sun's energy. The only organisms able to use the radiant energy to make food, however, are green plants. In a series of complex chemical reactions they use the energy in sunlight to rearrange the molecules of water and carbon dioxide (raw materials) into sugars and other carbon compounds. This process of photosynthesis takes place only in living cells containing chlorophyll, the green colour of plants.

In addition, the plants need compounds of nitrogen, phosphorous, potassium, iron, and other elements for their growth. They obtain these minerals in the water they absorb from the environment. Together with the carbon compounds built up in photosynthesis, these substances are used to make amino acids.

Amino acids, in turn, are used to make proteins, the basic constituents of all living things.

In any given community these green plants, along with a few chemosynthetic organisms such as sulphur and iron bacteria which derive their energy from the reduction of inorganic compounds, start a series of energy exchanges though the ecosystems.

By combining the idea of minimum and the concept of tolerance, we arrive at an understanding of why plants or animals may be destroyed or eliminated when a natural community is upset by pollution, erosion or disturbed in any way. The presence and success of an organism or a group of organisms in a community depends upon a complex of conditions. Any condition which approaches or exceeds the limits of tolerance of an organism or species is said to be a limiting condition or factor. Thus, organisms are controlled in nature by:

1. Materials for which there is a minimum requirement, such as minerals, water and food, and physical factors which are critical such as temperature, shelter, light, wind, altitude, and many others; and,
2. The limits of tolerance of the organisms themselves to their and other components of the environment.

One conclusion emerges from these observations more strongly than any other, and that is that every local population of organisms is very precisely the plants and animals that are living and reproducing in any particular community under natural conditions and there because the biotic and physical factors of that environment are within their ranges of tolerance. If some plant or animal is eliminated from a community after once having lived there, it means that some biotic factor such as overpopulation of predators, disease, or lack of food for some trophic level.

Pollution of streams, rivers, oceans, and other disturbances by man to natural communities will, of course, change some physical or biotic factor to the point that species will be eliminated from the community. If the organism is motile, such as an animal, it may find another home to live in where its range of tolerance would be met, but more likely it would become a wanderer. A wanderer, or an animal without a home, becomes more subject to predators, disease, and starvation than one that is living in a community it is adapted to and is familiar with.

Plants, on the other hand, must stay and put up with whatever disturbance comes it ways unless their seeds get transported to another area and get established.

Populations that are well adapted in their native environment are often very vulnerable when transplanted into different environments or are forced to move because of disturbance in their own community. This is why it is important for wildlife and plants to live in not only a balanced ecosystem, but in one that is suitable for their particular ranges of tolerance to the biotic and physical factors of the environment. Populations of the community and the non-lining environment function together as a unit under similar ecological conditions, each influencing the other and both are necessary for the maintenance of life. When a community is disturbed, its ecological conditions are changed so it can no longer function as a balanced ecosystem. So it is here that an understanding of the general principles of ecology can help you as an individual to do your part to help keep nature balance.

By knowing something about how the sun's energy is used to start a flow of energy through food chains and food webs, how plants and animals in the various trophic levels depend upon each other and the importance of all the physical factors of the environment, especially the necessity for recycling these elements, should help to recognise a balance community; or, on the other hand, a community that is disturbed and out of balance. Ecology projects usually centre around restoring these communities that have been disturbed so that nature may have a chance to get them back into balance.

Some of the clues of a disturbed community are, among others, excess weeds, erosion, dying shrubs and trees, absence of wildlife, absence of the normal spring wild flowers, excess cutting of trees, overgrazing, burning, and of course litter which not only interferes with normal vegetation ground cover and normal nutrient recycling, but also mars the beauty of a natural landscape.

Removal of litter, reseeding burned or cut over area, taking measures to prevent erosion, and in general studying disturbed communities to try to determine measures needed to restore them to normal are just some of the things that can be done to help keep our natural communities in balance and beautiful. It is hoped that the study of this and other articles on ecology will help you in some way to better understand the workings of nature and thus help you to do something about the destruction to our natural resources before it is too late.

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REQUIREMENT 6. Investigate the disposal of garbage in your community. How much is disposed per family per day? per week? per year? How better can it be taken care of?

Investigate the disposal of garbage in your community

For local information it is recommended that you speak to your local Council. The methods of garbage disposal vary depending on the size of your community, the amount of recycling and the presence of transfer stations.

How much is disposed

For local information it is recommended that you speak to your local Council.

General statistics relevant to all of Australia can be taken from the Australian Bureau of Statistics (ABS). ABS has produced a report title "Australian Social Trends – Article: Household waste" (Commonwealth of Australia, 2007). A pdf of the report can be downloaded at:
http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/E15A3A2832FCC99BCA25732F001CA721/$File/41020_Household%20waste_2007.pdf

The ABS report provides indicative waste production per person. It indicates that 2002-2003 1639 kg of waste was produced per person. This was comprised of 880 kg of waste to landfill and 759 kg of recycled waste.

Based on a family of four (2002-2003), the amount of waste sent to landfill was:

Waste produced per day	= 9.6 kg/day
Waste produced per week	= 67.2 kg/week
Waste produced per year	= 3520 kg/year

How better can care be taken of our amount of waste

The components of waste minimisation can be referred to as the "Four R's"

1. Reduce:
   The best way of control waste is to prevent its generation in the first place.
   Avoid unnecessary packaging and products.
   An example is to use alternatives to plastic grocery bags.

2. Reuse:
   The waste that cannot be reduced should be reused.
   Find ways to use packaging or waste in ways beyond their original intention.
   An example is to us containers as pots or plastic bags as bin liners.

3. Recycle:
   The waste that cannot be reused should be recycled
   Recycling converts waste into other forms of usable products.
   Examples include the recycling of plastic into playground equipment or vegetation into compost.
   Other recyclable products include paper, cardboard, steel, plastic and glass.

4. Refuse:
   The waste that cannot be recycled should be disposed of as refuse.
   All waste (refuse) should be disposed of appropriately (council landfills.

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REQUIREMENT 7. Check your nearest large city for one month for its air pollution level. Plot a curve for this level on a graph for the month. Find out what caused the peaks in your curve.

The following table outlines the three most commonly known air pollutants. These are often reported in local newspapers and can be found on the web:

POLLUTANT	UNIT	PRIMARY SOURCE	HEALTH EFFECTS
Carbon Monoxide	ppm	Cars, trucks and fires	Reduces oxygen absorption in the lungs. May cause chest pain.
Ozone	ppm	Vehicles	Can cause eye and lung irritations. May cause shortness of breath
Particles	*u*g/m^3	Burning, vehicles and mining	Larger particles may cause Asthma. Smaller particles may cause lung problems.

The Queensland Environmental Protection Agency website provides a comprehensive description of these three pollutants (http://www.epa.qld.gov.au/projects/air/)
The information from this website is reproduced below.

Carbon Monoxide
Carbon monoxide is a colourless, odourless gas. It is formed when substances containing carbon are burned with an insufficient supply of air.

The combustion of fuels such as petrol, gas, coal and wood generate emissions of carbon monoxide. We burn coal to generate energy and electricity for our homes. Gas and wood can be used for cooking and heating in appliances like stoves and barbecues.

Motor vehicles are the main source of carbon monoxide pollution in urban areas. The motor vehicles we drive operate on petrol, diesel, or gas. Car exhaust emissions contain carbon monoxide from incomplete burning of fuel in the engine.

Carbon monoxide can have serious health impacts on humans and animals. When inhaled, the carbon monoxide bonds to the haemoglobin in the blood (and becomes carboxyhaemoglobin) in place of oxygen and is carried through the blood stream. This reduces the oxygen-carrying capacity of the red blood cells and decreases the supply of oxygen to tissues and organs, especially the heart and brain. This can be a serious problem for people with cardiovascular disease. Most people in the community need to be exposed to a level of 200 ppm for several hours before they start to feel effects. Carboxyhaemoglobin formation is reversible when the person is no longer exposed to carbon monoxide.

Ozone
Bushfires generate large quantities of the primary pollutants that form ozone, in addition to the everyday emissions from other sources. In recent years, ozone levels in south-east Queensland in excess of guideline values have almost always been associated with bushfires or burning-off events that occur during still weather conditions. The still conditions cause the emissions to build up near the source instead of being dispersed on winds.

Ozone can affect the human cardiac and respiratory systems, irritating the eyes, nose, throat, and lungs.

Ground-level ozone irritates the respiratory tract when present at concentrations significantly above natural background levels. Symptoms of ozone exposure include itchy and watery eyes, sore throats, swelling within the nasal passages and nasal congestion. Effects from ozone are experienced only for the period of exposure to elevated levels.

Particles PM10

Particulate matter is the term used to describe particles that are suspended in the air. Particles may be solid or liquid and are one of the most obvious forms of pollution as they are visible in the hazes that cover a city or region.

Combustion processes using coal and other fossil fuels, such as power generation, industrial operations and motor vehicle fuels, emit most of the particulate matter in urban areas. Other noticeable sources of particles include agricultural burning practices (e.g. burning of sugar cane prior to harvesting) and emissions from domestic solid fuel heaters and woodstoves

Particulate air pollution can cause a wide range of damage to surfaces and materials. Merely by requiring more frequent cleaning, particulates can accelerate deterioration. If the particle is corrosive or has other pollutants, for example sulphur dioxide, attached to it then it may also react with or corrode the surface or material.

Under normal conditions a human respiratory tract in good health is able to deal with inhaled particles without undue stress or long-term effects. In sensitive individuals, or when high levels of particles are present, particulate matter may contribute to increased rates of respiratory illnesses and symptoms.

Air Quality Data

Newspapers in your nearest capital city may provide daily air quality data. Daily records may also be viewed at the websites provided below:

Queensland
http://www.epa.qld.gov.au/projects/air/

New South Wales
http://www.environment.nsw.gov.au/aqms/aqitable.htm

Victoria
www.epa.vic.gov.au/**Air**

South Australia
http://www.epa.sa.gov.au/airindex_sum.html

Tasmania
http://www.environment.tas.gov.au/anw_aq_map_current_air_quality_data.html

Western Australia
http://www.dec.wa.gov.au/pollution-prevention/air-quality/air-quality-data.html

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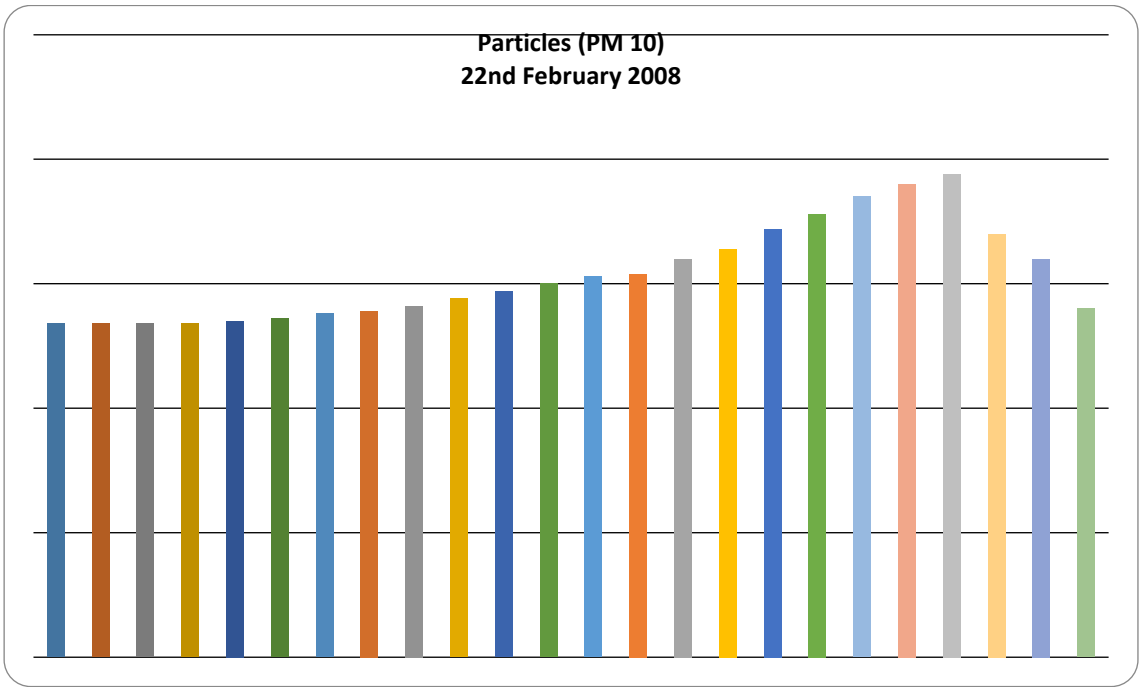
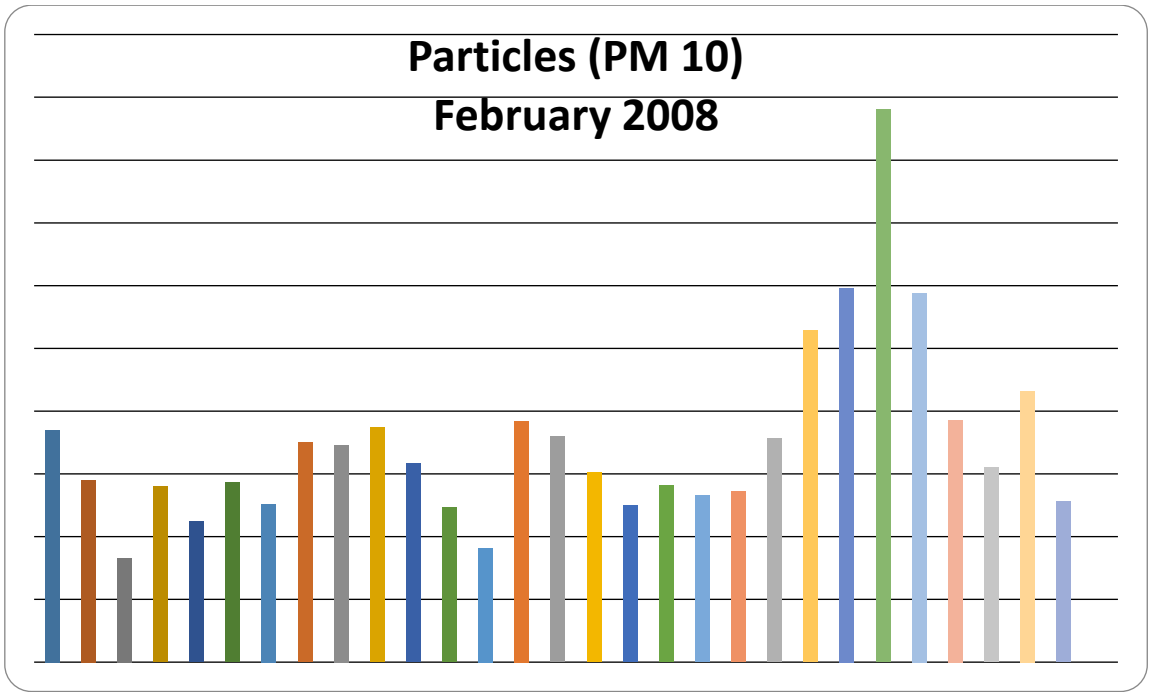
Graphing

It is suggested that the pathfinder create:

- a graph of particles (PM10) over a single day
- a graph of particles (PM10) over a month.

Example graphs are provided below.





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REQUIREMENT 8. List ten ways in which you might actively work to improve the environment in which you live. Put four of these into practice.

1. The four "R's"
    a. Reduce – decrease the amount of rubbish (e.g. less packaging).
    b. Reuse – think of other uses for your rubbish (e.g. containers and bags)
    c. Recycle – recycle as much of your rubbish as possible (e.g. glass & plastic).
    d. Refuse – put all other rubbish into bins for safe disposal.
2. Plant native trees and shrubs in your back yard.
3. Participate in a community tree planting day.
4. Construction of a bird bath for small birds in your back yard.
5. Stop rubbish from entering waterways by keeping gutters and footpaths free of rubbish and lawn clippings.
6. Participate in clean up Australia Day or a similar project.
7. Pick up litter along river banks, beaches and forest national parks.
8. Learn to identify the common noxious weeds in your area and remove them when you see them.
9. Reduce the amount of chemicals used around the house.
10. Allow native animals to know when domestic pets are close by either restricting their movement (especially at night time) or placing bells around their necks.
11. Leave some leaf litter around the base of trees for frogs, lizards and insects.
12. Get involved in community tree plantings.
13. Know the contact details of your local wildlife recovery centre and let them know when you see injured native animals.

REQUIREMENT 9. Find a Spirit of Prophecy quotation and a Bible text pertinent to ecology and be able to explain their relevance and application to our day.

"During the sojourn in the wilderness the Israelites were almost continually in the open air, where impurities would have a less harmful effect than upon the dwellers in close houses.

But the strictest regard to cleanliness was required both within and without their tents. No refuse was allowed to remain within or about the encampment. The Lord said: 'The Lord they God walketh in the midst of thy camp, to deliver thee, and to give up thine enemies before thee; therefore shall thy camp be hold'. Deuteronomy 23:14". *Ministry of Healing, page 279*

Use this text (as well as any others you may find) to be a springboard for discussion.

Samples questions for pathfinders:

- What do you think is meant by an "unclean encampment"?
- What type of rubbish do you think the Israelites would have generated?
- What impact would this rubbish have to the ecosystem?
- How can we relate this passage to our pathfinder campsites?