Teachers' Notes

The Gravity Discovery Centre (GDC) at Gingin, situated in pristine bushland, provides students with unique opportunities to visit and study within one of the world's top 10 biodiversity 'hot spots' (http://www.biodiversityhotspots.org).

The activities in this package are divided into Pre-visit School Based Activities, On Site Activities to be carried out while at the Gravity Discovery Centre, and Post-visit follow up activities to be done on return to school.

The reasons for the particular richness of biodiversity that exists in the area are explored in early activities (Pre-visit activity 1 and Pre-visit activity 2). In addition a background lesson on "Understanding Biodiversity" (Pre-visit activity 3) is provided which may be carried out in preparation for a visit to the Centre.

A range of activities exploring species biodiversity, genetic biodiversity and ecosystem biodiversity is provided, which are designed to be carried out on site.

A word of warning! Students should be made aware of the dangers associated with collecting and examining invertebrates. Besides "redbacks", a number of other animals that may be harmful are likely to be present in the bush. Students are advised not to venture too far from the designated tracks and to take the usual precautions when walking in the bush.

On return to school, suggested follow up activities are provided to assist students gain an improved understanding of the issues surrounding Biodiversity.

The tasks address outcomes at levels 3-6 in both the Life and Living and the Investigating Scientifically sub-strands. Some activities include cross-curricular links and connections to other science sub-strands. An indication of the levels covered in each activity has been provided in the accompanying teacher's notes.

SUGGESTED PREVISIT ACTIVITIES

Pre-visit Activity 1 – From Pangea to the Present and into the Future

Outcomes

This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify a process of change to show that groups of living things may have changed over time: *Life and Living: Level 4*
- explain interactions between living things and the external environment that change over time: *Life and Living: Level 5*
- use concepts to explain how continuity and change occur from generation to generation: *Life and Living: Level 6*

Cross curricular and science sub-strand links

- Earth and Beyond: Level 4 – Students understand processes that can help explain and predict interactions and changes in physical systems and environments.
- Society and Environment – Natural and Social Systems – Students understand that systems provide order to the dynamic natural and social relationships occurring in the world.

Prior learning

Students may be familiar with the concepts of plate tectonics and Continental shift. The process whereby mountains are formed as a result of movement of the plates should also be familiar to them. As an introduction or reminder of these concepts, students might like the work through the exercises at http://www.volcanoworld.org/vwdocs/vwlessons/lessons/Pangea/Pangea1.html.

Background Information

The rich biodiversity that exists in the south west of Western Australia can be better explained as a direct consequence of the movements of land-masses that have occurred over millions of years. Pre-visit Activity 2 offers a comprehensive background to these geological phenomena and it is recommended that teachers read this even if their students do not carry out the activity. This activity offers much of the same content as Pre-visit Activity 2 but in a simpler format. It has been adapted form the information available at
http://www.volcanoworld.org/vwdocs/vwlessons/lessons/Pangea/Pangea1.html.
Teachers may wish to review this site.

Process

This activity is comprised of two sections. The first involves students participating in a "hands-on" activity to increase their awareness of the movement of tectonic plates over millions of years, the resulting changes in climate and habitats, and the consequent adaptations of life-forms. The answers to the questions on the students' worksheet can be found at http://www.volcanoworld.org/vwdocs/vwlessons/lessons/Pangea/Pangea1.html. Teachers may either supply students with this website or allow them to conduct their own research to discover the answers to the questions posed. It is suggested that some class discussion is used to consolidate the ideas presented in Part 1 before Part 2 is commenced. Questions that could be raised include:

- What changes do you think would have occurred to the environments of various landmasses as their position on the globe changed?
- What changes do you think would have occurred to the types of plants and animals found in these areas?
- What changes do you think might have occurred in Australia?

Part 2 of the Activity provides a further extension and application of the concepts students have been using in part 1.

Pre-visit Activity 2 – Continental Drift, Climate and Ecosystems

Outcomes

This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify a process of change to show that groups of living things may have changed over time: *Life and Living: Level 4*
- explain interactions between living things and the external environment over time: *Life and Living: Level 5*

- use concepts to concepts to explain how continuity and change occur from generation to generation: *Life and Living: Level 6*

Cross curricular and science sub-strand links

- Earth and Beyond: Level 4 – Students understand processes that can help explain and predict interactions and changes in physical systems and environments.
- Society and Environment – Natural and Social Systems – Students understand that systems provide order to the dynamic natural and social relationships occurring in the world.
- English – Reading – Students read a variety of texts with purpose, understanding and critical awareness.

Prior learning

Students need to be familiar with scientific language including some geological and biological terms. Some understanding of biological classifications and geological phenomena such as plate tectonics would also be helpful.

Background Information

This activity is similar in content to the previous Pre-visit Activity 1 but is likely to be better suited to students working at a higher level. It is a self-contained activity with all the information required by the students being provided in the reading.

Process

Students read the article then extract the relevant information to construct a timeline from 420 million year ago to the present day. Students can work individually or in small groups with each member collecting data for different times. They need to include information regarding continental movement, climate and ecosystem changes. The connection between these events needs to be stressed and may be reinforced in a class discussion following the activity.

Pre-visit Activity 3 – Understanding Biodiversity

Outcomes

This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe patterns of similarities and differences within and between groups of familiar living things: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify a process of change to show that groups of living things may have changed over time: *Life and Living: Level 4*
- explain interactions between living things and the external environment that change over time: *Life and Living: Level 5*

Cross curricular and science sub-strand links

Investigating Scientifically: Conducting: Level 3 – Students record data in simple tables, diagrams or observations.

Prior learning
Some understanding of what constitutes a species would be helpful for this activity however this is covered at the beginning of the lesson.

Background Information
The purpose of this activity is to familiarise students with the concept that biodiversity encompasses species diversity, genetic diversity and ecosystem diversity.

Process
The lesson should begin with a class discussion of the students' understanding of what makes a species. The agreed definition is then recorded on the students' worksheet. The remaining questions in the *Exploring Species Diversity* section can be completed individually or in pairs. The following sections, *Exploring Genetic Diversity* and *Exploring Ecosystem Diversity* should be carried out in groups of 4 students.

ON SITE ACTIVITIES

On Site Activity 1 – Measuring Invertebrate Diversity
Outcomes
This activity allows the student to potentially:
- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe patterns of similarities and differences within and between groups of familiar living things: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- describe different roles of living things in the environment *Life and Living Level 4*
- group animals according to several physical features *Life and Living Level 4*
- explain how particular adaptations enable an organism to survive. *Life and Living Level 5*
- give examples of relationships between organisms in the environment *Life and Living Level 5*
- use simple keys to determine relationships between animals, such as insects. *Life and Living Level 5*
- collect information concerning specific features of animals, such as insects, and use classification keys to place them into groups. *Life and Living Level 6.*

Cross curricular and science sub-strand links
- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner and record data in simple tables, diagrams or observations.
- Investigating Scientifically: Processing Data: Level 3 – Students display numerical data as tables or bar graphs and identify patterns in data and summarise data.
- Mathematics: Measurement – Students use direct and indirect measurement and estimation skills to describe, compare, evaluate and construct.
- Mathematics: Chance and Data – Students use their knowledge of chance and data handling processes in dealing with data and with situations in which uncertainty is involved.

Prior learning
Some awareness of graphing techniques, in particular the use of bar graphs is needed.

Background Information
This activity does not require students to be familiar with the biological classification of the specimens they collect. They merely need to be able to broadly identify them into groups such as worms, flies, beetles etc.

Process
Students should be warned about the danger of collecting spiders, bees or wasps. Where possible they should avoid touching the specimens they collect with their bare hands.
Following this activity, the insects collected can be used in On Site Activity 2.

On Site Activity 2 – Classifying Insects
Outcomes
This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe patterns of similarities and differences within and between groups of familiar living things: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- describe different roles of living things in the environment *Life and Living Level 4*
- group animals according to several physical features *Life and Living Level 4*
- explain how particular adaptations enable an organism to survive. *Life and Living Level 5*
- give examples of relationships between organisms in the environment *Life and Living Level 5*
- use simple keys to determine relationships between animals, such as insects. *Life and Living Level 5*
- collect information concerning specific features of animals, such as insects, and use classification keys to place them into groups. *Life and Living Level 6.*

Cross curricular and science sub-strand links

- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner and record data in simple tables, diagrams or observations.
- Investigating Scientifically: Evaluating: Level 3 – Students identify difficulties experiences in doing the investigation.

Prior learning
Students may benefit from an understanding of biological classification, in particular the Order of a species as this activity guides students in identifying the Order of the insects they have collected. Previous use of a dichotomous key may be helpful but not essential.

Background Information
This activity makes use of a dichotomous key available at http://www.ex.ac.uk/bugclub/bugid.html to identify insects by Order. As the source of the site is European there may be instances where students are unable to identify a specimen they have collected. This potential difficulty is acknowledged by asking students to explain why they may experience problems in identification.

Process
Students can use the insect specimens they have collected during On Site Activity 1, *Measuring Invertebrate Diversity*, or On Site Activity 3, *Comparing Populations in Different Ecosystems.* Reminding students of the features characteristic of insects will assist them in sorting their

specimens. Students can work individually or in pairs and can carry out this activity on site or, alternatively, on return to school.

Assessment

On Site Activity3 – Comparing Populations in Different Ecosystems

Outcomes

This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- use concepts and models to explain the interaction between systems and the xternal environment: *Life and Living: Level 5*

Cross curricular and science sub-strand links

- Investigating Scientifically: Planning: Level 3 – Students show some awareness of the need for fair testing.
- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner, record data in simple tables, diagrams or observations.
- Investigating Scientifically: Processing Data: Level 3 – Students display data as tables or bar graphs and identify patterns in data and summarises data.
- Mathematics: Measurement – Students use direct and indirect measurement and estimation skills to describe, compare, evaluate and construct.

Prior learning

No specific requirements

Background Information

This activity draws students' attention to diversity of ecosystems and the connection between them and the species diversity found there.

Process

Students should work in pairs or small groups. As with other activities involving the collection of invertebrates, care should be taken to avoid touching specimens with bare hands. In particular, spiders, bees and wasps should be avoided.

Following the activity a class discussion may help consolidate the understanding that species diversity can be associated to ecosystem diversity and that both these form aspects of biodiversity generally.

On Site Activity 4 – Plant Diversity

Outcomes

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*

Cross curricular and science sub-strand links

- Investigating Scientifically: Planning: Level 3 – Students show some awareness of the need for fair testing.
- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner, record data in simple tables, diagrams or observations.

Prior learning
Students need not be able to specifically identify the different plants in their survey merely to give them some identifying label such as grass 1, grass 2, native plant, weed, leaf 1 etc.

Background Information
No specific requirements

Process
Students should carry out this activity in pairs or small groups. While one student throws the tennis ball the other can observe where it lands. Students should be encouraged to throw the tennis ball high into the air, over their shoulder (to optimise the random selection of the survey sites and to avoid throwing it too deeply into the bush)

On Site Activity 5 – Calculating Species Diversity
Outcomes
This activity allows the student to potentially:
- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*

Cross curricular and science sub-strand links
- Investigating Scientifically: Processing Data: Level 3 – Students display numerical data at tables and identify patterns in data and summarise data.
- Investigating Scientifically: Conducting: Level 3 – Students show some awareness for the need of fair testing.
- Investigating Scientifically: Conducting: Level 4 – Students take care with data collection so that data are accurate, use repeated trials.
- Mathematics: Working Mathematically – Students use mathematical thinking processes and skills in interpreting and dealing with mathematical and non-mathematical situations.
- Mathematics: Number – Students use numbers and operations and the relationships between them efficiently and flexibly.

Prior learning
No specific requirements. A familiarity with mathematical formulae would be helpful

Background Information

Process
This activity can be carried out, using the specimens collected and recorded in either On Site Activity 1 or On Site Activity 3. It is suggested that students be allowed to practice the calculation using hypothetical numbers supplied by the teacher.

On Site Activity 6 – Oo – Poo! Alternative ways of monitoring the presence of species
Outcomes
This activity allows the student to potentially:
- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*

Cross curricular and science sub-strand links

- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner and records data in a simple tables, diagrams or observations

Prior learning

No specific requirements

Background Information

More information can be found in Barbara Triggs book "Tracks, Scats and Other Traces: A Field Guide to Australian Mammals"

Process

Students look for and photograph evidence of the presence of different animals in the area including scats, tracks, hair, and feathers. The photographic evidence is pooled and identification is carried out by the group as a whole.

On Site Activity 7 – Genetic Diversity

Outcomes

This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe patterns of similarities and differences within and between groups of familiar living things: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify processes of reproduction, growth and change and compare how different groups of living things may have changed over time *Life and Living Level 4*
- use cellular concepts to explain processes in reproduction that can lead to change. *Life and Living Level 5*
- use concepts such as inheritance and genetic variation to explain how features are passed on. *Life and Living Level 6*
- explain how variety in genetic characteristics results in diversity within living things. *Life and Living Level 6*

Cross curricular and science sub-strand links

- Investigating Scientifically: Planning: Level 3 – Students plan for investigations, showing some awareness of the need for fair testing and make simple predictions based on personal experience.
- Investigating Scientifically: Conducting: Level 3 – Students use simple equipment in a consistent manner and records data in simple tables, diagrams or observations.
- Mathematics: Working Mathematically – Students use mathematical thinking processes and skills in interpreting and dealing with mathematical and non-mathematical situations.
- Mathematics: Measurement – Students use direct and indirect measurement and estimation skills to describe, compare, evaluate, plan and construct.
- Mathematics: Number – Students use numbers and operations and the relationships between them efficiently and flexibly.

Prior learning

No specific requirements

Background Information
This activity is designed to increase students' awareness of genetic diversity. Students should question the validity of measuring either height or circumference alone as an indicator of genetic variation. Students will design a method of estimating the diameter of the tree's canopy and determine the height:diameter ratio as an indicator of genetic diversity.

Post activity discussion should include questions related to the reliability and validity of the measurements taken. How reliable are the results obtained? How could they be improved? If the height and spread of a tree are determined by genetics, why is it not sufficient to merely measure the height or the spread of the tree to determine genetic variability? How can the results be explained in terms of the genetic variation?

Process
Students should work in pairs or small groups to complete this activity.

SUGGESTED POST-VISIT ACTIVITIES

Post-visit Activity 1 – Threats to Biodiversity

Outcomes
This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify a process of change to show that groups of living things may have changed over time: *Life and Living: Level 4*
- explain interactions between living things and the external environment that change over time: *Life and Living: Level 5*
- use concepts to explain how continuity and change occur from generation to generation: *Life and Living: Level 6*

Prior learning
An appreciation of biodiversity, such as may have been gained through the On Site activities, is necessary.

Background Information
Threats to biodiversity come in many forms. Besides species extinction, which many scientists reckon is at its highest rate since the period of the dinosaur, many species have lost significant genetic diversity, often due to habitat destruction. Australia has a particularly bad record when it comes to biodiversity destruction. The main threats to biodiversity are:

- Habitat loss – The destruction of forests worldwide have gained much attention as a cause of biodiversity degradation. However, many other ecosystems are also suffering losses. Natural grasslands, which have been destroyed through farming practices including clearing, ploughing, fertilising and grazing cannot be restored to their original biodiversity. In Australia the largest number of endangered and extinct mammals are from grassland s and woodlands.
- Habitat fragmentation – In many cases ecosystems have been either fragmented or reduced in size resulting in a species becoming isolated from the large gene pool. When a disaster occurs (such as fire or flood) the species may be wiped out and others of the species can not migrate back to the isolated ecosystem leaving small populations of at risk animals living in fragmented locations.

- Weeds – are unwanted plants living in places where they do not naturally occur. Some are introduced deliberately, others by mistake, but they have the effect of taking the place of indigenous species. They cannot be eaten by indigenous animals and often make poor homes for them.
- Feral animals – In Australia there are many examples of feral animals destroying biodiversity. Like the weeds, they were often intentionally introduced, to perform some function. These include rabbits and foxes, whose presence in the southern parts of Australia have changed many ecosystems and cane toads, whose poison glands kill any animal that tries to eat it. It in turn eats smaller animals. There has been much debate about the potential problems that can be caused by domestic cats being allowed to become feral.
- Over exploitation – modern fishing and forestry techniques mean that natural resources can be used faster than they can be replaced. The over exploitation of whales is an example of this, which has only recently been curtailed by protecting them. The increasing demand for timber has put pressure on the remaining old growth forests in Australia.
- Changed fire regimes – The arrival of Europeans in Australia has meant a change in the natural occurrence of fires in forests, woodlands and grasslands. This can have a dramatic impact on many ecosystems. While control burns are often necessary, scientists believe that much more research is required to better understand how to mange fire in forests, woodlands and grasslands.
- Pollution – Air, soil and water pollution due to human activity has affected many ecosystems worldwide. Examples include the destruction of the Black Forest in Germany from acid rain. Many waterways have suffered from solid litter, fertiliser, chemicals and nutrient run-off.
- Climate change – The effect of global warming brought about by additional release of carbon dioxide into the atmosphere is expected to impact many ecosystems. Scientists believe that Australia’s alpine ecosystem might disappear and some corals that form the Great Barrier Reef may die as the temperature of the ocean increases.
- Disease -

Process
Students begin the activity with a class brainstorm to determine the nine major threats to the biodiversity of a region. They then break into groups of 3 and for each threat, list how it can affect biodiversity and if possible an actual example. The results of each group’s discussion are the shared with the class. The final stage of the activity is for each group to produce either a poster or Powerpoint presentation entitled *“Threats to Biodiversity*”.

Post-visit Activity 2 – Why is Biodiversity Important?

Outcomes
This activity allows the student to potentially:

- make connections among living things and/or the environment: *Life and Living: Level 3*
- describe processes that connect living things in an ecosystem: *Life and Living: Level 4*
- identify a process of change to show that groups of living things may have changed over time: *Life and Living: Level 4*
- explain interactions between living things and the external environment that change over time: *Life and Living: Level 5*
- use concepts to explain how continuity and change occur from generation to generation: *Life and Living: Level 6*

Cross curricular and science sub-strand links

- English: Speaking and Listening – Students speak and listen with purpose, understanding and critical awareness in a wide range of contexts.
- English: Writing – Students write for a range of purposes and in a range of forms using conventions appropriate to audience, purpose and context.

Prior learning

While this activity is best carried out at the end of a group of lessons on biodiversity when students have a body of knowledge to bring to the debate, it can be used as a means of exploring the topic.

Background Information

Process

Students participate in a *fish bowl* debate on the importance of biodiversity. The process should provide students with a cross section of opinions and require them to examine and discuss them. Once the debate has been exhausted the students are required to take a personal position on the relative importance biodiversity, and write a short essay outlining their position, presenting examples to support their argument, list contrary views and argue against them and conclude with a final statement, summarising their argument.

ACKNOWLEDGMENTS

Many of the activities in this package have been adapted from ideas presented in the resource book published by ASTA for National Science Week, 2001.

REFERENCES

Bob Winters, (2001), Exploring Biodiversity, Australian Science Teachers Association, Deakin West, ACT.

Barbara Triggs, (1984), Mammal Tracks and Signs, Oxford University Press.

Barbara Triggs, (1996), Tracks, Scats and Other Traces: A Field Guide to Australian Mammals, Oxford University Press.

Mary E. White, (1990), The Nature of Hidden Worlds, Reed, Frenchs Forest, N.S.W.

S.D. Hopper et al.,(1996), Gondwanan heritage : past, present and future of the Western Australian biota, Surrey Beatty & Sons, Chipping Norton, N.S.W.

Nigel Stork, (1999), "Estimating the Number of Species on Earth" in The Other 99%: The Consevation and Biodiversity of Invertebrates, transactions of the Royal Zoological Society of New South Wales, p 1-7.

Student Worksheets

LIFE AND LIVING

Biodiversity

Secondary Module

Years 8-10

PRE VISIT ACTIVITY 1

From Pangea to the Present and into the Future

Part 1:

1. Cut out one of the "World Cut Up" maps separating the landmasses along the lines shown.

2. Using the map of Pangea as a guide arrange, the landmasses in the positions they were in 250 million years ago and paste them into position on a sheet of paper. Label the landmasses and the ocean surrounding it.

3. Study the map of Pangea and "The World Today", comparing the positions of the various continents and landmasses. Describe where each land mass is compared to 250 million years ago:

Asia/Europe:____

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North America: ____

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South America: ____

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Africa and Arabia: ____

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India: ____

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Antarctica: ____

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Australia: ____

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4. Explain what has caused this rearrangement of land over time? ______________________

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5. How do scientists know that the landmasses were in different positions 250 million years ago? ____

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6. The arrows on "The World Today" map indicate the movement of land that is currently occurring. Using this information try to predict what the world map would look like in 100 million years. Cut out the second "World Cut Up" map and paste the landmasses into the positions you think they might occupy.

7. How do you think this movement will affect the climate, flora and fauna of Australia? Explain your reasons for the answers you give'

- The climate: ____
____
____
____
- The flora: ____
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____
- The fauna: ____
____
____

Something extra to think about!

8. How were the Himalayan Mountains formed? ______________________________
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A Challenge!

9. The Indian subcontinent appears to have moved farther and faster than any other land mass. Find out what speed it has been moving at. List the source of the information you find. *(Make sure you correctly cite where you found your answer. If you are unsure how to do this ask your teacher or school librarian).*

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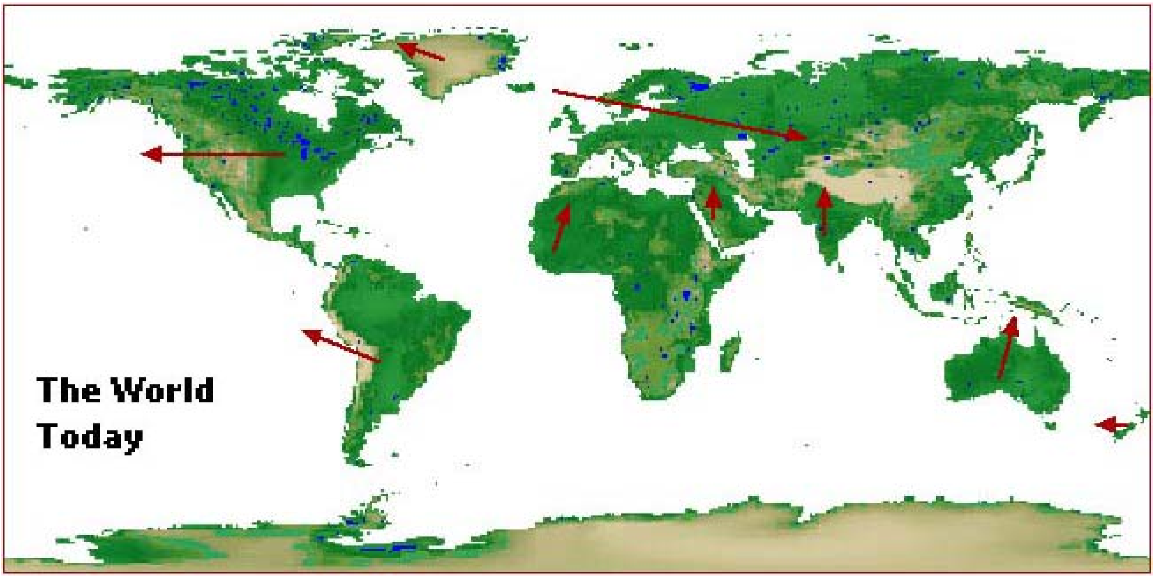
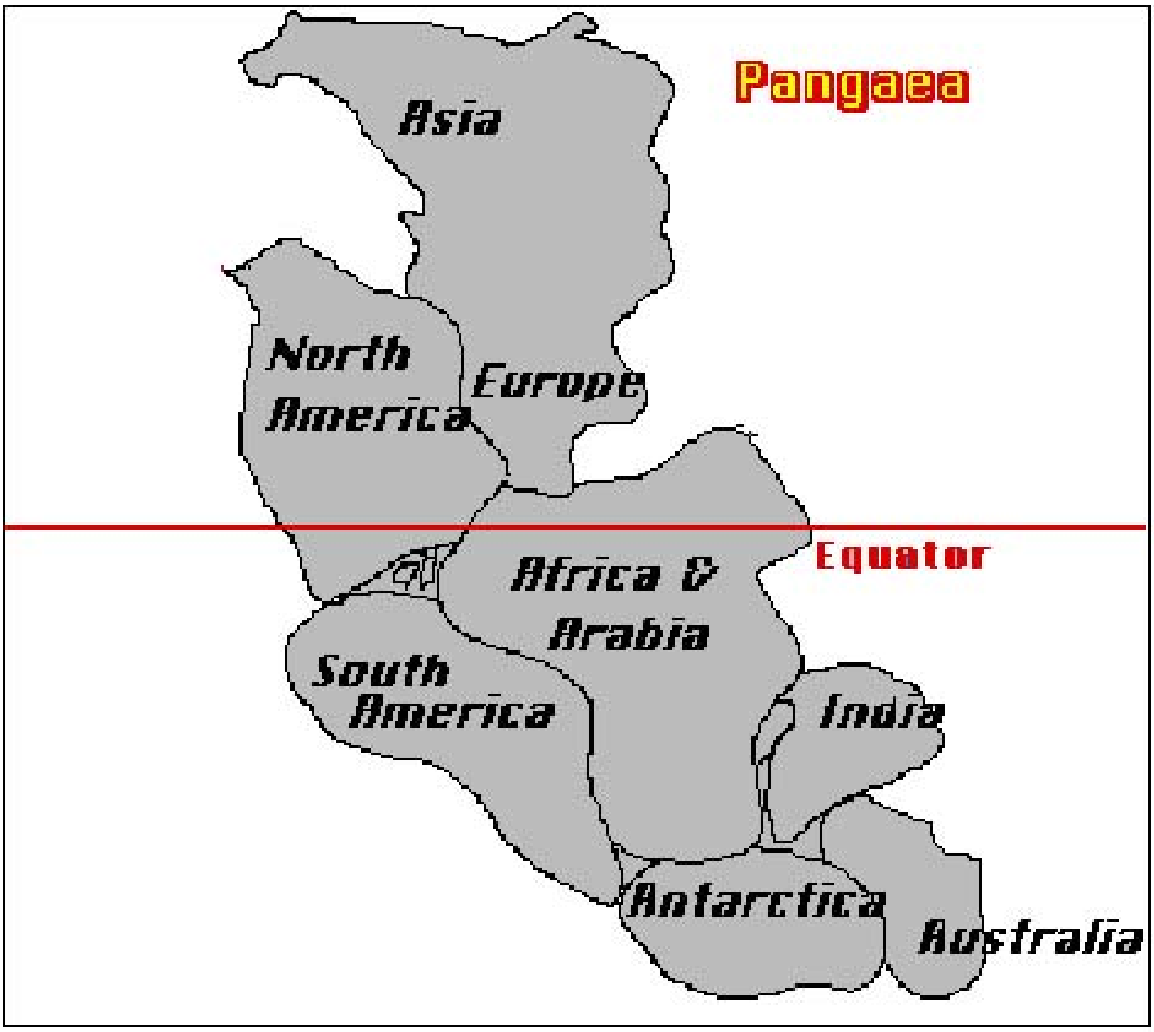
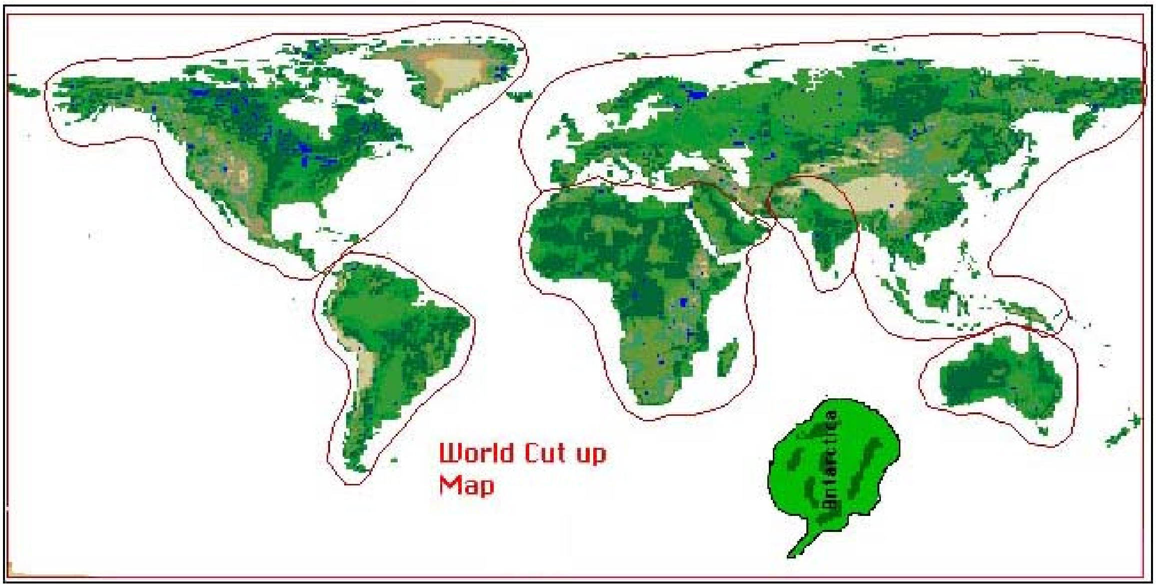
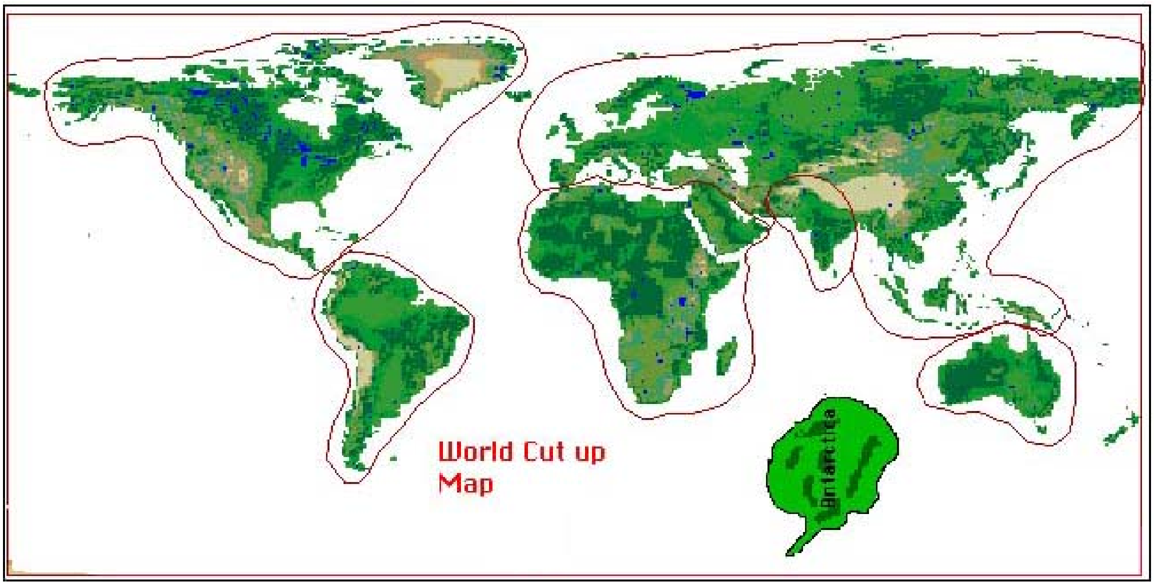




source: http://volcano.und.nodak.edu/vwdocs/vwlessons.lessons/Pangea.html.


World Cut up
Map
Antarctica


World Cut up
Map
Antarctica

Part 2: Construct a Timeline

10. Draw a timeline similar but larger than the one below. Make sure it is to scale:

11. Cut out the statements on the "When and Where?" sheet and paste them in the correct position on the time line.

12. * Note that the statements about what the world will be like in 50 million years from now are predictions being made by scientists. What assumptions must scientists make to be able to predict what might happen?

13. Compare the scientists predictions for 50 million years from now with your predictions for 100 million years from now (Part 1).

When and Where?

Earth's continents are all connected into one huge landmass called ***Pangea***

A huge super continent is surrounded by one gigantic ocean called ***Panthalassa***

Pangea breaks into two new continents Laurasia and Gondwanaland

Laurasia is made of the present day continents of North America (Greenland), Europe, and Asia

India is not connected to Asia and is hundreds of miles away

Australia is flipped sideways and far west of its current position

Gondwanaland is made of the present day continents of Antarctica, Australia and South America

The subcontinent of India is also part of *Gondwanaland*

The North American continent is located much farther south and east of its position today

Laurasia is still moving, and as it moved it broke up into the continents of North America, Europe and Asia

The huge ocean of *Panthalassa* remains but the Atlantic Ocean is going to be born soon with the splitting of North America from the Europe-Asia landmass

Much of North America is in or near the tropics

Before the days of the dinosaurs

Arabia starts to separate from Africa as the Red Sea opens up.

The Atlantic, Indian, Arctic, and Pacific Oceans all begin to take shape

Gondwanaland continues to spread apart and it broke up into the continents of Africa, Antarctica, Australia, South America, and the subcontinent of India.

The Atlantic Ocean is much larger than it is today

The Pacific Ocean is much smaller than it is today

The western part of Africa has rotated clockwise and crashed into Europe causing great mountain building

North and South America have moved farther west

Greenland is located farther west but also farther north.

The far eastern region of Africa has rotated eastward toward the Arabian Peninsula

Australia has moved farther north into the tropics

New Zealand has moved to the south of Australia.

Antarctica is far north of its current position

PRE VISIT ACTIVITY 2

Continental drift, climate and ecosystems

Read the following article and then construct a timeline ranging from 420 million years ago to the present. Incorporate information about continental movement, climate change and the consequent effect on ecosystems, including the flora and fauna present.

Gondwanan Invertebrates of the South-West

by

Paul Van Heurck, Conservation and Land Management, W.A.

The south-west of Australia is one of the 25 most biodiverse "hot-spots" in the world. About 8,000 known plant species grow in the south-west and three-quarters of these grow nowhere else in the world. The animals of the south-west are even more diverse than the plants, especially the land dwelling arthropods such as spiders and insects. For every plant species in the south-west it is estimated that there are 10 arthropod species living on or around it. That's around 80,000 arthropod species. Very little is known about the majority of these arthropod species, as only about 10% have been collected or given scientific names, let alone studied. There is a whole mysterious microcosm right under our feet.

Where did all these arthropod species come from? Well to find that out you have to go back a long long way in time. Back 420 million years ago to the Silurian period when life first colonized the land. The climate of the south-west was much hotter and humid than today as the Australian continent was positioned much further north, above the equator. Also the sea level was much higher causing many shallow coastal estuaries and swamps. At this time, only the wet fringes of these coastal and inland water bodies had been colonized by small plants, ancestors of the club mosses and horsetails ferns. No life had colonized dry land, which remained eroded and barren. In contrast the water was full of bizarre life such as huge ancestors of worms, snails, millipedes and crabs. One of the earliest signs of animal life on land are the tracks of a large arthropod on a fossilized beach near Kalbarri. These 15 cm wide "tram-line" like tracks that criss-cross the rippled fossilized sands of this ancient beach are thought to be left by a group of two-foot long "scorpion-like" arthropods, the Eurypterids, which were closely related to the horseshoe crabs of today. The arthropod colonization of southwest Australia had begun!

By 360 million years ago, in the Early Carboniferous, the arthropods were highly evolved. In Australia arthropod life was abundant around the hot tropical swamps vegetated with giant club mosses and horsetails. And many arthropods were giants; even the silverfish grew 6 cm long. Giant arthropod species, the ancestors to most of our modern groups had already evolved sophisticated biological hardware and software. It could even be argued that arthropod aeronautical technology at that time was far more advanced than modern man's today. Fossils of huge dragonflies with 70cm wingspans have been found. Imagine the nervous system or biological "computer-brain" required to control the pitch and yaw of four rapidly and independently beating huge wings made of strong transparent "Mylar" like exoskeleton. Imagine the processing of all the incoming nervous signals from the many "motion detector" sensory hairs covering the dragonfly's body. Imagine the memory required to digitize the thousands of visual signals from the multiple facets of the huge compound eyes. All this biological technology had evolved 360 million years ago and from the most basic biodegradable chemical compounds such as carbon, nitrogen and phosphorous.

By 280 million years ago, in the Late Carboniferous, the great Panagean landmass, made up of all the earth's continents, had split and the super-continent Gondwana containing Australia, India, Antarctica, South America and Africa had drifted south across the south pole. Half of Gondwana was covered with a permanent ice sheet causing the tropical vegetation in Australia to be replaced with tundra composed of cold adapted seed-ferns, peat mosses, and herbaceous horsetails. The diversity of arthropods had also greatly declined and few fossils have been found from Australia for this time.

By about 250 million years ago, in the Late Permian, the climate of Australia had warmed to cool temperate. Arthropods became abundant, but smaller and more modern species such as cockroaches, earwigs, dragonflies, and ancestral beetles had evolved. The ancestral beetles had not only evolved wings but they had evolved one of the most important technological advances in the history of life, hard waterproof sclerotised fore-wing covers and this technology has made them the most successful living group today. One in every five species on earth today is a beetle. One third of all animal species are beetles and there are 6 times more beetle species than animals with back-bones. In Australia it is estimated there are over 30,000 beetle species. The evolution of this incredible technological advance, the waterproof wing covers, not only allowed beetles to disperse widely by flight, but also protected their complex folding hind-wings, allowing them to colonized every habitat from burrows through solid wood and soil to arid deserts and also the bottom of freshwater lakes. In the south west, at this time, vast vegetated swamps were present due to the cool moist temperate climate and these Permian swamps have formed the coal fields of the Collie area present today. Since the Late Permian, south-west Australia has remained free of glaciers and this is one of the main reasons why our ecosystems are so diverse. Our south-west ecosystems are very "old" compared to the northern hemisphere, which had its last ice age only about 10,000 years ago.

In the last 70 million years, Australia has slowly separated from Antarctica, the last of the "Gondwanan" continents, and drifted gradually northward until colliding with the Asian continent. In the first 30 million years of this period, Australia's climate was warm and wet and was mostly covered with Broad-leafed Rainforest dominated by the recently evolved flowering plants. A number of relict arthropods from this Gondwana time now only occur in the south-west. These relict arthropods include species of earthworms, snails (*Bothriembryon spp*), velvet worms (Onychophorans), millipedes, slaters, freshwater crayfish and trapdoor spiders to name a few and are mostly restricted to cool moist habitats in the southern forests and Stirling and Porongorup Ranges near the southern coast.

In the second 30 million years, Australia completely separated from Antarctica, allowing a circum-polar ocean current to develop which isolated Antarctica and caused the onset of a series of world ice ages that have continued up to the present day. As the climate cooled, southern Australia was dominated by cool temperate forests of Southern Beech (*Nothofagus*) like those which grow in southern Victoria and Tasmania today. This Southern Beech forest also contained the early ancestors of eucalypts and banksias. Many of the "Gondwanan" relict arthropods from this time live in the south-west today and have related species living in the South Beech forests of eastern Australia. These include many Gondwanan bugs and flies, carnivorous Rhytidid snails, tiny Orslobid spiders and also many localized species of velvet worms (Onychophora) the ancient link between worms and the legged arthropods. Velvet worms look like a soft-bodied worm but have many pairs of legs like a millipede. They live mostly in rotten logs in permanently moist habitats and feed by turning their mouths inside-out.

After Australia colliding with the Asian Plate, the climate of southern Australia gradually became more seasonal and arid. The southern climate became so seasonal in the last 40,000 years, about the time aborigines came to Australia, that fires have become much more common in the summer dry season. By this time the cool temperate Southern Beech forests had almost disappeared and were replaced by fire adapted plants such as eucalypts, wattles and banksias present today. However, many Gondwanan relict arthropods still survive in our south-west ecosystems. Some species adapted to aridity and forest fires by "hibernating" in summer deep in the litter, or in cracks in rocks and rotten logs such as the tiny orange Micropholcommatid spiders and the large conical shelled *Bothriembryon* snails. While other species lived in permanently moist and shaded microhabitats such as rotten logs, moss swards, creek banks, and mossy tree trunks that did not burnt very often. These species include the shiny brown marble-sized Roly-Poly millipede (*Cynotelopus notabilis*) found near Walpole and trapdoor spiders from the genera *Moggridgea*, *Stanwellia*, *Teyl,* and *Eucrytops*. The *Moggridgea* trapdoor spider group is a relict from the mostly moist tropical Jurassic period when Australia was joined to Africa. Luckily *Moggridgea* were probably too small to make much of a meal for a dinosaur, but a few probably got stepped on and squashed! There are many species of *Moggridgea* trapdoors living in Africa today. But only about four species survived in Australia. One on Kangaroo Island off the coast of South Australia, several species in the cool moist shaded long unburnt gullies high up in the Stirling Range, one species lives in cocoon-like tubes on the bark of long unburnt Karri trees in the Porongorup Range and another the Tingle Trapdoor lives in tiny tubes on the mossy bark of long unburnt Tingle trees in only four small areas of moist forest near Walpole on the south coast.

The Gondwanan arthropod relicts of the south-west have changed relatively little over millions and millions of years, but we must be careful that humans don't cause any rapid changes to their relict habitats that they are not adapted too. Clearing of habitat and introduction of weeds and diseases like the die-back fungus are the biggest dangers.

PRE VISIT ACTIVITY 3

Understanding Biodiversity

Biodiversity, as the name implies, refers to the range (diversity) of life but it is more than just the total number of kinds of living things (species diversity), it also includes genetic diversity and ecosystem diversity

Exploring Species Diversity:

1. First of all we need to understand what a species is. After discussing it in class write down a definition of a species:

   A species is____

   ____

   ____

2. Are these living things members of the same species. Explain why.

   - Dogs and cats____________________ why?______________________________
   - Lions and tigers____________________why?______________________________
   - Snakes and bears___________________why? _____________________________
   - Spiders and beetles_________________why? ______________________________
   - People and cows ___________________ why? ______________________________
   - Bees and ants ______________________why? ______________________________
   - People and apes ____________________ why? _____________________________
   - Horses and donkeys _________________ why? _____________________________
   - Dockers fans and Eagles fans__________why? ______________________________

3. Can you think of 3 more examples of a pair of living thing that **belong** to the same species? ____

   ____

4. Can you think of 3 more examples of a pair of living thing that **do not belong** to the same species?____

   ____

Exploring Genetic diversity:

Biodiversity also refers to the diversity (differences) within a species due to genetic makeup. An example of genetic diversity is the fact that some people have blues eyes and some people have brown eyes. They all belong to the same species (human) but their genes that control their eye colour are different.

5. In groups of 4 complete the following table recording the eye colour of each member of the group.

GROUP MEMBER	EYE COLOUR

6. What other differences between people can you think of that are determined by their genes? ____
____
____

7. Choose 4 human features that are controlled by genes. Record the features of each member of your group in the table below:

Insert features here

Insert group members names here

Record individuals' features here

8. Do all the members of your group belong to the same species?

____

9. Why are they all different then?

____

Biodiversity describes not only the range of species, but also the differences (diversity) within a species which are due to genetic differences.

Exploring Ecosystem Diversity:

Biodiversity also refers to the differences between environments (including the living, *biotic*, and non-living, *abiotic*, components of the environment

10. With your group go to one area of the school eg. classroom, garden, oval, playground, and collect one of each of the types of items listed below. Mark them off the list as you find them.
Collect something that is:

☐ Rough	☐ Pointed	☐ Broken
☐ Smooth	☐ Old	☐ Shiny
☐ Curved	☐ Soft	☐ Chewed
☐ Smelly	☐ Tiny	☐ Dirty

11. Back in the classroom, join other groups that were collecting items in the same area as your group. Combine all the items you collected and sort them into *Natural Objects* and *Objects Made or Modified by Humans.*

12. Compare what was collected from your area with what was collected from other areas (ecosystems) around the school. Record the results in the table below:

AREA	What is the main use of this area?	Number of man-made objects?	Number of natural objects?	Were the natural objects mainly plants or animals?

13. Was there a variety of objects collected in each area or were they mostly of the same type? ____

____

____

14. Can you tell from the objects collected in each area what the area looks like and what it is used for? ____

____

____

These areas are all examples of different ecosystems eg. the living and non-living components of the environment which influence the activity that occurs there. In the same way different environmental ecosystems can influence and determine the life forms that exist within them.

SUMMARY

Biodiversity describes not only the differences between species but also the differences within species, due to genetic variations, and the differences between ecosystems.

So…..

15. Biodiversity describes ____________________ diversity, ___________________ diversity and ____________________________ diversity.

ON SITE ACTIVITY 1

Measuring invertebrate diversity

This activity allows you to examine and compare species diversity in different environments.

Materials needed: bug catchers, 100 petri dishes with lids, gloves, adhesive labels, graph paper.

1. Choose one area in which to collect samples of invertebrates. Use the "bug catchers" supplied and place each invertebrate caught into a separate petri dish until all the dishes are full. Use the first 100 caught.

Avoid catching bees and wasps. Use gloves and beware of spiders!
Be gentle with all organisms and try to return them to their home (habitat) when finished with them.

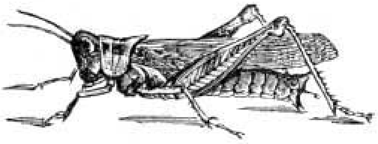
2. Examine the animals caught and attempt to sort them into different species. What features will you look for to decide if they are members of the same species?

3. Place all the petri dishes containing the same species carefully on top of one another so that you have a series of stacks of various heights. Arrange the stacks from smallest to largest. What do these stacks remind you of? ________________________________
What do they represent?____

4. Label each stack with the species contained within them eg. beetle, fly, worm etc.

5. Draw a bar graph to represent the stack of petri dishes. Remember to give your graph a title and label both axes.

6. Repeat the process above in a different place.

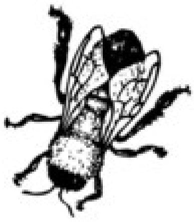


7. Compare and contrast your results in the two different environments. Can you explain any differences you might observe between the two environments?

ON SITE ACTIVITY 2
(ALTERNATIVELY THIS ACIVITY CAN BE DONE ON RETURN TO SCHOOL)

Classifying Insects

Biologists use various methods to classify living things and so identify them. One such method is a *dichotomous key*, which provides scientists with a series of questions about the specimen they are trying to identify. By working your way progressively through the questions you are usually able to identify the specimen.



If you have completed On Site Activity 1, *Measuring Invertebrate Diversity*, or On Site Activity 3, *Comparing Populations in Different Ecosystems*, separate those specimens, which are insect species. Alternatively collect a variety of insects to use in this activity.

In this activity you will attempt to identify the insects you have collected using the dichotomous key provided at the website:

http://www.ex.ac.uk/bugclub/bugid.html

*Note: this key will allow you to identify the insects to a specific Order, but not to a species level

1. Using the information on the website complete the table on the next page and identify the insects you have collected.

2. Were there any of your specimens that you were unable to identify? If there had been, why do you think this might be so?

____

____

3. The information on the website notes that the dichotomous key provided can only be used to identify adult specimens of insects. Explain why it can't be used if the insects are not fully grown.

____

____

4. Draw each insect and identify the Order it belongs to using the dichotomous key

available at http://www.ex.ac.uk/bugclub/bugid.html

Order:	Order:
Order:	Order:
Order:	Order:

Please return organisms to the environment when finished. This way we don't disturb the biodiversity around the Centre.

ON SITE ACTIVITY 3

Comparing Populations in Different Ecosystems

This activity can be used to collect specimens for On Site Activity 4, *Calculating Species Diversity*, or may be carried out as a separate activity

Materials: 1 x metre rule, 4 x wooden stakes, 5 metres rope or tape, gloves, hand held battery operated vacuum cleaner.

Avoid catching bees and wasps. Use gloves and beware of spiders!

1. Using a meter rule, measure out a 1meter x 1 meter square of bush, placing wooden stakes at each corners of the square. Tie tape or rope around the pegs to mark the edges of the square.

2. Using a hand held battery operated vacuum cleaner, vacuum the area within the square for approximately 30 seconds.

3. Why do you think it is necessary to measure the area you will vacuum? ______________

____

4. Carefully empty the contents of the vacuum cleaner into a clean white tray.

5. Record the species present in a table similar to the one below:

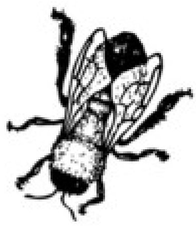
SPECIMEN TYPE	NUMBER IN SAMPLE

TOTAL SAMPLE SIZE = ______________________________

6. Record any particular features of the site such as type of soil, moisture present, plants growing, fallen logs – anything that might effect the type and number of species present.

Site	**Features**

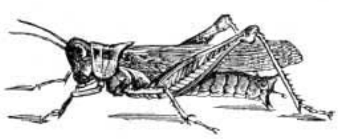
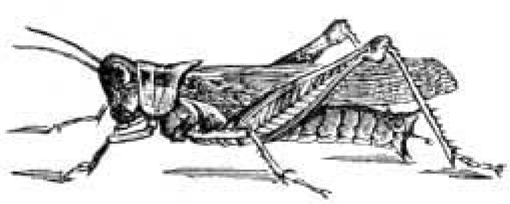
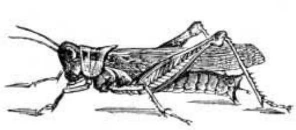
7. Repeat steps 1-4 at a different site



8. Record the results from the different sites in bar graphs.

9. Compare and contrast the results from the sites you examined. Can you explain any variations you noted.

Please return organisms to the environment when finished. This way we don't disturb the biodiversity around the Centre.

ON SITE ACTIVITY 4

Plant Diversity

Materials: Per group: 1 x tennis ball, 1 x hoop
Herbarium sheet.

1. Throw a tennis ball into the air and where it lands, place the hoop on the ground in an area of bush. Draw a circle to represent the hoop and sketch the different types of plants, leaf litter etc. within the circle.

2. Label the plants if you know their names, otherwise give them general names such as grass 1, grass 2, native plant, weed 1, leaf 1 etc.

3. Repeat steps 1 and 2 in a number of different areas and then record your findings in the chart below:

AREA	PLANTS OBSERVED

4. Did any of the areas you studied appear to have a greater diversity of plant life than any other? If so can you explain why that might be?

5. What was the purpose of throwing the tennis ball in the air at the beginning of the activity? Do you think it was necessary or could you have carried out the investigation in another way without this step?

6. What difference would it have made to your investigation if you had just chosen a spot to place the hoop instead of throwing the ball up first?

ON SITE ACTIVITY 5

Calculating Species Diversity

Species diversity can be calculated mathematically. In this activity you will use the *Simpson Index* to calculate the diversity present at a particular site.

This activity can be carried out following On Site Activity 1, *Measuring Invertebrate Diversity* or On Site Activity 3, *Comparing Populations in Different Ecosystem,* or alternatively as a separate activity.

The Simpson Index is a simple mathematical procedure that allows comparison of different samples to determine diversity of species.

1. A variety of specimens need to be collected from a site in order to conduct this activity (ideally 100 specimens, but any large sample can be used). Why do you think you need such a large number of specimens to carry out this assessment of species diversity?

____

____

____

2. According to the Simpson Index:

$$\textbf{Diversity (D)} = \textbf{N(N-1)/ Sum n(n-1)}$$

Where **N** = total number of specimens and **n** = number of specimens of each species

For example: If a sample of 100 specimens had 20 beetles, 30 ants, 40 flies and 10 worms in it, then the Diversity Index, D, would be:

$$D = 100 \times 99/(20 \times 19) + (30 \times 29) + (40 \times 39) + (10 \times 9)$$
$$= 9900/380 + 870 + 1560 + 90$$
$$= 9900/2900$$
$$= 3.414$$

The larger the Diversity Index the greater the diversity of species.

3. Record the number of each species in a table like the one below. Carry out the calculation on specimens from different areas and compare the diversity present in each environment.

Area 1		Area 2		Area 3	
Number	**Species**	**Number**	**Species**	**Number**	**Species**

Calculation

AREA 1:

Diversity Index (D) =

AREA 2:

Diversity Index (D) =

AREA 3:

Diversity Index (D) =

ALTERNATIVELY……

4. Enter the numbers of specimens and variety found at each site into an Excel spreadsheet and write the appropriate commands so that the Diversity Index will be automatically calculated for each site.

ON SITE ACTIVITY 6

Oo –poo!

Alternative ways of monitoring the presences of species

Measuring biodiversity by observing scats:

Scats are animal droppings that can be used by scientists to identify the presence of specific animals. This is made possible because of the fact the different animals have distinctively different shaped and coloured *poo*.

For example:

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/ ovoid balls
Bird	white uric acid is present in the dropping

Other clues to the presence of particular species:

A keen observer will pick up other signs that certain animals have been in the area.

For example:

- A small pile of feathers may indicate the presence of a cat since they are the only animals in Australia that pluck their prey.
- The headless body of a bird may be a sign of either a cat or a fox since both these animals have the habit of biting the head from their prey and leaving the body.

1. Using a digital camera to record the evidence take a walk through the grounds and photograph any such signs that particular animals have been present.

2. For each photograph you take, explain what you have been able to deduce about the animal that might be present.

ON SITE ACTIVITY 7

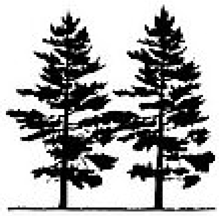
Genetic Diversity

Within a species variations in genetic material can result in differing physical characteristics such as the height or spread of trees

Materials: 5 metre tape measure, string or fine rope, protractor, 30 cm ruler

In this activity you will estimate or measure a number of physical properties of a particular tree species.

Estimating the height of a large tree



Measuring the height of a large tree is not always possible and so a means of estimation needs to be used.

1. Choose a particular type of tree that has a number of specimens present.

   This method can be used if it is a sunny day and the tree is casting a clear shadow that can be measured.

   - Measure the length of the shadow cast by the tree.
   - Place the 30 cm ruler on the ground and measure the length of the shadow it casts.
   - The height of the tree can be calculated from the formula:

$$\text{Height of tree (in metres)} = \frac{0.3 \times \text{Length of the tree's shadow (in metres)}}{\text{Length of the ruler's shadow (in metres)}}$$

	Length of tree shadow (in metres)	Length of ruler shadow (cm/100 = metres)	Height of tree (in metres)
Tree 1			
Tree 2			
Tree 3			

Estimate the diameter of the trees' canopies

2. The spread of the leaves can also vary. Estimate the diameter of the leaf spread for each tree you are examining. Explain the process you use for your estimation

___

___

___

- Record the estimated diameter of the canopy of each tree in the table below.
- Calculate the height of the tree/diameter of the canopy

	Height of tree (in metres)	Diameter of canopy (in metres)	Height of tree / Diameter of canopy
Tree 1			
Tree 2			
Tree 3			

Measure the circumference of the trees' trunks

- Measure up the trunk of the tree 1 metre from the ground.
- Wrap the fine rope around the trunk at this point.
- Measure the length of the rope that was wrapped around the tree.

	Height of tree (in metres)	Height of tree / Diameter of canopy	Circumference of the trunk (in metres)
Tree 1			
Tree 2			
Tree 3			

3. Which of these three measures do you think can be used as a reasonable way of comparing trees for genetic variation? Why are they suitable or unsuitable as a means of comparison?

Height of tree: ___

Height/Diameter: ___

Circumference: ___

POST-VISIT ACTIVITY 1

Threats to biodiversity

This activity will be conducted in groups of 3 students.

1. What are some of the things that might threaten the Biodiversity of a region.

2. List the threats that the class came up with

________________ ________________ ________________

________________ ________________ ________________

________________ ________________ ________________

3. In your groups discuss what you know about how these things might affect biodiversity and list any specific examples of each that you might know.

THREAT	HOW DOES IT AFFECT BIODIVERSITY?	EXAMPLE

4. Share your answers with the class.

5. Group Biodiversity Task

Each group is required to construct a poster or Powerpoint presentation entitled *Threats to Biodiversity*. In your group decide who will research each threat.

GROUP MEMBER	THREATS
	• • •
	• • •
	• • •

In your presentation you should:

- Cover all the threats that you have discussed and listed on your worksheet.
- Explain in what way each threatens biodiversity.
- Give an actual example of each threat, stating what happened, when, where and whether or not anything has been done to restore the biodiversity.
- Include a conclusion which summarises why biodiversity is important and why steps should be taken to guard against the threats you have outlined.

POST-VISIT ACTIVITY 2

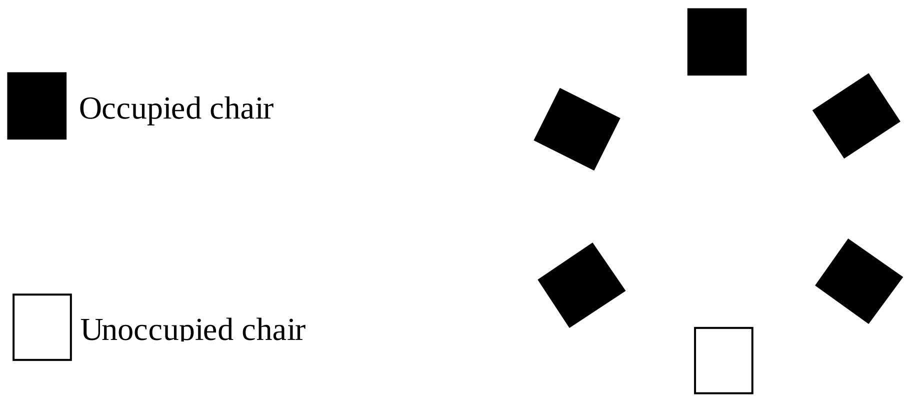
Why is biodiversity important?

Students engage in a *fish bowl* debate on the importance of biodiversity, critically analysing beliefs and formulating arguments.

1. In pairs discuss and write down as many arguments for the importance of maintaining biodiversity.

2. Share your reasons with the class in a brainstorming session.

3. ***Fish bowl* Activity**
Arrange 6 chairs in a circle. Five students occupy 5 of the chairs and leave the sixth vacant. The remainder of the class gathers around the circle to witness the discussion.



4. The 5 students commence a discussion of the importance of biodiversity using the points raised during the brainstorming session or any other points they may think of during the course of the discussion. **Only one person at a time may speak and no-one should be interrupted.** At any time the 6th chair may be occupied by any of the other students who can make a statement arguing against what has been said or querying any comment that has been made. Once they have made their contribution to the discussion they must leave the chair and allow the remaining 5 students to respond. *Remember! Only the people sitting on the chairs can speak. If a student wants to be involved in the discussion they must sit in the 6th chair. Only one person can speak at a time and no-one should be interrupted while speaking.*

5. Using the points raised in the *fish bowl activity*, take a position on the importance of biodiversity. It may be one of the supporting arguments or even a negative argument. Write a minimum of one page:

- outlining your position,
- presenting examples or evidence in support of your argument,
- listing contrary views and arguing against them,
- concluding with a final statement, summarising your argument.