MVAC
BIOLOGY

MODULE 3/4 FIELD STUDY

Students will participate in pilot studies with Universities. Scan the QR codes to learn more about each project.

SCAN ME

echidna CSI
2023

return to 1616
2016-2023

1 million turtles
2023

CITIZEN SCIENCE PROJECTS 2023

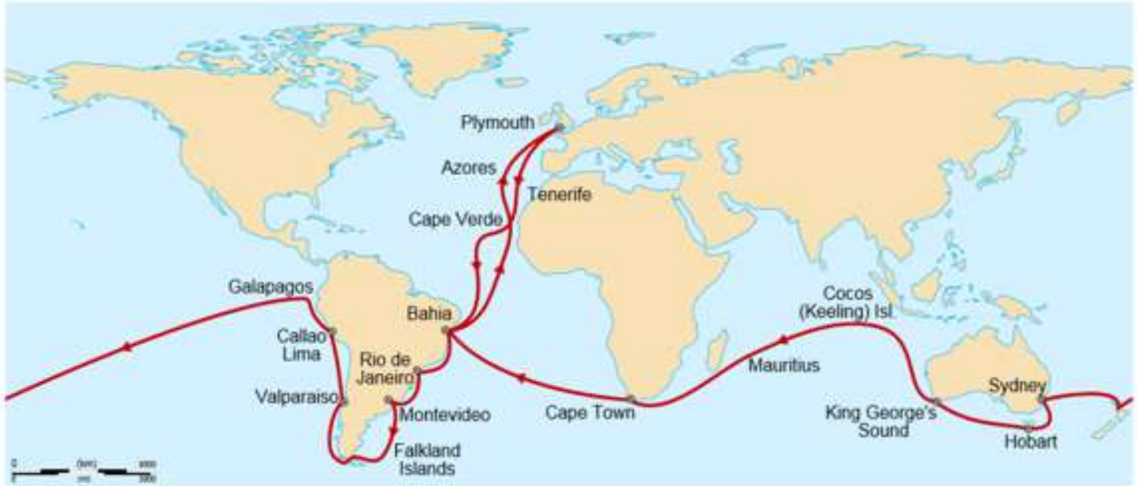
Some of the main points to keep in mind throughout the field studies are:

- The world is a changing place- the continents move, the climate changes, the plants and animals respond to these changes continuously.
- In Biology, we consider the ability of an animal to produce successful offspring as the ultimate achievement. This is known as fitness.
- Evolution can take place slowly or quickly due to various selective pressures.
- Human impact can, and is, affecting biodiversity.

Module 3 & 4 Outcomes **A student:** - Develops and evaluates questions and hypotheses for scientific investigation BIO11/12-1 - Designs and evaluates investigations in order to obtain primary and secondary data and information BIO11/12-1 - Conducts investigations to collect valid and reliable primary and secondary data and information BIO11/12-3 - Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media BIO11/12-4 - Analyses and evaluates primary and secondary data and information BIO11/12-5 - Analyses ecosystem dynamics and the interrelationships of organisms within the ecosystem BIO11-11	Year 11 Working Scientifically Skills - BIO11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information - BIO11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media - BIO11/12-5 analyses and evaluates primary and secondary data and information - BIO11/12-1 develops and evaluates questions and hypotheses for scientific investigation - BIO11/12-6 solves scientific problems using primary and secondary data, critical thinking skills and scientific processes - BIO11/12-7 communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Module 3 Content
 	
Inquiry Question: How do environmental pressures promote a change in species diversity and abundance?
Students:
• Investigate changes in a population of organisms due to selection pressures over time for example:
  o Cane toads in Australia
 	
Inquiry Question: How do adaptations increase the organism's ability to survive?
Students:
• Conduct practical investigations, individually or in teams, or use secondary sources to examine the adaptations of organisms that increase their ability to survive in their environment, including:
  o Structural adaptations
  o Physiological adaptations
  o Behavioural adaptations
 	
• Investigate, through secondary sources, the observations and collection of data that were obtained by Charles Darwin to support the Theory of Evolution by Natural Selection, for example:
  o finches of the Galapagos Islands
  o Australian flora and fauna
 	
Inquiry Question: What is the relationship between evolution and biodiversity?
Students:
• explain biological diversity in terms of the Theory of Evolution by Natural Selection by examining the changes in and diversification of life since it first appeared on the Earth (ACSBL088)
• analyse how an accumulation of microevolutionary changes can drive evolutionary changes and speciation over time, for example:
  o evolution of a horse
  o evolution of the platypus
• explain, using examples, how Darwin and Wallace's Theory of Evolution by Natural Selection accounts for:
  o convergent evolution
  o divergent evolution
 	
Inquiry Question: *What is the evidence that supports the Theory of Evolution by Natural Selection?*
Students:
• explain modern day examples that demonstrate evolutionary change, for example:
  o the cane toad
	Module 4 Content
	
	Inquiry Question: *What effect can one species have on the other species in a community?*
	Students:
	• Investigate and determine relationships between biotic and abiotic factors in an ecosystem, including: (ACSBL019)
	  o the impact of abiotic factors (ACSBL021, ACSBL022, ACSBL025)
	  o the impact of biotic factors, including predation, competition, and symbiotic relationships (ACSBL024) – the ecological niches occupied by species (ACSBL023)
	• predicting consequences for populations in ecosystems due to predation, competition, symbiosis, and disease (ACSBL019, ACSBL020)
	• measuring populations of organisms using sampling techniques (ACSBL003, ACSBL015)
	
	Inquiry Question: How can human activity impact on an ecosystem?
	Students:
	• investigate practices used to restore damaged ecosystems for example:
	  o land degradation from agricultural practices

The Voyage of *The Beagle* (1831-1836)



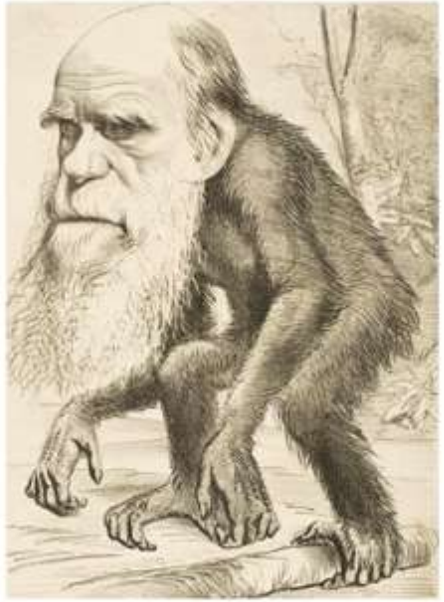
After his return home he formulated what he called "natural selection" to explain how living things adapt to a changing world.

"It is not the strongest or the most intelligent who will survive but those what can best manage change"

Charles Darwin

Australia has one of the highest extinction rates of flora and fauna in the world. Thinking about natural selection, do you think that the Koala is biologically fit? Do you think it is at risk of becoming extinct? Why/why not?

Charles Darwin studied the geology, animals, plants and peoples of the countries that he visited, which eventually led him to realise that living things must evolve over time.



Editorial cartoon depicting Charles Darwin as an ape (1871) Originally published in *The Hornet* magazine, 22 March 1871

TARONGA ZOO SYDNEY

For the Wild

Adaptations

Inquiry question: How do adaptations increase the organism's ability to survive?

On Sep 15, 1835 the *Beagle* arrived in the Galapagos Islands. Extract from *The Voyage of the Beagle:* It is, that the different islands to a considerable extent are inhabited by a different set of beings. My attention was first called to this fact by the Vice-Governor, Mr. Lawson, declaring that the tortoises differed from the different islands, and that he could, with certainty tell from which island any one was brought.

Content descriptor: Investigate, through secondary sources, the observations and collection of data that were obtained by Charles Darwin to support his Theory of Evolution by Natural Selection, for example:
– Finches of the Galapagos Islands
– Australian flora and fauna

A "dome-shell" Galapagos Tortoise

Habitat:

Adaptations:

A "saddle-back" Galapagos Tortoise

Habitat:

Adaptations:

Adaptations

ADAPTATIONS

Content descriptor: Conduct primary investigations, individually or in teams, or use secondary sources to examine the adaptations of organisms that increase their ability to survive in their environment, including:
– structural adaptations
– physiological adaptations
– behavioural adaptations

Inquiry question: How do adaptations increase the organism's ability to survive?

Structural	Behavioural	Physiological

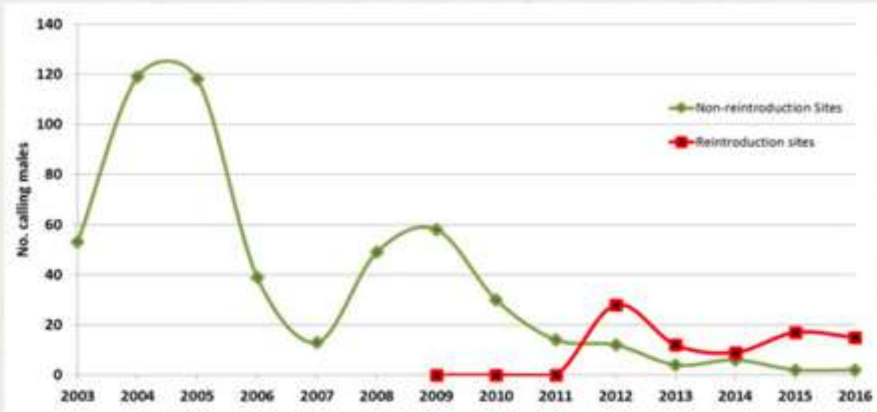
Inquiry question: How do environmental pressures promote a change in species diversity and abundance?

Content descriptor: Investigate changes in a population of organisms due to selection pressures over time for example:
– Cane toads in Australia
– Prickley Pear distribution in Australia

Working Scientifically Outcome
BIO11/12-5 analyses and evaluates primary and secondary data and information

The most reliable monitoring technique is to survey the number of breeding males. The breeding males reliably respond with their threat call when researchers shout near their sphagnum nests and the calls can be easily counted. In 2009, the first Corroboree Frog eggs were reintroduced back into the wild. The frogs that survived from these eggs became sexually mature and started being recorded as breeding males in 2012.

Source - http://www.corroboreefrog.org.au/



The graph shows the number of Southern Corroboree Frog males recorded in annual surveys from 2003- 2016.

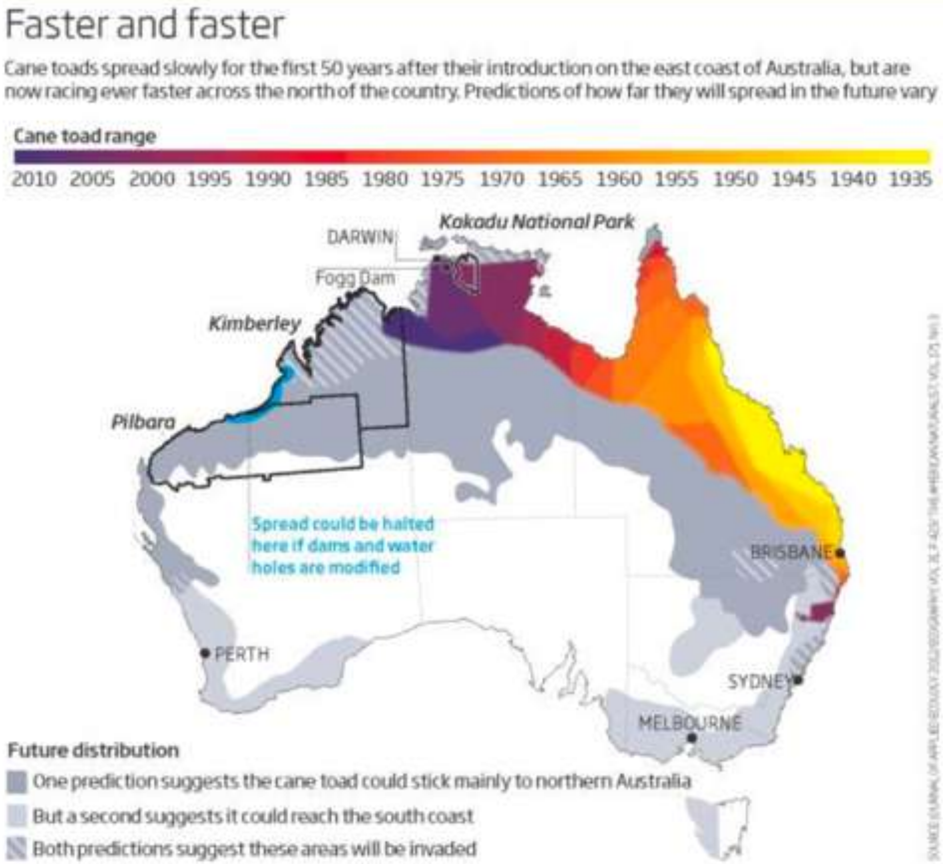
The Southern Corroboree Frog is Listed on the IUCN Red List as Critically Endangered. Describe the changes in the population over the last 14 years and account for the changes.

Selection Pressures

Apply your Knowledge

Cane Toad Populations in Australia

Working Scientifically Outcome BIO11/12-1
develops and evaluates questions and hypotheses for scientific investigation



1. Describe the changes over time in the Cane Toad population

2. Why do predictions of how far they will spread in the future vary?

3. Based on your understanding of Natural Selection, describe why the Cane Toads are getting faster.

Selection Pressures

CONVERGENT EVOLUTION

A kind of evolution wherein organisms evolve structures that have similar (analogous) structures or functions in spite of their evolutionary ancestors being very dissimilar or unrelated.

Inquiry question: What is the relationship between evolution and biodiversity?

Content descriptor: Explain, using examples, how Darwin and Wallace's Theory of Evolution by Natural Selection accounts for:
-convergent evolution
-divergent evolution

Example of Convergent Evolution	Explanation
	

Evolution

Inquiry question: What is the relationship between evolution and biodiversity?

Content descriptor: Analyse how an accumulation of micro-evolutionary changes can drive evolutionary changes and speciation over time, for example:
– evolution of the horse
– evolution of the platypus

RED KANGAROO EVOLUTION

25 MYA
Northern Australia is warm and wet and covered in rainforest. Kangaroo ancestors are arboreal.

Features

20 MYA to present
Musky Rat Kangaroos evolved 20MYA but still live in remnant areas of rainforest in Northern QLD.

Features

20 -15 MYA
Southern Australia is dominated by savannah/open woodland. Huge radiation of kangaroo species in this time. The first megafauna appear.

Features

8 MYA
Arid areas increasing as polar ice caps increase. Hopping Kangaroo species dominated.

Features

5 - 3 MYA
Rainforests return to large areas of northern Australia & PNG - some species of Kangaroo return to an arboreal existence—Tree Kangaroo's.

Features

4 - 2 MYA
Southern Australia experiences larger arid areas than present due to glaciations. The beginning of modern kangaroo evolution. Reds appear at 2MYA.

Features

Present Day
There are now over 60 species of Macropods in Australia. Red Kangaroo's are one of the most successful species in Australia.

TARONGA ZOO SYDNEY For the Wild

Evolution

Apply your Knowledge

Based on your knowledge of Natural Selection, explain Darwin's following observations:

Working Scientifically Outcome BIO11/12-7
communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Darwin's Observations	Explanation
West of the Blue Mountains, Darwin examined a rat-kangaroo and a platypus. Noting that they occupied ecological niches similar to those of the rabbit and water rat in the northern hemisphere, he wondered in his diary why a single creator would make such different animals for the same apparent purpose: "Surely two distinct Creators must have been at work."	
It was back in Europe when Darwin enlisted the help of John Gould who was surprised to see the differences in the beaks of the Galapagos birds and identified the 14 different specimens as actual different species. The other, similar birds Darwin had brought back from the South American mainland were much more common, but different than the new Galapagos species.	

Evolution

Student Tasks:

- Create a specific inquiry question relating to the inter-relationship of foxes with Eastern quolls and Loggerhead turtles.
- Predict/hypothesise the outcome of your field study based on your research of fox/quoll population dynamics.
- Complete a first-hand investigation as part of a field trip to collect primary data.
- Process and analyse the data to help solve the problem presented by your inquiry questions.

Common Name
Scientific Name
Colour
Size
Diet
Breeding
Species Status
Preferred Habitat

Common Name
Scientific Name
Colour
Size
Diet
Breeding
Species Status
Preferred Habitat

The Target Species

Loggerhead turtle (Caretta caretta) and Red fox (Vulpes vulpes).

Spotted tailed quoll (Dasyurus maculatus) and Red fox (Vulpes vulpes).

We are interested in the relationship between these two species in an ecological community. Complete some research into each species to answer the following:

- Distribution, diet, habitat, breeding, threats, ecological niche
- Describe known facts about the inter-relationship between foxes and turtles.
- Research the vegetation associations for both species and discuss how sampling vegetation will be important to your research. (think about how this might relate to the target species)

The Field study/excursion

Overall inquiry question "What effect can one species have on the other species in a community?"

- Create your own inquiry question specific to these two species
- What type of data do you need to collect and what first-hand investigation methods could you use in the field to answer this question? (Hint think about relationships – Abiotic/vegetation/animals/target species)
- Hypothesise an outcome of your investigation based on your prior research.
- We have provided a scaffold and various activities that will help you collect primary data on both vegetation and the target species.

Inquiry Question:

Type(s) of data?

Hypothesis:

Survey Recording Form

Abiotic Components - Physical & Chemical Characteristics Along the Transect

		Method	1	2	3	4	Mean	Range
Soil	Temperature	Remove the cover from the thermometer and place probe in soil.						
	Colour	Rub fore fingers on ground & colour in the worksheet section						
	pH	Step 1-Place soil on white tray with spoon Step 2-Place 2-3 drops of universal indicator over the sample Step 3-Sprinkle barium sulphate on sample Step 4-Use colour chart to assess pH level						
	Texture	See notes ***at back***						
	Leaf Litter Depth	Place trowel into leaf litter. Take measurement from centre of trowel						
Air	Temperature	Use the temperature meter						
	% Moisture	Use hygrometer. Step 1-Read dry bulb temperature Step 2-Read wet bulb temperature Step 3-Calculate difference between wet & dry bulb temperatures Use chart in centre to assess relative humidity						
	Light Intensity	Use lux meter. 1 lux = light of one candle per square meter. Turn on to x100 & take a reading from waist height (add two zeros to your reading)						
Geography	Slope	Use clinometer. (blue colour) (in degrees)						
	Aspect	Use compass. Step 1-Assess where north is Step 2-Assess direction of transect line						
	Elevation							
	Lithology	Assess the rock type observed						

Survey Recording Form

Abiotic Results – interpretation sheet

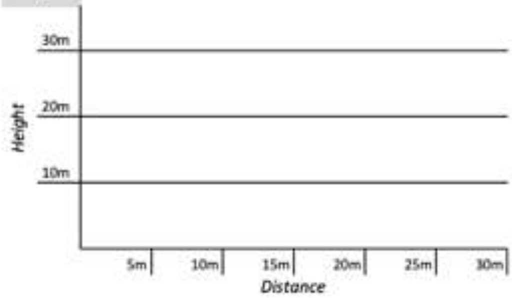
Soil	Temperature	What would soil temperature influence?				
	pH	1 – 5.5 = unhealthy	5.5 – 8 = healthy	8 – 12 = unhealthy	***H=Healthy U=Unhealthy***	
	Texture	How would the texture influence vegetation?				
	Leaf Litter Depth	<1cm = unhealthy	2 – 3cm = adequate	3cm & above = healthy	***H=Healthy U=Unhealthy***	
Air	Temperature	How does your result compare to the average for Sackville North for this time of year?				
	Light Intensity	*<100 lux = very dark day Full daylight = ~10,000 lux Bright sunlight = ~100,000 lux*				
		What factors contribute to a variation in lux readings?				
	% Moisture	How would the humidity infuence vegetation?				
Geography	Slope	How would the slope influence vegetation?				
	Aspect	How would the aspect of the slope change the type of vegetation?				
	Elevation	Would the vegetation change as you move between the gully and ridge? Explain differences.				
	Lithology	Why are we interested in the type of rock observed?				

Survey Recording Form

Vegetation - Type and Height

__Distribution__ of a species describes where it is found. A transect can be used to measure distribution. Follow your 30m transect and record tree species and tree height on the table below. Draw a line for each tree with a symbol at the top that represents the species. Utilise the field guide iBook provided to identify tree species and vegetation sheets to identify structure

1

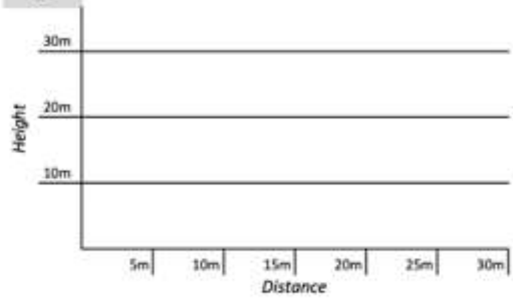


Highest Tree Height ____________________

Canopy Cover ____________________

Vegetation Structure ____________________

2

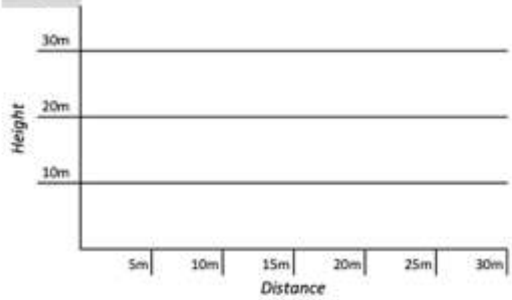


Highest Tree Height ____________________

Canopy Cover ____________________

Vegetation Structure ____________________

3

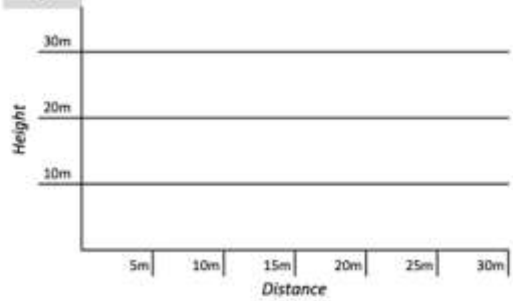


Highest Tree Height ____________________

Canopy Cover ____________________

Vegetation Structure ____________________

4



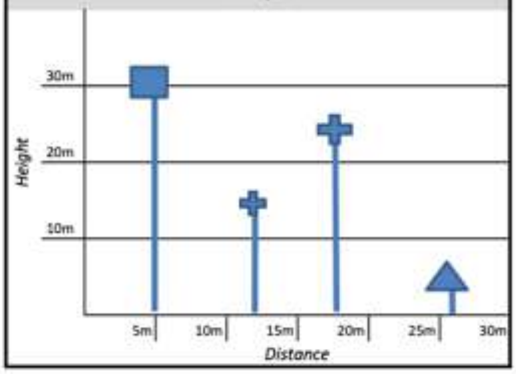
Highest Tree Height ____________________

Canopy Cover ____________________

Vegetation Structure ____________________

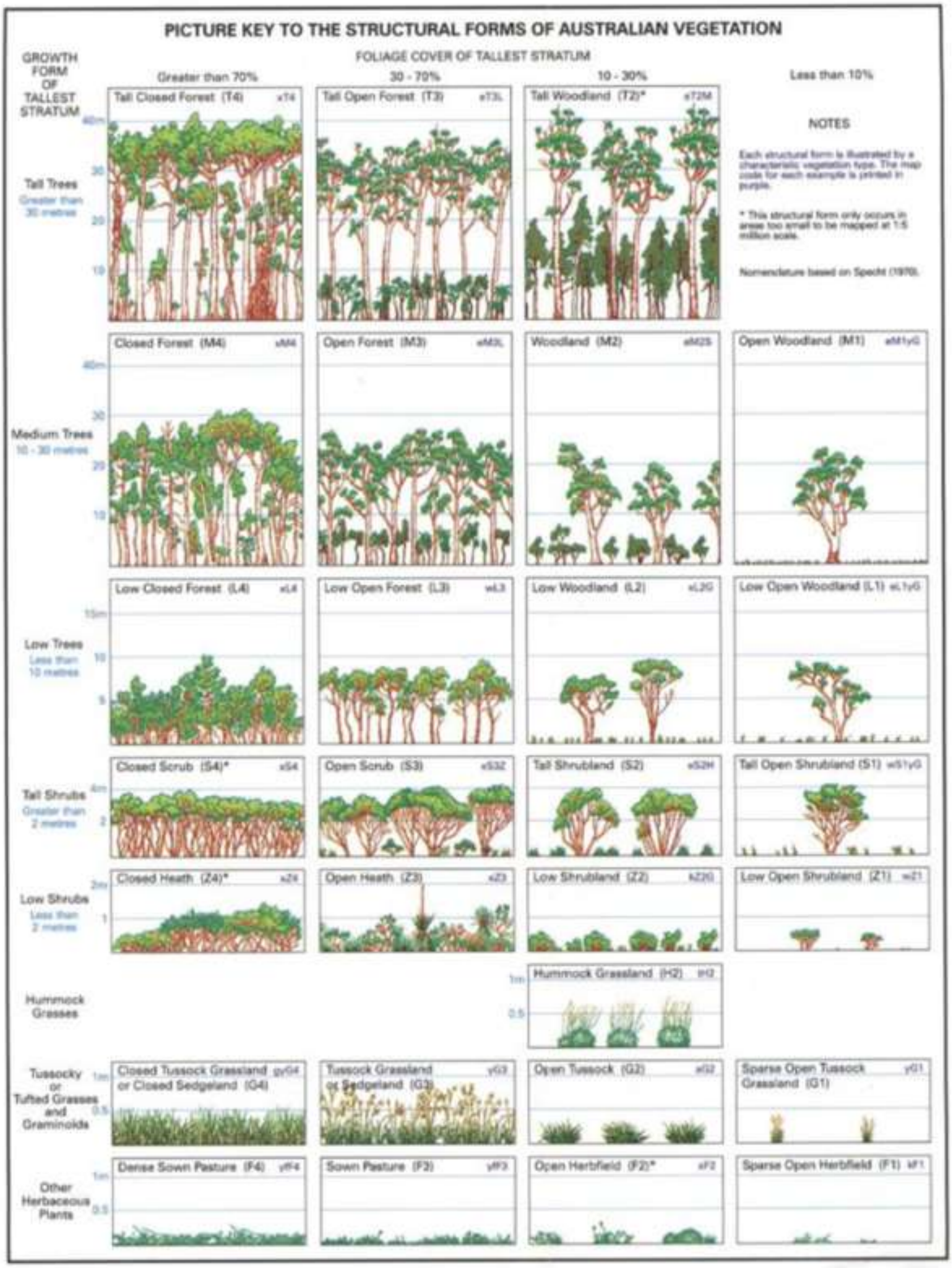
TREE SPECIES KEY

Example



Quolls prefer a structurally diverse forest (plenty of grasses, shrubs, small and large trees). Do your observations show adequate vegetation layers for the quoll? YES / NO

What layer of vegetation (if any) is missing? ____________________


PICTURE KEY TO THE STRUCTURAL FORMS OF AUSTRALIAN VEGETATION
GROWTH FORM OF TALLEST STRATUM
FOLIAGE COVER OF TALLEST STRATUM
Greater than 70%
30 - 70%
10 - 30%
Less than 10%
Tall Trees
Greater than 30 metres
Tall Closed Forest (T4)
Tall Open Forest (T3)
Tall Woodland (T2)*
NOTES
Each structural form is illustrated by a characteristic vegetation type. The map code for each example is printed in purple.
* This structural form only occurs in areas too small to be mapped at 1:5 million scale.
Nomenclature based on Specht (1970).
Medium Trees
10 - 30 metres
Closed Forest (M4)
Open Forest (M3)
Woodland (M2)
Open Woodland (M1)
Low Trees
Less than 10 metres
Low Closed Forest (L4)
Low Open Forest (L3)
Low Woodland (L2)
Low Open Woodland (L1)
Tall Shrubs
Greater than 2 metres
Closed Scrub (S4)*
Open Scrub (S3)
Tall Shrubland (S2)
Tall Open Shrubland (S1)
Low Shrubs
Less than 2 metres
Closed Heath (Z4)*
Open Heath (Z3)
Low Shrubland (Z2)
Low Open Shrubland (Z1)
Hummock Grasses
Hummock Grassland (H2)
Tussocky or Tufted Grasses and Graminoids
Closed Tussock Grassland or Closed Sedgeland (G4)
Tussock Grassland or Sedgeland (G3)
Open Tussock (G2)
Sparse Open Tussock Grassland (G1)
Other Herbaceous Plants
Dense Sown Pasture (F4)
Sown Pasture (F3)
Open Herbfield (F2)*
Sparse Open Herbfield (F1)

Relationships

HABITAT ASSESSMENT

	Habitat Element					1	2	3	4	Mean	Range
TREES	**Trees**	1 – 3 large trees (> 6m) **1**		More than 5 large trees **2**							
	One or more trees native to Australia	**2**									
	A variety of 4 or more plant species	**2**									
	Healthy Tree Canopy /Plant Foliage	Healthy **2**	Moderately Healthy **1**	Defoliation Evident **0**	Evidence of Dieback **0**						
SHRUBS	**Shrubs**	None **0**	Some **1**	Many **2**							
	Native Shrubs	None **0**	Some **1**	Most **2**							
GROUND COVERS	**Ground Cover**	None **0**	Some **1**	Most **2**							
	Native Grasses or Spreading Plants	**2**									
SHELTER	**Hollows**	Butt Hollows **1**	Limb Hollows **1**	Fallen Log Hollows **1**							
	Rocks & Crevices	None **0**	Some **1**	Most **2**							
	Leaf Litter	None **0**	Some **1**	Most **2**							
	Loose Bark (attached or shed)	None **0**	Some **1**	Most **2**							
	Logs & Fallen Branches	None **0**	Some **1**	Most **2**							
WATER	**Pond/Water**	Yes **1**	No **0**								
FOOD	**Plants with Fruits / Seeds**	None **0**	Some **1**	Most **2**							
HABITAT SPACE	**Plants of Different Ages**	None **0**	Some **1**	Most **2**							
	Joined or Located to Other Gardens / Bush by Gardens / Bush	Yes **1**	No **0**								
					TOTAL SCORE / 33						

A LOW SCORE WILL INDICATE THE ZONE IS POOR HABITAT. This may be because it has been disturbed or requires additional habitat parameters to better support the amazing variety of living things.

A quoll requires a minimum score of 20 to survive

Decide on a minimum score for a turtle:

INTERPRETING THE HABITAT ASSESSMENT

AREA – the higher the score the better. Larger animals and those higher up the food chain require more territory/range in which to support themselves. Wildlife corridors play an important role in sustaining and conserving plant and animal species.

TREES – provide nesting sites and food for nectar and fruit eaters.

HEALTHY TREE CANOPY – a healthy canopy will indicate the site is relatively free of human disturbances (eg; erosion, compaction) or natural disturbances (storm damage, major presence of mistletoe)

SHRUBS – dense native shrubs allow small native animals and birds to shelter and to hide from predators such as feral cats.

HERBS & GROUND COVERS – provide the food for finches, lyrebirds, lizards, frogs and wallabies, and also provide habitats for small mammals, insects and spiders.

NATIVE PLANTS – native plants are adapted to the Australian environment. They require less watering, little or no fertiliser and provide the right food at the right time for the native animals that have evolved with them.

HOLLOWS – are important homes for native wildlife. It can take over a hundred years for hollows to develop in forests. Hollows also provide nesting sites for birds, possums and bats.

ROCKS & CREVICES – provide habitat for many animals to live and feed and for certain species of plants to grow – they are valuable habitat. Bush rock collection has had a significant impact on our wildlife and degraded many areas.

LEAF LITTER – provides habitat for smaller animals like lizards, geckos, frogs and invertebrates. Leaf litter, when broken down, provides humus – a rich source of nutrients for trees and shrubs.

LOOSE BARK – provides habitat for invertebrates, spiders and lizards.

LOGS OR FALLEN BRANCHES – 20% of native mammals need logs to nest in. They provide habitat for invertebrates and reptiles. When they decay they provide nutrients for the ecosystem.

POND / WATER – provides homes for frogs, native fish, dragonfly nymphs and other invertebrates. Also drinking water for birds and animals.

PLANTS WITH FRUIT / SEEDS – an important source of food for birds, bats, possums and invertebrates.

PLANTS OF DIFFERENT AGES – indicates that an area has more habitat spaces for a variety of plants and animals.

JOINED OR LOCATED TO OTHER GARDENS / BUSH – a variety of vegetation, vegetation density and landscapes will allow a greater range of animal species to find food and nesting sites.

Vegetation ID

Iron Bark *Eucalyptus crebra*	Stringy Bark *Eucalyptus eugeniodies*	Yellow Bloodwood *Corymbia eximia*
		
Bark description-	Bark description-	Bark description-
Average height –	Average height –	Average height –
Preferred habitat –	Preferred habitat –	Preferred habitat –
Canopy Density-	Canopy Density-	Canopy Density-
Grey Gum *Eucalyptus Punctata*	Grey Myrtle *Backhousia myrtifolia*	Geebung *Personia lineraris*
		
Bark description-	Bark description-	Bark description-
Average height –	Average height –	Average height –
Preferred habitat –	Preferred habitat –	Preferred habitat –
Canopy Density-	Canopy Density-	Canopy Density-

Human Impacts on a Vegetation Community

There are many ways in which a vegetation community can be disturbed and each disturbance can have a varying degree of impact.

Observe the vegetation community around you to complete the following checklist.

1. Has the soil been disturbed by;

	None (o)	minor (1)	major (2)
erosion (sheet, rill, gully)	☐	☐	☐
mining of soil, clay or sand	☐	☐	☐
dumping of rubbish/garden waste	☐	☐	☐
bushrock collection	☐	☐	☐
access roads, paths or tracks	☐	☐	☐

2. Has the vegetation been disturbed by;

	None (o)	minor (1)	major (2)
weed invasion	☐	☐	☐
logging	☐	☐	☐
past clearing	☐	☐	☐
off road vehicle use	☐	☐	☐
nutrient/sewage seepage from adjacent farmland	☐	☐	☐

3. Is the site;

	No (0)	Yes (2)
adjacent to an urban area	☐	☐
adjacent to recreational facilities	☐	☐
showing evidence of feral animals	☐	☐

Score:

Poor	=	21 - 30
Average	=	11 - 20
Good	=	0 - 10

Recorded score:

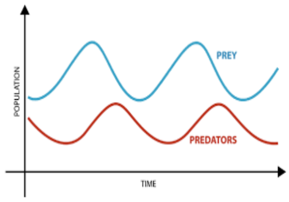
Observe as many alterations to the vegetation community at the study site.

Alteration	Environmental Impact

Survey of Turtle Nest Predation:

Location & Date (Coordinates if possible)	Description of habitat	Number of eggs left in nest initially	Number of eggs remaining after 14 days?

Using the surveys, predict a predator-prey relationship for (i) foxes with quolls, (ii) foxes with turtles in your area.



Number of animals

Time (years)

Insect Investigators

Insect Investigators

Insects and their arthropod friends are everywhere! Carefully check around your school grounds and see how many of the arthropods below you can find. Try to complete a row or column to get bingo or even better, find them all!

Remember!

Be safe - always be aware of what's around you.
Be careful - don't damage the plants around you.
Be prepared - make sure you're sun safe.


Ant


Aphid


Blow fly or house fly


Centipede


Wasp


Earwig


Dragonfly


Butterfly


Lady beetle


Millipede


Praying mantis

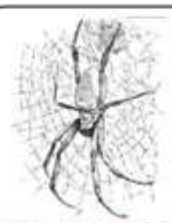

Moth


Slater


Wolf spider


Longhorn beetle


Grasshopper


Orb weaver spider


Cockroach


Crane fly


Cricket

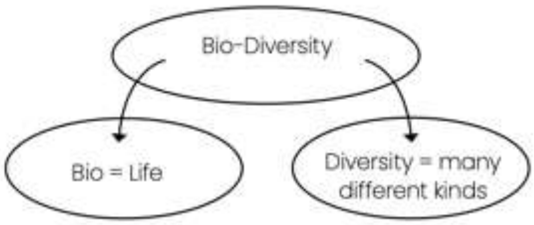
Images courtesy of WA Gould League

What is Biodiversity?

Have you ever thought about how many living creatures there are in the world?
Once you start making a list you could go on forever!
Use a timer to see how many living creatures you can list in 30 seconds:

________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________

The scientific term for the huge variety of living creatures on earth is BIODIVERSITY.



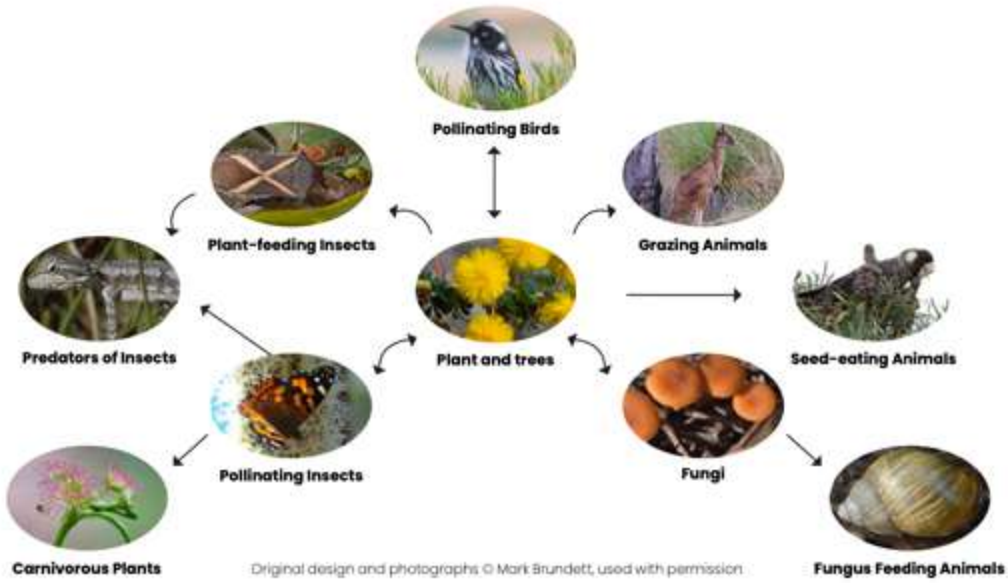
Biodiversity is very important because all of the living things within an ecosystem rely on each other for survival. So, if a plant or animal is affected by changes in the ecosystem all living things are also affected in some way. The health of an ecosystems can be measured by its biodiversity.A strong ecosystem has lots of living things (organisms) in it which means that if one type of organism dies out or gets sick there are things to fall back on. An unhealthy ecosystem is not as bio-diverse and i is harder for living things to survive.

An **ecosystem** is the environment where living things interact with each other and non-living things around them like dead plants, rocks, soil, water and air. Ecosystems can be really small, like a fish tank, or huge, like the ocean.

What is a Biodiversity Web?

A great way to see how an ecosystem works and how living things rely on each other and their environment is to create a Biodiversity Web.

A biodiversity web is a diagram that shows not only how living things support and rely on each other and their environment making connections, like a web, it is also a great way to see how even the smallest changes can cause the web to breakdown or weaken.



Original design and photographs © Mark Brundett, used with permission

1. In your own words explain what a biodiversity web is.

____

____

____

2. What impact would removing one of the living things from this biodiversity web have on the rest of the web?

____

____

____

3. Can you add anymore living things to this biodiversity web? Explain your answer and add them to the graphic above including labels and arrows showing their connections to other living things in the web.

____

____

____

Habitat Assessment: Making Quadrats

When collecting information on insects in your school yard it's important to learn about the habitat that you're working in. This information will be used to try and predict what sort of insects you might find there, and help explain your results from later lessons. A quadrat is a representative area of your school that you can use to assess the habitat available for insects and other animals.

Your Task

As a class, you will need to measure out a square in your school yard in which to assess the habitat available for insects and other animals. This is a representative area of the whole school, which will allow you to carry out the habitat assessment measurements in a reasonable timeframe. Scientists call these representative areas 'quadrats'.

The square can be any size, depending how big your school yard is, and how much time you have to carry out the habitat assessment. For example, you might use a square that has 10m long sides. This would mean the total area inside the quadrat is $10m^2$.

Measure out the quadrat as a class. You can use a tape measure, or take 10 large steps on each side.

You can mark each corner of the quadrat with something like a hat or a cone, or use rope or string to run along the sides.

Make sure everyone in the class knows where the quadrat is in the school.

Take a photo of each of the quadrat and record the locations (you could use google maps or the compass app on a smartphone to find the GPS location if you want).

Insect Investigators

Relationships

Habitat Assessment: Trees and Canopy

Counting living trees

A habitat is the natural home, or environment, of living things, it provides food and water, shelter and protection from predators. A habitat can look different for any animal or plant or animal, they can be small or large and species can share the same habitat.

Your task is to focus on the trees in your quadrat and collect data on how many living trees are in the area. Trees are important for providing habitat for insects. Leaves and sticks falling from the canopy also provide much of the material on the ground, such as leaf litter and other organic material. Trees and shrubs of the overstory/understory offer insects structures to live, find food, find mates, and lay eggs. Insects often prefer certain types of trees and shrubs, or plants because they provide exactly what that insect needs, such as sap from tree trunks, hollow branches, or decaying wood.

Your Task

You are required to count the number of living trees in your quadrat. You will need to count both the large (more than 6 metres) and small trees (less than 6 metres). You can use tally marks to count the trees and total them up at the end.

	Tally	Total
Large Trees		
Small Trees		

Insect Investigators

Habitat Assessment: Trees and Canopy

Counting dead trees and measuring logs

A habitat is the natural home, or environment, of living things, it provides food and water, shelter and protection from predators. A habitat can look different for any animal or plant or animal, they can be small or large and species can share the same habitat.

Your task is to focus on the number of dead trees, both standing and fallen, in your quadrats. Dead and decaying trees are very important for providing habitat for many types of insects. They use the decaying wood and fungi for laying egg and rearing larvae and hunting.

To help with this activity, watch the videos:

Habitat Assessment: Counting dead trees

Habitat Assessment: Counting and measuring logs

Your Task

Your group is responsible for recording the number of dead trees around your insect trap.

1. You must count the standing dead trees and record them in the table below. Look for trees with no leaves and visible signs of decay such as fungi, split trunks or branches.
2. You must also record the number of logs, and choose five to measure their length, the circumference and if any fungi is present. Only count logs that are thicker than an adult's ankle (about 10 cm diameter or 25 cm circumference).

	Tally	Total
Standing dead large trees		
Standing dead small trees		
Logs		

	Length	Circumference	Is fungi present?
Log 1			
Log 2			
Log 3			
Log 4			
Log 5			

Habitat Assessment: Understory

Characterising understory vegetation

A habitat is the natural home, or environment, of living things, it provides food and water, shelter and protection from predators. A habitat can look different for any animal or plant or animal, they can be small or large and species can share the same habitat.

Your task will focus on the trees in the quadrat and on the plants, soil, leaf litter, rocks etc underneath trees. This is called the understory and usually has a great variety of plant species and is a very important source of shelter and food for many animals and fungi (and many other organisms). Different plant species provide different structures and materials for animals to construct nests from, to spin webs between and many insects feed from the many flowering herbs in the low to mid understory.

Insects which decompose organic matter are found in abundance in leaf litter – as too are the predatory insects and spiders which rely on them for nutrition. Furthermore, rocks, bark, branches and twigs are perfect for insects and spiders to forage and hide in. Bare soil is important as a site for seed germination, but also for insects basking in sunlight. Similarly, temporary puddles are used by many organisms, such as birds, dragonflies, bees and flies use puddles for drinking, bathing, but also egg laying.

To help with this activity, watch the video: Habitat Assessment: characterising the understory vegetation

Your Task

Your task is to identify which of the following is present in the understory of the quadrat. Put a tick or a cross in the box to show if you can see each one.

	✓ / x
Tree <6m tall	
Shrub (1 - 5m tall) **Shrubs are smaller than trees and often have more than one woody stem.**	
Small Shrub <1m tall	
Large herb >0.5m tall	
Small herb <0.5m tall	
Fern or bracken	
Moss or lichen **(can be on other plants or rocks)**	
Scrambling/Climbing vine	
Tall Grass >1m (or grass-like)	
Small Grass <0.5m (or grass-like)	
Branches/twigs/sticks on ground	
Patches of bare soil	
Rocks larger than your hand	
Shallow water puddles	
Stream/Creek (note if temporary or permanent)	

Relationships

Insect Investigators

Insect Collection Methods

Important reminders:

Be safe - always be aware of what's around you.
Be careful - don't damage the plants around you.
Be informed - don't collect insects in areas where you need a permit.
Be prepared - make sure you're sun safe.

Entomologists (insect scientists) use a lot of different methods to survey for insects when undertaking a biodiversity assessment. A Malaise trap is very good at catching small flying insects like wasps and flies. However, there are a lot of other methods that entomologists use to collect insects.

Some methods keep the insects alive, whilst others (like pan traps) involve killing the insects.

Whilst insects are incredibly important in the environment, sometimes scientists have to collect specimens (kill the insects) to be able to identify them accurately.

Choose one of the methods below to use to survey the insects and other arthropods in your school.

Method #1: Sweep netting

Entomologists (insect scientists) use a net with very small holes to 'sweep' along vegetation like shrubs and leaves. Sweep nets are also useful for sweeping the air just above flowering plants, where insects might be hovering. Once insects fall into the net, you can collect them into vials or containers.

Method #2: Branch shaking

This method is very simple. Take a container or an upside down umbrella and hold it under a branch. Shake the branch over the container, or use a stick to tap the branch and knock any insects that are on the leaves into your container.

Method #3: lifting rocks/search on bare ground

Many insects like ants can be found walking over bare ground. Other arthropods, like spiders, scorpions and slaters, are often found under rocks. Always be careful lifting rocks as snakes also like to hang out there!

Method #4: Sifting leaf litter

Many arthropods live in leaf litter (all of the dried leaves, sticks and flowers on the ground under trees and plants). You can collect leaf litter using gardening gloves or a spade, and spread it over a white piece of paper or a white tray. Watch closely and see what starts to move!

Insect Collection Methods

Important reminders:

Be safe - always be aware of what's around you.
Be careful - don't damage the plants around you.
Be informed - don't collect insects in areas where you need a permit.
Be prepared - make sure you're sun safe.

Method #5: Yellow Pan Traps

Yellow pan traps are quick and easy to set up and are perfect for collecting insects that are attracted to brightly coloured plants such as bees and wasps.

What you'll need:
A yellow plastic party plate

How to use it:
Place the party plate in a sunny spot on the ground where it won't get tipped over. Fill up the plate with clean water and add a drop of dishwashing detergent. The detergent helps to break the surface tension so the insects can fall into the water. Leave the trap for at least a few hours to collect a good sample.

Method #6 Pitfall Trap

Pitfall traps are perfect for collecting insects that crawl along the ground such as beetles and ants.

What you'll need:
A plastic cup

How to use it:
Dig a hole in the ground and place your cup inside. Fill in the dirt around the cup and flatten it down to make sure the top of the cup is level with the ground. Leave the cup for a few hours or even overnight.

You can place some leaf litter or a torn up egg carton in the bottom of the cup to give arthropods a place to hide when they fall in. Always check your trap regularly, and if leaving overnight check it early in the morning before it gets too hot.

Insect Investigators

Insect Biodiveristy

Date:

Group Members:

Location Evaluation

Describe the location of your insect collection site.

1. Are there plants in your collection site? List them if you know their names, or describe them.

____
____
____

2. Study the ground in your location. Describe what you see. Is the soil dark or sandy? Is there leaf matter, rocks or sticks?

____
____
____

3. Record any sources of water near your collection location and measure the distance from your site.

____
____
____

4. If your collection area is near mown lawn or grass record the distance from your site to the mown lawn.

____
____
____

5. Is your collection site in a high traffic area? How will it be protected from students walking through the area?

____
____
____

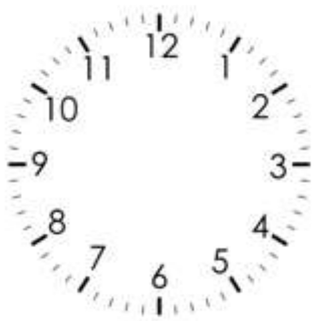
6. What kind of collection method are you using?

- ☐ Sweep netting
- ☐ Branch shaking
- ☐ Lifting rocks/searching on bare ground
- ☐ Sifting through leaf litter
- ☐ Yellow pan trap
- ☐ Pitfall trap
- ☐ Other ______________________

7. Why did you choose to use this type of collection method?

____
____
____
____
____

8. Record the time of day you set your trap, or started collecting.



9. How long will you collect for, or leave your trap set up? Why have you chosen this length of time?

____
____
____

Habitat Assessment: Understory

Plant species

A habitat is the natural home, or environment, of living things, it provides food and water, shelter and protection from predators. A habitat can look different for any animal or plant or animal, they can be small or large and species can share the same habitat.

Your task will focus on the trees surrounding your insect trap and on the plants, soil, leaf litter, rocks etc underneath trees. This is called the understory and usually has a great variety of plant species and is a very important source of shelter and food for many animals and fungi (and many other organisms). Different plant species provide different structures and materials for animals to construct nests from, to spin webs between and many insects feed from the many flowering herbs in the low to mid understory.

Many plants and insects rely on each other. Many butterflies (Lepidoptera) and bugs (Hemiptera) use specific plant species or groups of plants. However, other insects are not so picky. Different insects eat different plant parts, e.g., some eat fruits, others leaves, some pollen and nectar, while some eat plant roots. Over half of all insect species are estimated to eat plants.

The number of plant species in your quadrat can help explain the number of insect species.

To help with this activity, watch the video Habitat Assessment: Plant species

Your Task

1. Count the number of different leaf shapes; include overstory, understory and herb layer plants. You might find overstory leaves on the ground. The number of leaf shapes give us an idea of the number of plant species in the quadrat.
2. Count the number of flower types you can collect.
3. You could also draw or photograph the leaves and flowers to keep a record of the different plant species.

How many different leaf shapes?	
Tally	**Total**

How many different flower shapes?	
Tally	**Total**

Insect Biodiveristy

10. Weather conditions.

Today's temperature: ____________________

11. Is the weather:

- ☐ Hot
- ☐ Cold
- ☐ Humid
- ☐ Sunny
- ☐ Overcast
- ☐ Raining
- ☐ Windy

12. How do you think the weather conditions will impact the effectiveness of your trap or collecting method?

____

____

____

____

13. Based on all the information you have about the habitat, predict what sort of insects and other arthropods you think you will find using this collection method? Explain your prediction.

____

____

____

____

14. Conduct your insect survey using your chosen method. Following the directions of your teacher, either keep specimens until the identification lesson, or draw or photograph the insects, and then release the insects where you found them.

15. What changes would you make to your method or trap design if you were to survey for insects again. Explain your answer.

____

____

____

____

____

____

____

____

____

____

____

____

Collection Day

If using pan traps or pitfall traps

1. Was the trap disturbed? This could be by wind or rain, other animals or people. Describe what you see and how you think it was disturbed.

____

____

____

____

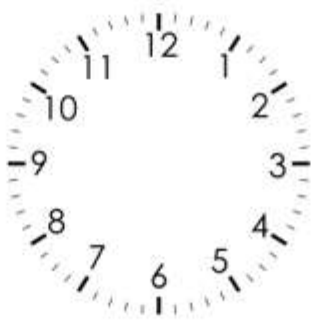
____

____

____

____

2. Record the time of day you collected your trap.



Who's Who and Who's New?

Identify the arthropods you collected using the Insect Investigators identification guide or the Insect Investigators dichotomous key to insects. Complete the chart below to compare the key features of up to 5 of the arthropods.

Once you have completed the table create a dichotomous key in the space provided for the 5 arthropods you selected.

Does your arthropod have:	Arthropod 1	Arthropod 2	Arthropod 3	Arthropod 4	Arthropod 5
Wings					
Antennae					

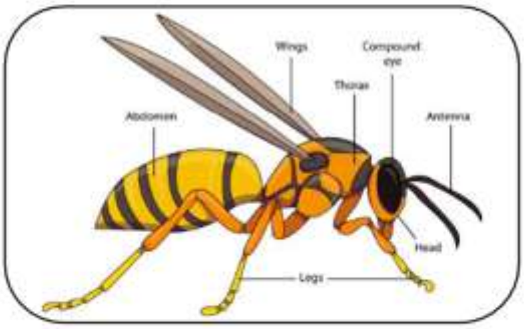
1	a.	
	b.	
2	a.	
	b.	
3	a.	
	b.	
4	a.	
	b.	

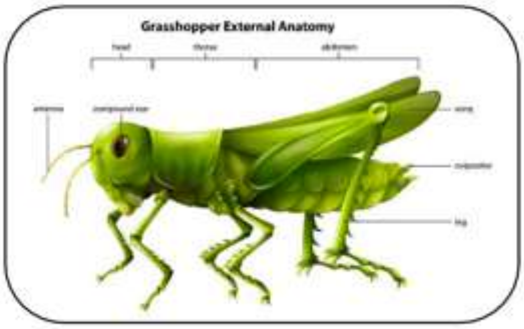
Insect Investigators

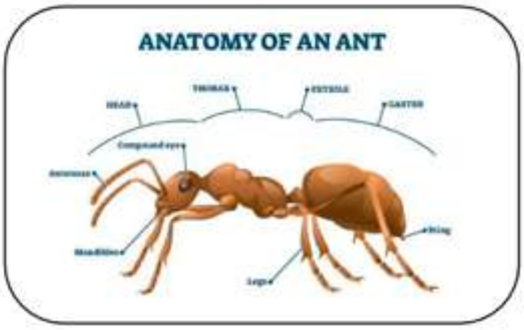
Relationships

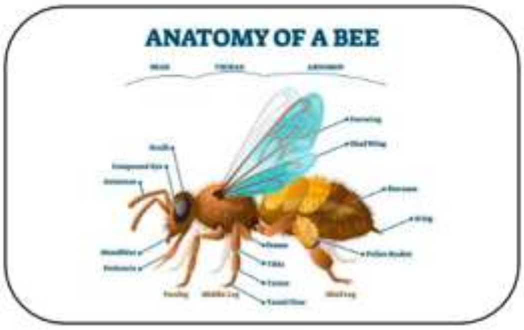
Who's Who and Who's New?

Use the chart below to help you compare your insects and identify their key features.









Insect Investigators

Insect Investigation: Desert Ecosystem

Desert Delma (*Delma desmosa*) © tom_brennan, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Military Dragon (*Ctenophorus isolepis*) © Gavin Goodyear, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Spinifex Pigeon (*Geophaps plumifera*) © Gavin Goodyear, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Echidna (*Tachyglossus aculeatus*) © Joe Carmichael, iNaturalist, used under a Creative Commons license (CC0).

Australian Golden Orbweaver (*Trichonephila edulis*) © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Perentie (*Varanus giganteus*) © Bruce McLennan, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Insect Investigation: Rainforest Ecosystem

Pale Hunter *(Austrogomphus amphiclitus)* © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Black flying fox large *(Pteropus alecto)* © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Common Brown Ringlet *(Hypocysta metirius)* © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Dark Barsided Skink *(Concinnia martini)* © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Green-Eyed Tree Frog (Ranoidea serrata) © RichardReams, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Metallic Starling (Metallic) *(Aplonis metallica ssp. metallica)* © baronsamedi, iNaturalist, used under a Creative Commons license (CC0).

Insect Investigation: Bushland Ecosystem

Sulphur-crested Cockatoo (*Cacatua galerita*) © Stephen Matthews, iNaturalist, used under a Creative Commons license (CC0).

Common Grass-Blue (*Zizina otis*) © Pam Whetnall, iNaturalist, used under a Creative Commons license (CC-BY-NC).

Long-nosed Water Dragon (*Gowidon longirostris*) © Gavin Goodyear iNaturalist, used under a Creative Commons license (CC-BY-NC).

Superb Fairywren (*Malurus cyaneus*) © Claudia Schipp, iNaturalist, used under a Creative Commons license (CC0).

Australian Wood Frog (*Papurana daemeli*) © Richard Fuller, iNaturalist, used under a Creative Commons license (CC0).

Eastern Grey Kangaroo (*Macropus giganteus*) © Claudia Schipp iNaturalist, used under a Creative Commons license (CC0).

Survey of Insect Population around MVAC.
Upload all insects to the iNaturalist app for identification.

Location & Date (Coordinates if possible)	Description of habitat	Taxonomy of Insect	iNaturalist Data

Insect Investigators

Amazing Adaptations

Using the arthropods you collected, and your habitat assessment sheets, complete the chart below to identify key features you think show how they have adapted to their habitat. Include a photograph or a sketch of at least 3 arthropods.

1. Name: ____________________

(Check the identification chart on the Insect Investigators website)
List 2 features that indicate this arthropod has adapted to their habitat.

____

____

How do you think these features help them to live within their habitat and the wider ecosystem? Use what you know about the habitat to justify your answer.

____

____

____

2. Name: ____________________

(Check the identification chart on the Insect Investigators website)
List 2 features that indicate this arthropod has adapted to their habitat.

____

____

How do you think these features help them to live within their habitat and the wider ecosystem? Use what you know about the habitat to justify your answer.

____

____

____

3. Name: ____________________

(Check the identification chart on the Insect Investigators website)
List 2 features that indicate this arthropod has adapted to their habitat.

____

____

How do you think these features help them to live within their habitat and the wider ecosystem? Use what you know about the habitat to justify your answer.

____

____

____

It is important to collect a full data set by sharing primary data with your fellow students. Ensure that your tables have all data to enable you to calculate means and ranges.

Utilise links such as the [Atlas of Living Australia]

How do the abiotic data effect the biotic data? (hint: how do the soil, air, and geography influence vegetation and can you then relate to the animal population?)

____

____

____

____

Are there sufficient habitat elements for turtles and foxes?

____

____

Have you found any evidence of the target species?

____

____

Is there diversity evident in the vegetation that may support a wide range of food for the turtle?

____

____

Are there potentially enough habitat space requirements for loggerhead turtles/quolls and red foxes?

____

____

If you found no evidence of quolls/turtles, discuss the reasons for this? (Lack of habitat? Competition? Predation? Human Impacts? Other threats?

____

____

____

____

____

____

Is there a Fox Threat Abatement Plan and a recovery plan for the quolls and/or turtles?

____

____

____

____

____

____

____

____

Outline your recommendations to improve or manage the site as a habitat for the loggerhead turtle and the quoll.

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

How can Australia reduce extinction rates of our native animals?

____

____

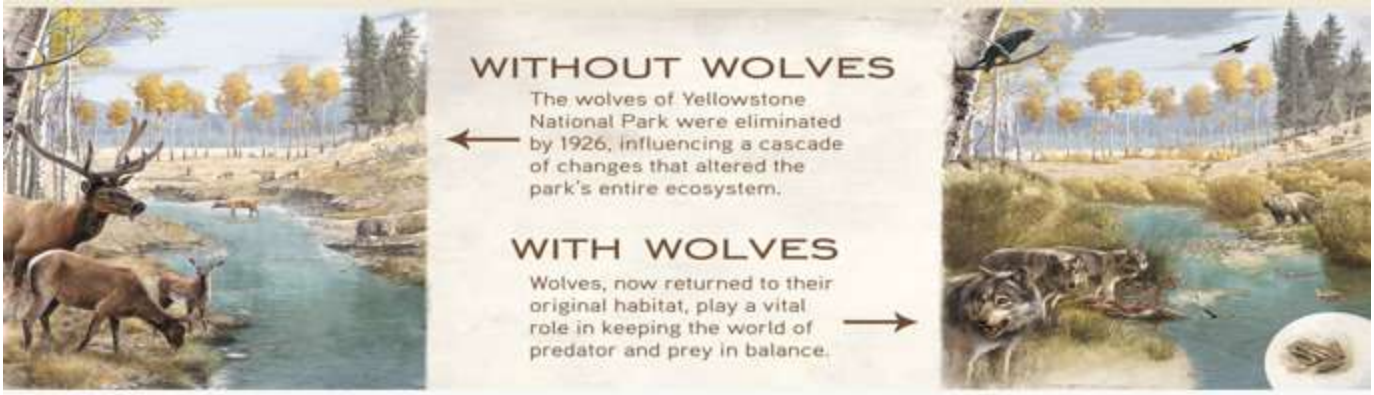
____

Why is it important to ensure that native animals survive in the Australian landscape?
Use evidence to support your argument.

____

Yellowstone Ecosystem With and Without Wolves Evidence:
How did the ecosystem change when the wolves returned to Yellowstone?

Without Wolves	With Wolves
How has the absence of gray wolves affected the components of an ecosystem?	How has the presence of gray wolves impacted the components of the Yellowstone ecosystem?



Watch the following video. Add more evidence to your table as you watch.
https://youtu.be/ysa5OBhXz-Q

Please visit https://www.livingwithwolves.org/about-wolves/why-wolves-matter and **https://yellowstoneinfo.weebly.com/predator-prey-relationships.html**

Make sure to scroll down the page to gather information

Find another example of an ecosystem being impacted by the removal of a keystone species. In a drawing, show how the removal impacts other species

____

____

____

____

____

____

____

____

____

What happened to the deer (elk) when the wolves were brought back to Yellowstone in 1995?

- The wolves made the deer increase in population.
- The wolves made the deer decrease in population.
- The wolves did not make any change to Yellowstone.

Wolves made the water quality of rivers, streams, and lakes better in Yellowstone.

- True
- False

What happened to the Aspen Trees when the wolves returned to Yellowstone?

- Aspen trees did not grow.
- Aspen trees stayed the same.
- Aspen trees grew to full maturity.

Define trophic cascade.

____

____

____

____

What effect would the removal of a keystone species, like the wolves, have on an ecological community? (hint: use the word trpphic cascade)

____

____

____

____

____

____

Give at least ONE alternative reason besides the wolves, that caused this area of Yellowstone to flourish again.

____

____

Explain why this alternative reason could have caused the change and not the wolves.

____

____

____

____

Soil Glossary:

Humus: decomposed organic matter that is dark brown/black in colour. It is a colloid and reactive, cementing soil particles together thus, improving a soils structure. It has a negative surface charge, high water holding capacity (WHC), high cation exchange capacity (CEC) and encourages microbial activity.

Parent material: the material that soil develops from. It may be rock that has decomposed in place, or eroded material that has been deposited by wind, water, or ice. The nature of the parent material strongly influences soil properties such as texture, pH, fertility, and mineralogy. For example, coarse-grained, quartz-rich parent material such as glacial outwash generates gravely soils with a coarse (sandy) texture.

pH: (potential of hydrogen) is a scale of acidity from 0 to 14. It indicates how acidic or alkaline a substance is. More acidic solutions have lower pH while more alkaline solutions have higher pH. Substances that are not acidic or alkaline have a pH of 7 and are termed neutral. Each one- unit change in the pH scale corresponds to a ten-fold (logarithmic) change in hydrogen ion concentration.

Soil: thin outer layer covering the earth (lithosphere). Made up of five components:

- Mineral particles (sand, silt and clay);
- Organic Matter- dead and decaying plants animals and animal products
- Water
- Gas- this fills the spaces (pores) between soil particles
- Organisms- living organisms such as macro and micro invertebrates, bacteria, fungi and protozoa.

Soil horizon: A soil horizon makes up a layer of soil. The horizon runs roughly parallel to the soil surface and has different properties and characteristics than the adjacent layers above and below. Characteristics used to distinguish between horizons are obvious physical features, such as soil particles, colour and texture. Horizons are obvious in some soils, because changes in soil appearance are abrupt, however, in many soils the change is more gradual and horizons are hard to distinguish. Horizons are categorised as the following:

- O horizon (surface organic litter) This is the layer of organic matter sitting on top of the soil. It tends to be deepest in undisturbed forest environments.
- A1 horizon (topsoil). This is the surface soil, referred to as topsoil. It has the most organic matter and biological activity of any of the horizons. The decayed organic matter (humus) darkens the soil colour.
- A2 horizon (topsoil). This layer is not present in all profiles. It frequently has a pale, bleached appearance and is poorly structured. Bleaching is an indication of periodic waterlogging often due to formation of a 'perched' watertable above a relatively impermeable subsoil.
- B horizon (subsoil). This horizon frequently has more clay than topsoil. In clay soils, the difference in clay content between the A and B horizons is less than those for other soils, such as the red brown earths, where the topsoil is loamy or sandy.
- C horizon (weathering rock). This layer may be very deep, and may not be present in the root zone of many vegetable-growing soils.

Soil profile: A soil profile is a vertical section of the soil that depicts all of its horizons. It allows you to examine the layers of the soil from the surface down to the rock or sediment from which the soil was formed (parent material).

Soil salinity: both soil salinity and sodicity are caused by accumulation of too much salt in the soil. Salinity is the presence of soluble salts in the soil solution. Elements contributing to salinity include cations: Sodium (Na+), Magnesium (Mg2+), Potassium (K+), Calcium (Ca+), Ammonium (NH_{4+}); and anions Chloride (Cl-), Sulphate (SO4 2-), Carbonate (CO3 2-), Bicarbonate (HCO3 -) and Nitrate (NO3 2-).

Soluble salts occur naturally in Australian soils; however the accumulation of these salts can be amplified through inefficient irrigation practices or inefficient fertiliser usage. Excess soluble salts in the root zone reduce plant growth through osmotic stress or specific ion toxicities.

Soil sodicity: caused by the presence of sodium (Na+) (cation) attached to clay in soil. A soil is considered to be sodic when the sodium reaches a concentration where it begins to affect soil structure. The sodium weakens the bonds between soil particles. When the soil is wetted the clay particles become detached and spread out (disperse). The soil solution will appear cloudy and the soil structure will be poor. Water infiltration, gas exchange and drainage can be negatively affected by dispersed clay particles. Sodic soils are very prone to erosion.

Soil structure: Structure refers to the arrangements of soil particles. It describes the way which the sand, silt and clay peds are arranged or aggregated. Structure influences the amount and nature of porosity, affects tilling capability, nutrient retention, drainage, water holding capacity (WHC) and root penetration. Structure can be degraded or improved through farming practice.

Soil texture: Texture refers to the proportion of sand, silt and clay sized particles that make up the mineral fraction of the soil. Texture influences the soils minerology, ability for draining, WHC, nutrient retention and CEC, tilling workability and root penetration. Soil texture cannot easily be naturally altered.

References and Further Reading:

Cation exchange capacity
Jenkins, A 2007, "*Cation exchange capacity*", NSW Department of Primary Industries, https://www. dpi.nsw.gov.au/agriculture/soils/structure/cec, viewed 23 February 2018

Diagnosing Soil Condition
Nachimuthu, G 2007, "*Cotton Part C Diagnosing Soil Condition*", SOILpak for cotton, NSW

Department of Primary Industries,
https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/167499/soilpak- cotton-Part-C.pdf, viewed 20 February 2018

Dryland salinity- causes and impacts
Podmore, C 2009, "*Dryland salinity- causes and impacts*", Primefact 936, https://www.dpi.nsw. gov.au/__data/assets/pdf_file/0006/309381/Dryland-salinity-causes-and-impacts.pdf, viewed 26 February 2018

Features of soil
Parker, M 2007, "*Features of soil*", SOILpak for vegetable growers, NSW Department of Primary Industries,
https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/127215/Features-of-soil. pdf, viewed 23 February 2018

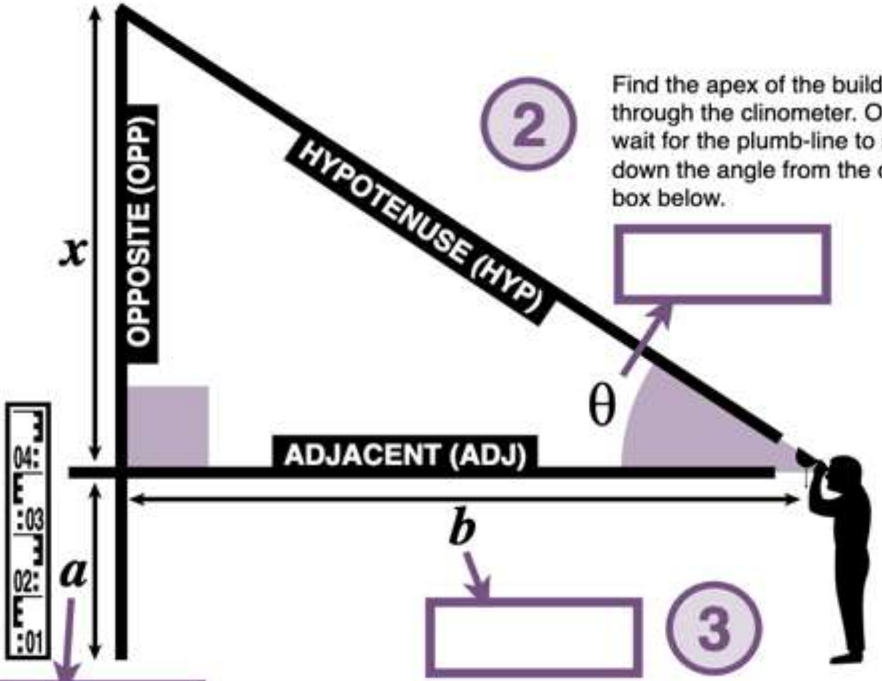
Calculating the height of a building

http://www.virtualmaths.org/activities/shapes/theod2

Virtual*maths*

www.virtualmaths.org

We're going to use a clinometer to find the total height of a building.
First assemble the attached clinometer and continue with this activity.



2 Find the apex of the building by looking through the clinometer. Once you've found it, wait for the plumb-line to settle and note down the angle from the clinometer in the box below.

3 Find an area on the ground directly beneath the plumb-line and mark it with an object, like a coin.
Now measure the distance between the marker and the building, and write the measurement in the box above.

Set up the levelling staff, or the measuring tape on the wall of the building you want to find the height of.

1 Stand as far back as you need to, so you can clearly see the apex of the building.
Look though the clinometer at the leveling staff or measuring tape, **making sure the the angle on the clinometer reads 0**. Now take the reading and write it in the box above.

We know that...

$$\text{Tan } \theta = \frac{\text{OPP}}{\text{ADJ}}$$

We want to work out the height of **OPP**, so we need to make **OPP** the subject of the above equation.

We can do that by multiplying both sides by **ADJ**, which will cancel out the **ADJ** on the right side of the equation.

$$\text{ADJ} \times \text{Tan}\,\theta = \cancel{\text{ADJ}}\left(\frac{\text{OPP}}{\cancel{\text{ADJ}}}\right)$$

Now we have...

$$\text{OPP} = \text{ADJ} \times \text{Tan}\,\theta$$

So...

$$x = \text{ADJ} \times \text{Tan}\,\theta$$

What is x ?

....

To find the height of the building, add x to height a that you found earlier

height = ...

Calculating the height of a building

http://www.virtualmaths.org/activities/shapes/theod2

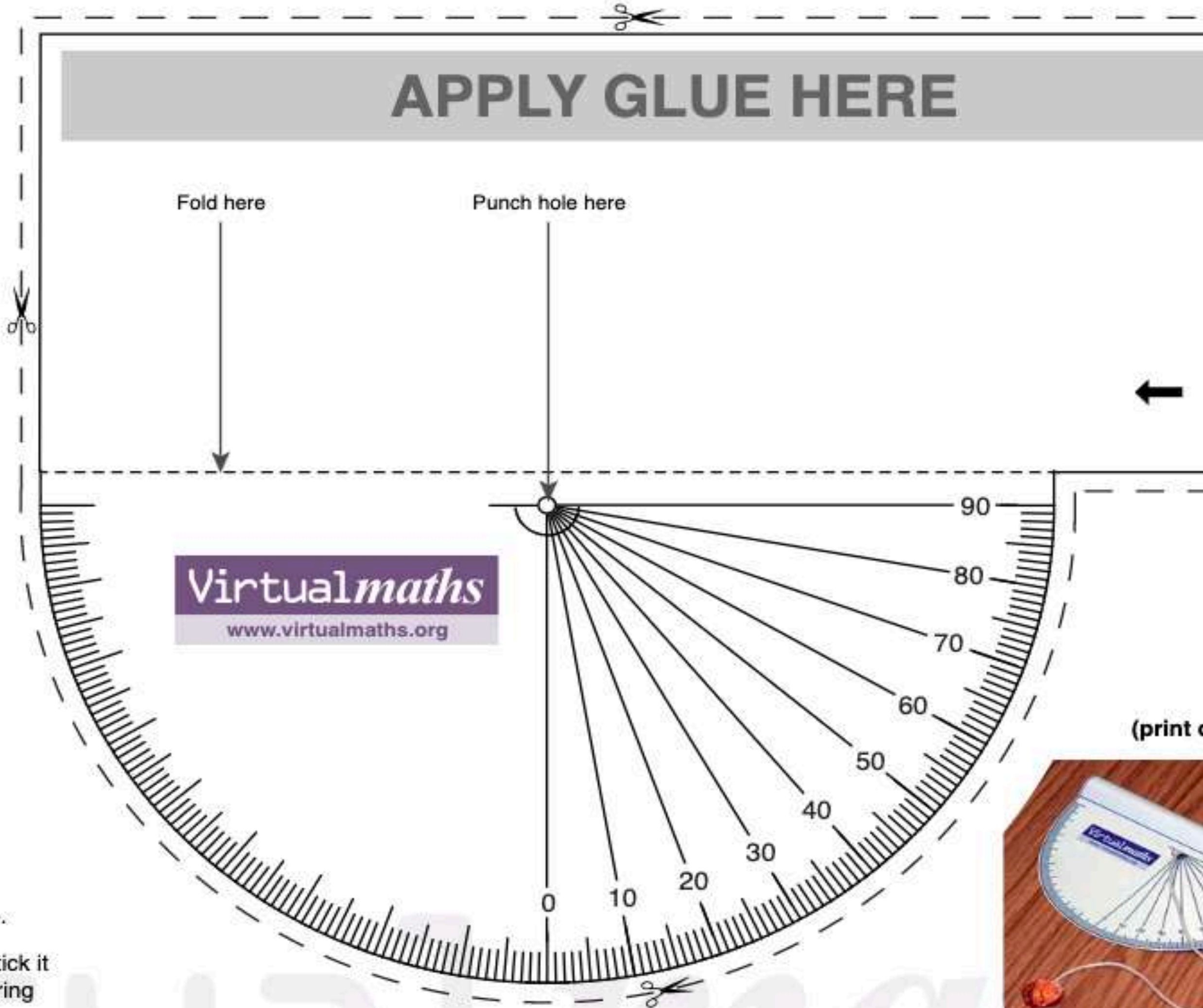
Virtual*maths*
www.virtualmaths.org

DIY CLINOMETER

Things you'll need

- Some string
- A coin or similar weight
- Scissors
- Glue
- Adhesive tape

1. Cut along the dashed line and separate the clinometer shape from this template sheet.
2. Carefully punch a hole at the center point of the protractor. Make sure the hole is just large enough to pass your piece of string through - the larger the hole, the less accurate the readings!
3. Now fold along the line that attaches the rectangle shape to the protractor, creating a hinge.
4. Apply some glue to the gray marked area and roll the rectangle to form your scope.
5. Apply some adhesive tape to the scope hinge to add strength.
6. Cut off about a foot length of string and thread it through the hole you created earlier. Now take the length you passed through and tie some knots in it so it is held in place and can't pass back through the hole.
7. Take a coin or another weighted object and stick it with adhesive tape, to the other side of the string creating a plumb-line.



(print on card)

Calculating the height of a building

http://www.virtualmaths.org/activities/shapes/theod2

Virtualmaths

www.virtualmaths.org

TAN TABLE

Angle	tan	Angle	tan	Angle	tan	Angle	tan	Angle	tan	Angle	tan
0°	0.00	15°	0.2679	30°	0.5773	45°	1.000	60°	1.7321	75°	3.7321
1°	0.0175	16°	0.2867	31°	0.6009	46°	1.0355	61°	1.8040	76°	4.0108
2°	0.0349	17°	0.3057	32°	0.6249	47°	1.0724	62°	1.8907	77°	4.3315
3°	0.0524	18°	0.3249	33°	0.6494	48°	1.1106	63°	1.9626	78°	4.7046
4°	0.0699	19°	0.3443	34°	0.6745	49°	1.1504	64°	2.0503	79°	5.1446
5°	0.0875	20°	0.3640	35°	0.7002	50°	1.1918	65°	2.1445	80°	5.6713
6°	0.1051	21°	0.3839	36°	0.7265	51°	1.2349	66°	2.2460	81°	6.3138
7°	0.1228	22°	0.4040	37°	0.7535	52°	1.2799	67°	2.3559	82°	7.1154
8°	0.1405	23°	0.4245	38°	0.7813	53°	1.3270	68°	2.4751	83°	8.1443
9°	0.1584	24°	0.4452	39°	0.8098	54°	1.3764	69°	2.6051	84°	9.5144
10°	0.1763	25°	0.4663	40°	0.8391	55°	1.4281	70°	2.7475	85°	11.430
11°	0.1944	26°	0.4877	41°	0.8693	56°	1.4826	71°	2.9042	86°	14.301
12°	0.2126	27°	0.5095	42°	0.9004	57°	1.5399	72°	3.0777	87°	19.081
13°	0.2309	28°	0.5317	43°	0.9325	58°	1.6003	73°	3.2709	88°	28.636
14°	0.2493	29°	0.5543	44°	0.9657	59°	1.6643	74°	3.4874	89°	57.290
										90°	infinite