

SECTION 8



Work sheets and Q&A sheets

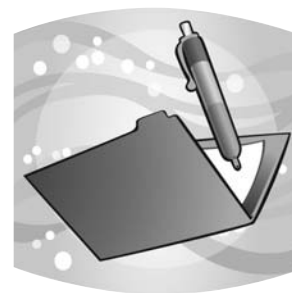
The work sheets in this section are designed to introduce students to some key concepts. Some are best used in the classroom setting prior to going on a field trip, while others can be used before, during or following a site visit.

A Q&A is also provided to assess and/or reinforce students' understanding of the water quality tests used in the Waterwatch program.

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8.1 Graph the results of investigations work sheet



Graph the results:

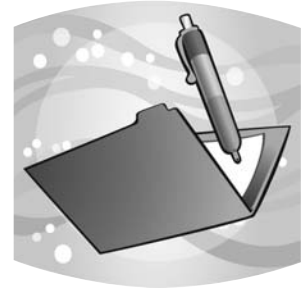
.....
(enter a title here that includes the dependent and independent variables)

What I measured

.....
(dependant variable, e.g. EC)

What I changed
(independent variable, e.g. site, time of day)

8.3 Investigations at the waterway: evaluation work sheet



What were the main sources of experimental error?

(sample size and selection, measurement error, poor control of variables)

.....

.....

.....

How confident are you with your conclusions?
How much uncertainty/error is associated with your data?

.....

.....

.....

How could the design of the experiment be improved to reduce error?

.....

.....

.....

What have you learned about the topic of your investigation?
Was the outcome different from your prediction? Explain.

.....

.....

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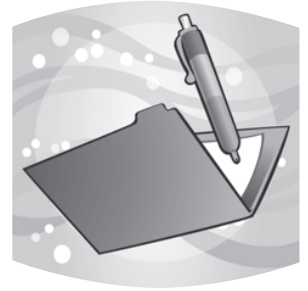
What have you learned about the methods of investigating in science?

.....

.....

.....

8.4 Water quality tests: what do they mean? Q&A answers for teachers



The following questions and answers refer to information in the Waterwatch Field Manual about water quality parameters. It is important for students to know what they are testing, why they are testing and the management needed to reduce any negative impacts. A work sheet for students, containing the questions only, is provided in Section 8.5.

Teachers may use the Q&A for:

- class discussion **prior to** a visit to the waterway
- reviewing testing activities **at** the waterway
- reviewing testing activities **after** you test
- developing an investigation question
- work done in conjunction with models and experiments about these issues
- part of your class study of catchments and water quality
- the design of a school environmental management plan to reduce water quality problems in the catchment in relation to your school.

Answers for teachers

Temperature

What is it?

A measure of how hot or cold the water is.

How do we measure it?

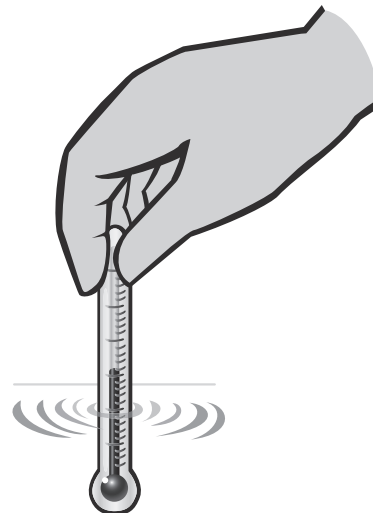
Using a thermometer

Units of measurement?

Degrees Celsius (°C)

What influences it?

- *Shade/sunlight*
- *Water depth*
- *Vegetation cover*
- *Turbidity*
- *Flow*
- *Seasonality*
- *Time of day*



Important notes ...

Each animal and plant has a preferred temperature range in which it can survive. Temperature change has a major influence on biological activity and the growth of aquatic organisms.

pH

What is it?

pH is a measure of how acidic or alkaline a substance is.

How do we measure it?

Using pH strips (Universal Indicator)

Units of measurement?

pH units



What influences it?

- Geology
- Acid sulfate soils
- Characteristics of the catchment
- Urban runoff/stormwater
- Sewage
- Detergents and fertilisers
- Industrial waste

Important notes ...

The optimal pH for most organisms (plants and animals) in Australian freshwaters is 6.5 to 8.5. Levels of pH outside this normal range will cause a reduction in species diversity, as the more sensitive species disappear.

Electrical conductivity (EC)

What is it?

A measure of the amount of electric current that can be passed through the water sample. This is a measure of salinity.

How do we measure it?

Using an electrical conductivity meter (EC meter)

Units of measurement?

Millisiemens per centimetre (mS/cm) EC high range meter

Microsiemens per centimetre (μ S/cm) EC low range meter

1 mS/cm = 1000 μ S/cm



What influences it?

- Removal of vegetation
- Mining/industry
- Stormwater and agricultural runoff
- Poor irrigation practices
- Sewage effluent discharge
- Rising water table
- Geology
- Characteristics of the catchment

Important notes ...

Many species can only survive in a very narrow range of salt concentration.

The removal of deep-rooted vegetation causes the water table to rise.

Tank water is ~ 100 $\mu\text{S}/\text{cm}$ and sea water is ~ 65,000 $\mu\text{S}/\text{cm}$.

Turbidity**What is it?**

Turbidity is a measure of the cloudiness or muddiness of the water. The more silt and sediment in the water, the higher the turbidity.

How do we measure it?

With a turbidity tube

Units of measurement?

NTU = Nephelometric Turbidity Units

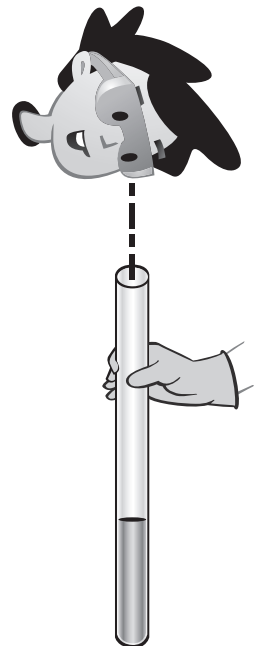
What influences it?

- River/stream bank erosion
- Rural and urban runoff
- Removal of vegetation
- Algal growth
- Heavy rain or floods
- Stormwater
- Animal access to waterways, in particular livestock

Important notes ...

High turbidity can:

- suffocate aquatic organisms by clogging or damaging gills and mouthparts
- reduce light penetration to aquatic plants, decreasing the rate of photosynthesis
- smother aquatic plants as sediments settle in areas where water flow slows.



Available phosphate

What is it?

A measure of the phosphate compounds that are soluble in water and therefore available to be absorbed by plants.

Phosphorus (P) + 4 x Oxygen (O) = Phosphate (PO₄)

How do we measure it?

Using a colorimeter – DC1200 or SMART or SMART2

Units of measurement?

Parts per million (ppm)

Note: ppm is equivalent to mg/L.

What influences it?

Sources of phosphate compounds in a waterway may be:

- *sediment from erosion*
- *manure from feedlots, dairies and pet droppings*
- *sewage*
- *phosphate-based detergents*
- *decaying plant material*
- *fertilisers*
- *industrial waste.*

Important notes ...

Phosphorus occurs naturally in low concentrations in Australian soils and water.

Native vegetation (both aquatic and terrestrial) has adapted to these low levels.

In contrast, many introduced plants and weeds are adapted to higher phosphorus levels.

Consequences of high phosphate levels are:

- *an abundance of algae and aquatic weeds (e.g. blue-green algal blooms)*
- *waterways choked with vegetation, resulting in reduced light penetration*
- *reduced dissolved oxygen, which can lead to eutrophication and fish kills*
- *reduced animal and plant diversity (exotic species are favoured, to the detriment of native species).*

Dissolved oxygen

What is it?

Dissolved oxygen (DO) is the volume of oxygen gas (O₂) contained in the water.

Note: It is not the O in H₂O.

How do we measure it?

Winkler titration method



Units of measurement?

Milligrams per litre (mg/L) and per cent saturation (% sat.)

What influences it?

Oxygen enters the water:

- as a waste product from the photosynthesis of aquatic plants and algae
- via the transfer of oxygen across the water surface
- through wave action, waterfalls and riffles.

Oxygen is lost from water when:

- water temperature rises
- salinity increases
- plants and animals increase respiration
- micro-organisms are feeding on decaying organic matter (e.g. sewage, leaf litter).

Important notes ...

DO levels are highest in the afternoon as plants photosynthesise during the day.

Very low oxygen levels can lead to fish kills.

Faecal coliforms/*E. coli***What is it?**

Faecal coliforms are naturally occurring bacteria found in the intestines of all warm blooded animals (including humans) and birds.

The presence of faecal coliforms is an indicator of contamination by sewage waste.

How do we measure it?

Faecal coliforms are measured by the number of colonies that grow per 100 mL of sample water. A sample is incubated for 24 hours and colonies can then be identified as pink or blue dots.

Units of measurement?

Number of colonies counted per 100 mL of sample water

What influences it?

Faecal coliforms enter a waterway in a number of ways, reducing the water quality and the ability to use water for primary contact. The main sources of faecal coliforms are:

- sewerage and septic systems
- feedlot and dairy runoff, i.e. from intensive farming
- runoff from broad acre farming
- stormwater carrying dog and cat droppings
- waterfowl and livestock defecating directly into the water.



Important notes ...

The presence of faecal coliforms can affect the use of water for primary contact.

Faecal coliform numbers can rise dramatically in wet weather as stormwater flushes manure and pet droppings into streams, and sewerage and septic systems overflow.

Faecal coliform limits for primary and secondary contact:

- **Primary contact** refers to activities where you are completely immersed in water, e.g. swimming, diving or surfing. The level of faecal coliforms should not exceed 150 faecal coliforms per 100 mL.
- **Secondary contact** refers to activities where you come into contact with water but are not completely immersed in it, e.g. boating and fishing. The level of faecal coliforms should not exceed 1000 faecal coliforms per 100 mL.

Above 1000 faecal coliforms per 100 mL no contact should be made with the water as serious illness may result.



8.5 Water quality tests: what do they mean? work sheet



Q&A

Answer the questions for each of the following water quality parameters and add some other useful points under 'Important notes'.

Temperature
What is it?
.....
How do we measure it?
.....
Units of measurement?
.....
What influences it?
.....
Important notes ...
.....

pH
What is it?
.....
How do we measure it?
.....
Units of measurement?
.....
What influences it?
.....
Important notes ...
.....

Electrical conductivity (EC)
What is it?
.....
How do we measure it?
.....
Units of measurement?
.....
What influences it?
.....
Important notes ...
.....

Turbidity
What is it?
.....
How do we measure it?
.....
Units of measurement?
.....
What influences it?
.....
Important notes ...
.....

Available phosphate

What is it?

How do we measure it?

Units of measurement?

What influences it?

Important notes ...

Dissolved oxygen

What is it?

How do we measure it?

Units of measurement?

What influences it?

Important notes ...

Faecal coliforms/E.coli

What is it?

How do we measure it?

Units of measurement?

What influences it?

Important notes ...



8.6 Climate change: water quality and habitats work sheet



Name:

Date:

Select **one** aspect of climate change that might affect water quality.

Describe what could happen as a result of this change.

.....

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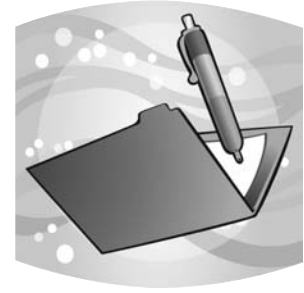
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Name **one** water bug that may need to adapt to this change.

.....



8.7 Adaptation to climate change work sheet



Name:

Date:

How a water bug or a plant might adapt to
climate change at my site

1. Draw a plant or animal that lives at your site.
2. Add the new features that may help it to survive in a new climate.
3. Label the new features.
4. Explain how the new features will help the plant or animal to survive.
5. Make a model of your animal or plant in its new environment.

8.8 Activity futures wheel work sheet

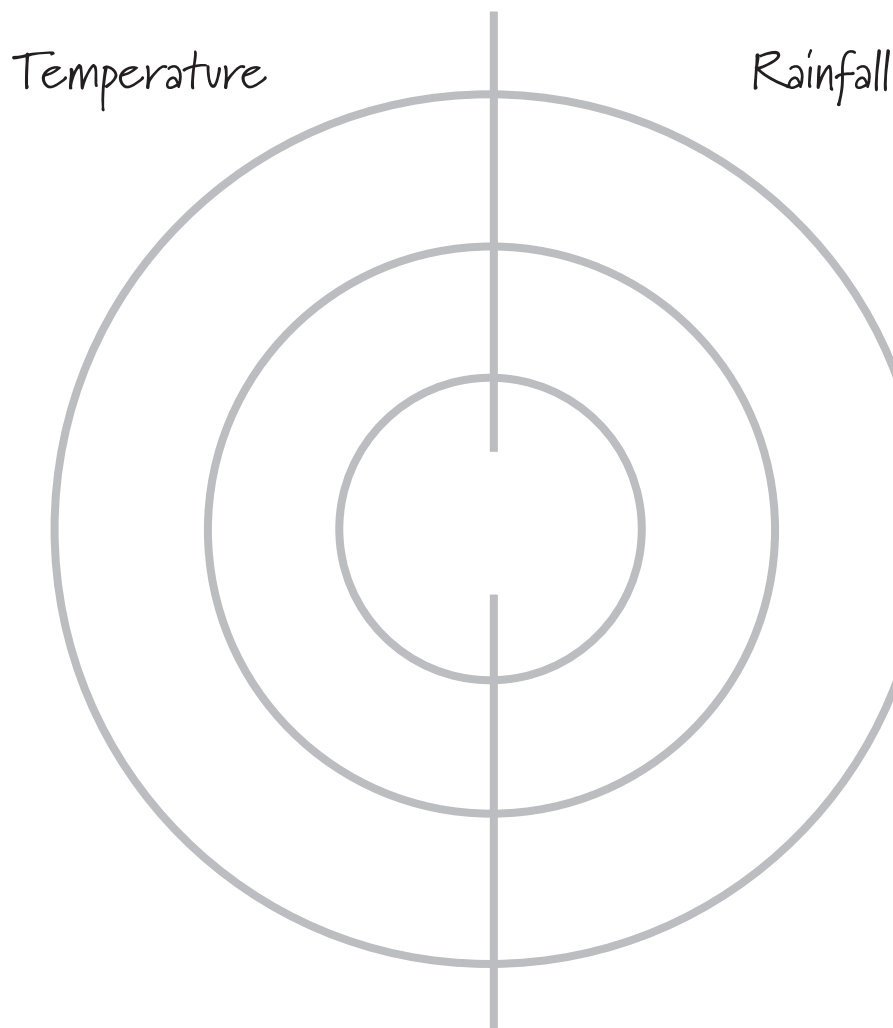


On the diagram below show **one** possible impact of climate change.

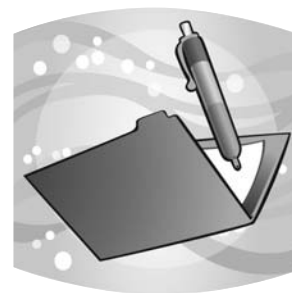
Write the impact selected in the centre of the circle.

Show the direct and indirect effects of the impact you have chosen on temperature and rainfall by following the directions below.

1. Write the **immediate** effects of the impact in the inner circle, around or below the chosen impact.
2. Use the inner ring to show the **direct** effects that changes in water quality resulting from the impact and its immediate effects might have on plants and animals at your site.
3. Use the outer ring to show **indirect** effects at your site and beyond.



8.9 Develop an action plan for your site work sheet



1. What can be protected or improved?

.....

2. What is your vision for this site in the future?

.....

3. What do **you** want to change, protect or improve?

.....

4. Who can be involved?

.....

Actions

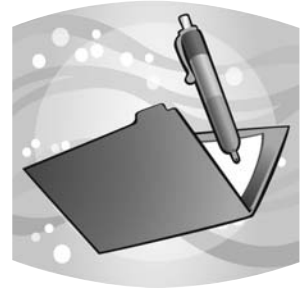
List the steps taken to improve or protect your site:

Actions	Who?	When? (date)

Telling the world

Write a report for your local newspaper, Catchment Management Authority or council or do a presentation at your school assembly.

8.10 Classifying water bugs by structural features work sheet



Name:

Date:

Water bugs that live at your local creek can be identified by their features. This will also provide an indication of how they move, what they eat and their life cycle.

Use the example below to develop a better understanding of the structural features of water bugs. Add the features to each box. Are there additional features that will help you identify this water bug? Use the water bug detective guide in the *Waterwatch field manual* to help with your description.

Example: Damselfly nymph

Mouthparts
(e.g. predators have scoop-like mouths)

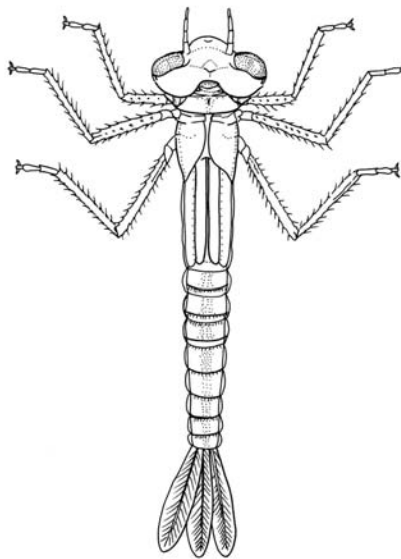
- Body shape**
Length, thickness

- Nymph or larva**

- How they move**
e.g. legs, suction cups

- Wings developing?**

- Position of legs**



- Hairy or smooth**

- Size of legs**

- Shell or no shell**

- Length (mm)**

- Colour**

- Number of tails**

Based on the structural features identified:

- Describe the damselfly nymph.

.....

.....

- Comment on its method of getting around and the stage of its life cycle.

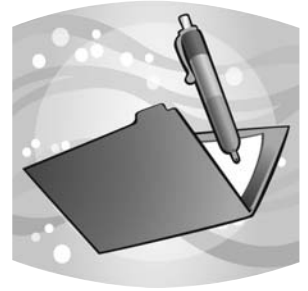
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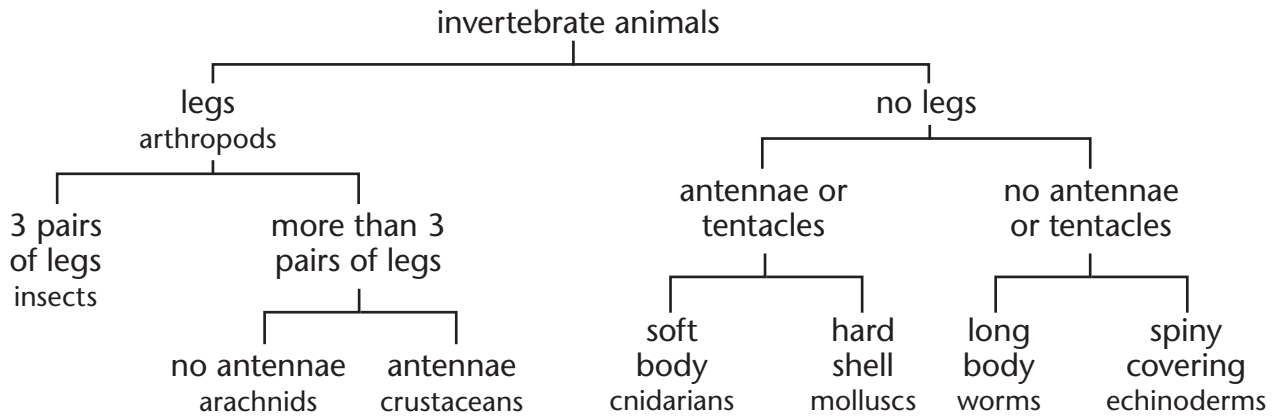
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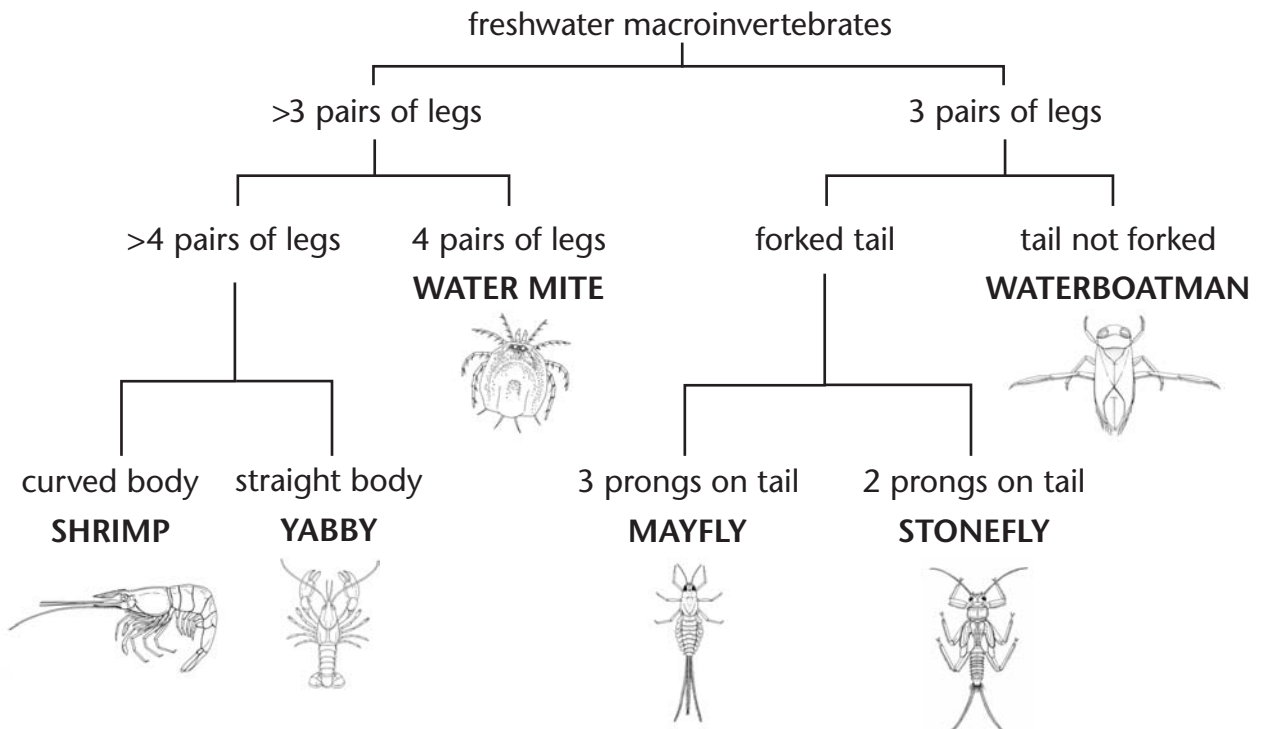
8.11 Identifying water bugs: using simple keys work sheet



Below is a simple classification for invertebrate animals.



Using the generalised key above, a more detailed key can be developed for freshwater macroinvertebrates:



1. Choose **one** water bug from the key above and describe its structural features.

.....

.....

.....

2. Using the examples above and the freshwater macroinvertebrate key provided, draw up a key for a macroinvertebrate that you have found at the waterway.



Describe its features based on the key.

.....

.....

.....

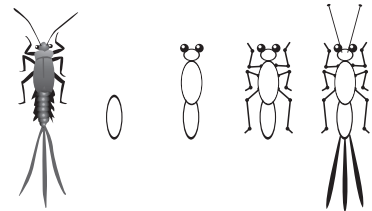
8.12 Introduction to scientific drawing work sheet



My favourite water bug

Procedure

1. Collect water bugs from your local waterway.
2. Select a water bug to draw.
3. Use simple shapes to put together a drawing of your bug:
 - How long is your bug (include antennae and tails)?
Write the length on the side of the frame.
 - Draw the body shape of your bug.
 - Count and draw the other body parts (insects usually have 3).
 - Count the legs and draw them in the right place.
 - Draw in the antennae and tails.
 - Label the main features.



The bug you have drawn will be larger than its real size. Indicate the real size of the bug (scale) by labelling the arrow to the right of the box.

Scientific drawing of a water bug



.....
Size in mm

Date:

Collection-site:

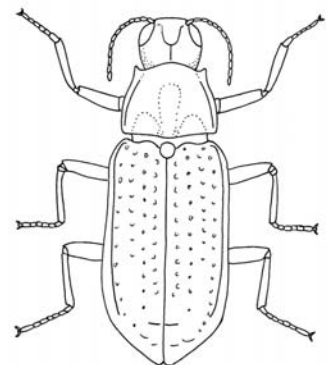
Common name:

Habitat:

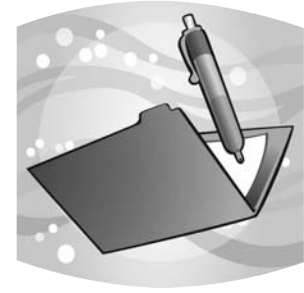
Special features:

.....

.....



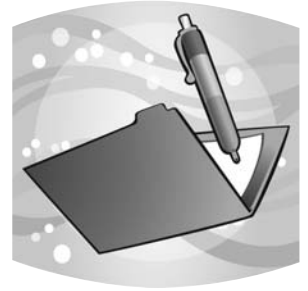
8.13 Food chains: diets of common aquatic species work sheet



From the list of common aquatic species below, draw up a food chain that may occur at your local waterway.

Aquatic species	Main diet
Damselfly	Other adult insects
Dragonfly	Other adult insects
Frog	Insects, water worms, snails, slugs, worms
Mayfly	Does not eat since it only lives for a day or two; it uses the energy gained when it was a nymph
Algae/water plants	Sunlight
Caddisfly larva	Microscopic plants, algae, microscopic fungi, small particles of dead plants
Damselfly nymph	Tadpoles, young fish, freshwater shrimps, water lice and beetles
Water plants	Sunlight
Dragonfly nymph	Tadpoles, young fish, freshwater shrimps, water lice and beetles
Duck	Pondweed, large water plants, insects, tadpoles, small fish, pond snails
Flatworm	Water lice, water mites, microscopic animals, tadpoles and caddisfly larvae
Freshwater shrimp	Microscopic fungi, small particles of dead plants
Diving beetle	Water fleas, midge larvae, pond snails, nymphs, flatworms, leeches, water boatmen
Pelican	Fish, frogs, tadpoles, larger insects, turtles
Leech	Insect nymphs, tadpoles, flatworms, water lice, pond snails, midge larvae
Mayfly nymph	Microscopic fungi, microscopic animals and plants, small particles of dead plants
Midge larva	Microscopic plants, small particles of dead plants
Snail	Large water plants and algae
Water boatman	Tadpoles, freshwater shrimps, aquatic worms, midge larvae
Water mite	Body fluids of beetles, water boatmen, insect nymphs
Aquatic worm	Microscopic fungi, small particles of dead plants

8.14 Water bug investigation work sheet



Name:

Date:

1. What am I going to investigate? (*what it eats, where it lives, how it moves?*)

.....

2. How will I investigate the question?

.....

3. What procedure will I follow to collect water bugs from the river or creek and investigate the question?

.....

.....

4. What will I need to help me with this investigation?

.....

5. Draw your water bug using scientific drawing skills.

6. How will I make it a fair test?

.....

7. What happened? Write down your results.

.....

8. Why did this happen?

.....

9. How could I improve the investigation?

.....

10. Can this information be used to make a more general comment about water bugs in your creek or river?

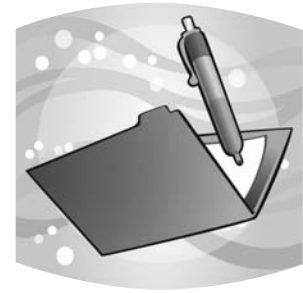
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Draw a water bug you have investigated



8.15 Life cycle of a dragonfly work sheet

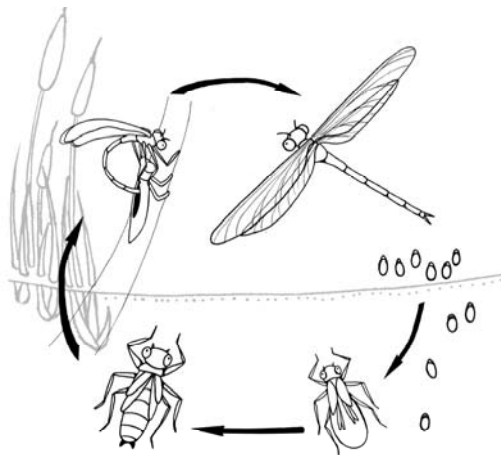


Name:

Date:

Number the pictures below according to the life cycle and match the information about each stage of the life cycle to these pictures.

Life Cycle of a Dragonfly



Life cycle stages

Egg	Nymph	Emerging adult	Adult
<p>Female dragonflies lay their eggs on the water or on plants that live on or near the water.</p>	<p>Dragonfly nymphs live underwater. They breathe through gills and eat small bugs that live in the river. As they grow they have to shed their skin each time it becomes too small.</p> <p>When dragonflies are completely grown, the nymphs climb up plants and shed their skin.</p>	<p>Dragonflies' bodies and wings grow rapidly once they emerge from their skin. The insect pushes blood into its 4 wings and they begin to get hard. In a few hours the dragonfly can fly.</p>	<p>The adult dragonfly lives out of the water. It stays near rivers and wetlands ready to lay its eggs.</p> <p>Dragonflies mate on the wing and can live up to 2 months.</p>

8.16 Life cycle of a mosquito work sheet



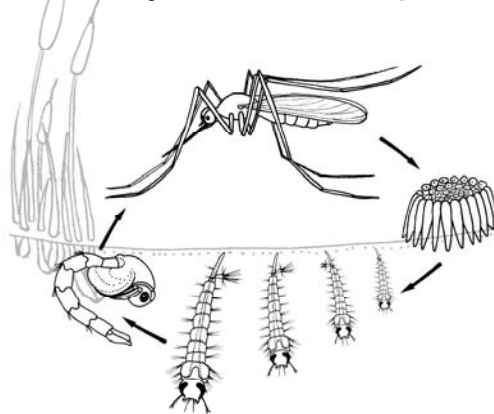
Name:

Date:

Mosquitoes undergo four distinct stages of development during a lifetime. The four stages are egg, larva, pupa and adult. The full life cycle of a mosquito takes about a month.

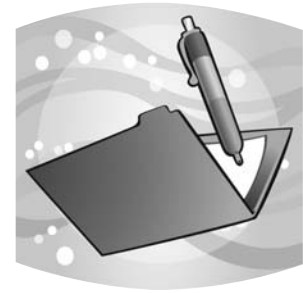
Label the four stages of the life cycle of a mosquito.

Life Cycle of a Mosquito



Egg	Larva	Pupa	Adult
<p>Mating occurs while flying. After drinking blood, adult females lay a raft of 40 to 400 tiny white eggs in standing water or very slow moving water.</p>	<p>Within a week, the eggs hatch into larvae (sometimes called wrigglers) that breathe air through tubes which they poke above the surface of the water. Larvae eat bits of floating organic matter and each other. Larvae moult 4 times as they grow; after the 4th moult, they are called pupae.</p>	<p>Pupae (also called tumblers) also live near the surface of the water, breathing through 2 horn-like tubes (called siphons) on their back. Pupae do not eat.</p>	<p>An adult emerges from a pupa when the skin splits after a few days. The adult lives for only a few weeks. Adult mosquitoes feed on nectar.</p>

8.17 Life cycle of a caddisfly work sheet

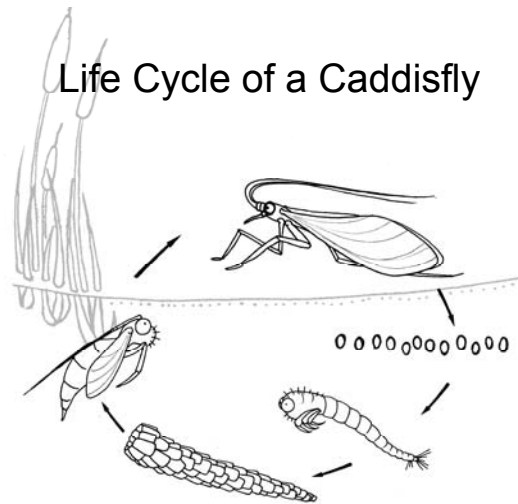


Name:

Date:

Caddisflies undergo four distinct stages of development during their lifetime. The four stages are egg, pupa, larva and adult.

Write labels for each stage of the life cycle.



Egg	Larva	Larva casing	Pupa	Adult
<p>Mating usually occurs on the ground or among shoreline vegetation. After fertilisation, the female skims over the water surface depositing eggs. The eggs are often bright green in colour and are usually laid in strands.</p>	<p>Larvae hatch and usually develop through 6-7 stages. As they grow, more material is added to the front of their protective casing.</p>	<p>Larvae make their casing by binding together small rocks, twigs, leaves or other material.</p>	<p>Pupation takes place underwater within the larval case or in a pupal case made from silk. The pupa looks much like the adult but with under-developed wings. Pupae swim to the surface for hatching.</p>	<p>The adult caddisfly emerges. Adult caddisflies do not feed.</p>