Junior Waterwatch Teachers' Guide

A guide for involving Stages 2–3 students in monitoring their local waterway

Waterwatch NEW SOUTH WALES
Communities Caring for Catchments

NSW GOVERNMENT
Environment, Climate Change & Water

Australian Government

Acknowledgements

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How to use this guide

This Junior Waterwatch Teachers' Guide and the accompanying Junior Waterwatch Field Manual have been designed to provide a complete guide to designing and implementing Waterwatch within primary schools in New South Wales, to meet curriculum outcomes.

The methods and procedures described combine best practice and scientific rigour with straight-forward instructions, to ensure students gain maximum benefit from participation while also contributing high quality data to the Waterwatch database. Such data becomes a valuable tool for natural resource managers to use in catchment planning.

This guide for teachers provides links to the curriculum and examples of how Waterwatch complements environmental education and sustainable schools initiatives. It incorporates information about designing and developing a Waterwatch program within schools and how to link activities to local community initiatives.

The guide is divided into numbered sections:

Section 1: Introducing Waterwatch and maintaining healthy waterways
Section 2: Organising a day at the waterway
Section 3: Templates and checklists
Section 4: Background to the water quality tests
Section 5: Background to the habitat assessments
Section 6: Background to the water bug survey
Section 7: Student fact sheets
Section 8: Student work sheets
Section 9: Experiments and models
Section 10: Curriculum links
Section 11: Glossary
Section 12: Bibliography

This teachers' guide is to be used in conjunction with the Junior Waterwatch Field Manual and contains cross-references to that document.

Learning by doing is often the best way. Waterwatch offers a way for your students to get involved in monitoring the health of their environment and to take part in managing local issues.

Congratulations on your involvement in Waterwatch!

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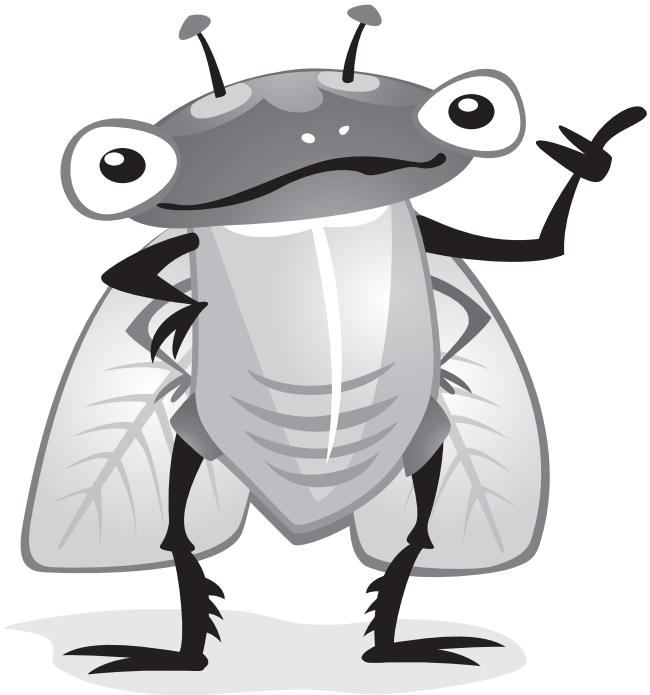
SECTION 1

Introducing Waterwatch and maintaining healthy waterways

Waterwatch develops an understanding of the sustainable use and management of catchments and the health of our waterways through hands-on discovery – based learning experiences. In this section you will be introduced to Waterwatch and its role in involving the community, including primary school students, in working together for healthy waterways.

Included in this section:



1.1 Welcome to Waterwatch!

Waterwatch helps the community, including school students, understand water quality issues and how to manage them within catchments to create healthy waterways and promote the sustainable use of this precious and limited resource.

WATERWATCH VISION:

Current and future generations empowered and actively involved in the sustainable use and management of catchments.

In Australia, climate change, drought and the pressure of population have all contributed to increasing pressure on our water resources. When waterways are degraded by natural or human factors, it not only reduces freshwater supplies, but it also affects aquatic ecosystems.

Waterwatch uses action learning methods, and by adopting an investigative approach, students can become involved in natural resource management within their local environment. Waterwatch engages communities by:

- raising awareness
- capacity building
- collection of quality assured community data
- participation in collaborative action
- building networks and partnerships.

Raising awareness

Waterwatch provides a range of programs, activities and events to raise awareness of water quality and sustainability issues. By promoting sustainable rivers and healthy catchments, Waterwatch aligns with key sustainability principles.

Capacity building

Waterwatch develops knowledge, skills and understanding of natural resource management issues by involvement in the care and management of local environments. This participatory approach to teaching and learning promotes quality teaching within schools and community involvement in local issues.

Within schools, Waterwatch provides teachers with resources and professional development opportunities that help link the school curriculum to current water and natural resource management issues. By developing partnerships with a broad cross-section of the catchment community, Waterwatch provides a wealth of learning experiences.

Collection of quality assured community data

Waterwatch provides a framework to support groups to develop and implement a monitoring plan that leads to the collection of quality assured community data. The data confidence standards of Waterwatch mean that the data can then be used for local natural resource planning and decision-making for on-ground action. Water quality data is stored on the NSW Waterwatch online database.

Participation in collaborative action

Waterwatch facilitates the involvement of the community in actions to restore the condition of their local creek, river, wetland or groundwater. Partnerships between community groups, schools, Catchment Management Authorities, local government agencies, catchment groups and businesses result in productive and sustainable joint projects. Collaborative projects to improve catchment health move Waterwatch from monitoring to action.

Building networks and partnerships

Integrated catchment management involves community groups, schools, the business sector and local and state government agencies working together to manage our precious natural resources. Waterwatch encourages and reinforces the value of community consultation and provides links to strong networks of environmental management and education. Waterwatch networks and partnerships enrich and strengthen the program throughout New South Wales while having the flexibility to meet local and regional needs.

1.2 Getting to know your place in the catchment

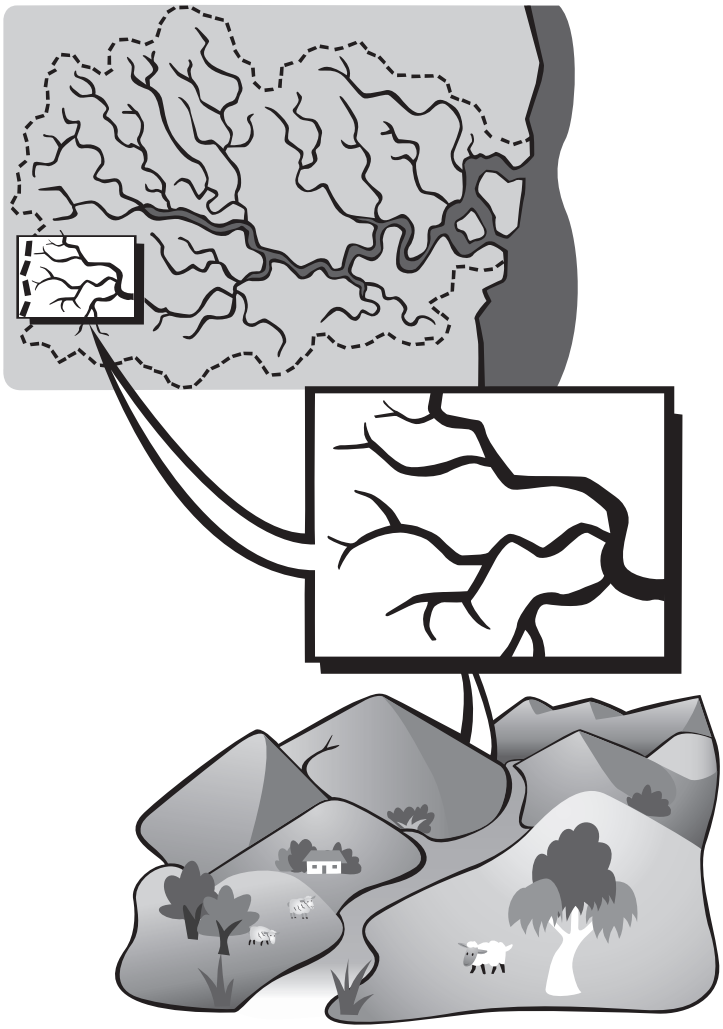
A catchment is an area of land catching rainfall that flows into a creek, river, wetland or ocean. It is essential to know where you are located within your catchment as activities upstream and downstream and in your local area will impact on water quality and catchment health.

What is a catchment?

A **catchment** is an area of land catching rainfall that flows into a creek, river, wetland or the ocean. Hills or ridges separate each catchment and direct the flow of water into different waterways. Within catchments, there are natural features such as native vegetation, water, rocks and soils. However, catchments are also the places where people live, work and play. **Human use in catchments** can have an impact on water quality. This will affect the availability of water for a variety of uses.

Catchments occur at a variety of scales from very large catchments such as the Murray–Darling Basin to local creeks and streams that may only flow occasionally. The interconnectedness of catchments means that changes in water quality in small local catchments will impact on larger creeks and rivers downstream.

Waterwatch works with communities to monitor and develop actions to improve local catchments. As small catchments make up as much as 75% of the total stream network within any given catchment, local actions can make a significant contribution to water quality and catchment health, even when the creek may run only occasionally.



Catchments require management to be sustainable for future generations. Sustainable management will maintain and improve the quality of natural resources within a catchment and meet the needs of the community, ecosystems and the environment. In New South Wales, Catchment Management Authorities (CMAs) have been set up to work with the community, state government and local government agencies, industry and individuals to identify and manage key natural resource management issues within the various catchments in their region.

Catchment Management Authorities (CMAs) are regional bodies that have developed Catchment Action Plans to manage key natural resource management (NRM) issues within their regions. It is important to identify the CMA region in which your school is located and link your Waterwatch monitoring actions to the priorities within the region's Catchment Action Plan.

NSW CMAs operate in the following regions:

Border Rivers/Gwydir; Central West; Hawkesbury–Nepean; Hunter–Central Rivers; Lachlan; Lower Murray–Darling; Murray; Murrumbidgee; Namoi; Northern Rivers; Southern Rivers; Sydney Metro; Western.

i **For more information, see www.cma.nsw.gov.au**

Parts of a catchment

Upper catchment

In the upper parts of the catchment, such as mountain regions or foothills, rivers are usually fast flowing. This means they have the energy to carry large pieces of rock and gravel eroded from stream beds and banks. Vegetation along the banks (riparian) provides a buffer from overland flow, reducing the input of sediment and nutrients.

The upper parts of a river system are very important to the health of the entire river because this is the source of much of the food carried downstream. Dams and weirs impede the distribution of food and seeds and the migration of aquatic animals, as well as altering flow rates and flood frequencies.

Overhanging vegetation provides much of the food (in the form of leaves, fruits, seeds, twigs and bark) required by stream organisms such as macroinvertebrate 'shredders', which convert coarse material to finer fragments. These macroinvertebrates (water bugs) are adapted to fast moving water, e.g. by having streamlined bodies.

Middle catchment

In the middle part of the catchment, the river meanders through flood plains. During large floods, water spills out over banks onto the flood plain and deposits a layer of sediment. Occasional floods are important for maintaining the health of wetlands.

Often in these middle reaches, the stream bank and its trees no longer shade all the water surface. Here the sun is able to warm the water through the day, particularly where the current slows to form pools. Water temperature tends to drop at night as the accumulated heat is given off to the cold air. Daily and seasonal changes in water temperature tend to be greatest here.

Attached algae become more abundant and grazer (plant eating) and collector macroinvertebrates dominate this section of the stream. Organisms like mayfly nymphs shear off pieces of algae growing on rocks. Collectors feed upon fine material (shredder faeces and small plant fragments) transported from upstream and from local vegetation.

Lower catchment

As a river gets very close to the sea or other large bodies of water, it travels very slowly and deposits the large quantities of sediment it has been carrying from further upstream. Collector macroinvertebrates predominate in this stretch of the stream, filtering out accumulated minute particles suspended in the water and gathering fine particles that have settled to the river bottom. Organisms that are tolerant to lower oxygen levels and slow moving water are more common in this part of the catchment. In the lower catchment, riparian vegetation influences bank stability and slows flood flows.

Estuary/marine

An estuary can be described as a semi-enclosed body of water occurring where fresh water joins and mixes with salt water from the ocean with tidal influences. Estuaries are some of the most productive ecosystems and a valuable asset of the coastal environment. They also play an important role in providing food and shelter for a wide range of aquatic organisms such as crustaceans and molluscs. Estuarine habitats include saltmarshes, mangroves, seagrasses, reedbeds, shallow sand and mud flats, rocky shores and reefs, and deeper zones of fine sediments.

Marine ecosystems are those that occur in sea water.

i **Worksheet 8.1: Parts of a catchment provides a diagram of a catchment for students to label.**

Healthy catchments and rivers

A healthy catchment is one that is sustainable and able to meet the needs of the community, ecosystems and the environment.

The health of a waterway can be measured by characteristics such as:

- water quality measured by physical, chemical and biological parameters
- healthy ecosystems with a high biodiversity. This includes both aquatic and terrestrial ecosystems, especially along riverbanks
- the resilience or capacity of the ecosystem to maintain its structure and function in the presence of stress. This may be caused by natural factors such as floods or human-induced change.

Land use is a key factor determining the health of waterways. Human activity can impact on river health by influencing the interactions between natural resources (land, water, vegetation and soils) and between aquatic and terrestrial ecosystems.

It is essential to know where you are located within your catchment. Activities upstream and downstream and in your local area will impact on water quality and catchment health. River health reflects catchment health.

i **Worksheet 8.2: Which riverside is best? provides a diagram with discussion points about factors which influence catchment health.**

1.3 Human impacts on waterways, including climate change

Human activity has modified the natural environment and this has led to many environmental problems or issues. Some of the most significant of these issues are increased soil and river salinity, land degradation, water pollution, loss of biodiversity and climate change. Management of these issues while maintaining the productivity and sustainability of the natural environment is a key challenge for the future.

Worksheets 8.4 to 8.11 are designed to help students explore the issues surrounding human impacts on waterways.

Climate change

Climate change is one of the most significant human impacts on the environment. Higher air and sea temperatures, sea level rises, more extreme storms, more drought, less rainfall with most of it falling in storm events, and more flooding, are all predictions for how climate change will affect New South Wales.

Climate change will also impact on water quality. As temperatures rise, water becomes less able to hold dissolved oxygen. Reduced rainfall, particularly during the hotter months, will reduce vegetation cover over the landscape. Increased frequency of higher intensity storm events will produce greater sediment and nutrient loads. As a result, water quality and the overall health of river systems are likely to decline.

Waterwatch groups can help to track the effect of climate change by monitoring water and air temperature, plus turbidity, dissolved oxygen and nutrients, particularly following storm events.

Climate change will impact on both aquatic and terrestrial ecosystems. Waterwatch groups can monitor these changes through the ongoing sampling of macroinvertebrates and riparian condition.

Worksheets 8.8 and 8.9 are designed to help students explore the effects of climate change on waterways.

1.4 Getting started in Waterwatch and formulating a Junior Waterwatch Plan

Planning is important for the ongoing success of the Waterwatch program. This section outlines the steps you will need to take to develop a successful Junior Waterwatch Plan, also known as a monitoring plan. It also outlines Occupational Health and Safety (OH&S) issues you will need to consider and contains a template for a Junior Waterwatch Plan.

What is Waterwatch?

Waterwatch is an ongoing monitoring program that involves the community and schools in monitoring a local waterway. The program is designed to be flexible, to meet different outcomes, including school curriculum outcomes and community needs.

Monitoring is the regular observation and measurement of natural resource conditions over time, usually to detect change.

Waterwatch focuses on building skills within the community so the program can be run on an ongoing basis. Participants develop ownership of their site by monitoring water quality and ecosystems and by implementing actions to protect the environmental values at their site.

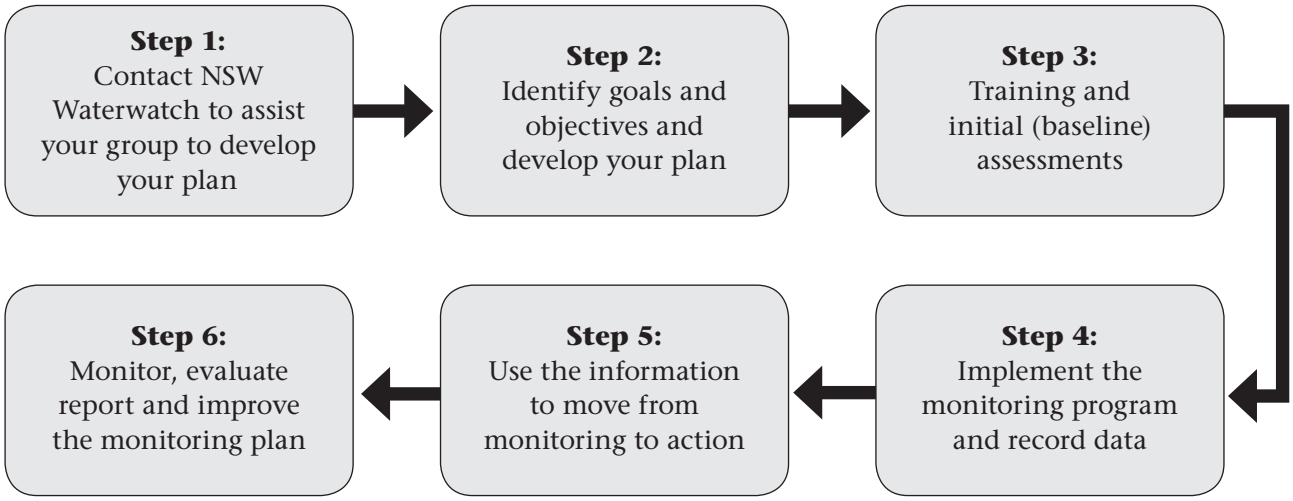
Waterwatch procedures, equipment and methods have been developed to ensure that the data collected by your group is quality assured and can be used for planning purposes by other organisations such as Catchment Management Authorities, local government and water authorities.

Developing a monitoring plan

Planning is essential

An effective Waterwatch program involves designing and developing a monitoring program that meets the needs of the group while collecting quality assured community data.

The flowchart below gives an overview of the suggested process to help your school group implement the Waterwatch program successfully.



The answers to the following questions will form the basis of your Waterwatch Plan.

Why are you testing?

Waterwatch engages students and communities in natural resource management through community water quality monitoring. This may include the following outcomes:

- **Educational** – developing knowledge, skills and understanding to meet curriculum outcomes. This may include the integration of Waterwatch as a tool to teach a range of subjects or as an environmental education activity within the school.
- **Data collection** – Waterwatch uses best practice in community monitoring and students use a range of skills and equipment to investigate an issue, collect data and record results. By storing the information on the Waterwatch online database, natural resource managers can use the data for planning and managing waterways at the local and regional scale.

What is the purpose of your testing?

Develop a question that students can investigate. For example:

- Do stormwater drains affect water quality?
- Will planting trees along riverbanks improve water quality?

Can you develop partnerships outside the school?

Consider the following possibilities for partnerships:

- Your local Catchment Management Authority may assist with your testing. They are interested in protecting and managing natural resources within a regional context.
- Local councils may have a project for your students and provide support.
- Landcare/Bushcare groups may be working on a local project which could involve students.

Where are you testing?

It is convenient for schools to test at a site on public land close to the school. This provides ease of access and local interest. Students can develop an understanding of their site over time and watch for future changes.

What makes a suitable site?

- an open flat area where students can work
- easy and safe access to water (if possible 20 centimetres deep)
- shallow water for bug surveys
- accessible all year round
- at least 100 metres downstream of any drain
- above tidal influence (unless estuarine water quality is being tested)
- upstream and downstream of where the creek enters another water body
- stable site that will not wash away during floods.

How often will you test?

Waterwatch is an ongoing monitoring program. You will need to consider:

- how testing can take place throughout the year
- whether testing will be done by one class or shared between classes (or schools)
- how additional staff and students will be trained
- whether water can be brought to the school for more regular testing.

Contacting Waterwatch

Waterwatch is a national community monitoring program. It has a high level of integrity and a national network to draw on to assist you to run an effective Waterwatch group.

The NSW Waterwatch website provides details of your local contact: www.waterwatch.nsw.gov.au

If there is no regional contact, please email nsw.waterwatch@environment.nsw.gov.au. Your enquiry will be referred to your closest Waterwatch Coordinator, who will assist you to develop a monitoring group.

Occupational Health and Safety (OH&S) for Junior Waterwatch groups

Waterwatch groups have a number of identified Occupational Health and Safety (OH&S) risks. NSW Waterwatch is committed to reducing risks to students involved in monitoring and has developed a comprehensive OH&S policy. This strategy contains important information to assist teachers to reduce risks.

Risk assessment

A risk assessment at water testing sites is required for **each** activity. The purpose of a risk assessment is to:

- identify potential hazards that staff and students may be exposed to
- assess the level of risk associated with the hazard
- implement and enforce corrective measures to eliminate/control or reduce the level of risk of hazards according to the hierarchy of controls (write a work method statement where necessary)
- review risk assessment and evaluation of the effectiveness of the corrective measures.

What can harm you – potential hazards	What can happen – outcomes/consequences
• UV radiation (sunlight)	• Sunburn
• Walking on uneven ground	• Slip, trip fall
• Unstable riverbanks/steep banks	• Slip, trip fall
• Water hazards	• Drowning, water contamination and impact on hygiene
• Vegetation – long grass, weeds	• Rashes/cuts
• Fencing – barbed wire, star pickets, electric fences	• Injury related to hazard: cuts and scratches
• Hazardous objects/syringes	• Needle stick injury
• Hot/cold weather	• Exposure to the elements
• Outdoor environment – snakes, insects, spiders, water	• Bites and stings; falling in/drowning
• Carrying equipment – long poles	• Electrocution from power lines
• Travel, transport, public places	• Accidents travelling to site; strangers in public places such as toilets

Risk management

It is the responsibility of the teacher in charge of the group to ensure the following action is taken:

- A risk assessment is completed **each time** the site is visited using the pro forma provided in Section 3.1, as conditions may change over time.
- A student list is compiled for each field event. A list of students will identify students with welfare issues such as allergies, broken limbs, wheelchairs.
- The supervising teacher will mark off and confirm a list of students who are actually present before and after the event.
- As a group, students are to be warned of the risks at the site, and have safety procedures and the importance of 'looking after each other' explained to them. This warning will cover the following issues.

Water hazards

- Always have a buddy for safety when collecting a sample.
- Develop procedures in the event of flash flooding and/or sudden stormwater discharges.
- Teachers are to undertake an assessment of the site to familiarise themselves with the site and the surrounding local environment and conditions.
- Beware of water quality contamination and personal hygiene and protection.
- Handle water samples as little as possible. Hands should be washed after sampling.

Mosquitoes

- Teachers will ensure that mosquito repellent is provided and used at all Waterwatch events and activities in accordance with school policies.

Sun sense

- Sunscreen will be provided at all Waterwatch events and activities.
- Hats are to be worn at field locations.

Syringes

In areas where this is a recognised risk:

- a sharps container and gloves for collecting syringes will be carried by the teacher
- only teachers are to handle needles and syringes and the sharps container
- if a student locates a needle or syringe, they are not to touch it and must notify the teacher immediately for collection and disposal into the sharps container.

Wildlife hazards (snakes, spiders)

- A general warning will be given about potential hazards which may arise depending on the site.
- Teachers must carry a first aid kit at all times.
- Students are not to lift logs or rocks, or put their limbs into hollows.

Safety in public places

- The buddy system will be in place for visiting toilets and other public places.
- Provide warnings to students about interacting with people apart from those involved in the training session.

Clothing and footwear

- Students will be required to wear closed-toe footwear and appropriate clothing in the field.

First aid

- First aid kits will be fully stocked and taken on all field trips.
- Clean water will be available for dealing with spills or chemical contact.
- A mobile phone will be available on all field trips.

Permission

- All students attending Waterwatch events will have permission from their school and from their parents in accordance with their school's policy.

Bus transportation and road safety

- Teachers will supervise and direct students with regard to road safety and bus transportation to minimise hazards.

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Junior Waterwatch Plan (template)

School: .....

Address: .....

Telephone: ..... Fax: .....

Email: .....

Date: .....

WATERWATCH VISION:
Current and future generations empowered and actively involved in the sustainable use and management of catchments.

The purpose of this agreement is to:
- identify the purpose of your monitoring plan
- record the equipment, sites and methods used by your group
- outline management issues related to your monitoring
- record your responsibilities in implementing Waterwatch.

Group name: .....

Date: .....

1. Waterwatch and our school curriculum

Waterwatch fits into our school programs or activities in the following ways:

.....

.....

.....

2. Who will be involved in Waterwatch?

.....

.....

.....

3. Level of participation

We will participate in the following Waterwatch activities (tick the appropriate boxes):

WATERWATCH ACTIVITY	YES	NO
Spring / autumn water bug survey	☐	☐
Water quality monitoring	☐	☐
Parameters: ☐ Turbidity ☐ Temperature ☐ pH ☐ Electrical conductivity (EC) ☐ Water bugs		
Testing frequency:		

Read the following list and tick the boxes that apply to the aims of your monitoring plan:

☐ Providing information about natural resource condition at the site
☐ Enhancing knowledge and understanding of natural resource management issues
☐ Monitoring of on-ground works projects
☐ Identifying pollution events
☐ Other (please specify) .....

4. Waterwatch kits

To ensure the quality of the data entered onto the Waterwatch website, only equipment and methods endorsed by the NSW Waterwatch Best Practices Committee can be used for Waterwatch testing.

Equipment sponsorships

Equipment may be provided by a sponsor, such as your local council or Catchment Management Authority, or through other grants and sponsorships, etc.

Name of sponsor (if applicable) .....

NOTE: Equipment provided by a sponsor remains the property of the sponsor unless stated below.

Additional requirements by sponsor:

Waterwatch kit contents (tick the appropriate box)

☐ Junior Waterwatch kit
☐ Macroinvertebrate kit

Test	Tick	Equipment	Tick
Temperature	☐	Thermometer	☐
pH	☐	pH strips	☐
Electrical conductivity	☐	ECScan low	☐
		ECScan high	☐
		ECScan dual range	☐
Turbidity	☐	Turbidity tube	☐
Macroinvertebrates	☐	Macroinvertebrate kit	☐

5. Identifying water bodies by type and naming the site

Complete the information below for **each** site. Sites can be located by latitude and longitude using a GPS unit or by using the mapping facility on the Waterwatch website. The Waterwatch Coordinator will assist you to name and locate the site and plot it onto the online database.

Type of water body (Circle the most relevant description)

Lowland stream (below 150 metres asl)	**Coastal stream** (below 150 metres asl)	**Upland stream** (greater than 150 metres asl)	**Standing water** (e.g. lakes, dams)	**Groundwater:** bore piezometer spring

Note: Altitude is measured as distance above sea level (asl)

Naming the site

Name of catchment				
Name of sub-catchment (if applicable)				
Name of water body				
Locality (town)				
Specific site location				
Location (grid numbers or GPS coordinates)				
Site code (if required, will be provided by Waterwatch Coordinator)				
Type of water	**Tick the types of water found at your site**			
Surface water	☐ Fresh		☐ Estuary	
Standing water	☐ Dam	☐ Lake	☐ Wetland	☐ Other (specify) .....
Groundwater	☐ Bore	☐ Piezometer	☐ Spring	☐ Other (specify) .....

6. Recording data on the online database

The username and password given below are to be used to enter or review the data section of the Waterwatch website.

Username: .....

Password: .....

Waterwatch web address: www.waterwatch.nsw.gov.au

7. Waterwatch management

Contact information

Role	Name and position	Contact details
Group coordinator		Phone:
		Fax:
		Mobile:
		Email:
2nd contact		Phone:
		Fax:
		Mobile:
		Email:
Support stakeholder (sponsor, if applicable)		Phone:
		Fax:
		Mobile:
		Email:
Waterwatch Coordinator		Phone:
		Fax:
		Mobile:
		Email:

Incident management

In case of a pollution incident, the group coordinator will contact their Waterwatch Coordinator by telephone to report the incident as soon as possible.

Supervision

School teachers in our Waterwatch group accept the responsibility of ensuring that students are supervised and controlled during Waterwatch training sessions.

Training and safety

Training and retraining will be provided in all aspects of implementing the program. Anyone using the kit must be familiar with safety procedures and first aid.

Our group will strive towards best practice to ensure that results can be used by organisations such as Catchment Management Authorities and local government. This will involve:

- ☐ Waterwatch methods, equipment and testing procedures in accordance with the Waterwatch manual
- ☐ safety procedures and first aid awareness
- ☐ OH&S risk assessment and risk management
- ☐ quality assurance (QA), including:
  - calibration of equipment
  - maintenance of kit and equipment
  - participation in yearly QA events.

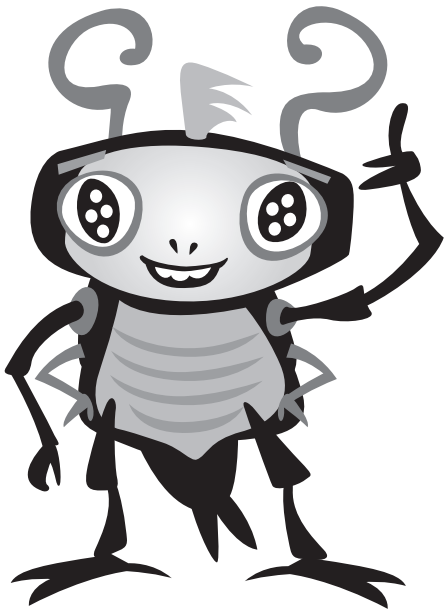
Insurance

All Waterwatch groups must have their own insurance policy to cover any injury, loss or damage for their members and any other persons or property while participating in Waterwatch.

8. Telling the world

Waterwatch is about learning and communication. Our Waterwatch group will share our results and achievements with others through:

- ☐ water quality data entered on the NSW Waterwatch online database
- ☐ communication with your local Waterwatch Coordinator
- ☐ regular reports to the school community
  - in the school newsletter
  - at the school assembly
- ☐ regular reports, displays or presentations to sponsors such as:
  - the Catchment Management Authority
  - local councils
  - other (specify) .....



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Waterwatch Agreement

..... (group name)

agrees to:

- develop a monitoring plan that identifies the purpose of monitoring
- monitor at least twice per term (8 times per year)
- monitor at least one site that will be identified on the Waterwatch online database
- use only NSW Waterwatch equipment and Waterwatch methods to obtain results
- update equipment/methods in line with any reviews by Waterwatch
- ensure that all equipment is kept in good condition and that meters are calibrated to produce accurate results
- participate in training and refresher sessions
- participate in quality assurance (QA) testing as arranged by Waterwatch
- communicate and share results with sponsors
- enter water quality test results onto the Waterwatch website after testing
- contact the local Waterwatch Coordinator in the event of a pollution incident
- contact the local Waterwatch Coordinator and sponsor if we no longer wish to participate in Waterwatch testing
- review our Waterwatch Plan with the local Waterwatch Coordinator as appropriate
- participate in activities organised by the Waterwatch network in our area, e.g. water bug surveys, snapshot monitoring events, QA
- incorporate catchment studies as part of the curriculum, e.g. in HSIE, Science and Technology and/or environmental education.

Additional sponsor requirements

Signed:

Group's Waterwatch Coordinator ..... Date: .....

School Principal ..... Date: .....

Waterwatch Regional Coordinator ..... Date: .....

Other Stakeholder/Sponsor ..... Date: .....

Disclaimer

The Department of Environment, Climate Change and Water advises that those who participate in Waterwatch do so at their own risk. No responsibility or liability is accepted for any injury, loss or damage, however caused, arising from any participant's involvement in the organisation, conduct or participation in Waterwatch.

SECTION 2

Organising a day at the waterway

Good preparation for your students' participation in the Waterwatch program will maximise their enjoyment and the educational benefits gained. In this section you will be guided through the process of making sure students and equipment are ready for the field trip, given detailed instructions for ensuring the trip is a success, and provided with suggested post-excursion activities.

Included in this section: *Page*

The information provided in this section is to be used in conjunction with the relevant sections of the *Junior Waterwatch Field Manual*.

2.1 Preparations for the day

Preparing for a class excursion to the waterway will include student organisation, site assessments, preparing equipment and obtaining permission for student involvement.

Permissions and contacts

In preparing for a visit to your site, make sure you include the following permissions and contacts:

- parent permission to visit the site
- photographic permission
- site assessment
- organise parent helpers
- contact the local newspaper about the event.

> ***i*** **Useful checklists and templates are provided in Section 3.**

Preparing for the water quality tests

- Identify the main water tests and activities for your class. These may include:
  - water sample collection
  - temperature
  - pH
  - turbidity
  - salinity
  - flow
  - water bug surveys
  - observations.
- Select student work sheets and water test procedure sheets relevant to the school teaching objectives.
- Laminate the water test procedure sheets.
- Photocopy recording sheets and other student work sheets.
- Calibrate your EC meter.

2.2 Pre-visit activities

To get the most out of their trip to the waterway, students should be introduced to the following concepts, skills and activities prior to the day.

Location and human use of catchments

Students can begin to understand the environment of the catchment and the human influences on it by:

- mapping the catchment
- talking about human activity in the area
- understanding water quality parameters by using the Q&A in Section 8.3
- linking water quality to human activity.

Use of the equipment

To make sure testing runs smoothly on the field trip:

- practise using the equipment prior to the day
- conduct a range of experiments to develop skills in using the equipment and determine the purpose of investigations at the waterway.
- make equipment that may assist with monitoring, e.g. a bug dial, bug net and landscape viewer.

> ***i*** **Section 9 contains experiments and models for use in the classroom.**

Investigations at the site

Site assessment

The *Junior Waterwatch Field Manual* contains templates to help students conduct assessments at their site. The level of assessment required may be difficult for younger students and may be more appropriately completed by the teacher. Refer to Section 1.5 in the *Junior Waterwatch Field Manual* for the assessment required to set up a Waterwatch site on the online database.

Student investigations

Waterwatch has an inquiry-based approach to learning. Use the template below to stimulate student thinking about possible investigations at the site. This may include an investigation of water quality, water bugs, vegetation and fauna.

Example of investigation questions
Is the site urban, semi-urban or rural?
Does the water quality at my site affect the water bugs that live there?
What are the main water quality issues at the site?

My hypothesis:
What I think I may find out

How can I investigate this question?
Test
Assess
Observe
How can I make this a 'fair' test?

Equipment
What equipment will I need?

Results
What were the results?
What measurements were used to record results?
Who can I share the results with to add to common knowledge about the site?

Conclusions
What do the results mean?
Can the data be analysed to work out relationships between water quality, human use and plants and animals at the site?

Action planning
What can our class do to improve the site?

2.3 At the waterway

Make sure students are aware of the rules that will apply when they are on-site by explaining them in the classroom prior to the field trip and then revising them on arrival. Organise the group into teams and build anticipation and fun by choosing team names.

Rules at the site

Students need to understand and follow rules when on-site, to keep everybody safe, protect the environment and make the whole experience fun and enjoyable:

- Students should work in pairs or groups and never alone. The creek has many potential hazards and a lone student may get into difficulties without being noticed.
- No running – the ground may be uneven and there may be hidden holes and objects to avoid.
- Do not enter the waterway – all sampling must occur at the edge.
- Never put hands or fingers near eyes or mouth after handling water. Any pollutants can irritate the skin and eyes and may be dangerous if swallowed.
- Be sensible near the water and think of others. Don't do things which may be dangerous, e.g. pushing another student near the water.
- Look at and photograph animals and plants, but do not harm them.
- Take your litter away. A rubbish bag is also useful to collect up other litter you find, but take care with the kind of litter being picked up and watch for sharps and other dangerous objects. Students must tell a teacher straight away if they find something dangerous.
- Put pH papers, paper towel, etc. into a solid waste container, to be disposed of in a garbage bin away from the site.

Organising teams of students

When students are involved in water quality testing, it is important to organise teams based on the amount of time available and the purpose of the testing. Structure the time to make sure all students are involved.

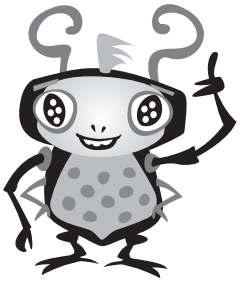
Procedure

- Divide the class into groups/teams depending on the number of students you have and the number of tests you will be doing.
- Provide names for each group – some sample water bug names are provided below or the students can make up their own.
- Decide the format for the day.

Team names

Sample name badges for groups

Luke Leech



Spotty Bug

Simon Stonefly

Crystal Caddisfly

Speedy Snail

Shelley Shrimp

Warm-up activity – land or sea?

This warm-up activity increases student awareness of the global proportions of land and sea.

Note: Although 70% of the Earth's surface is covered by oceans, less than 3% of the world's water is freshwater and of that, 75% is frozen.

Activity

- Students form a circle.
- Throw an inflatable globe-shaped ball or Earth ball from one person to another.
- When you catch it, is your right thumb on land or water?
- Call out land or water AND/OR make groups of 'land' or 'water'.

This activity can be used:

- to understand the relative quantities of fresh and salt water on the globe and the need to conserve and protect the limited freshwater available
- as an icebreaker to get to know other students, e.g. students call out their name and their favourite food, where they live, etc.
- to learn about the countries/continents and oceans, e.g. students call out the name of the country, continent or ocean under their right thumb.

Discussion

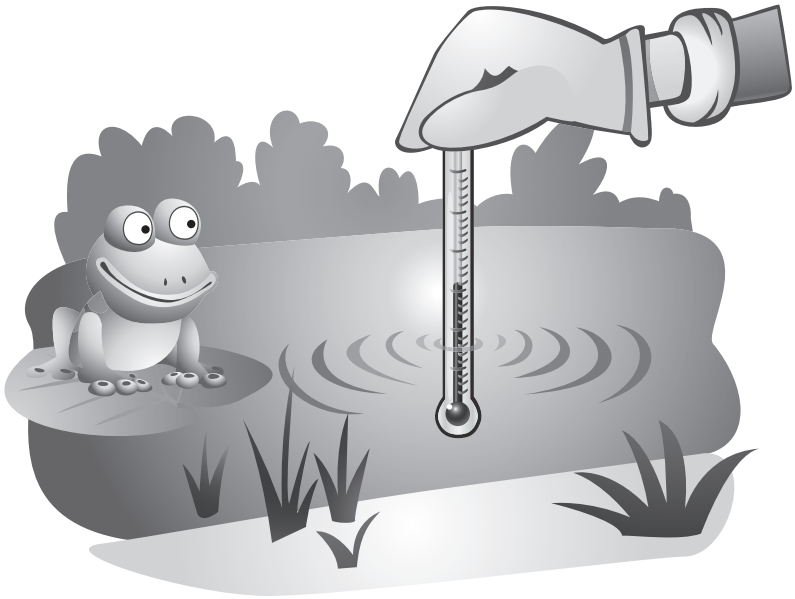
Compare the number of students in each group, 'land' or 'water'. What does this tell us about the proportions of land and sea on the globe?

Water quality tests: what do they mean? Q&A

The following questions and answers refer to information in the *Junior 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.

The Q&A provides an ideal way to introduce students to the water quality tests and guide discussion about the tests they will be conducting at the waterway. A work sheet for students, containing the questions only, is provided in Section 8.3.

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?

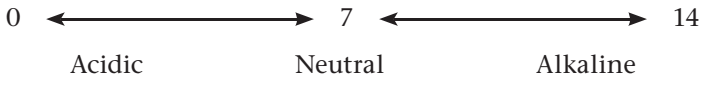
pH is a measure of how acidic or alkaline a substance is.

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): freshwater

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 (µS/cm) EC low range meter

1 mS/cm = 1000 µS/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 µS/cm and sea water is ~ 65,000 µS/cm.*

Electrical conductivity (EC): estuaries

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 (µS/cm) EC low range meter

1 mS/cm = 1000 µS/cm

What influences it?

- *In an estuary location tides will influence salinity on a daily basis.*
- *In the longer term, increased flooding or stormwater may reduce salinity by adding more freshwater to the system.*

Important notes ...

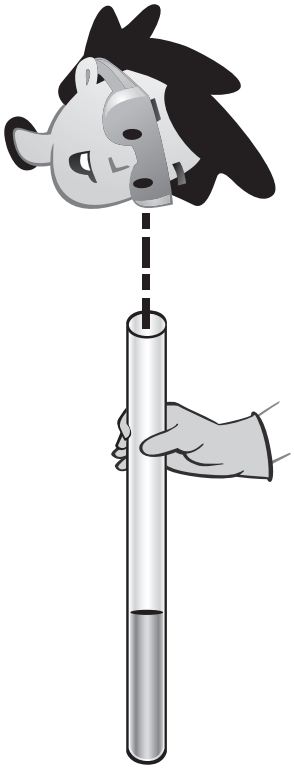
- *Many species can only survive in a very narrow range of salt concentration.*
- *Changes in salinity levels on a daily and seasonal basis are very significant, as this will determine the main ecosystems – whether fresh or saline.*

Classification	Electrical conductivity
Freshwater	<200 µS/cm
EC affects freshwater ecosystems	1500 µS/cm (Murray Darling Basin Commission)
Brackish	4800 µS/cm
Seawater	≈ 51,000 µS/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.*

2.4 Water testing activities at the site

The number and variety of tests you conduct at the site can be tailored to the amount of time you have and the number of students. Three options are outlined below. Refer to the* Junior Waterwatch Field Manual *for detailed instructions on conducting tests.

Once students understand the procedures for testing, other activities can be conducted to meet curriculum requirements. These include:

- observations – should be recorded **each time** you visit the waterway
- water bug surveys
- plant and animal assessments
- human impact assessments.

Organising testing groups

Option 1: A short stay	Short time period: 0.5–1 hour	All students conduct one test each
Option 2: Make a splash	1–2 hours	All students conduct all tests
Option 3: Dive in deep	All day	Multiple water samples + bug survey

Option 1: A short stay

- Set up 4–5 workstations. One group is allocated to each workstation.
- Each group collects a water sample for their workstation (except the group testing flow).
- Allocate at least one test to each group – in small classes groups may need to do a second test to ensure all tests are covered:
  - temperature
  - pH
  - turbidity
  - salinity
  - flow (optional)

- One student reads the directions in the field notes while another conducts their allocated test.
- Clean and dry the equipment and return it to the kit.
- Record the results on the group's field record sheets.
- Determine the water quality rating for each test by referring to Section 5 in the *Junior Waterwatch Field Manual*.

Bring everyone together again and talk about the things near your site and in your catchment that would affect each test result. Students then make an assessment of the health of the waterway.

Option 2: Make a splash

- Collect a water sample for the group.
- Set up 5 workstations – each workstation is a different test:
  - temperature
  - pH
  - turbidity
  - salinity (EC)
  - observations
  - flow (optional).
- Divide the students into 5 groups to visit each workstation in turn. Allow approximately 10 minutes at each workstation.
- One student reads the instructions in the field notes, while the others conduct the test.
- Clean the equipment and leave it out for the next group. The last group returns the equipment to the kit.
- Record the results for each workstation.
- When all tests are completed, use the results from all groups to obtain a median water quality rating for each test by referring to Section 5 in the *Junior Waterwatch Field Manual*.

Bring everyone together again and talk about the things near your site and in your catchment that would affect each test result. Students then make an assessment of the health of the waterway.

Option 3: Dive in deep

This option is the same as Option 2, but with one or more additional workstations set up for bug survey activities, or other assessments relevant to the class. These may include habitat, fauna and/or human impact assessments. The relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* contain work sheets for these activities.

2.5 Post-excursion activities

Be sure to record all information gathered on-site accurately on the field recording sheets. Keep these safe so the data can be uploaded to the Waterwatch website and analysed back in the classroom.

Uploading data

The water quality data should be uploaded to the Waterwatch website as soon as possible after testing. Training and instructions for uploading data will be provided by the Waterwatch Coordinator.

Analysing the data

To get the most out of the information you have collected:

- Pin up a poster of the recording sheets and assess water quality as a group.
- Draw conclusions about the health of the waterway by referring to the recording sheets.
- Brainstorm how water quality has changed over time.
- Suggest ways to improve the health of the waterway.

Action planning for your site: ideas for improving your waterway

Once you have conducted a range of assessments at the waterway, you can decide what your class can do to improve your local water quality.

Here are some ideas which may help you:

- Identify the main problems at the site.
- Make up a list and put the most important things first.
- Is the problem something the class can help with or will you need to notify the council or Landcare group?
- Can you assist another group with these actions?

Actions now!

Some of the things you can do might be able to be done straight away.
For example:

- Monitor the water quality regularly.
- Clean up rubbish.
- Invite local newspapers to report your water monitoring results.
- Write articles to the local newspaper about the value of the waterway and its plant and animal life.
- Make a display for school or the local shopping centre.
- Contact people who can help.

Longer term objectives

This may involve working with other groups in the community, e.g. Landcare groups or councils. With these groups you could:

- Plant native trees to revegetate a creek bank.
- Remove weeds.
- Fence off areas from livestock.
- Put up signage and/or design brochures to help educate the community.

> ***i*** **Sections 8.10 and 8.11 will help you do some action planning for your site.**

SECTION 3

Templates and checklists

This section provides a number of templates for important forms you will need to cover your Occupational Health and Safety (OH&S) and other responsibilities before involving students in Waterwatch activities. Some checklists are also provided to make getting ready for a field trip easier.

3.1 OH&S Site Risk Management Plan template

Please note: Site hazards change over time at the same site. Complete a risk assessment and priority **each time** a Waterwatch monitoring activity occurs at a site.

Group name: **Location:** **Date of monitoring:**	**Group coordinator:** **Contact numbers:** **Special needs:**		
Hazard/risk identification Preliminary site inspection and assessment completed **Date:**	**Assessed risk level** (see matrix below)	**Risk management plan – Management/control measures** Teachers should ensure they follow the OH&S policy of the school, plus:	**Who:**
General: all emergencies		Mobile phone and first aid kit carried in support vehicle and emergency numbers provided to school office staff with whereabouts known and expected time of return.	
Environmental hazards: weather • cold weather • heat, UV rays • extreme weather events, e.g. wind, storms, flash flooding		• Checking, warning, avoidance. Protection and shelter • **Cold weather** – students take warm clothing • **Sun** – hat, sunscreen and water bottle • **Extreme weather** – alternative sheltered location; checking, warning	
Environmental hazards: insect/plant/animal • snakes • mosquitoes and insect pests • trees and branches in windy conditions		• Warnings issued. Check sites. Avoid high risk sites • Insect repellent, sunscreen and water at each site • Checking trees, warnings and alternative venue	
Site: surface and dangerous objects • needles, broken glass, slippery • rough or uneven terrain – slipping, tripping, grazes and sprains		• Site check, explicit instructions prior to activities, sharps container • Wear enclosed, sturdy footwear	
Student: personal • poor student behaviour • existing medical conditions • allergic reactions		Teachers should ensure that: • students behave in an appropriate manner • information about student medical conditions is known • preparation is made for essential emergency treatment	
Water testing activities (cross out if it does not apply) • use of equipment • carrying equipment, e.g. poles		• Explicit instructions prior to activities • Close supervision of students • Carry poles horizontally	
Proximity to water • drowning • health issues – dirty water, mud and sediment		• Close supervision, no swimming, work with a buddy • Wash hands after contact with water. Gloves on request • Carry poles horizontally	
Road safety: walking in public space and roads (school groups)		• Teacher supervision to and from the site • Students wear enclosed footwear	

Risk assessment matrix	**How likely is it to be serious?**			
How serious could the injury be?	**Very likely**	**Likely**	**Unlikely**	**Very unlikely**
Death or permanent disability	1	1	2	3
Long-term illness or serious injury	1	2	3	4
Medical attention and several days off	2	3	4	5
First aid needed	3	4	5	6

Note: Risk management for this activity is the responsibility of the school and teachers from the school.

Consultation with Principal/Senior Teacher prior to monitoring:

Date: Consulted with (signature):

Persons exposed to risk: Attach list of participants and students with special needs if not known to Waterwatch coordinator.

3.2 Student welfare information form template

waterwatch NEW SOUTH WALES
Communities Caring for Catchments

Student welfare information

(to be provided to Waterwatch Coordinator if special needs are not known)

Please list the names (**first name only**) of students attending a training workshop who may have welfare concerns or special needs. This information will assist the Waterwatch Coordinator to ensure the safe management of students.

- Students who have asthma, allergies, diabetes or other medical conditions.
- Students with physical disabilities such as broken limbs or who use wheelchairs.
- Students with behaviour concerns.

(This information will be kept confidential and the information returned to the supervising teacher or destroyed after the event.)

Note: Management of the overall safety and behaviour of students is the responsibility of the teacher in attandance at all times.

Name of group: .....

Date: .....

First name of student	Welfare concern/Special needs

Teacher signature: .....

Risk management responsibilities for student participation:

Summer: students will need water bottles, hats, sunscreen, enclosed shoes (no sandals/thongs).

Winter: students will need hats, sunscreen, enclosed shoes (no sandals/thongs) and warm clothing.

Medication: please bring medication for students with asthma, allergies, diabetes and other medical conditions.

Behaviour: it is the teacher's responsibility to ensure that students work with other students and that their behaviour does not endanger others.

3.3 Parent/guardian permission to use photographs letter template

Waterwatch NEW SOUTH WALES
Communities Caring for Catchments

Dear Parent/Guardian,

Your son/daughter/person in care is involved in Waterwatch activities as part of the school curriculum.

Waterwatch NSW has a commitment to promoting the efforts of young people in environmental activities, and seeks your permission to use photographs and/or student work in publications and/or on the internet to promote and raise awareness of student involvement in local environments.

Please nominate your consent and return this form to <teacher> at <school>.

I hereby do / do not (delete one) consent to photographs and/or student work of my son/daughter/person in care, being used in any publications, reports or promotional materials produced by NSW Waterwatch or host agencies and organisations. Waterwatch NSW may/may not use the photographs produced in various forms of media, including digital and electronic media.

For more information please discuss this with the class teacher or the Waterwatch Coordinator.

Name: ..... Signed: .....
(Parent/Guardian)

Name: ..... Signed: .....
(Student)

School: .....

Date: .....

3.4 Fieldwork checklist for water quality testing

Date: .....

Class: .....

Item	Checked
TEACHER	
Permission notes	☐
Class list	☐
Special needs student list	☐
Risk assessment sheet for completion	☐
Buses (if applicable)	☐
First aid kit	☐
Sunscreen	☐
Medications needed by students	☐
Mobile phone	☐
STUDENTS' CLOTHING	
Hats	☐
Closed-toe shoes	☐
Water (drinking and washing)	☐
FIELD EQUIPMENT	
Waterwatch kit	☐
Junior Waterwatch Field Manual	☐
Waterwatch procedure sheets (laminated)	☐
Sampling pole	☐
Waste bag	☐
Deionised water	☐
RECORDING EQUIPMENT	
Camera	☐
Pencil case	☐
Marker pens	☐
Folder of result sheets and information	☐
Clipboards	☐

3.5 Fieldwork checklist for a water bug survey

Date: .....

Class: .....

Item	Checked
TEACHER ORGANISATION	
Permission notes	☐
Class list	☐
Special needs student list	☐
Risk assessment sheet for completion	☐
Buses (if applicable)	☐
First aid kit	☐
Sunscreen	☐
Student medications	☐
Mobile phone	☐
STUDENTS' CLOTHING	
Hats	☐
Closed-toe shoes	☐
Water (drinking and washing)	☐
FIELD EQUIPMENT	
Bucket	☐
Large trays	☐
Ice cube trays	☐
Plastic teaspoons, pipettes, paintbrushes	☐
Magnifying glass (optional)	☐
Macro nets	☐
RECORDING AND ID SHEETS	
Pencil case	☐
Marker pens	☐
Folder of result sheets and information	☐
Clipboards	☐
Camera	☐
Bug identification sheets (laminated)	☐
Gambusia information sheet	☐

SECTION 4

Background to the water quality tests

There are a number of water quality parameters that can provide information about the health of your waterway. Understanding these parameters and how they affect aquatic ecosystems is important if monitoring is to lead to actions to protect aquatic ecosystems.

This section provides detailed background information on all the tests performed by primary school students as part of the Waterwatch program – what the tests measure and why they are important in the context of healthy waterways.

Included in this section: *Page*

4.1 Water quality testing

Why test water quality?

Water quality is the 'suitability' of water for particular purposes.

There are two aspects to think about when testing water quality: the usefulness of water for human use, and the impact that changes in water quality have on plants and animals living in the river environment.

Human activities can have a major effect on water quality. When the quality of the water makes it no longer useful for a particular use, it is said to be polluted.

Pollution can occur directly, such as by wastewater disposal or urban stormwater. This is called point source pollution. Pollution can also occur indirectly from runoff from agricultural land or by the removal of native vegetation leading to increased erosion.

Water quality tests will give an indication of the health of the waterway. It is important to know what the problem is in order to fix it up!

By testing water over a period of time the changes in water quality can be noted. It is important to record changes in water quality so something can be done to reduce the problem.

Waterwatch provides the tools and methods that allow students to conduct investigations at their local creek or river and to report any changes.

Monitoring water quality promotes an interest and awareness of environmental issues. The Waterwatch program complements Stages 2 and 3 HSIE and Science and Technology environmental education within schools.

> ***i*** **Section 10 provides links between the Junior Waterwatch program and Stages 2 and 3 curriculum outcomes.**

The tests

The tests conducted as part of the Junior Waterwatch program include:

- temperature
- electrical conductivity (salinity)
- pH
- turbidity
- rate of flow

These tests have been selected because:

- they are simple
- they tell us about important catchment issues
- they develop an understanding of water quality and how the interaction between land and water affects water quality
- they do not use dangerous chemicals
- the results will be very accurate so long as some simple rules are followed.

4.2 Temperature

What is temperature?

Temperature is a measure of heat and cold. Temperature is measured in degrees Celsius (°C).

Why is it important?

The main effect of water temperature on the environment is related to oxygen in the water. The amount of oxygen that water can hold decreases as the temperature of the water increases. So if water gets too hot there is less available oxygen for living things to extract, for example, aquatic animals that need oxygen to breathe.

Temperature also affects the metabolic rate of aquatic animals, rates of development, breeding cycles, mobility, migration patterns and the sensitivity of organisms to toxins, parasites and disease. Life cycles of many organisms are related to temperature. Organisms can tolerate slow changes in temperature, but thermal stress can occur where the temperature changes more than 1 or 2°C in 24 hours.

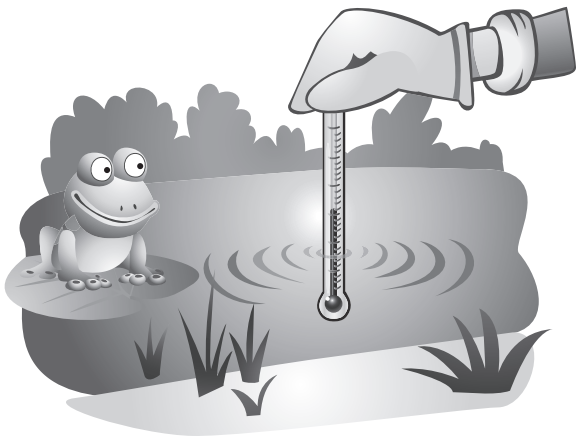
Things which affect water temperature

Temperature is directly affected by:

- depth of water
- flow rate
- season
- time of day.

Other influences on temperature include:

- air temperature
- altitude – high altitudes are colder
- the amount of sunlight and shade
- surrounding vegetation – provides shade and traps sediment
- turbidity – high turbidity warms the water and smothers aquatic plants
- stormwater and urban runoff from hard surfaces such as streets and footpaths
- cold water releases from dams.



Effects on water bugs

Keep it cool!

Warm water reduces oxygen levels in the water and impacts directly on water bugs, which rely on dissolved oxygen in the water to breathe.

The vulnerable (sensitive)

Caddisflies, dragonflies, damselflies, mayflies

More tolerant

Snails, leeches, mosquito larvae

Protecting waterways

Cool to moderate water temperatures increase oxygen levels, which promotes healthy ecosystems. Protecting the plants that grow on the stream banks (riparian plants), or replanting where they have been removed, will help our waterways to stay cool and healthy.

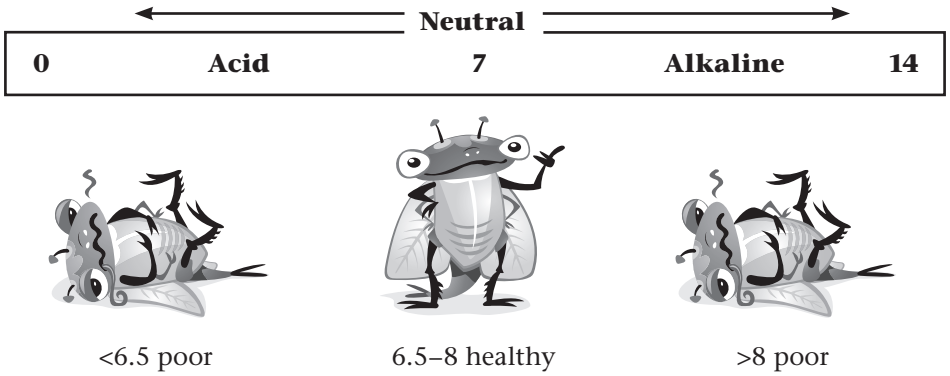
The lowering of water temperature through cold water releases from dams can delay summer peak temperatures by up to 10 weeks, the rapid temperature rise in spring is eliminated, and the annual range of maximum and minimum temperatures is much smaller. This has very big impacts on breeding patterns for fish and other animals living in water. Keeping the right temperature balance means maintaining natural patterns of water flow and vegetation as much as possible.

4.3 pH

What is pH?

pH is a measure of the acidity or alkalinity of a substance. The pH scale ranges from 0 to 14, where 7 is classed as neutral, 0 to less than 7 is acidic and greater than 7 to 14 is alkaline or basic. Rainwater usually has a pH value between 5.5 and 6.0. Natural sea water has a pH of 8.2. A pH range of 6.5 to 8.2 is best for most fish and other freshwater aquatic organisms.

pH



<6.5 poor | 6.5–8 healthy | >8 poor

Note: Sudden changes in pH are undesirable and may cause a loss of native plants and animals.

Why is it important?

The best pH level for most organisms in Australian freshwater waterways is pH 6.5 to pH 8.2. Changes in pH outside this normal range can cause a reduction in species diversity, with many of the more sensitive species disappearing.

Things which affect pH

Natural factors – pH will vary depending on the geology of the area. Water flowing through limestone country will be alkaline but in basalt and sandstone country the water will be slightly acidic. Water from a forested catchment will be slightly acidic after draining through the leaf litter.

Human activity – Industrial runoff and sewage may affect the pH of water. Chemicals on road surfaces washing into the water after rain can affect pH. The application of lime to agricultural land may raise the pH if washed into waterways, while fertilisers may lower it.

Daily changes – pH will rise (become more alkaline) during the day due to plant photosynthesis. During the night, pH may fall.

Chemical changes in the water – When carbon dioxide is removed from the water pH increases, and when carbon dioxide is added, pH decreases. pH can also change if polluting chemicals are added to the water.

How acid affects waterways

Water with a pH of less than 5.5 may cause the release of heavy metals trapped in sediments. Fish and other aquatic species may suffer skin irritations, tumours, ulcers and impaired gill functioning. People may get irritated skin or eyes in affected water.

How acid affects macroinvertebrates

Water bugs have different sensitivities to low pH:

- **vulnerable (very sensitive)** – mayflies
- **sensitive** – caddisflies, stoneflies
- **very tolerant** – dragonflies, damselflies, beetles, true bugs.

How alkalinity affects waterways

If the water is too alkaline, fish and other aquatic species may suffer skin irritations, tumours, ulcers and impaired gill functioning. People may suffer skin or eye irritations in affected water.

pH of some common substances

The approximate pH reading for each of these substances is:

Acid	Neutral	Basic or alkaline
Hydrochloric acid 0		Blood 7.4
Vinegar 2.2		Baking soda 8.3
Orange juice 4.4		Ammonia 11
Rainwater 5.8		Lime (calcium hydroxide) 12.4
Milk 6.6		Bleach 12.9

4.4 Electrical conductivity (salinity)

What is salinity?

Salinity is the presence of salt in the landscape, in soil or rocks, or dissolved in water or groundwater. The most common salts include not only sodium chloride (table salt), but also the chlorides of calcium, magnesium, potassium and the bicarbonates and sulfates of these.

Why is it important?

Salt is present naturally in our land and water, but human changes due to land use have mobilised natural salt, concentrating it in certain areas of land and water, where it causes major economic and environmental problems.

Salinity is measured by electrical conductivity (EC). Salts conduct electricity, so electrical conductivity can be used to estimate the amount of salt in a water sample or soil/water solution. EC readings increase as salinity levels increase. EC is recorded in microsiemens per centimetre (µS/cm) or millisiemens per centimetre (mS/c).

Causes and consequences of increased salinity

Increases in salt in the landscape can be caused by:

- erosion of rocks containing salts
- salty groundwater storage (aquifers)
- cyclic salt – salt deposited over millions of years from the atmosphere, including salt from soil particles
- rainfall
- runoff from urban and agricultural land
- discharges from industrial areas and sewage treatment plants (STPs).

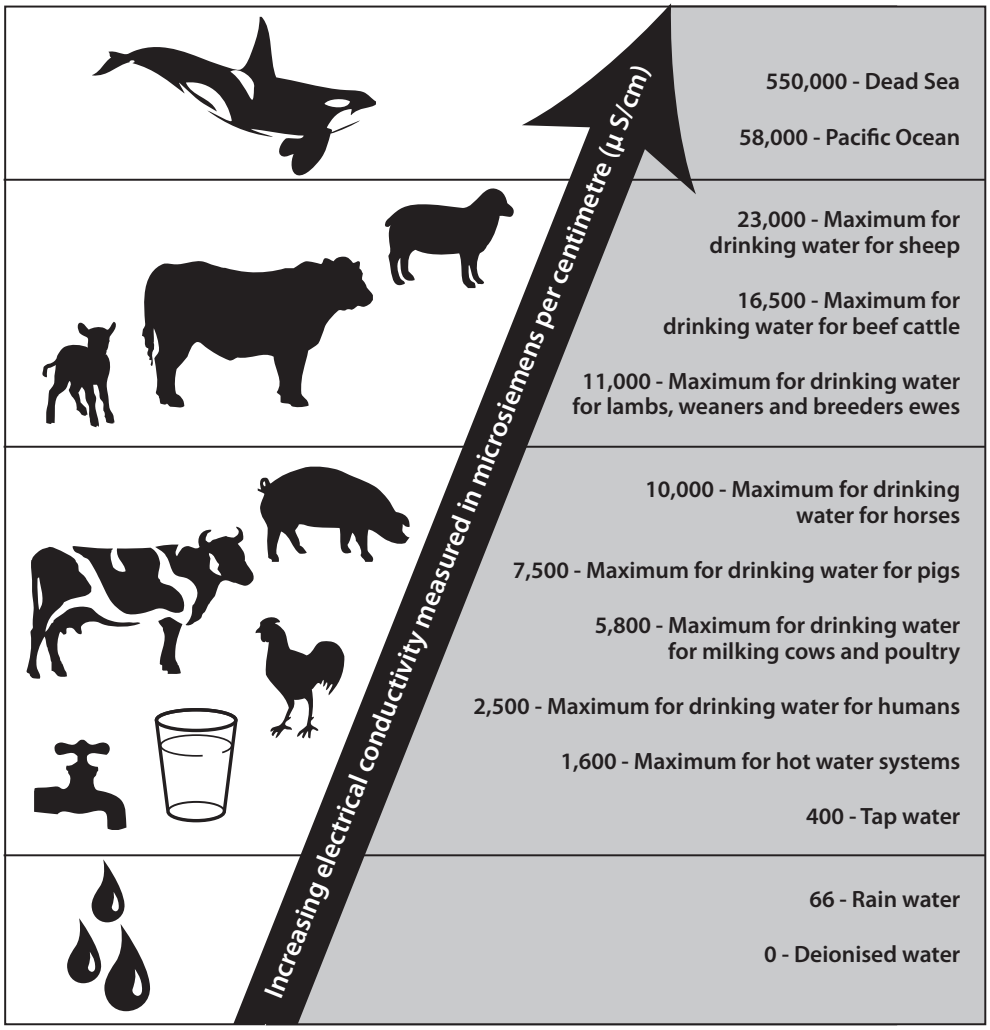
Salts can be stored in soil or water. Human activities that change the natural balance can move more salts into waterways. This can be caused by:

- removing perennial native plants (trees, shrubs and grasses)
- poor irrigation practices that use too much water
- saline groundwater seepage into creeks and rivers
- industrial and sewage effluent
- agricultural runoff
- urban development in saline areas.

Increased salinity can have a range of environmental consequences:

- salt scald, causing areas that are bare or have only salt-tolerant species
- inability to use saline waters for irrigation, drinking, industry, etc.
- dieback of trees and other vegetation
- changes to the number and diversity of living things in waterways
- damage to roads, building foundations and other infrastructure
- high water treatment costs.

Salinity levels



Source: *Ribbons of blue: in and out of the classroom*, WA Dept of Education and Training.

4.5 Turbidity

What is turbidity?

Turbidity is the cloudiness or muddiness of water. Particles of clay, silt, sand, algae, plankton and other substances increase turbidity.

'Blackwater' is discolouration due to natural dyes in wetland/aquatic plants or caused by leaf litter as it breaks down. Blackwater also increases turbidity.

Why is it important?

Increased turbidity can affect:

- how much light can penetrate the water, reducing plant growth and oxygen production
- breeding and survival of fish and other aquatic animals
- water temperature, because sediments absorb more sunlight, raising the temperature
- oxygen levels, which decrease as water temperature rises
- visual clarity of water.

i **Bug fact: Many water bugs are filter feeders. This means they filter food particles out of the water with special feeding mechanisms. When these are blocked by sediment, the numbers of these species will decline. For example, water boatmen have siphon mouthparts (sucking tubes) that clog up in turbid water, affecting the behaviour of the boatmen. If turbid water is replaced with fresh, clear water, the boatmen resume their normal behaviour.**

Causes and consequences of increased turbidity

Some waterways are naturally turbid, e.g. in clay soil areas; however, many human activities increase turbidity to unnatural levels:

- agriculture
- animals accessing waterways, particularly livestock
- removal of vegetation along stream banks
- stormwater and other urban runoff
- sewage treatment plants (STPs)
- building sites not using sediment and erosion control
- land-use changes in catchments
- industrial discharges.

When the turbidity of waterways increases beyond natural levels, the consequences may include:

- reduced light penetration leading to reduced growth of aquatic plants
- clogged fish gills
- suffocation of aquatic plants
- siltation of stream beds leading to the loss of breeding habitat
- death of water bugs or disruption to breeding cycles
- increased temperature and reduced oxygen
- reduced long-term biodiversity.

4.6 Rate of flow

What is the rate of flow?

The rate of flow is the volume of water passing a particular point in a stream at any given time. Flow rates affect water temperature, dissolved oxygen, turbidity, salinity and the concentrations of pollution levels.

Why is it important?

Stream flow will vary due to the natural variability of rainfall. However, more permanent changes have occurred due to human modifications to the water cycle, such as the construction of dams, weirs and other channel obstructions. These obstructions even out the natural high and low flows to which many ecosystems have adapted, especially wetlands.

The best water quality usually occurs under conditions where there is sufficient flow to ensure:

- good oxygenation of the water
- dilution and flushing of pollutants
- limits to the build-up of algae.

High flows after heavy rain can also cause problems such as erosion and turbidity, especially in heavily developed areas with hard surfaces.

Consequences of changes in rates of flow

Low flows

Low flow rates can lead to:

- low oxygen levels
- reduced flushing of pollutants that build up over time
- increased salinity
- larger temperature variations, placing stress on aquatic life
- increased algal growth.

High flows

High flows due to heavy rainfall or releases of water from dams can result in:

- increased sediment load
- increased turbidity
- increased nutrients
- reduced salt concentrations
- increased salt loads.

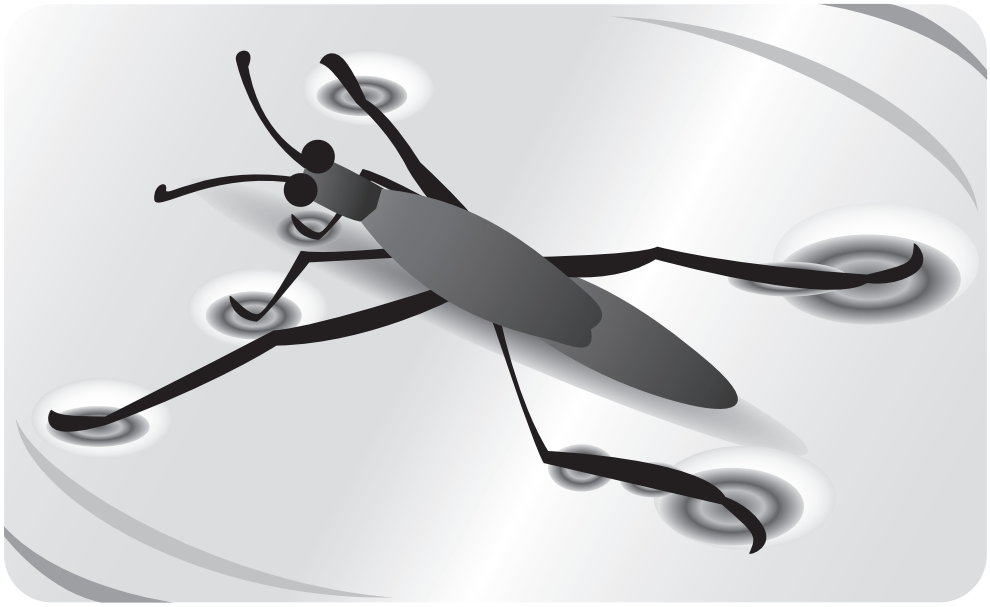
Flows in estuaries

In estuaries tidal movements almost totally dominate flow patterns, except in periods of flooding. This affects the movement of litter and sediment, and the movement of discharges from stormwater pipes and sewerage systems. It is usually the practice to monitor water quality on the ebb tide (going out).

Consequences for macroinvertebrates

The diversity and types of water bugs will vary with flow. Some are tolerant of low oxygen levels and prefer still pools, e.g. bloodworms, yabbies. However, many bugs are adapted to resist currents. Many have streamlined bodies and can swim fast or grip with claws, e.g. damselfly nymphs, dragonfly nymphs, beetles, mayfly nymphs, stonefly nymphs, snails and water boatmen.

Other water bugs have no mechanism to resist currents and may be washed away during high flows, e.g. mosquito larvae, water scorpions, lesser water striders. Water striders are able to hop upstream on the water's surface during periods of high flow because of pads on the ends of their legs.



SECTION 5

Background to the habitat assessments

A habitat is a place that provides food and shelter for living things. There are many different habitats on land and in water, and each has its own collection of plant and animal species. At a waterway, the two main habitats are the riparian zone and the aquatic zone. Each of these is made up of a variety of smaller habitats.

This section provides background material for the habitat assessment activities included in the Junior Waterwatch Field Manual.

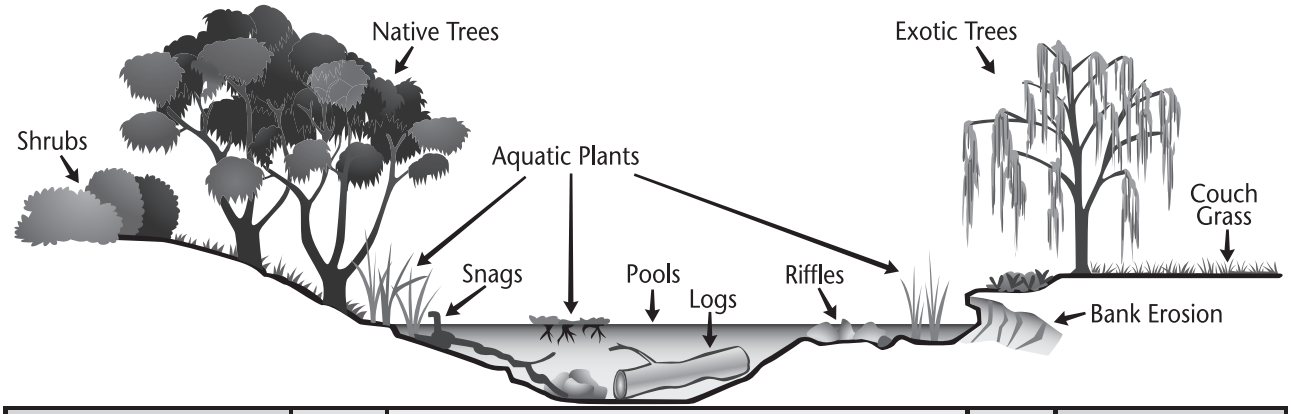
Included in this section: *Page*

5.1 What is a habitat?

A habitat is a place that provides food and shelter for living things. At waterways there are two main habitats:

- the riparian zone
- the aquatic zone.

The aquatic and riparian zones are interlinked and are important because they protect the health of the waterway. Changes in one zone will impact on the other. Erosion or revegetation of the banks directly impacts on water quality and aquatic habitats. Erosion causes sedimentation which smothers aquatic plants, the channel bed and fish breeding sites. Revegetation of riparian zones using native plants reduces erosion and provides a greater range of food sources for aquatic animals.



VERGE	BANK	IN-STREAM	BANK	VERGE
Riparian Zone		Aquatic Zone		Riparian Zone

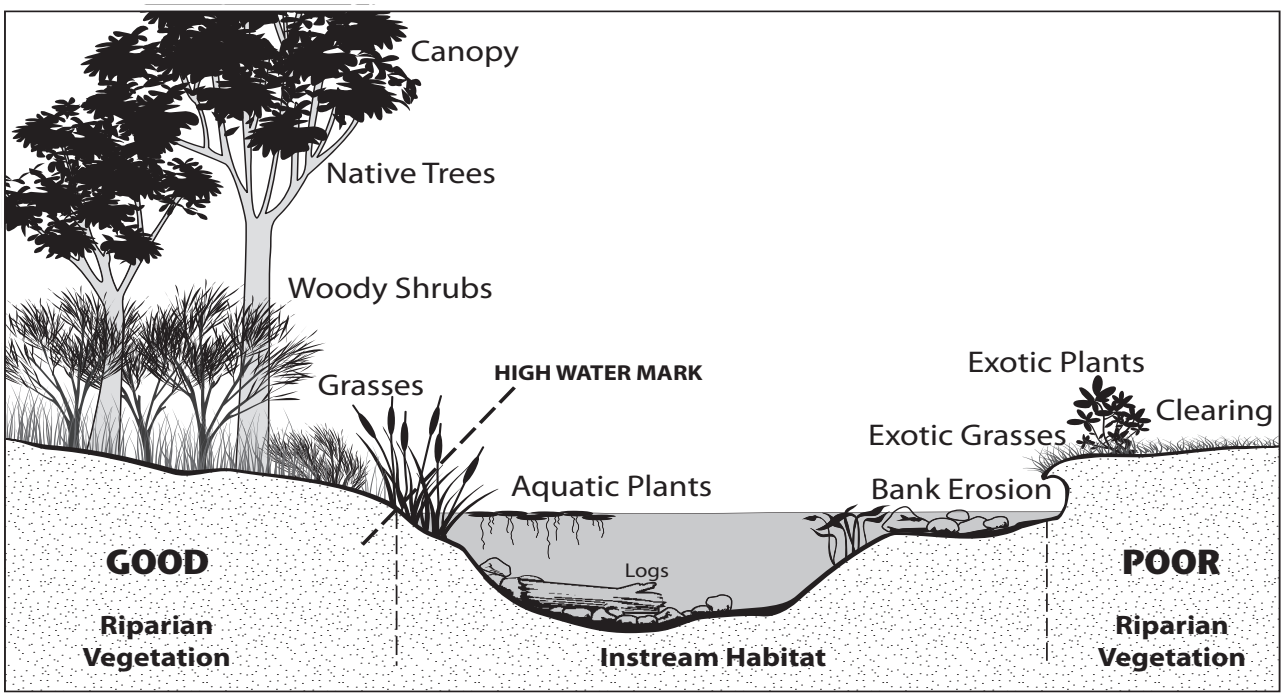
5.2 The riparian zone

The riparian zone extends along the banks of a river, creek or wetland. This area is next to, and influenced by, the water body. It includes aquatic and semi-aquatic plants, as well as tree and shrub vegetation.

The riparian zone habitat is an important link between the aquatic environment and the adjoining land. It provides food and shelter for aquatic, semi-aquatic and land animals such as lizards, snakes, bats, frogs and birds. When riparian vegetation is lost, many animals can no longer survive due to loss of habitat.

Riparian vegetation is also important to protect the waterway from erosion and prevent pollutants entering the stream. A lack of plants along the banks may cause poor water quality by increasing turbidity, which will affect aquatic life.

Typical riparian zone



Aliens at the site

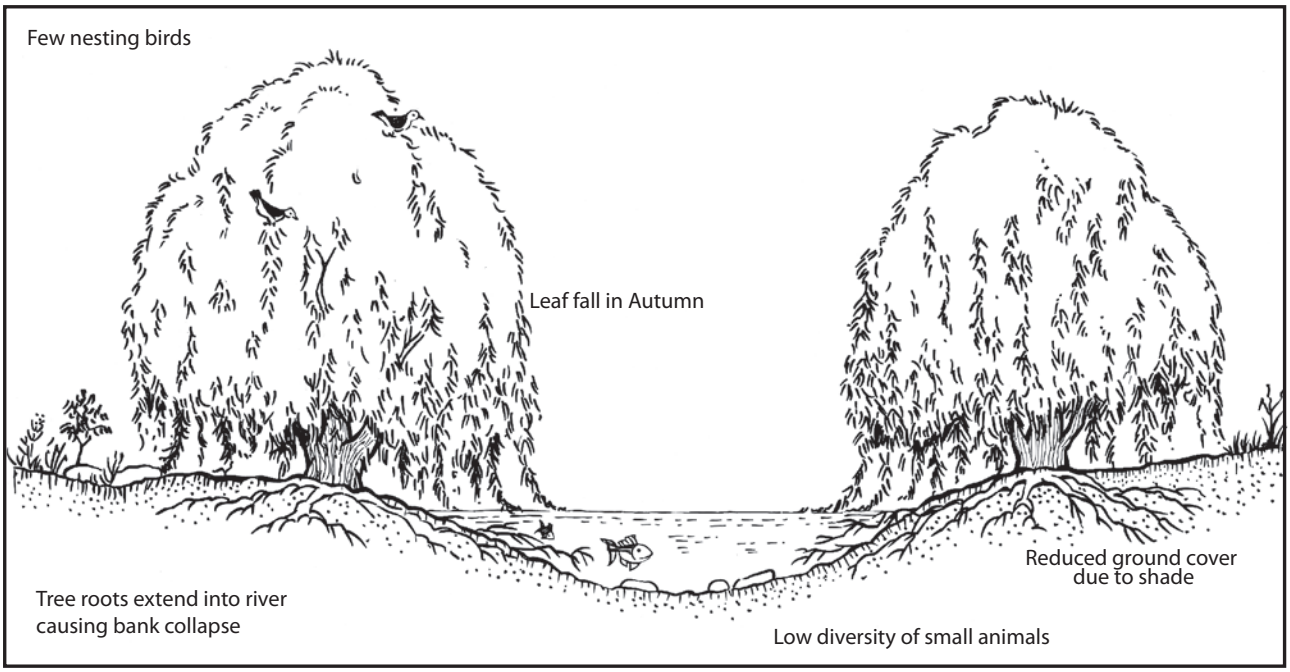
Weeds are alien plants that have been introduced to the area from another place. They can include:

- trees such as willows
- vines and bushes such as blackberries and lantana
- pasture weeds such as Paterson's curse
- aquatic plants such as alligator weed and salvinia.

Many weeds have been introduced to Australia. Few insects or birds live under or in exotic (weed) species. These weed species can also pollute the waterways. Examples of this include the leaves of weeping willows, which clog waterways, and camphor laurel leaves, which can be toxic to native fish.

Because introduced species sometimes don't have any natural predators or diseases in Australia, they can easily spread out of control.

Effects of willow trees on waterways



5.3 The aquatic zone

In-stream habitats are provided by the shape of the stream channel and by logs, branches, aquatic vegetation, stones and rocks within the channel.

The features of habitats in the aquatic zone can be described as follows:

- **riffles** – shallow areas where the water rushes over rocks
- **pools** – deeper areas of still water which provide important habitats for larger fish and aquatic species
- **runs** – links between pools and riffles, with deep flowing water and little or no turbulence
- **snags** – fallen branches and washed-in shrubs
- **logs and rocks**.

Fish and other aquatic organisms need snags, rocks and logs to shelter from predators and the current and to reproduce. Protruding snags provide safe perching and roosting sites for birds. Aquatic plants provide food and dissolved oxygen for aquatic species.

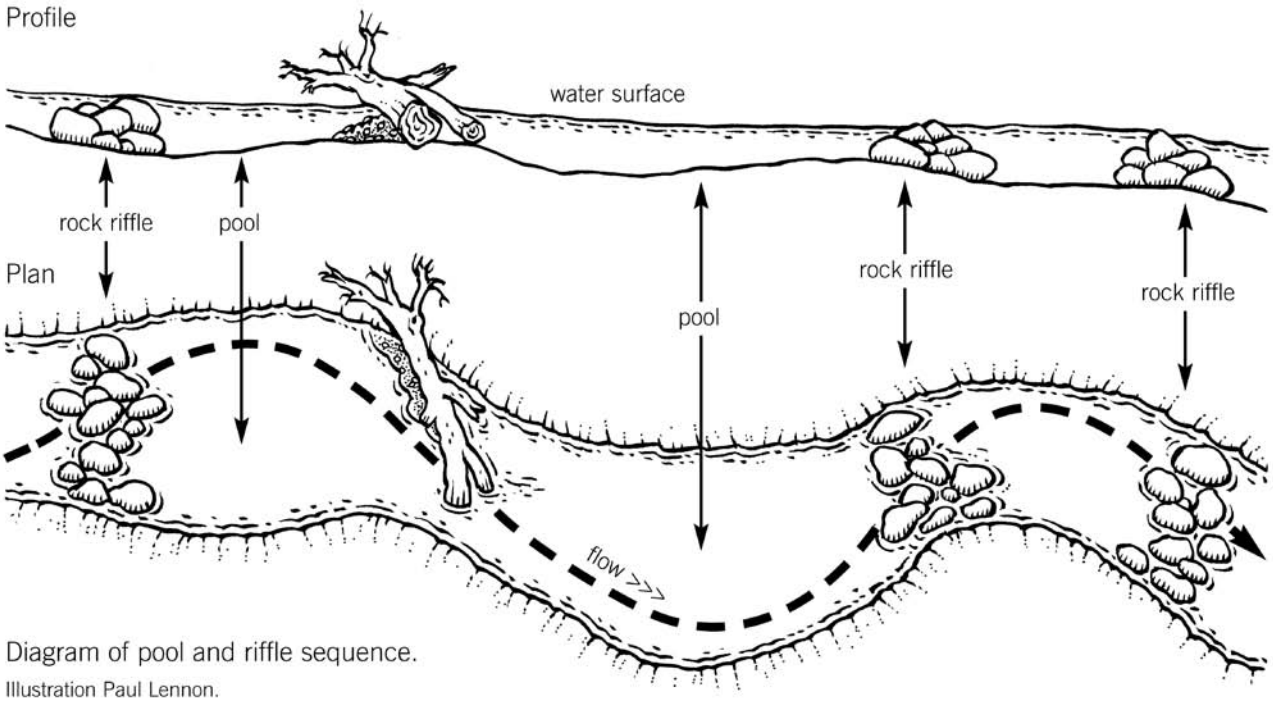
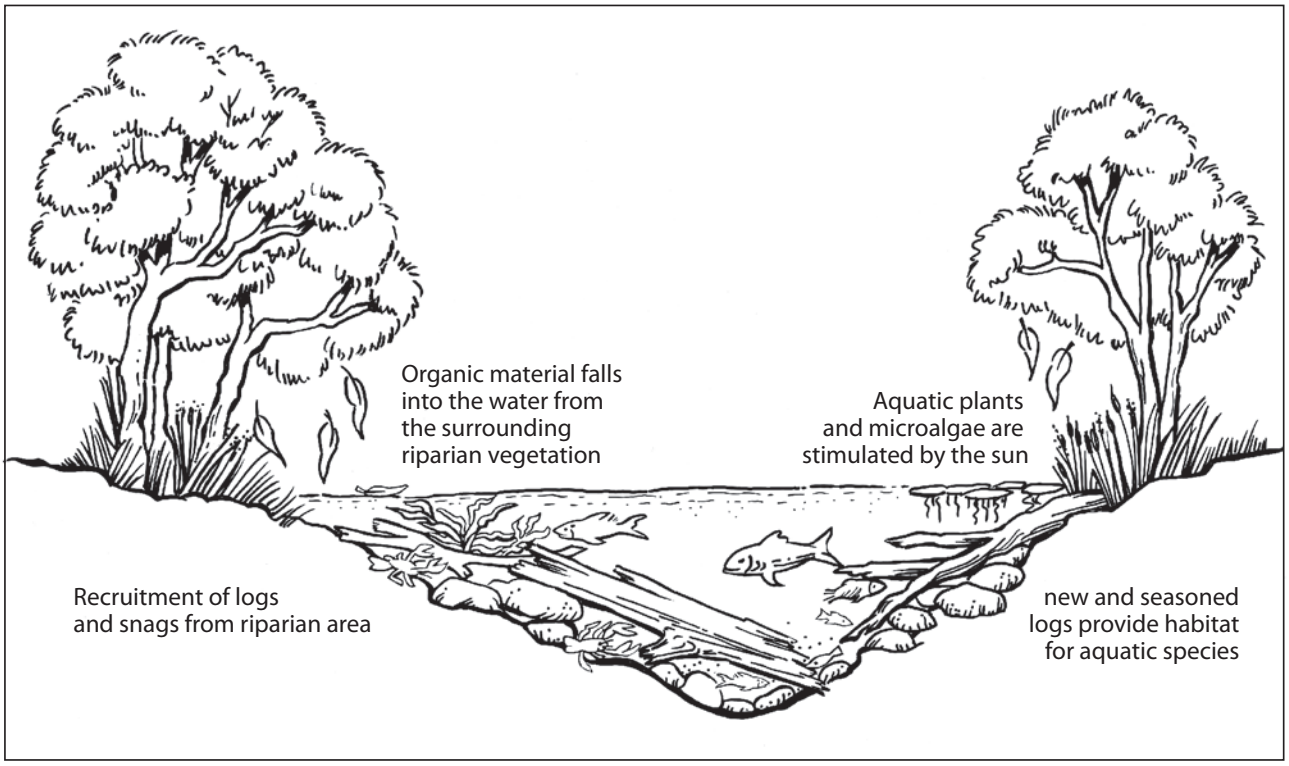
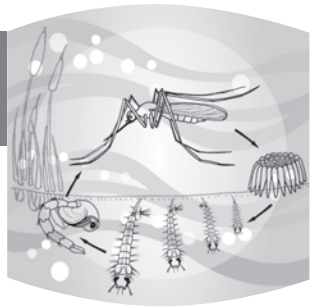


Diagram of pool and riffle sequence.
Illustration Paul Lennon.

The health of habitats in the aquatic zone is closely linked to the nature of the surrounding riparian zone. Plants along the stream support a range of aquatic plant and animal species. Logs and branches provide a habitat for fish and water bugs. Organic matter assists plant growth while insects falling from branches may provide food for some aquatic species.



SECTION 6



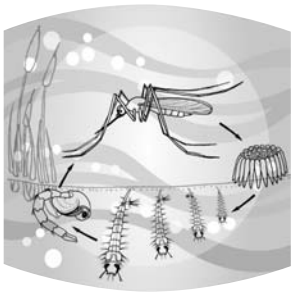
Background to the water bug survey

Water bugs, also known as macroinvertebrates, are small creatures with no backbone that can be seen with the unaided eye. Different kinds of water bugs have different tolerances to pollution and can therefore provide an indication of the health of your waterway. A healthy waterway will have an abundance and wide diversity of water bugs.

This section provides background information for the water bug survey in the Junior Waterwatch Field Manual.

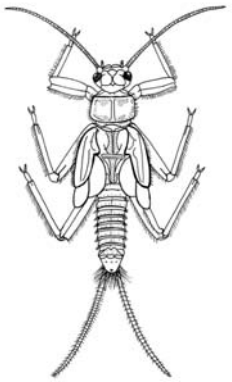
Included in this section:

6.1 What are water bugs (macroinvertebrates)?



Water bugs or aquatic macroinvertebrates are small creatures that have no backbone and can be seen with the unaided eye. They live all or part of their life in water, providing a food source for larger animals such as fish, frogs and birds. Macroinvertebrates include snails, beetles, dragonflies, yabbies and worms.

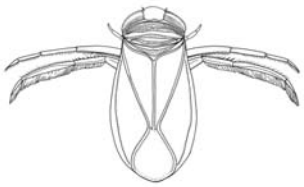
> ***i*** **Macro = visible to the unaided or naked eye**
> **Invertebrate = animal without a backbone**



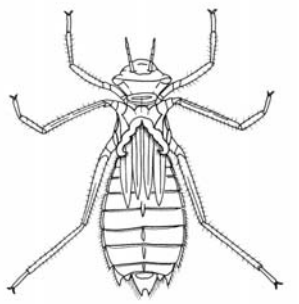
Macroinvertebrates and waterway health

Water bugs provide a biological indication of the health of our waterways and are used to assess river health for the following reasons:

- Macroinvertebrates are found in almost every water body, even those that are dry from time to time.
- They are easy to catch with simple hand nets and are relatively easy to identify.
- They have different tolerances to pollution.
- The sedentary nature of some macroinvertebrates means they provide an indication of past conditions as well as present conditions.
- Macroinvertebrates are a major component of biological diversity. About 99% of animal species are invertebrates. Understanding the effects of human activity on aquatic macroinvertebrates helps in finding ways to conserve them.
- A healthy macroinvertebrate community is important to the normal functioning of a water body. Macroinvertebrates occupy a central position in the food webs of rivers and streams.



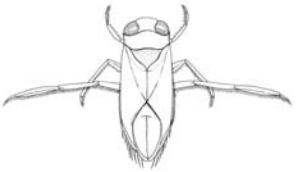
What does macroinvertebrate sampling provide?



Sampling reveals information about the abundance, diversity and composition of water bugs. This in turn gives an indication of the health of the waterway.

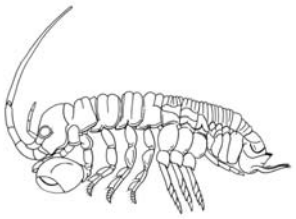
Abundance

Abundance refers to the **number of animals present**. Excessive numbers of macroinvertebrates, particularly gastropod snails, tend to be found in water artificially enriched with nutrients. Small numbers may indicate erosion, toxic pollution or scouring by floodwaters.



Diversity

Diversity refers to the **number of different types of animal present**. Healthy streams usually have a greater diversity than degraded streams, although the diversity in headwaters may be naturally low due to a lack of food variety. Communities with many different species appear to be more stable and healthy than less diverse ones.

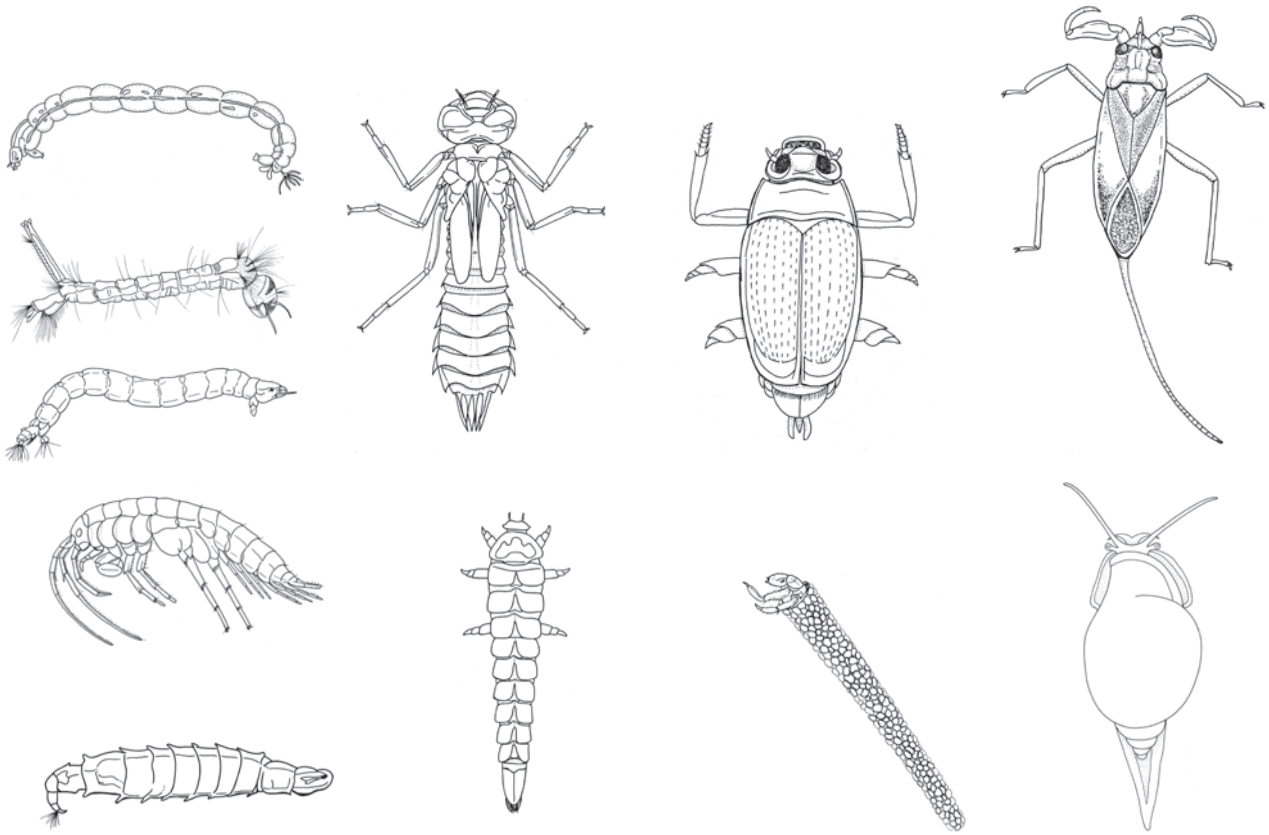


Composition

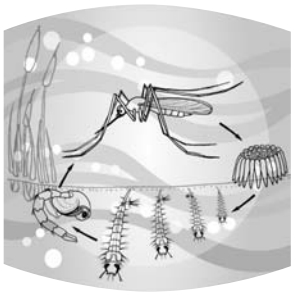
Composition of the community refers to the **proportion of different types of animals living together**. A sample from a healthy stream tends to contain a good number of mayfly, stonefly and caddisfly nymphs. However, if the sample contains a lot of worms and midge larvae (chironomids), the stream is probably degraded.

Pollution tolerance

Pollution tolerance refers to the **ability of macroinvertebrates to withstand pollution** from a range of sources, such as stormwater runoff, sewage, industrial effluent or heated water. This is reflected in the macroninvertebrate's SIGNAL 2 score – a simple scoring system for water bug samples.



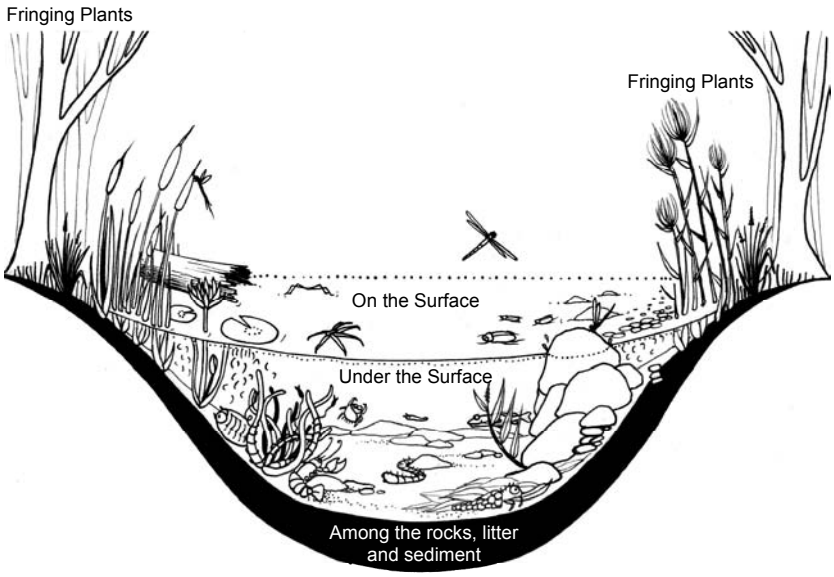
6.2 Habitats of water bugs



A habitat is the environment where an organism lives and grows. Habitats provide the basic requirements and conditions to survive. Water bugs live in different habitats within streams:

Freshwater habitat	**Macroinvertebrates that may live there**
Still water (edge and water surface), including overhanging vegetation from banks	Fast moving bugs and beetles and freshwater shrimp
Bottom mud, sand, silt, gravel and rocks	Worms and fly larvae, mussels and clams
Aquatic plants (under the surface as well as those growing through the water and floating)	Gripping insects, caddisflies, damselflies, shrimp, snails and caterpillars
Flowing water, riffle zone where water tumbles over rocks and logs and flows faster around bends	Gripping insects, caddisflies, beetle larvae that have burrowed into logs and under rocks, mayfly and stonefly nymphs

When a habitat is missing from a location, the diversity of bugs will be reduced. Make sure sampling takes place in all habitats so you really know what lives there!



Changes within water bug communities

Communities of macroinvertebrates change throughout the year:

Seasonal change – Some macroinvertebrates will be more abundant at certain times of the year, depending on the stage of their life cycle and opportunities for breeding.

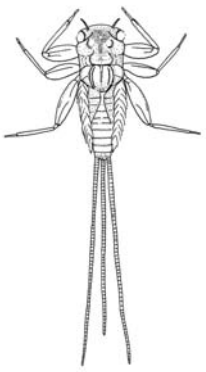
Weather patterns – Storms may disturb sites by flushing macroinvertebrates downstream (this can also occur when water is released from dams). Periods of low flow and drying up of waterways will concentrate animals into smaller areas. Some animals will cope better with these types of stresses, so changes may occur in the diversity and numbers of macroinvertebrates.

Habitats in streams

Riffles

What is a riffle?

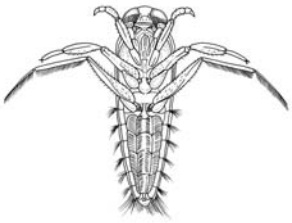
A riffle is an area of relatively fast moving water where the water is flowing over a shallower bed and forms small rippled waves compared to the slow flowing areas of the stream. It often consists of a rocky bed of gravel or other small stones.



Adaptations of bugs in the riffle zone

Macroinvertebrates that live in the riffle zone have adaptations which include:

- streamlined bodies – long, slender and flat
- legs are often straight out to the side, to allow the bugs to lie flat against the rocks
- some have hooks (mayflies) or suction cups (snails) which allow them to cling to rocks
- resisting currents by swimming upside down – backswimmer
- sluggish and obtaining food by grabbing it as it moves past.

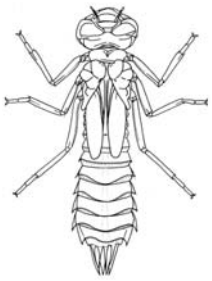


Pools – still water

Pools are still, so macroinvertebrates move to catch their food.

The bugs that live in pools:

- have long legs so they can move quickly
- many are predators, with large scoop-like mouths, such as dragonfly and mayfly nymphs and whirligig beetles
- many live on the surface of pools and some, like the water strider, can walk or hop on the surface of the water



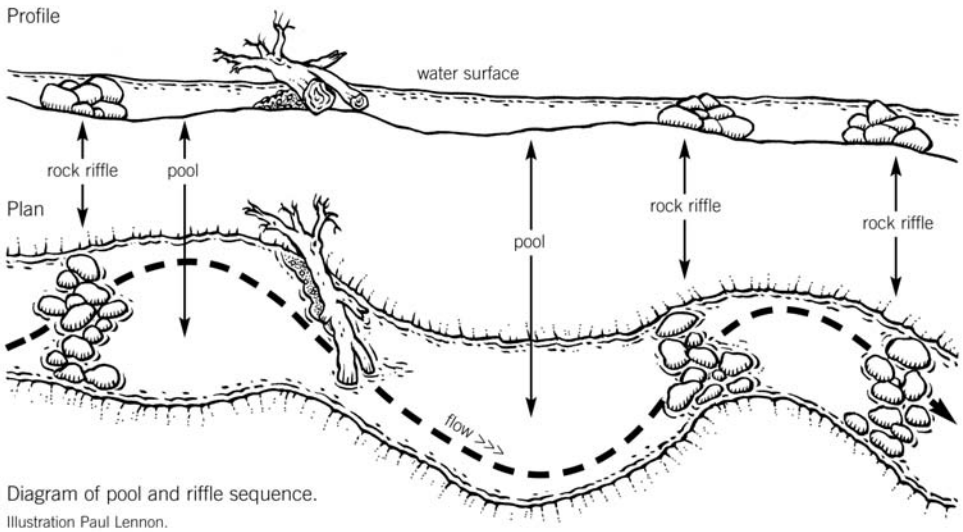
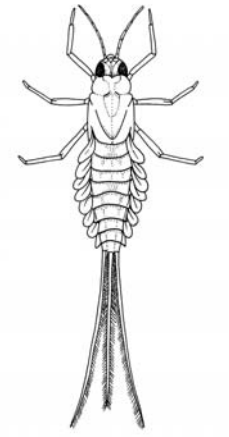
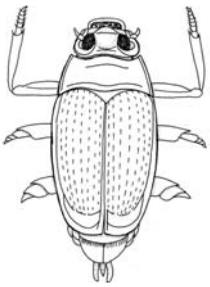


Diagram of pool and riffle sequence.
Illustration Paul Lennon.

- many invertebrates are adapted to living in the sediment at the bottom of the stream, where oxygen levels are low. Burrowing mayflies, for example, have gill structures along their abdomens to absorb oxygen.



Life at the top

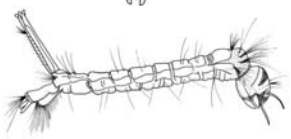


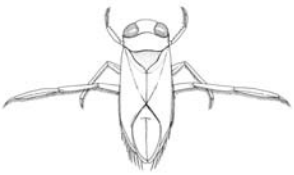
Water bugs which live at the top of the pool may be found:

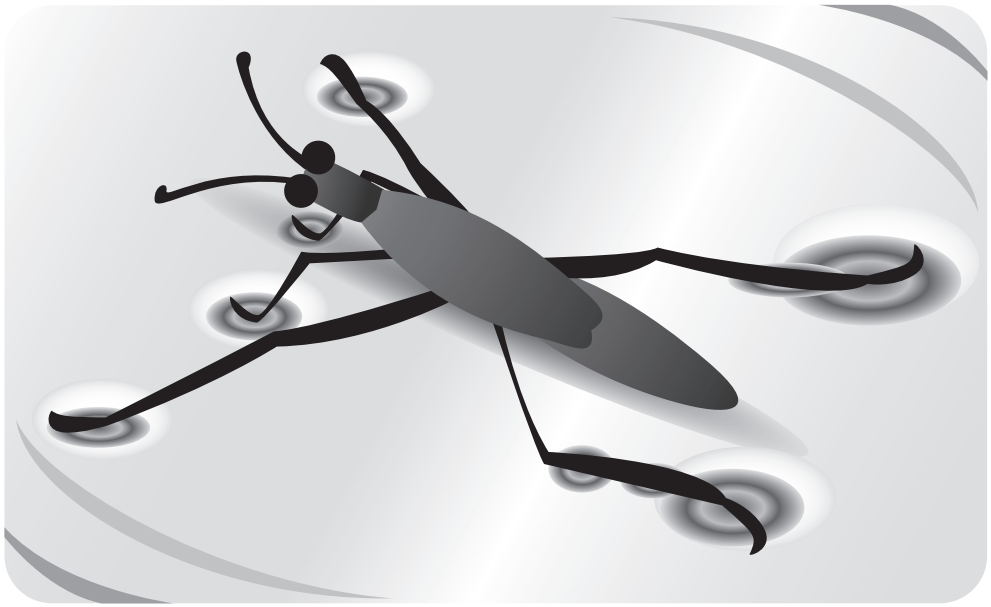
- on the water's surface
- just below the surface.

Bugs that live on the water's surface, or film, have adaptations which allow them to move across the surface. These include water striders and whirligig beetles.

Bugs which live just below the surface require oxygen from the air to breathe. These bugs include water boatmen, backswimmers and giant water bugs. The backswimmer uses two long breathing tubes to breathe and traps air bubbles around its body.

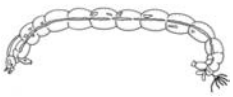






Life at the bottom

Bottom dwelling species include worms, molluscs and midge larvae which live in the bottom sediments. Snails graze on the bottom sediments while mussels attach to rocks and are filter feeders.

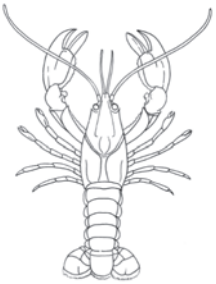


Life at the bottom has little oxygen and light. These dwellers often have adaptations to obtain oxygen, e.g. bloodworms have more red blood cells to hold oxygen.

6.3 What's for dinner?

In rivers and streams, leaves, sticks and twigs falling into the water are the main energy sources for bugs. Water bugs generally fall into one of three categories when it comes to their method of obtaining food: shredders, collectors or predators.

Shredders

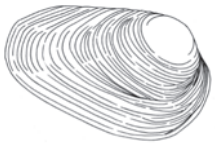


These bugs chew leaves, rotting sticks and twigs. This breaks down the plant matter into small pieces for other bugs to eat. Shredders include caddisflies and yabbies.

Collectors

The collectors gather, scrape or filter food broken down by shredders. They include:

- **gatherers** – water bugs which collect food deposited on rocks or found in the sediment, such as mayfly nymphs, caddisflies, worms and crustaceans
- **filter feeders** – water bugs which filter food particles from the water using specialised feeding mechanisms, such as net spinning caddisflies, midge larvae and mussels
- **scrapers or grazers** – water bugs which obtain algae from plant matter and rocks, such as caddisflies, snails and beetle larvae.

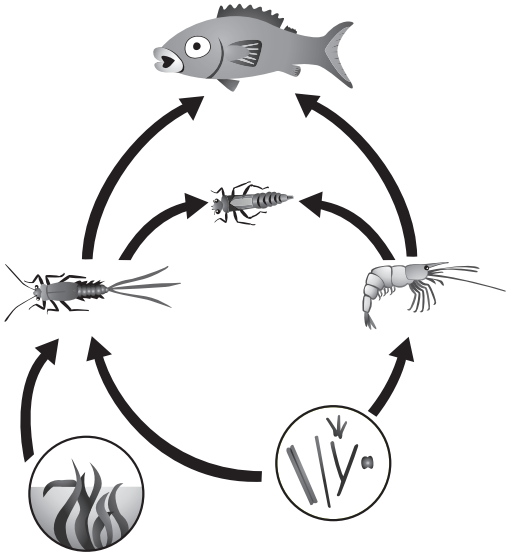


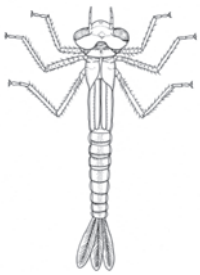
Predators

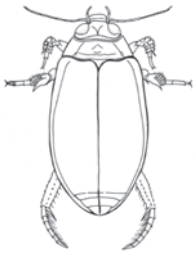
These bugs prey on other animals by biting, piercing or engulfing. They include dragonfly and damselfly nymphs, beetles and true bugs, which have beak-like sucking mouthparts to suck body fluids from their prey.

Bugs are part of the food chain

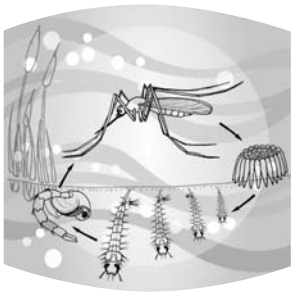
Just as water bugs survive by eating their own specialised diet and maybe each other, other animals also depend on macroinvertebrates for survival. These include ducks, fish, water rats and frogs. These are secondary and tertiary consumers.





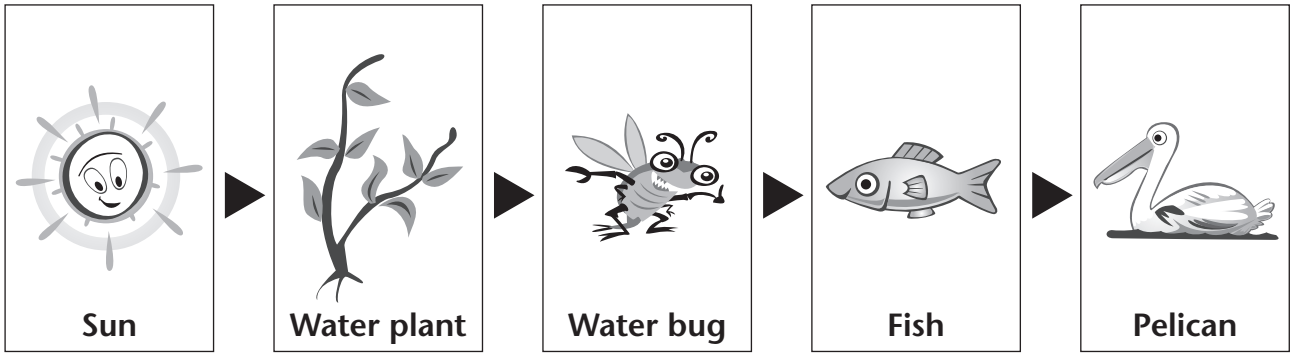


6.4 Food chains and webs



Energy is transferred between organisms by the food they eat. This is called a food chain. A simple food chain will include producers, consumers and decomposers.

Food chains begin with plants, which transform and store the sun's energy. Plants are called producers because they produce their own food. Many river dwellers eat plants and they are called primary consumers. These plant eaters are eaten by other animals, such as larger fish and birds, which are called secondary consumers. The pelican, like many waterbirds, eats a variety of fish and bugs. This complex interdependence of species is called a food web.



The parts of a food chain:

SUN provides the energy for the food chain.

PRODUCERS are green plants that use the sun, water, nutrients and carbon dioxide to produce energy. This process is called photosynthesis. Producers include water plants, phytoplankton and algae as well as leaves and twigs from stream bank vegetation.

CONSUMERS are all organisms which eat other organisms. They are classified as primary, secondary or tertiary consumers:

- **primary consumers** – animals that feed on plants (herbivores)
- **secondary consumers** – animals that eat primary consumers
- **tertiary consumers** – larger carnivores that eat secondary consumers.

DECOMPOSERS are bacteria and very small organisms which break down dead leaves and animals through a process called decomposition. Decomposers convert dead matter into small particles and gases which are released back into the water, air and soil.

The types of animals in a food chain

HERBIVORES are animals that eat plants.

CARNIVORES are animals that eat other animals.

OMNIVORES are animals that eat plants and animals.

PARASITES are animals that live off other organisms.

SCAVENGERS are animals that eat dead animal carcasses and rotting plant matter.

Macroinvertebrate food chain

The producers

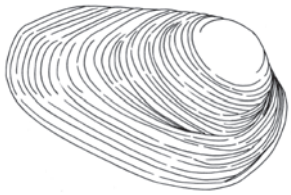
Plants, leaves and twigs

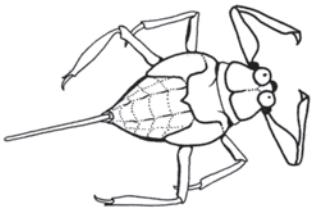
The shredders

Yabby, caddisfly larva

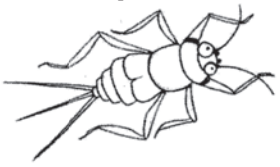
The collectors

Mayfly nymph, mussels





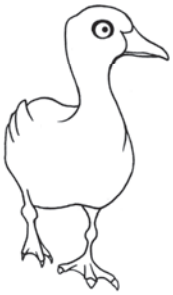
The predators



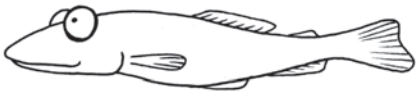
Water scorpion
Piercing

Mayfly nymph
Biting

Giant water bug
Engulfing

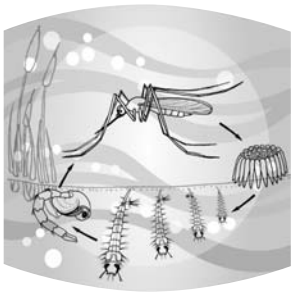


Non-macroinvertebrates



Ducks, frogs, fish

6.5 Life cycles



What is a life cycle?

A life cycle is the sequence of events in the lifetime of an organism from fertilisation, birth or hatching through to adulthood, when it reproduces and the cycle begins again.

Water is essential for at least one stage in the life cycle of many species that live in, on or near aquatic environments. Flying insects such as dragonflies, mosquitoes and midges spend most of their life underwater. Adults lay their eggs in water and the juveniles live, eat and grow underwater, emerging as flying adults.

Aquatic macroinvertebrates develop in a variety of ways, with 3 or 4 stage life cycles.

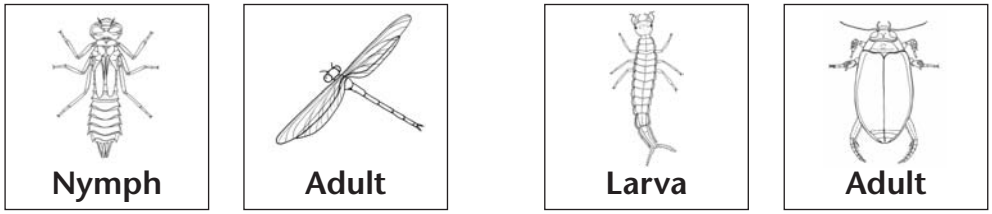
Nymphs

Eggs hatch into nymphs, which are miniature versions of the adult. As they grow they do not change much in appearance from baby to adult. Some, such as worms and snails, have soft skins that grow with them. Others, such as yabbies and dragonflies, have hard outer skins that are shed so that they can get bigger.

Larvae

Eggs hatch into larvae, which usually have very soft bodies and look nothing like their parents, e.g. mosquitoes. They go through a pupa stage and then develop into adults.

Dragonfly **Diving beetle**



Macroinvertebrate life cycles and weather patterns

The eggs of some macroinvertebrates lay dormant during dry periods, hatching when the water returns. Nymphs can burrow into the mud, or even crawl under damp leaf litter when water levels are low. Yabbies burrow and hibernate when water levels drop.

Mosquitoes have very short life cycles, needing very little time and water to reproduce.

Students will be able to trace the life cycle of a dragonfly, mosquito and caddisfly in Section 8.16 to 8.18 of this guide.

i **Discussion: How will climate change affect the breeding cycle of macroinvertebrates and other species in the food chain?**

SECTION 7

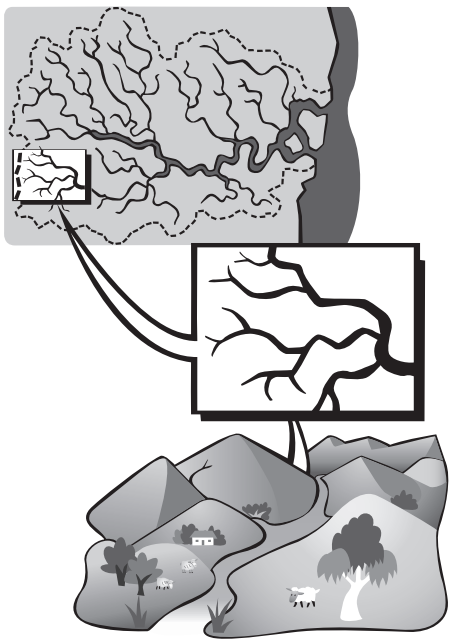
Student fact sheets

This section provides a series of fact sheets in larger type and using age-appropriate language that can be copied and given to students as background material for the various work sheets provided in Section 8. They can also be used in conjunction with the relevant work sheets and water quality testing procedures in the Junior Waterwatch Field Manual.

7.1 What is a catchment? fact sheet

A **catchment** is an area of land catching rainfall that flows into a creek, river, wetland or the ocean. Hills or ridges separate each catchment and direct the flow of water into different waterways. Within catchments, there are natural features such as native vegetation, water rocks and soils. However, catchments are also the places where people live, work and play. **Human use in catchments** can have an impact on water quality. This will affect the amount of water for a variety of uses.

Catchments occur at a variety of scales from very large catchments such as the Murray Darling Basin to local creeks and streams that may only flow occasionally. As small catchments are connected to larger catchments, changes in water quality in small local catchments can affect the water in larger creeks and rivers.



Catchments need to be **managed** to be sustainable for future generations. Maintaining and improving the quality of natural resources within a catchment will meet the needs of the community, ecosystems and the environment. In New South Wales, Catchment Management Authorities have been set up to work with the community, state government agencies, industry and individuals to identify and manage key natural resources within catchments.

7.2 Parts of a catchment fact sheet

Upper catchment

In the upper parts of the catchment, in places with hills and steeper slopes, rivers are usually fast flowing. This means they have the energy to carry large pieces of rock and gravel eroded from stream beds and banks and logs and branches from plants along the riverbank.

Plants along riverbanks are important because they reduce the amount of soil or sediment and nutrients washed off the land by rain. This means that less pollutants from the land will go into the waterway, keeping the stream healthy.

The upper part of a river is very important to the health of the entire river because this is the place that provides much of the food for aquatic animals that live downstream.

Overhanging vegetation provides much of the food (in the form of leaves, fruits, seeds, twigs and bark) required by stream organisms such as macroinvertebrates.

Dams and weirs regulate the amount of water moving along the stream. This can reduce flooding and make more water available for human use. However, by changing the stream flow, the types of plants and animals that live downstream may be changed.

Middle catchment

In the middle part of the catchment, the river winds or meanders across flat land called a flood plain. During floods, water spills out over banks onto the flood plain and deposits a layer of sediment. Occasional floods are important for maintaining the health of wetlands.

Often in the middle part of the catchment, the stream bank and its trees no longer shade all the water. Here the sun warms the water throughout the day and water temperature tends to drop at night as heat is lost into the air. Daily and seasonal changes in water temperature tend to be greatest in this part of the catchment.

Lower catchment

As a river gets very close to the sea, it travels very slowly and deposits the sediment it has been carrying from further upstream. Only organisms that can live with lower levels of oxygen and slow moving water can survive in this environment. These are called tolerant species. In the lower catchment, vegetation can make the banks more stable and prevent erosion.

Estuary/marine

Close to the sea, fresh water joins and mixes with salt water from the ocean. This is called an estuary. Estuaries are some of the most productive ecosystems and valuable assets of the coastal environment, providing food and shelter for a wide range of aquatic organisms such as crustaceans (e.g. crabs) and molluscs (e.g. water snails). Habitats in or beside estuaries include saltmarshes, mangroves, seagrasses, reedbeds, shallow sand and mud flats, rocky shores and reefs, and deeper zones of fine sediments.

Marine ecosystems are those that occur in sea water.

7.3 Healthy catchments and rivers fact sheet

A healthy catchment is one that is sustainable and able to meet the needs of the community, ecosystems and the environment.

The health of a waterway can be measured by various characteristics:

- Water quality is the 'suitability' of water for a particular use. By testing temperature, pH, salinity and turbidity, we collect information about water quality.
- Healthy ecosystems have a diversity of plants and animals both in the water and along the banks. A high diversity of water bugs collected during the autumn and spring water bug survey indicates a healthy river, creek or estuary.
- Healthy ecosystems cope better in times of stress. Stress may be caused by natural factors such as floods and droughts, or human changes due to the building of towns, use of the land for agriculture or industries, or other human activities.

The way people use the land around a waterway is a key factor for its health. Human activity can change the interactions between natural resources (land, water, vegetation and soils) and between plants and animals on the land and in the water.

It is essential to know where you are located within your catchment. Activities upstream and downstream and in your local area will impact on water quality and catchment health.

River health will affect the health of the whole catchment.

7.4 Human impacts in catchments fact sheet

Human activity has changed the natural environment, leading to changes in water quality and aquatic ecosystems.

Urban areas

In towns and cities, the natural environment is changed or replaced with buildings and hard surfaces such as concrete and tar. Water no longer soaks into the ground and goes through drains and pipes into local waterways. This water is not treated and is called stormwater.

When stormwater reaches our lakes and rivers it can have an effect on aquatic plants and animals. This is because stormwater is not just rainwater, it is water polluted by rubbish you can see, and also pollutants you can't see. These pollutants include litter, nutrients, dirt, bacteria, oil, fuel and other chemicals.

Rural areas

In rural areas, growing crops and grazing animals can have an effect on water quality. When fertiliser is added to farming land or when native plant cover is reduced, soil or sediment and nutrients can move from the land and enter the waterway. This reduces water quality and affects the plants and animals that live there.

Some pollutants caused by human activity

Litter

Litter includes paper, glass, cigarette butts, leaves and packaging. Plastics are a special problem as they can kill aquatic animals. Animals can eat plastic and then starve as they cannot get rid of the plastic in their stomach. Sometimes animals get tangled in plastic things, making it hard to swim and feed, or they may choke to death.

Nutrients

Nutrients come from fertilisers, detergents, animal wastes, soil and grazing animals, especially when they are allowed to use the river for drinking water. These extra nutrients can increase plant growth that may cause algal blooms. Some algae are poisonous and can harm animals and make it unsafe for humans to use the water, such as blue-green algae.

Nutrients that enter the waterway from surrounding land may affect plants and animals living in the water, causing changes to the aquatic ecosystem:

1. Plants take up nutrients and plant growth increases.
2. Algae grow quickly and may create an algal bloom.
3. The algae shade vegetation that grows under the water in the stream.
4. Aquatic plants do not grow as well because light is blocked out.
5. Algae soon die and sink to the bottom of the waterway.
6. Bacteria decompose the algae and this uses up oxygen.
7. Only species that are tolerant of low oxygen levels will survive.
8. If nutrients continue to be added, the cycle will continue.

Soil and silt

Soil washed into the river increases turbidity, making the water muddy. This can reduce the amount of light, making it harder for plants to grow. Less plant growth will reduce the amount of food available to the aquatic animals which feed on them. Muddy water can also clog up the gills of fish.

What can we do?

If you live in a town:

1. Reduce litter entering our creeks and streams by using rubbish bins.
2. Wash your car on the grass so detergents don't go down stormwater drains.
3. Always use phosphate-free detergents.
4. When walking your dog, carry a 'pooper scooper' and put droppings in the bin.

If you live in a rural area:

1. Reduce nutrients entering waterways by fencing out stock.
2. Keep riverbank vegetation healthy to reduce runoff from agricultural land.
3. Crop land alongside the river, rather than running livestock there, and use cropping methods that retain the stubble and reduce the risk of erosion.

7.5 Climate change fact sheet

Climate change is one of the most significant human impacts on the environment. In New South Wales future climate change may cause:

Higher air and sea temperatures – will increase evaporation and reduce the amount of water available for human use.

Sea level rise – will drown some coastal areas and be bad for fragile coastal ecosystems.

More drought – will affect the availability of water for urban and agricultural uses and the environment. Farming activities dependent upon reliable rainfall will be reduced.

Less rainfall, with most of it falling in storm events – extreme weather events can impact on residents and on agricultural production.

Climate change will impact on water quality:

Temperatures – as temperatures rise, water becomes less able to hold dissolved oxygen.

Rainfall – reduced rainfall, particularly during the hotter months, will reduce vegetation cover over the landscape. This will increase the risk of erosion and increased turbidity and nutrients in our waterways.

Increased frequency of higher intensity storm events – will increase erosion and dump more sediment and nutrients into rivers and streams. As a result, water quality and the overall health of river systems is likely to decline.

How can Waterwatch groups help?

Climate change will affect water quality and Waterwatch groups can help by monitoring water and air temperature, turbidity, dissolved oxygen and nutrients, particularly following storm events.

Climate change will impact on both aquatic and land-based ecosystems. Waterwatch groups can monitor these changes through the ongoing sampling of water temperature, macroinvertebrates and the plants and animals that live in the area.

7.6 Habitats in streams fact sheet

In-stream habitats are provided by the shape of the stream channel and by logs, branches, aquatic vegetation and stones within the channel.

The features of these habitats can be described as follows:

1. Riffles

What is a riffle?

A riffle is an area of relatively fast moving water where the water is flowing over a shallower bed and forms small rippled waves compared to the slow flowing areas of the stream. It often consists of a rocky bed of gravel or other small stones.

Adaptations of water bugs in the riffle zone

Macroinvertebrates (water bugs) that live in the riffle zone have adaptations which include:

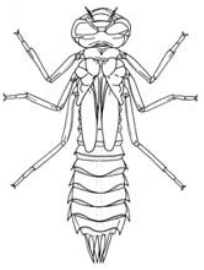
- streamlined bodies – long, slender and flat
- legs are often straight out to the side, to allow the bugs to lie flat against the rocks
- some have hooks (mayflies) or suction cups (snails) which allow them to cling to rocks
- resisting currents by swimming upside down – backswimmer
- sluggish and obtaining food by grabbing it as it moves past.

2. Pools – still water

Pools are still, so macroinvertebrates move to catch their food.

The bugs that live in pools:

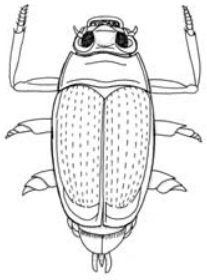
- have long legs so they can move quickly
- are often predators, with large scoop-like mouths, such as dragonfly and mayfly nymphs and whirligig beetles
- may live on the surface of pools and some, like the water strider, can walk or hop on the surface of the water



- many are adapted to living in the sediment at the bottom of the stream, where oxygen levels are low. Burrowing mayflies, for example, have gill structures along their abdomens to absorb oxygen.

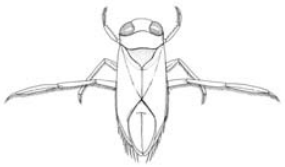
Life at the top

Water bugs which live at the top of the pool may be found on the water's surface or just below it.



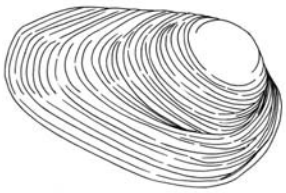
Bugs that live on the water's surface, or film, have adaptations which allow them to move across the surface. These include water striders and whirligig beetles.

Bugs which live just below the surface require oxygen from the air to breathe. These bugs include water boatmen, backswimmers and giant water bugs. The backswimmer uses two long breathing tubes to breathe and traps air bubbles around its body.

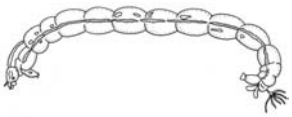


Life at the bottom

Bottom dwelling species include worms, molluscs and midge larvae which live in the bottom sediments. Snails graze on the bottom sediments while mussels attach to rocks and are filter feeders.



Life at the bottom has little oxygen and light. These dwellers often have adaptations to obtain oxygen, e.g. bloodworms have more red blood cells to hold more oxygen.

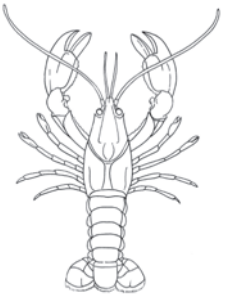


3. Logs, branches, aquatic vegetation and stones

Some bugs have adaptations for living under stones, on vegetation, or under logs and branches. These places provide habitats and a food supply for bugs and other aquatic species that live there.

7.7 What's for dinner? fact sheet

In rivers and streams, leaves, sticks and twigs falling into the water are the main energy sources for bugs. Water bugs generally fall into one of three categories when it comes to their method of obtaining food: shredders, collectors or predators.



Shredders

These bugs chew leaves, rotting sticks and twigs. This breaks down the plant matter into small pieces for other bugs to eat. Shredders include caddisflies and yabbies.

Collectors

The collectors gather, scrape or filter food broken down by shredders. They include:

Gatherers – These bugs collect food deposited on rocks or found in the sediment. They include mayfly nymphs, caddisflies, worms and crustaceans.

Filter feeders – These bugs filter food particles from the water. They have clever feeding mechanisms, like the net spinning caddisfly that can catch food from water as it washes over rocks.

Scrapers or grazers – These bugs obtain algae from plant matter and rocks. They include caddisflies, snails and beetle larvae.

Predators

These bugs prey on other animals by biting, piercing or engulfing. They include dragonfly and damselfly nymphs, beetles and true bugs, which have beak-like sucking mouthparts to suck body fluids from their prey.

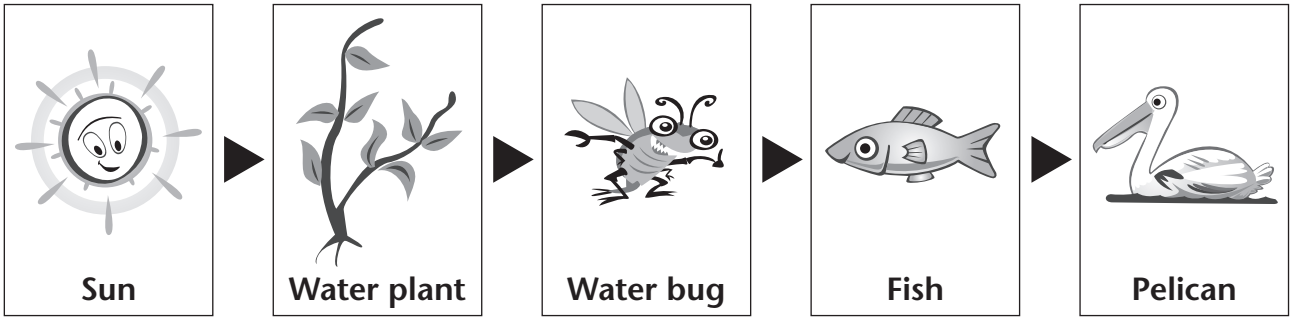
Bugs are part of the food chain

Just as water bugs survive by eating their own specialised diet and maybe each other, other animals also depend on macroinvertebrates for survival. These include ducks, fish, water rats and frogs. These are secondary and tertiary consumers.

7.8 Food chains and webs fact sheet

Energy is transferred between organisms by the food they eat. This is called a food chain. A simple food chain will include producers, consumers and decomposers.

Food chains begin with plants, which transform and store the sun's energy. Plants are called producers because they produce their own food. Many river dwellers eat plants and they are called primary consumers. These plant eaters are eaten by other animals, such as larger fish and birds, which are called secondary consumers. The pelican, like many waterbirds, eats a variety of fish and bugs. This complex interdependence of species is called a food web.



The parts of a food chain:

SUN provides the energy for the food chain.

PRODUCERS are green plants that use the sun, water, nutrients and carbon dioxide to produce energy. This process is called photosynthesis. Producers include water plants, phytoplankton and algae as well as leaves and twigs from stream bank vegetation.

CONSUMERS are all organisms which eat other organisms. They are classified as primary, secondary or tertiary consumers:

- Animals that feed on plants (herbivores) are **primary consumers**.
- Animals that eat primary consumers are called **secondary consumers**.
- The food chain continues with larger carnivores called **tertiary consumers**.

DECOMPOSERS are bacteria and very small organisms which break down dead leaves and animals through a process called decomposition. Decomposers convert dead matter into small particles and gases, which are released back into the water, air and soil.

7.9 Macroinvertebrate food chain fact sheet

The producers

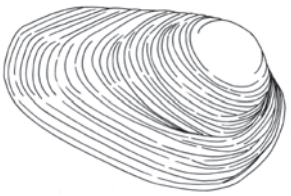
Plants, leaves and twigs

The shredders

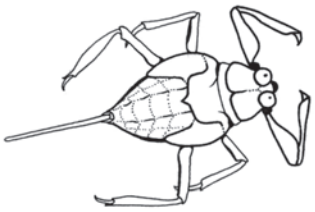
Yabby, caddisfly larva

The collectors

Mayfly nymph, mussels



The predators

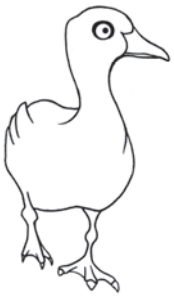


Water scorpion
Piercing

Mayfly nymph
Biting

Giant water bug
Engulfing

Non-macroinvertebrates



Ducks, frogs, fish

7.10 Life cycles fact sheet

What is a life cycle?

A life cycle is the sequence of events in the lifetime of an organism from fertilisation, birth or hatching through to adulthood, when it reproduces and the cycle begins again.

Water is essential for at least one stage in the life cycle of many species that live in, on or near aquatic environments. Flying insects such as dragonflies, mosquitoes and midges spend most of their life under water. Adults lay their eggs in water and the juveniles live, eat and grow underwater, emerging as flying adults.

Water bugs develop in a variety of ways, with 3 or 4 stage life cycles.

Nymphs

The eggs of some water bugs hatch into nymphs, which are miniature versions of the adult. As they grow they do not change much in appearance from baby to adult. Some, such as worms and snails, have soft skins that grow with them. Others, such as yabbies and dragonflies, have hard outer skins that are shed so that they can get bigger.

Larvae

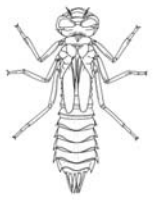
The eggs of some water bugs hatch into larvae, which usually have very soft bodies and look nothing like their parents, e.g. mosquitoes. They go through a pupa stage and then develop into adults.

Macroinvertebrate life cycles and weather patterns

The eggs of some macroinvertebrates lay dormant during dry periods, hatching when the water returns. Nymphs can burrow into the mud, or even crawl under damp leaf litter when water levels are low. Yabbies burrow and hibernate when water levels drop.

Mosquitoes have very short life cycles, needing very little time and water to reproduce.

Dragonfly

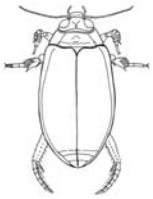


Nymph

Adult

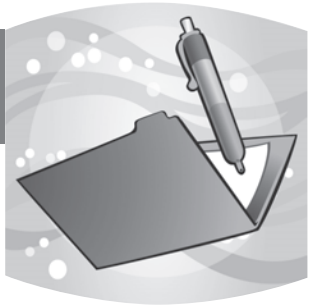
Adult diving beetle

Larva



Adult

SECTION 8



Student work 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.

8.1 Parts of a catchment work sheet

Label the following features on the catchment diagram:

- hills
- river
- tributary
- estuary
- dam
- upper catchment
- middle catchment
- lower catchment.

8.2 Which riverside is best? work sheet

Look at the two different sides of the river in the picture and answer the questions.

Where is a good place for a picnic? Why?

.....

In which town would you prefer to live? Why?

.....

Which farmer is taking the best care of their land? Why?

.....

On which side of the river would you rather swim? Why?

.....

Where do you think the animals are happiest? Why?

.....

Colour the riverside you would like to live on.

.....

8.3 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 (salinity)

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 …

8.4 Human changes work sheet

Name: .....

Date: .....

People make changes at or near rivers, creeks and estuaries.
Draw pictures to show some of the ways people have made changes that benefit others and the environment. Other changes may cause problems for native animals and birds and may affect the environment.

Changes that may benefit others and the environment

Example of change

Changes that may harm animals and birds and the environment

Example of change

8.5 Human impact in urban areas work sheet

Name: .....

Date: .....

In urban areas drains bring litter, detergents and other pollutants from homes to rivers, creeks and estuaries. This may cause plants and animals to die or move to other places.

Are there drains at your waterway?

☐ Yes How many?..... ☐ No

Draw pictures or describe the pollutants that drains may bring to your waterway?

In an urban area, a river, creek or estuary is important because:

.....

.....

Describe the things that would make you feel happy about a river, creek or estuary that is used by people living in towns.

.....

.....

Describe the things that would make you feel sad about an urban river, creek or estuary that is changed by people.

.....

.....

Describe what can be done about these changes.

.....

.....

8.6 Human impact in rural areas work sheet

Name: .....

Date: .....

Cropping and grazing may cause water quality problems in creeks, rivers and estuaries.

Is there cropping or grazing at or near your waterway?

☐ Yes How many?..... ☐ No

Draw pictures or describe the pollutants that may enter a waterway from agricultural land.

Describe the things that would make you feel happy about a river, creek or estuary in a rural area.

.....

.....

Describe the things that would make you feel sad about a river, creek or estuary in a rural area.

.....

.....

Describe what can be done about these problems.

.....

.....

8.7 Nutrients in streams work sheet

Name: .....

Date: .....

Nutrients come from fertilisers, detergents, soil, animal wastes and grazing animals, especially when they are allowed to use the river for drinking water.

Fill in the missing words to describe what happens to a healthy river when nutrients are added.

1. ..... enter waterway
2. Plant growth .....
3. ..... grows quickly
4. Aquatic plants obtain less .....
5. Algae ..... and sink .....
6. Bacteria use up .....
7. Oxygen levels are .....
8. Only species ..... will survive

Using these steps, draw your own nutrient cycle.

8.8 Adaptation to climate change work sheet

Name: .....

Date: .....

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

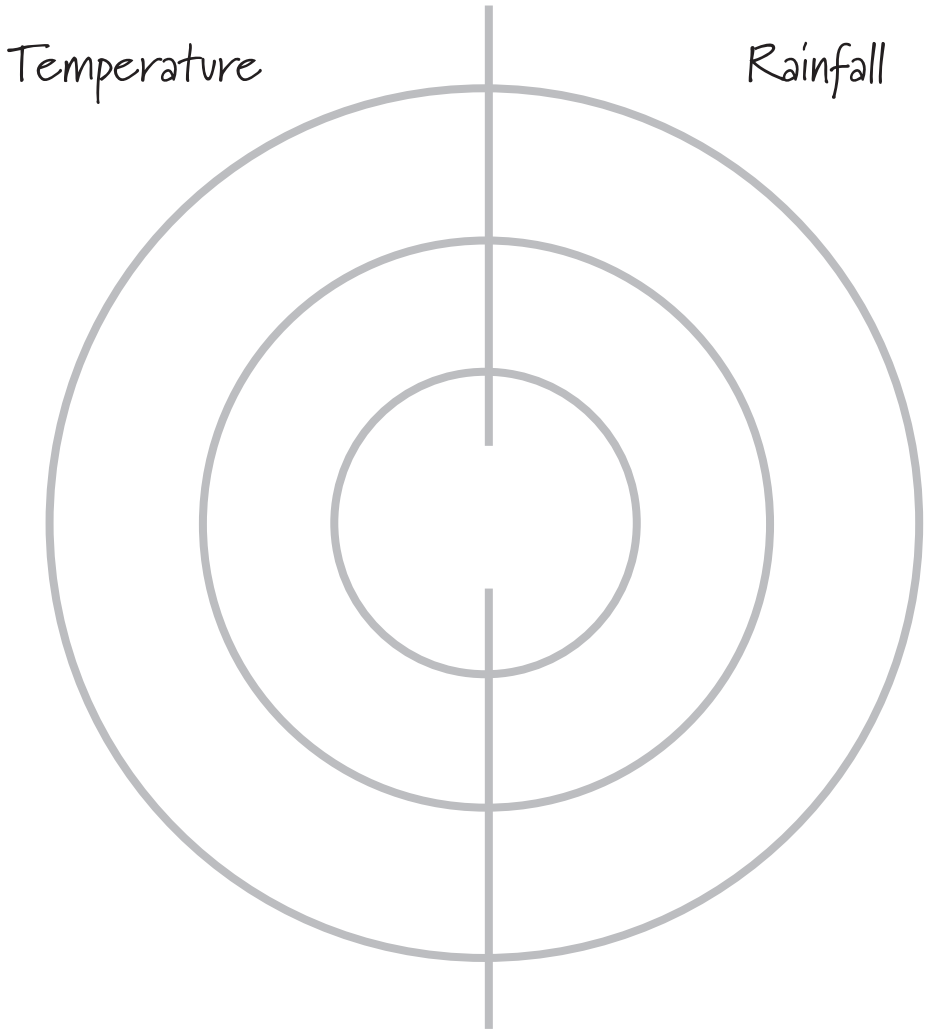
1. Draw a plant or animal that lives at your site.
2. Add the new features that may help it to survive in a new climate.
3. Label the new features.
4. Explain how the new features will help the plant or animal to survive.
5. Make a model of your animal or plant in its new environment.

8.9 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.



8.10 Action planning for your site work sheet

Name: .....

Date: .....

What is the problem?

What is the main problem?

When?

Timeframes: short and long term

Your vision?

How would you like your site to look in the future?

How?

List the steps involved:

What?

How can you make a difference?

Who?

Your class, Landcare, Catchment Management Authority, local council?

Monitoring

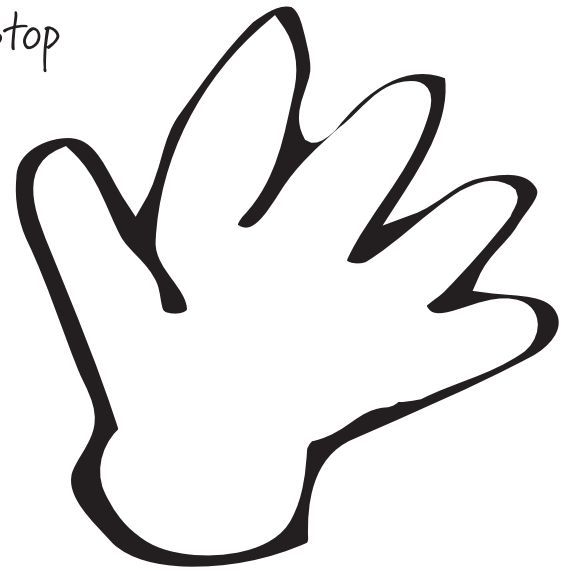
Did we make a difference to the site and our water quality?

8.11 Protect your site work sheet

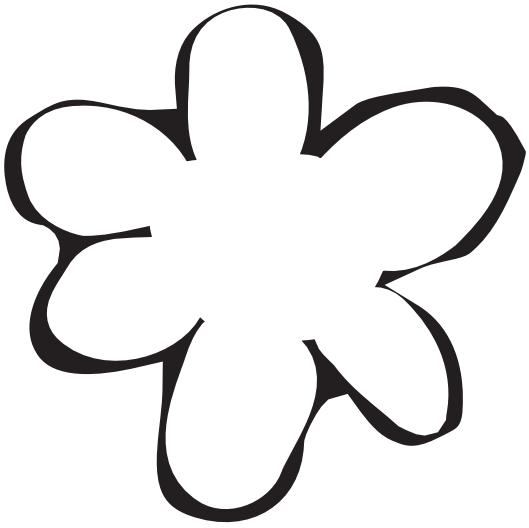
Name: .....

Date: .....

Stop

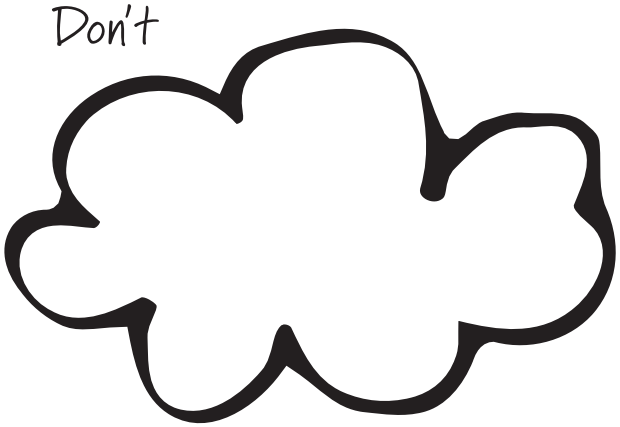


Plant



Do

Don't



Other suggestions?

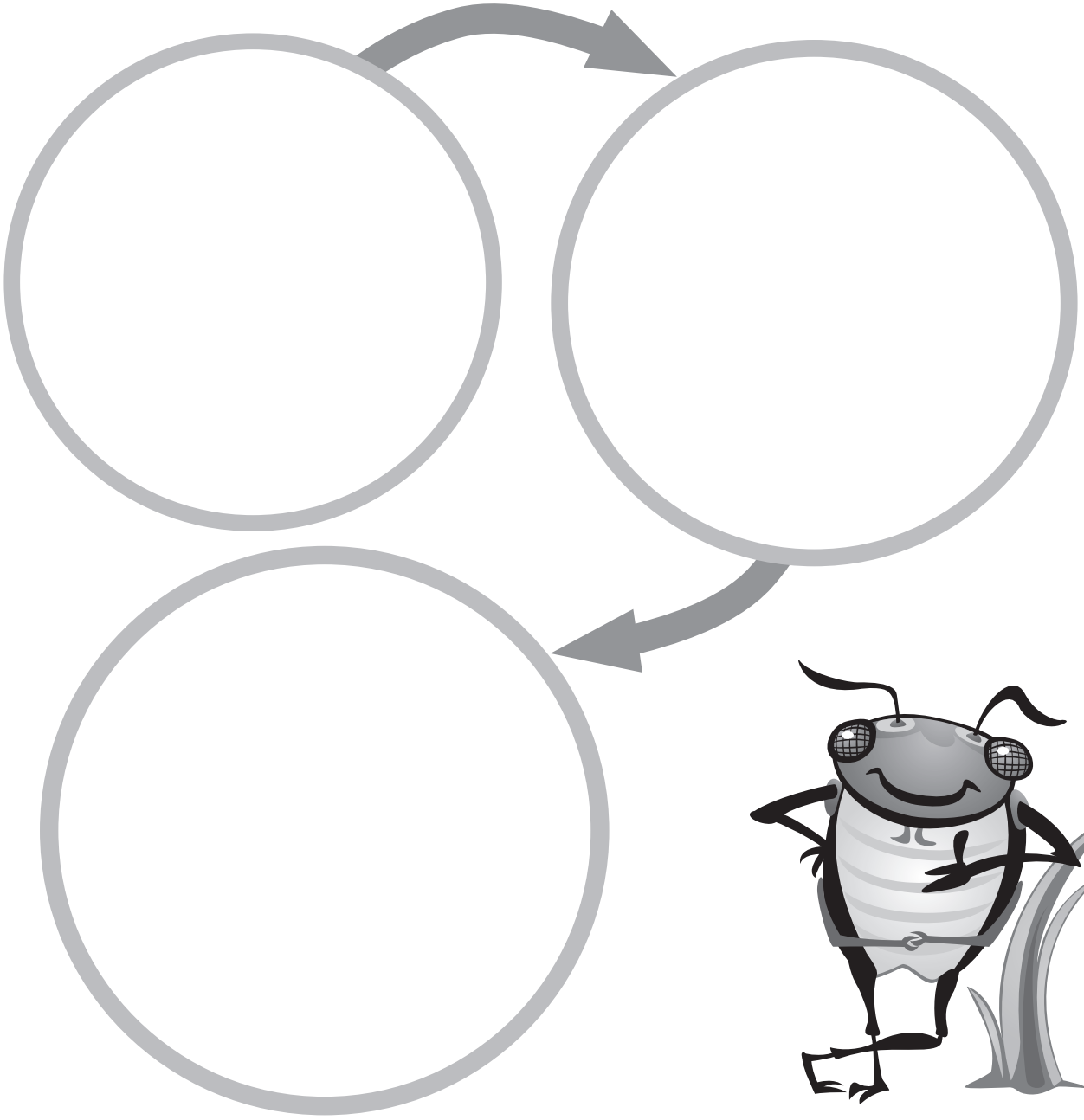
8.12 Food chains work sheet

Name: .....

Date: .....

Water bugs depend on other living things for life.

Draw a food chain to show what a water bug eats and what eats it.



8.13 Observing the features of water bugs 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 *Junior 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

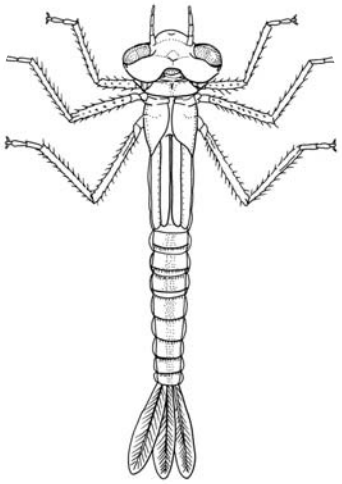
.....

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. .....

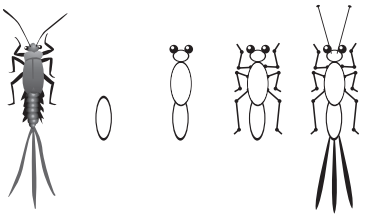
.....

8.14 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.

Date: .....

Collection-site: .....

Common name: .....

Habitat: .....

Special features: .....

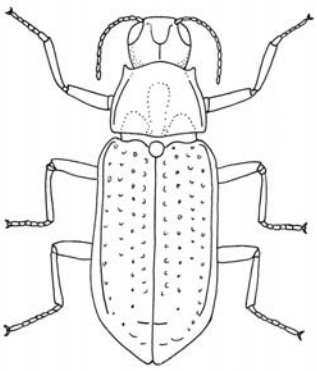
.....

.....

Scientific drawing of a water bug

.....

Size in mm



8.15 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.

Draw a water bug you have investigated

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?

.....

.....

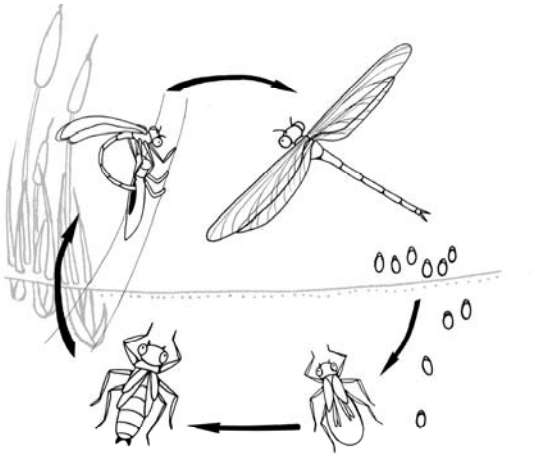
8.16 Life cycle of a dragonfly work sheet

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
Female dragonflies lay their eggs on the water or on plants that live on or near the water.	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. When dragonflies are completely grown, the nymphs climb up plants and shed their skin.	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.	The adult dragonfly lives out of the water. It stays near rivers and wetlands ready to lay its eggs. Dragonflies mate on the wing and can live up to 2 months.

8.17 Life cycle of a mosquito work sheet

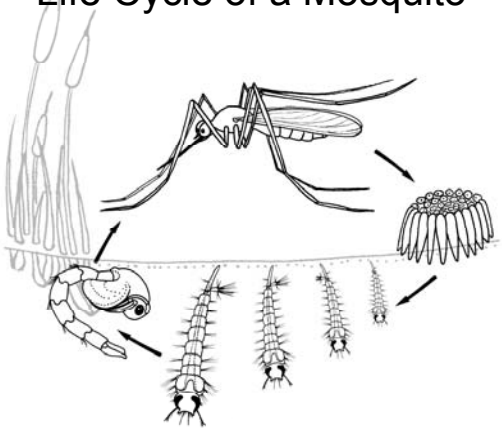
Name: .....

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**
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.	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.	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.	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.

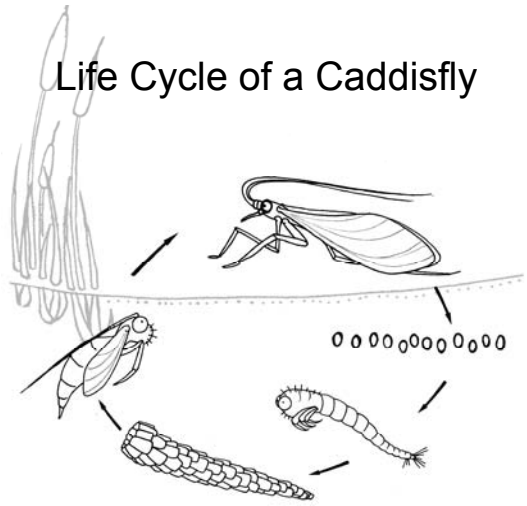
8.18 Life cycle of a caddisfly work sheet

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**
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.	Larvae hatch and usually develop through 6–7 stages. As they grow, more material is added to the front of their protective casing.	Larvae make their casing by binding together small rocks, twigs, leaves or other material.	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.	The adult caddisfly emerges. Adult caddisflies do not feed.

SECTION 9

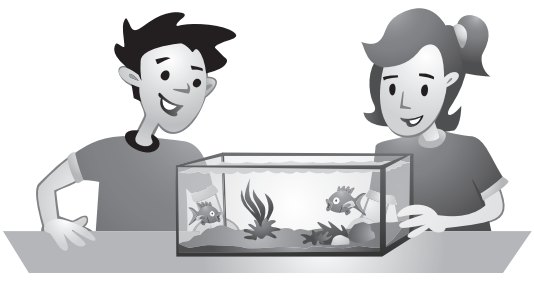
Experiments and models

Science and Technology experiments and models will develop an understanding of the water quality parameters to be tested at the waterway as part of the Junior Waterwatch program. They aim to increase awareness of catchment issues and the human impact on catchments. This should inspire active participation in the management and care of the environment. The models will also provide useful tools and monitoring equipment for use at the waterway.

These experiments and models have been designed to complement the curriculum requirements for Science and Technology. Select experiments and models which are appropriate for the age and interest of your students. Many can be completed individually, in groups or as a whole class activity.

Included in this section:

See Section 10 for links to the curriculum and existing work units.



9.1 Temperature experiment – shallow and deep

Temperature affects the diversity of species in a waterway, as many species can only live within a narrow temperature range. Temperature can also affect oxygen levels, which in turn have an impact on aquatic life.

AIM:
To determine the factors which may affect water temperature.

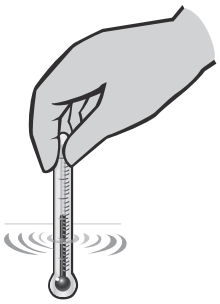
Materials required

A bucket and a basin, both of which can hold approximately the same amount of water, thermometer.

Method

1. Pour the same amount of water from the tap into each container. Record the temperature of the water (each container should be the same).

2. Place the containers in a sunny position and leave for a number of hours.



3. Record the temperature of the water in each container.

Discussion

- What conclusions can be drawn about water temperature and water depth?
- In what seasons would the temperature of water in the river be highest? Why?
- How would releases of water from a dam affect water temperature?

9.2 Solubility experiment – dissolved or suspended?

Water is sometimes called a universal solvent, because many things dissolve in it. However, polluting substances may be either dissolved or suspended in water. Substances suspended in water can be removed by filtering but substances dissolved in water are more difficult to remove and have a major effect on water quality in our creeks and rivers.

AIM:

To demonstrate the difference between suspended and dissolved substances in water.

Materials required

Containers, water, a range of substances such as salt, soil, sugar, chalk powder or talcum powder.

Method

1. Add 1 tablespoon of a substance to 1 litre of water.

2. Stir or shake the container.

3. Repeat the experiment for each substance.

4. Complete a table, listing the substances which dissolved or were suspended in the water. How could you test whether the substance was present?

	Suspended	Dissolved	Colour?
Salt			
Sugar			
Soil			
Chalk			

Discussion

- How could you remove the substances from the water?
- What sort of pollution problems might occur because so many things dissolve in water?
- Of the substances used in the experiment, which ones are most likely to be found in our waterways?
- Salt and soil are two of the most commonly found pollutants in our waterways.

9.3 Turbidity experiment – clear water?

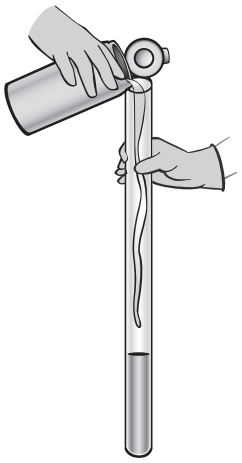
Turbidity measures the amount of soil particles suspended in water. Turbidity reduces the amount of light available to aquatic plants and this can reduce plant growth and oxygen levels in the water. Since aquatic invertebrates and fish require oxygen and plants for food and habitat, turbidity can have a major impact on aquatic food chains.

AIM:

To determine the turbidity of water samples and observe and record changes due to filtering.

Materials required

Water samples – one clear sample and one turbid sample (note: turbidity can be increased by adding soil to the sample), turbidity tube.

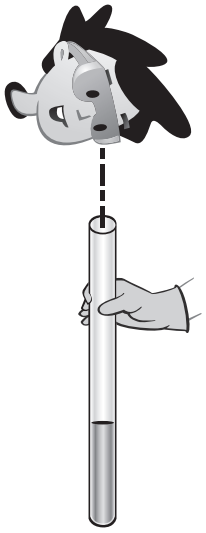


Method

1. Test the turbidity of the two samples using the procedure in Section 4.7 of the *Junior Waterwatch Field Manual*.

2. Record the result for each sample.

3. Rate the level of turbidity.



Discussion

- Compare the colour of the two samples
- How do you think the water became muddy?
- Compare the turbidity of the two samples.
- If people needed to drink the water, how could the water quality be improved?

9.4 pH experiment – acidic or alkaline?

pH is a measure of the acidity or alkalinity of a substance. The best pH level for most organisms in Australian waterways is between pH 6.5 and pH 8.2. Changes in pH outside this normal range can cause a reduction in species diversity, with many of the more sensitive species disappearing.

AIM:
To determine the acidity or alkalinity of a range of household products.

Materials required

Sample water jars, water, a range of household substances (e.g. lemon juice, bicarbonate soda, vinegar, distilled water, detergent), river water, pH strips.

Method

1. Pour distilled water into each sample container and river water into one container. Do not add additional substances to the river water or to one distilled water sample.

2. Add a small amount (20 ml) of the different substances to each of the remaining containers of distilled water.

3. Shake the containers.

4. Test the acidity/alkalinity of each sample using pH papers.

5. Record the results and rate the pH level.

Substance	pH	Acid/Alkaline/Neutral	Rating
Distilled water			
River water			
Lemon juice			
Carb soda			
Vinegar			
Detergent			

Discussion

- Which household products are acidic?
- Which household products are alkaline?
- Predict the pH of other products.
- If the water in a river is too acidic, what may be done to reduce the problem?
- How does the pH of your river water compare to the household products tested?

9.5 Salinity experiment – how salty is it?

Salinity is the concentration of salt in water. It is measured as electrical conductivity (EC), in microsiemens per centimetre (µS/cm) or millisiemens per centimetre (mS/cm).

The level of salinity in a waterway may be critical to the survival of aquatic plants and animals because many can survive only within certain salinity ranges. Salinity also affects the human use of water for irrigation and drinking.

AIM:
To develop an awareness of the amount of salt in our waterways.

Materials required

Distilled or tank water, table salt, 5 x 1 litre containers, kitchen measuring spoons, 1 sheet A4 paper, ruler, pencil, adhesive tape, EC meter.

Method

1. Prepare 5 salt solutions by filling each 1 litre container with distilled or tank water and adding a different measured quantity of salt to each, using kitchen measuring spoons such as ¼ teaspoon, ½ teaspoon, 1 teaspoon, etc.

2. Measure the level of salinity of each sample.

3. Record your result.

4. Rate the health of a hypothetical freshwater river or creek with these salinity levels.

i **Note: To be able to taste salt, there needs to be at least 1500 µS/cm (1.5 mS/cm).**

Discussion

- Where do you think the salt in waterways comes from?
- Is the salt in waterways only sodium chloride (table salt)?
- Can a sheep tolerate drinking water that is more or less salty than what humans can tolerate?

9.6 Turbidity meets salinity experiment – visible and invisible

Things are not always as they seem. A river with clear water may look healthy but sometimes we might be fooled by how pollutants behave in some situations.

AIM:
To determine the relationship between salinity, turbidity and water quality.

Materials required

1 or 2 large flat dishes (e.g. macroinvertebrate sampling trays), fresh water, 2 jars of muddy water (water can be made muddy by adding soil).

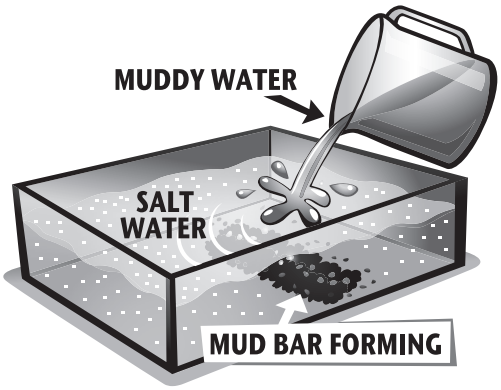
Method

1. Prepare a salt water sample by mixing 1 teaspoon of salt with fresh water.

2. Pour the salt water into one of the dishes and some fresh water into the other. (Do one kind of water at a time if you only have one dish.)

3. Add muddy water to each dish and observe what happens.

Note: When a river enters the sea, the mud from the river falls to the riverbed, forming sandbars and deltas at the river mouth.



Discussion

- What were the visible and invisible pollutants in the dishes?
- What happened to the turbidity of the water in each sample?
- Why may a clear river not always be the healthiest?
- How can you test for invisible pollutants such as salt?
- Why is salt invisible in water?

9.7 Salinity and flow experiment – strong and weak

The salinity level in a waterway does not stay the same all the time. In this experiment we will look at what effect more or less water can have when it enters a system.

AIM:
To determine the effect of the amount of water on salinity levels.

Materials required

1 litre distilled water, approximately 1/10 teaspoon salt, measuring cup, spoon or stirrer, EC meter.

Method

1. Pour 250 ml of distilled water into a measuring cup.

2. Add all the salt and stir.

3. Measure the salinity level with the EC meter.

4. Continue to add more distilled water to make up to 500 ml, then 750 ml and finally, 1 litre of water.

5. Stir and measure the salinity after each addition.

Amount of water	Salinity measure	Rating
250 ml		
500 ml		
750 ml		
1 litre		

Discussion

- What happened as additional water was added?
- In a river, how would high rainfall affect salinity levels?
- What would happen if our climate became drier in the long term and there were more droughts?

9.8 Make a water cycle in a cup model

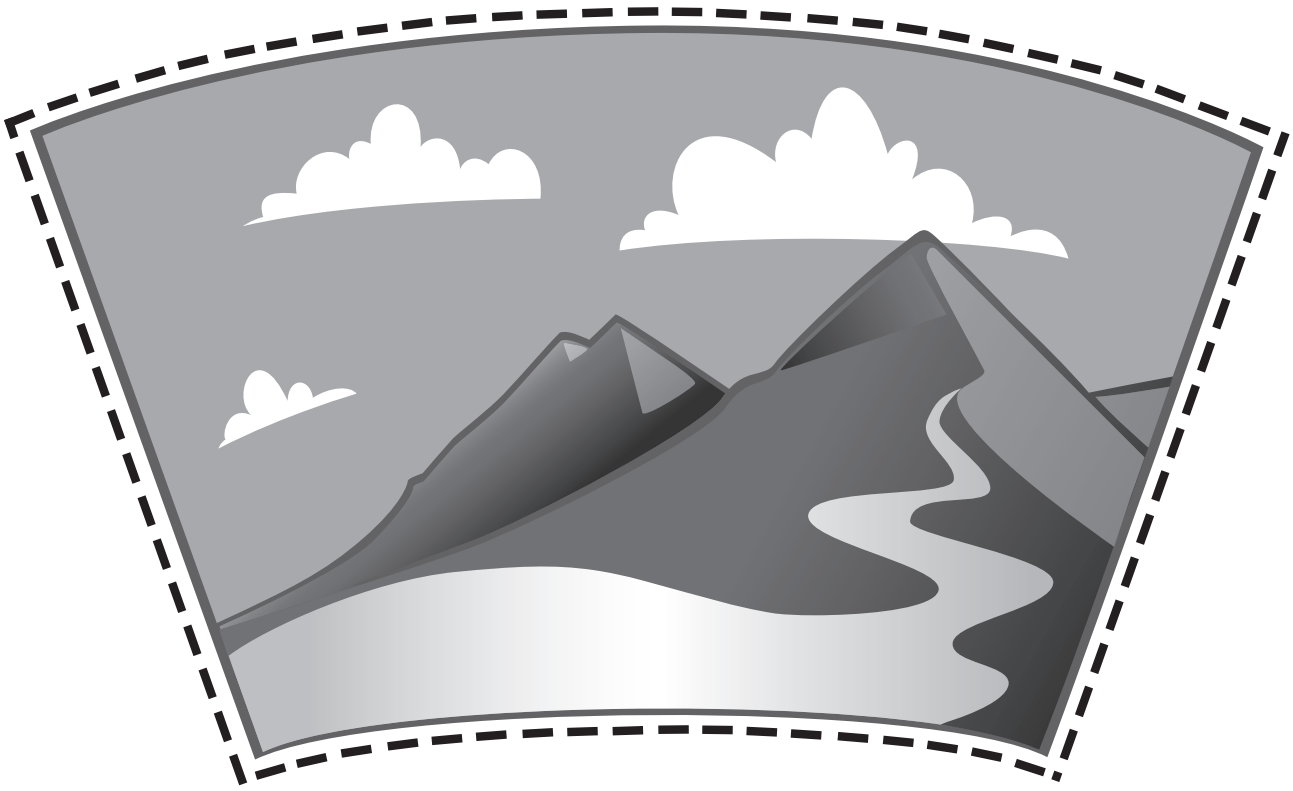
The water cycle refers to the cyclic movement of water between the atmosphere, the land and the sea. Water is present in the atmosphere as water vapour. It evaporates from inland water bodies, oceans and the land surface. It can also evaporate from the leaves of plants (evapotranspiration). Water vapour condenses to form clouds and is returned to the land as rain, snow and hail. This water flows into our waterways as surface runoff, or seeps into the ground where it can be used by plants. The cycle begins again when this water returns to the atmosphere through evaporation.

In this experiment we will create a mini version of some of these processes inside a plastic cup.

AIM:
To demonstrate the water cycle processes by making a water cycle model in a plastic cup.

Materials required

Clear plastic cup, tape, landform drawing, water, plastic wrap, elastic band.



Landform drawing to cut out and attach to the back of the cup

Method

1. Tape a landform drawing to the back of a plastic cup so the picture can be seen when looking through the cup.

2. Add 60 ml of hot tap water to the cup.

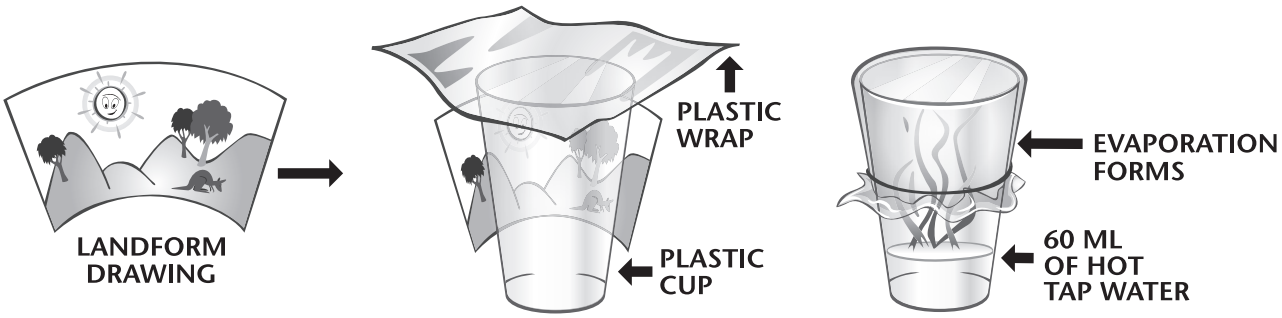
3. Cover the cup with plastic wrap and secure with an elastic band.

4. Mark where the water comes to on the outside of the cup.

5. Put the cup in the sun for about half an hour.

6. Mark the new water level on the cup.

7. See what has happened to the water level.



Discussion

- Suggest reasons for the change in the water level.
- Where did the water go?
- Devise methods for bringing back the water.

Note: Adapted from the *Waterwise Queensland teacher resource book*, 1993

9.9 Make a groundwater model

Groundwater is water that is under the surface of the ground, where it sits in tiny spaces between soil particles or larger spaces between rocks. Even when water is under the ground it reaches its own natural level and this level is known as the water table.

AIM:
This model aims to develop an understanding of the water table.

Materials required

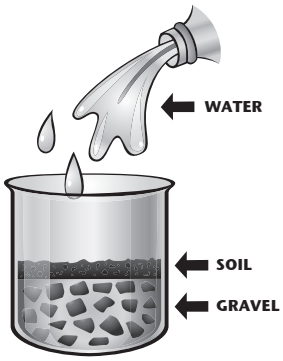
Plastic PET bottle, gravel, various kinds of topsoil, water, measuring jug.

Method

1. Cut the top off the PET bottle and use the base.

2. Place 5 cm gravel or small stones into the base of the bottle.

3. Spread 1 cm topsoil over the gravel.



4. Place approximately 400 ml water into a measuring jug and pour water slowly into the container until it covers half the gravel. Record the exact amount of water used in the experiment.

5. Mark the height of the water on the side of the bottle. (This is the water table.)

6. Repeat the experiment using the same amount of water but with different soil types on top of the gravel, e.g. sand and clays.

Discussion

- What happened to the water poured onto the soil?
- Where is the water table in the model?
- What happened to the height of the water table when different soil types were used? (Note: Some soils absorb more water than others, e.g. clays, so less water filters through to the water table.)

9.10 Make a bug pond

You can make a pond to observe macroinvertebrates (water bugs) caught at the waterway. These are interesting creatures and like frogs, change their body shape during their life cycle. When you make your pond, you will need to research the habitats, food needs, oxygen and other requirements of the bugs so you can give them what they need. Since the pond should be like a healthy stream, you should monitor the condition of the water and be aware of things which may pollute it.

AIM:

To develop a pond for macroinvertebrates caught at the waterway and learn about their habitats, food needs and other requirements, as well as their physical characteristics.

Materials required

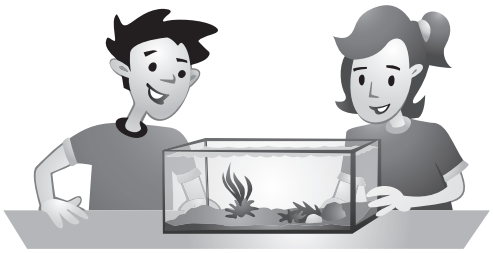
An aquarium or clear container, sand, sticks, stones, water, weeds, air stone and pump and a power point close to the aquarium, water bugs.

Setting up the pond

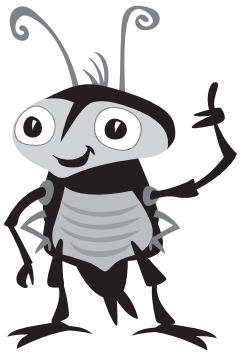
1. Place the tank on a bench near a power point.

2. Create habitats for the water bugs:

- Sand is needed for bottom dwellers. Sticks and stones are also needed for these creatures. Vary the depth of the sand to have a shallow and deep end.
- Plants and floating weed will provide habitat for some species. These can be established in the sand at the bottom of the tank or planted into small pots and buried under the sand. If plants are collected from the waterway, make sure you bring the roots and the leaves.



3. Set up an air stone to supply oxygen to the tank.

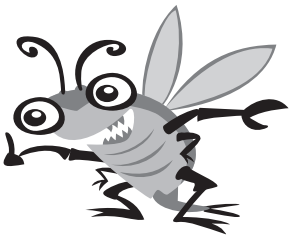


4. If tap water is used, leave the tank in the sunlight for approximately 1 week for the sand to settle and for any chlorine in the water to disappear.

5. Collect water bugs from the local river and empty into the tank, including leaves, pieces of bark and detritus, after sorting and recording.

6. Observe!

Food chains



Consider the food chains in the river environment. Some bugs are cannibals and may not live in harmony with other bugs – some of your bugs may disappear!

Make a backdrop for the pond

You can design and paint a backdrop for your pond. If you do this you will learn something interesting about water: your mural will look bigger because the water will magnify it!

Painting the backdrop

Use paints to paint directly onto the glass at the back of the fish tank or paint onto a piece of cardboard and attach it to the back.

Maintaining the pond

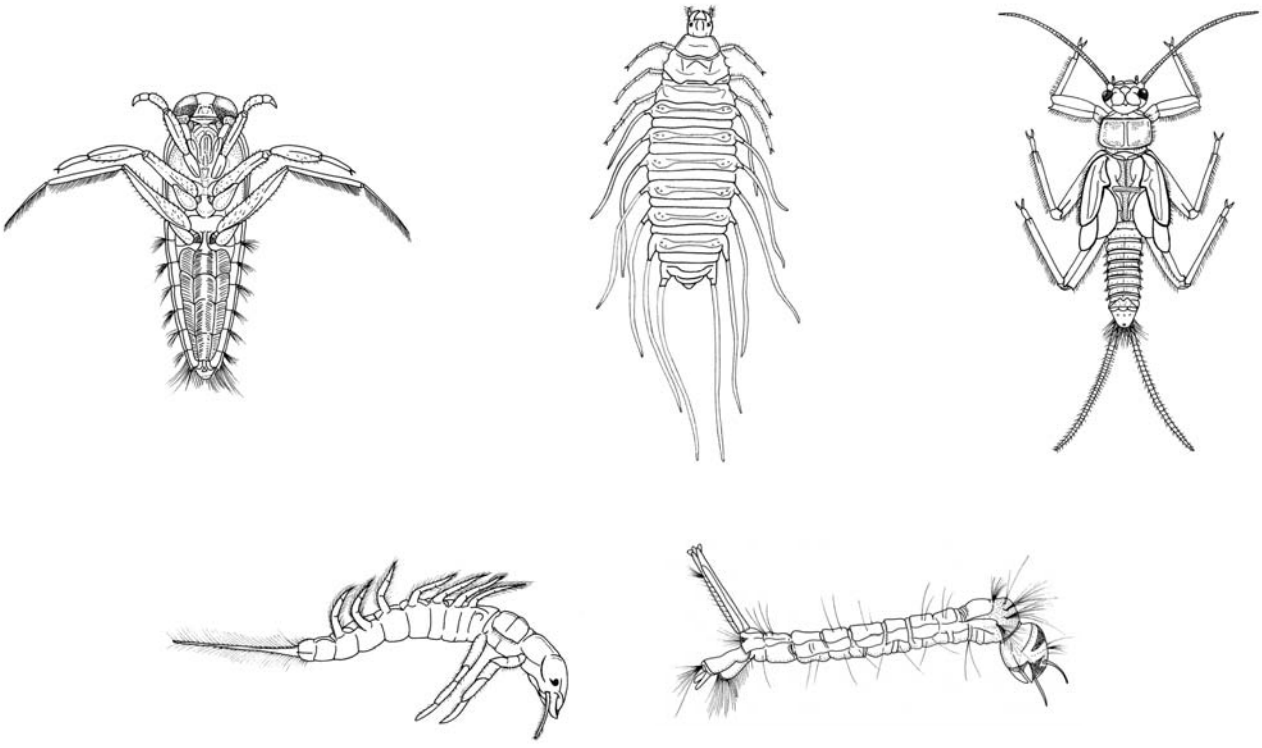
Monitor the pond life and water quality on a daily basis.

Draw up a roster for students to check the water quality of the pond regularly: pH, salinity and water temperature.

Arrange a regular food supply by adding more larvae each week. This will involve regular trips to the waterway.

Observe the interesting features of the water bugs and the changes which occur over time.

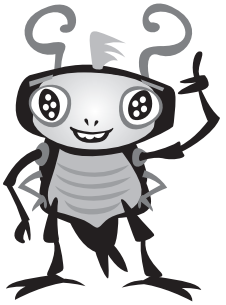
Source: Adapted from the Streamwatch *Bug Book*, based on the Gould League guide *Ponding*, 1992.



9.11 Make a bug dial

Wouldn't it be handy to have a portable device to help you identify the macroinvertebrates you find at the waterway? This bug dial is just what you need. When you find a bug, just point the arrow at what you think it is and notes will appear that tell you where that bug is normally found, how it moves and its special features.

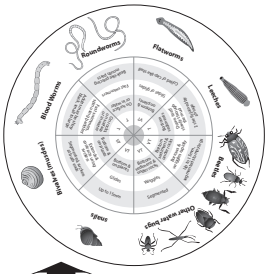
AIM:
To make a bug dial to use in macroinvertebrate identification at the waterway.



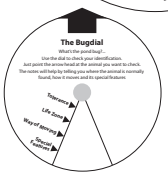
Materials required

Cardboard and paper suitable for photocopying, scissors, paste, laminator (optional), split pins.

How to assemble the bug dial



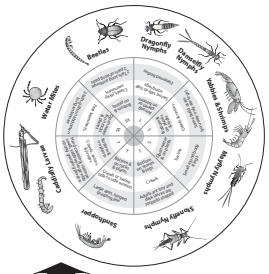
1. Photocopy the two sets of bug dials on the next two pages onto **cardboard**. Cut around the outlines, ensuring you cut out the wedges in the pointer dials.



2. Paste the two large circles back-to-back.

3. Optional – Laminate each of the 3 pieces you now have. This will protect them from water on-site.

4. Insert a split pin through the centre of the 3 pieces so you have a pointer on each side of the large circle.

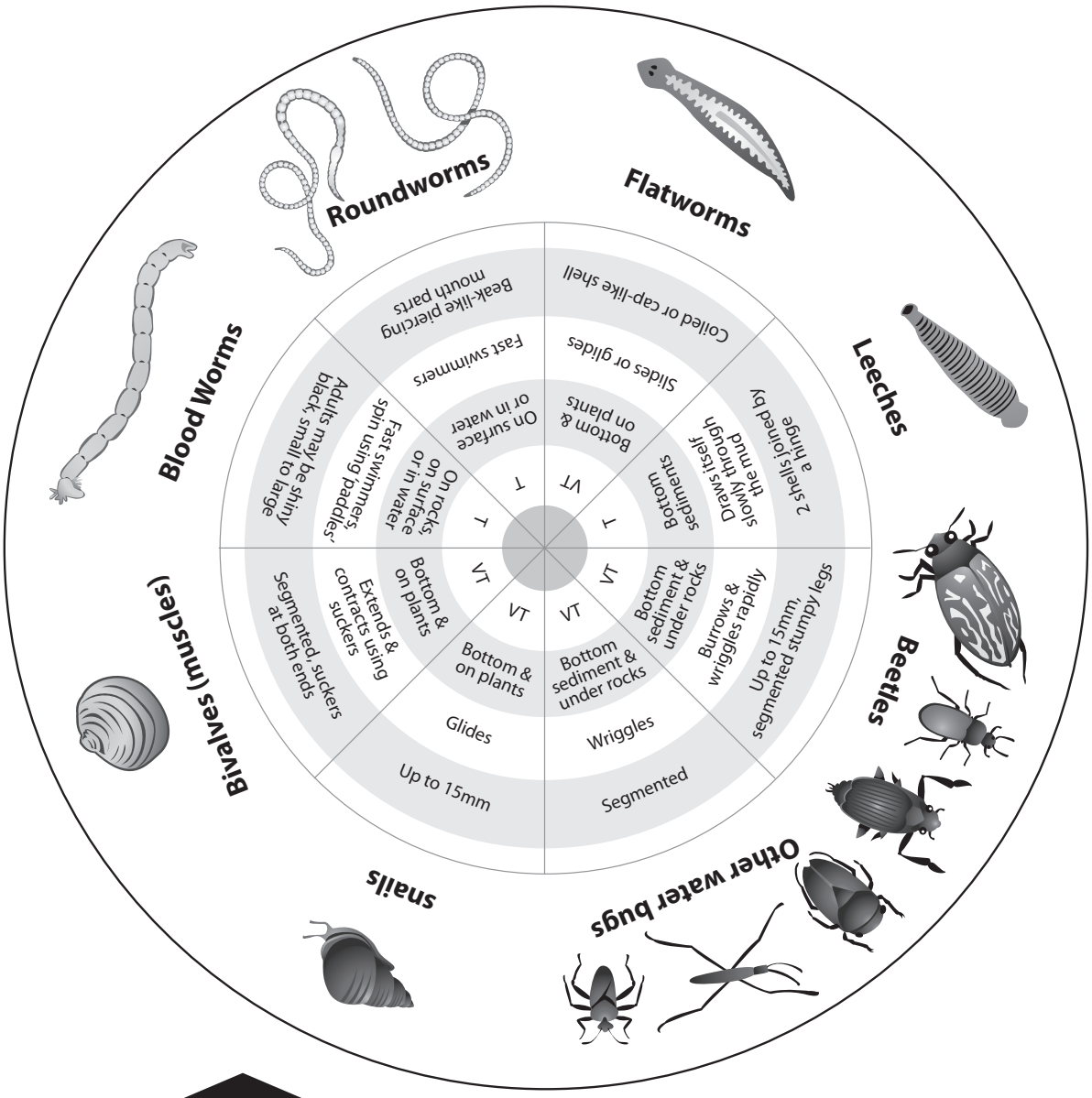


5. If you point to a macroinvertebrate you find during water sampling, the bug dial will give you details as to its tolerance to pollution, life zone, way(s) of moving and special features.

Discussion

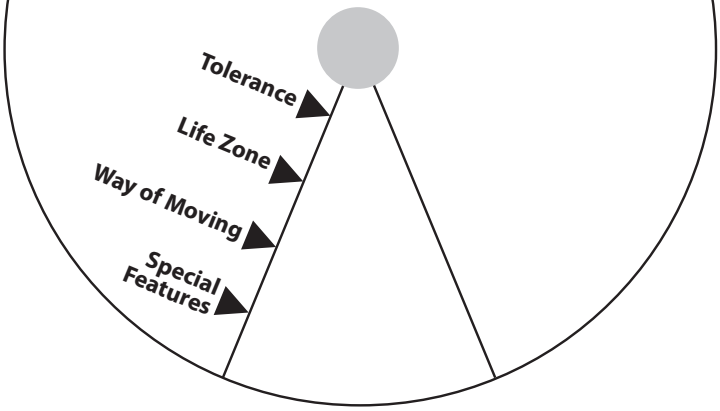
- Are there characteristics you notice are common to quite a few of the bugs?
- Which bugs are the most sensitive to pollution?
- How well do the soft-bodied animals like worms and snails tolerate pollution?
- If you were a water bug, are there other water bugs you wouldn't want to meet?

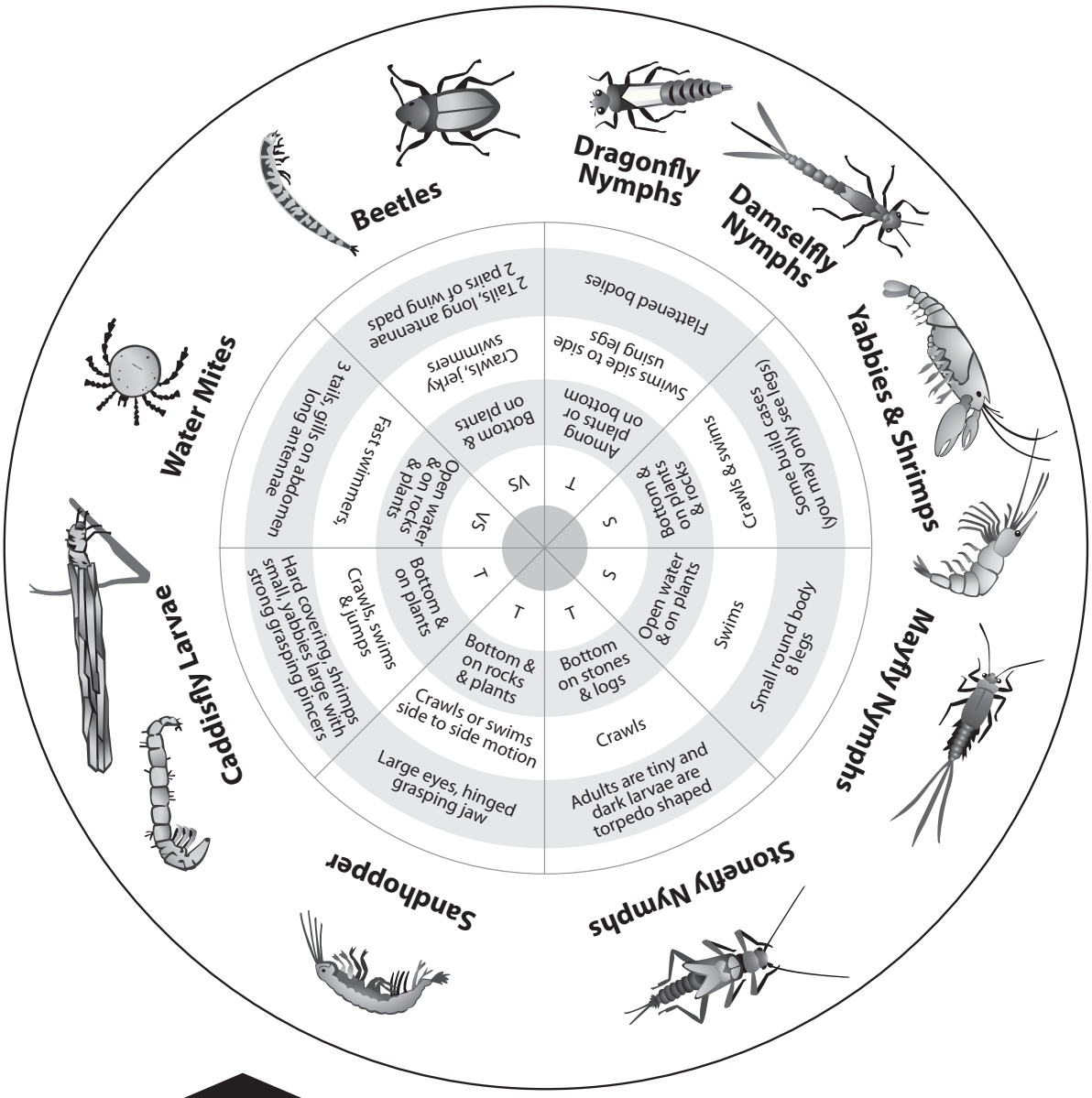
Note: Tolerance ratings on the bug dial are: very tolerant (VT), tolerant (T), sensitive (S) and very sensitive (VS).



The Bugdial

What's the pond bug?...
Use the dial to check your identification.
Just point the arrow head at the animal you want to check.
The notes will help by telling you where the animal is normally found, how it moves and its special features





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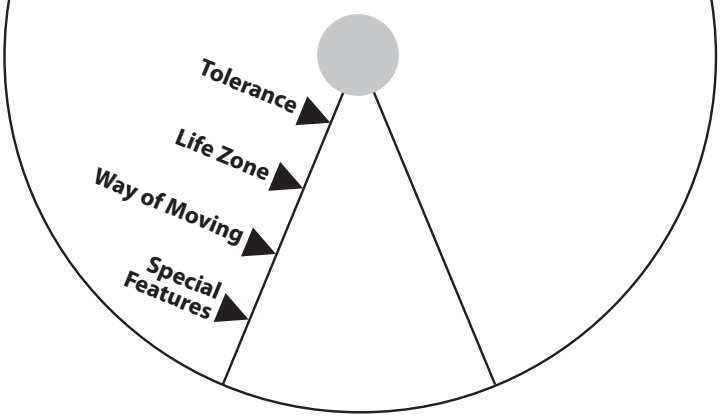


9.12 Make a water bug net

Water bugs provide an insight into the health of the waterway. No expensive equipment is needed to participate in water bug surveys. A simple net will allow students to be involved in these exciting surveys.

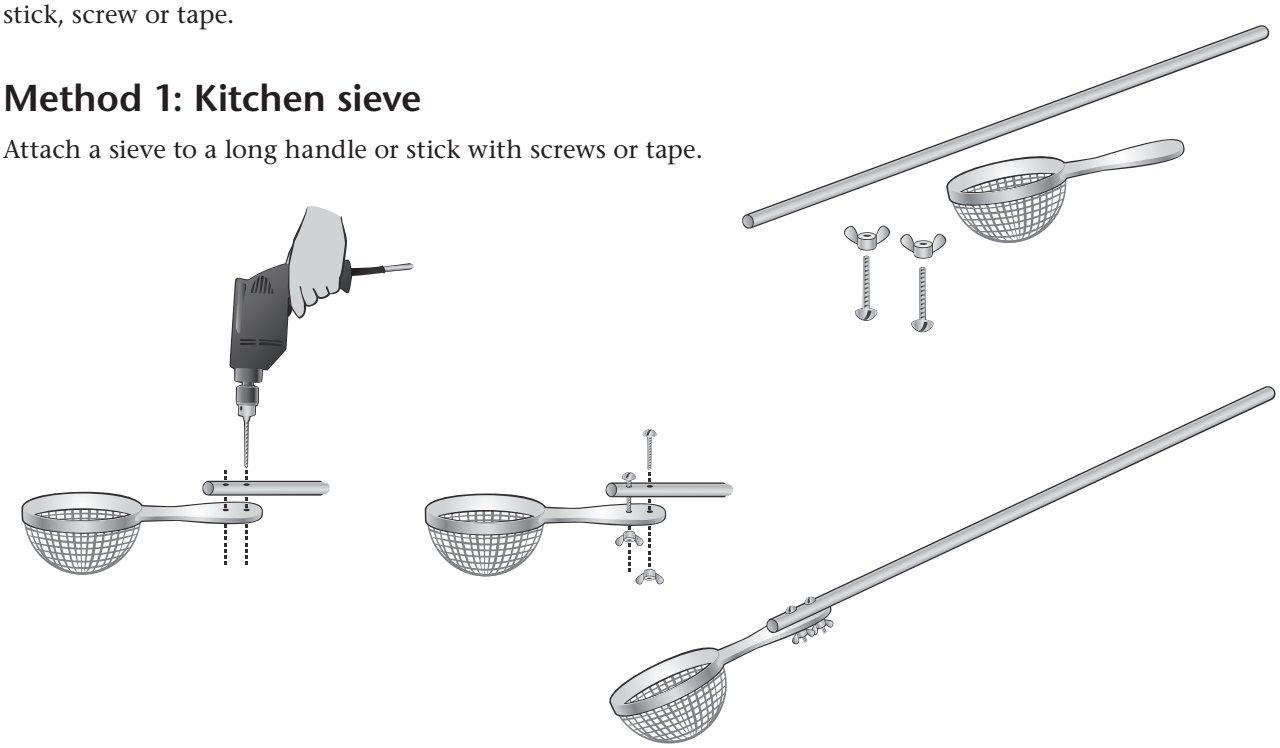
AIM:
To make a net for catching water bugs at the waterway, to observe and record them.

Materials required

Kitchen sieve or similar OR coathanger and pantihose, broom handle, dowel or stick, screw or tape.

Method 1: Kitchen sieve

Attach a sieve to a long handle or stick with screws or tape.



Method 2: Pantihose and coathanger

1. Cut the legs of the pantihose just below the knee and tie them together in a tight knot.

2. Make the frame for the net by shaping a coathanger into a rough square.

3. Twist the coathanger wire apart below the hook.

4. Thread the non-hook end of the coathanger wire through the hem at the top of the pantihose until it comes back out the same hole. Twist the ends of the wire together again.

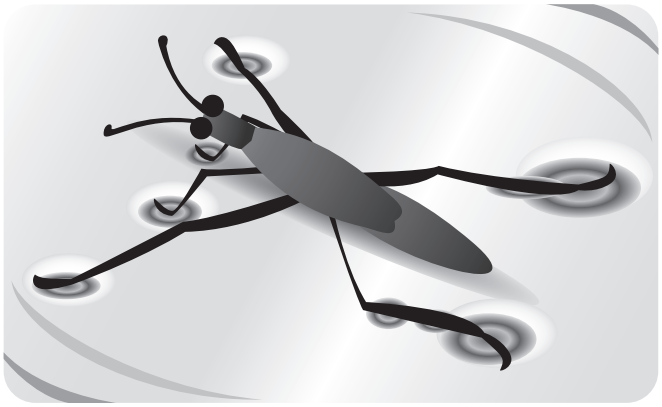
Discussion

- How could you use a bug net to estimate how many bugs of different types were in the waterway without having to catch them all? (Hint: if you know the area of the net opening and how far you moved it through the water, you can work out the volume of water that passed through it.)
- If the waterway is healthy, would you expect to find lots of different kinds of bugs, or lots of bugs but only a few different kinds?
- What do you think will happen to the oxygen level in the sediment at the bottom of the waterway if you stir it up with your net?

Source: Adapted from the Streamwatch *Bug Book*, based on the Gould League guide *Ponding*, 1992.

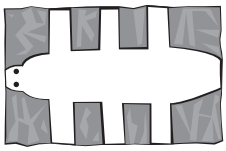
9.13 Make a model water strider

Still water has surface tension which forms a kind of 'skin'. The water strider uses this surface tension to stay on top of the water and move about there. Without the special adaptations it has on its legs and feet, the water strider would sink.



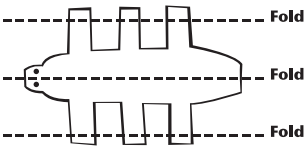
AIM:
To make a water strider and use it in experiments with water tension.

Materials required



Pencils, aluminium foil, basic water strider pattern from diagram at right, scissors.

Method



1. Copy the basic shape of the water strider from the diagram onto aluminium foil and cut it out in one piece. The legs should all be the same length.

2. Fold the water strider lengthwise down the middle.

3. Bend the ends of the legs of the strider up a little, so there is a right angle bend in each one.

4. Use your strider in experiments with water tension.

Discussion

- What other water bugs can walk on water?

  Note: Snails can move along the water surface upside down!

- Would you expect water striders to be found in fast flowing water? Why or why not?

Source: Adapted from the Streamwatch *Bug Book*, based on the Gould League guide *Ponding*, 1992.

SECTION 10

Curriculum links

Waterwatch assists teachers to involve students in local environmental issues by linking activities to their local waterway. This provides meaning and purpose to their studies while promoting the care and sustainable management of our natural resources in the home, at school and in the catchment.

Waterwatch supports schools that are committed to integrating environmental studies within the curriculum. This section outlines the many ways in which student participation in the Waterwatch program can be linked to curriculum outcomes.

Included in this section: *Page*

10.1 Environmental Education Policy for Schools

The Environmental Education Policy for Schools is a policy of the NSW Department of Education and Training which supports effective environmental education programs in government schools in New South Wales, provides guidelines on the management of school resources in accordance with ecological sustainability, and is a starting point for addressing global environmental issues.

Waterwatch contributes to Environmental Education Policy outcomes within schools by meeting curriculum outcomes related to sustainable natural resource management. The Waterwatch program involves students in learning about the key natural resource management issues of water, soils, vegetation and land within the context of their local environment and catchment.

Through participation in Waterwatch, student understanding of environmental issues developed through School Environmental Management Plans (SEMPs) is extended and enhanced.

Waterwatch contributes most to the key learning areas of HSIE and Science and Technology in Stages 2 and 3. The program can also complement curriculum outcomes in other subjects, such as English and Mathematics.

Objectives of environmental education

Waterwatch will assist students to develop:

- knowledge and understandings about:
  - the nature and function of ecosystems and how they are interrelated (Kl)
  - the impact of people on environments (K2)
  - the role of the community, politics and market forces in environmental decision-making (K3)
  - the principles of ecologically sustainable development (K4)
  - career opportunities associated with the environment (K5).
- skills in:
  - applying technical expertise within an environmental context (S1)
  - identifying and assessing environmental problems (S2)
  - communicating environmental problems to others (S3)
  - resolving environmental problems (S4)
  - adopting behaviours and practices that protect the environment (S5)
  - evaluating the success of their actions (S6).
- values and attitudes relating to:
  - respect for life on Earth (V1)
  - an appreciation for their cultural heritage (V2)
  - a commitment to act for the environment by supporting long-term solutions to environmental problems (V3).

10.2 Australian Sustainable Schools Initiative (AuSSI)

The Australian Sustainable Schools Initiative (AuSSI) is a partnership between the Australian Government and the states and territories that seeks to support schools and their communities to become sustainable.

Waterwatch supports the principles of the AuSSI by actively involving students in observing, monitoring and improving their local catchment for long-term sustainability. This is encompassed in the Waterwatch vision:

WATERWATCH VISION:

Current and future generations empowered and actively involved in the sustainable use and management of catchments.

Waterwatch supports the AuSSI through:

- opportunities for action learning based on sustainable natural resource management that can be integrated within the school curriculum
- partnerships that involve students in local community programs based on sustainable natural resource management
- the delivery of Waterwatch to ensure the integration of quality teaching and learning principles and environmental education for sustainability.

AuSSI goals and Waterwatch

Waterwatch can assist schools to meet the following AuSSI goals by:

- providing tools and resources to involve students in protecting and enhancing biodiversity and natural ecosystems within the context of the school curriculum
- developing skills in water quality monitoring that contribute data for natural resource planning for sustainability
- engaging young people in sustainability initiatives within their local catchment
- developing partnerships with their local communities in natural resource management projects and activities.

Waterwatch and AuSSI benefits for schools

The benefits to schools include:

- the opportunity to use Waterwatch to achieve curriculum outcomes in key learning areas while developing student understanding of the management of our natural resources for long-term sustainability
- the collection and uploading of data to a statewide database, which can contribute to natural resource decision-making at a wider scale
- training of teachers that is a valuable professional development activity that can contribute to quality teaching in schools
- recognition within the broader community of school (and student) contributions towards sustainability.

AuSSI–Waterwatch rubric: rivers and aquatic ecosystems

The Waterwatch rubric below will assist your school to identify the current level of integration of catchment and water quality programs within the curriculum and as part of your School Environmental Management Plan (SEMP). Waterwatch can assist schools to implement whole school programs and link schools to the community through partnerships with Catchment Management Authorities, local government and community groups and organisations.

Focus	Developing	Establishing	Achieving	Excelling
Overarching	Ad hoc approach to water issues (water use, catchments and pollution).	Consistent programs, curriculum-driven, running across all key learning areas. Students identify local water quality issues to focus on.	Whole school plan for participation in Waterwatch, building capacity of students through hands on involvement.	Whole school community working as partners with the broader community on action programs and projects.
Monitoring water quality, habitats and species	Students participate in activities such as water bug surveys, catchment crawls and Water Week. Students have a basic understanding of why and what they are monitoring.	Students have basic training in monitoring procedures for water bugs and water quality. Students are interpreting their results and uploading data to the online database.	A Waterwatch Plan is developed and integrated within a whole school plan. Students are involved in mentoring others.	The school is involved in negotiating appropriate local actions in partnership with local agencies, organisations and community groups.
QA/QC	Group understands the need for consistent procedures in collecting information about the catchment.	Group is trained in QA/QC procedures and implements these procedures while monitoring.	Group participates in state/regional QA/QC programs that validate the accuracy of their data or participates in further training if required.	High quality data being valued and used by agencies and organisations to monitor NRM outcomes.
Caring for catchments	Students develop an understanding of catchments and the link between water quantity and water quality.	Students develop an understanding of the importance of the interconnectedness of ecosystems, e.g. rivers, estuaries, wetlands, and flora and fauna.	The school community recognises its dependence on a healthy catchment and values and promotes its role in the management of the catchment.	The school community engages with the broader community to implement local projects to achieve a healthy catchment.
Minimising human impacts	Students develop an understanding of human impacts on catchments and water quality.	Teachers and students understand the value of catchments and participate in catchment activities, e.g. catchment crawls, Water Week.	The school community recognises and promotes individual and collective responsibility for minimising its impact on catchments, e.g. awards.	The school community participates in best practice for catchment care with the wider community, e.g. community action days.
School Environmental Management Plan (water quality)	Recognition that the school affects both the quantity and quality of water and that runoff from the school grounds will directly impact on catchment health.	The school conducts audits of water quality from different water sources and identifies potential pollutant sources, e.g. cleaning products, fertilisers, chemicals.	The school is developing and implementing policies for ongoing improvement of site water quality management and reduction of runoff.	The school evaluates, implements and promotes best practice strategies to improve water quality and reduce runoff.

10.3 NSW Quality Teaching Model

The NSW Quality Teaching Model has been shown to improve the academic outcomes of all students. It respects the work of teachers and provides them with a practical and useful framework for professional dialogue, for planning and redesigning lessons and for reflecting on the quality of what they do in the classroom.

Waterwatch is based on participatory learning processes and provides the opportunity for teachers to present curriculum-based information in a way that fosters quality teaching by:

- providing a framework for teachers to engage students in a range of local environmental issues
- providing a framework to investigate the interconnectedness of the natural and built environments
- providing training to support teachers to conduct environmental investigations with students
- providing tools and resources to conduct scientific investigations in the field
- assisting teachers to design environmental projects for sustainable natural resource management.

A table showing how Waterwatch meets the requirements of the three pedagogical dimensions of the NSW Quality Teaching Model is provided on page 10–7 of this guilde.

Salinity concept map: incorporating Waterwatch within a quality teaching curriculum framework

'Salinity – Salt in the Environment, a concept map', is provided as an example of how Waterwatch can assist teachers to plan and implement teaching and learning units of work, in line with the elements of the quality teaching curriculum framework. When Waterwatch salinity monitoring is undertaken using Waterwatch-approved procedures and processes on a regular basis, the opportunity exists to investigate any or all of the integral and related salinity concepts within the curriculum.

Waterwatch can be adapted appropriately and implemented in all stages from 1 to 6 (K–12) of the curriculum.

A quality teaching curriculum framework for teaching about salinity using Waterwatch

Water quality monitoring → **Methodology – best practice** →

Tests
Parameters
Water quality monitoring
Salinity measurement
Macroinvertebrate surveys

→

Participatory learning
Fieldwork
Measurement skills
Calibration
Recording skills
Macroinvertebrate surveys

→

Collecting and managing data
Water quality data
Uploading data
Online database
Calibration
Identify bugs

→

Data interpretation
Graphing
Analysis
Water quality trends
Water quality guidelines
Water quality trigger values
Water quality standards
Drinking water standards
Stream pollution index

Salinity applications

Stormwater
Water sensitive urban design
Stormwater harvesting
Stormwater management

Water treatment
Desalination
Reverse osmosis
Effluent reuse
Grey water reuse

Water sources and storages
Rainwater tanks
Groundwater bores

Uses of salt
Industrial applications
Chemical industries
Salt production
Acid production
Chlorine production
Chlorination
Saltwater pools
Bacteriological salts
Caustic soda
Food preparation

Managing salt in the environment
Water use efficiency
Trading scheme
Salt-tolerant crops
Double cropping for water use
Catchment Action Plan targets

Quality teaching: salinity concepts

Physical concepts
Salinity meter
Electrical conductivity
Measurement of electrical conductivity (EC)
Effect of salt concentration on EC
Calibration standard solution
Calibration process
Electrical terminals
Digital readout
Battery
Dissolved solids
Solution
Solubility
Mass
Volume
Concentration
Dilution
Metric system
Salinity units
Siemen
Electrons
Conversion of units
Evaporation
Density of water
Density of ocean water

Earth science / Geological concepts
Sources of salt
Salts in soil
Salts in rocks
Weathering
Erosion
Earth structure
Geology
Sedimentary rock
Sedimentary basin
Coal seams
Aquifer
Water table
Soil
Sodic soil
Permeability
Groundwater
Salt in landscapes
Salinity in Australian environments
Artesian basin
Playa lake
Ocean water
Estuaries
Tides
Landscape contours

Chemical concepts
Types of salts
Composition of salts
Common salt
Salt crystals
Properties of water
Distilled water
Deionised water
Pure water
Rainwater
Brackish water
Laundry detergent
Washing powder
Electrolysis

Biological concepts
Plant water use
Vegetation water use
Cell structure
Osmosis
Plant structure
Transpiration
Evapotranspiration
Plant adaptations
Effect of salt on plants
Salt-tolerant plant species
Deep rooted vegetation
Shallow rooted vegetation
Deep rooted pasture
Animal water use
Animal adaptations
Animal salt adaptations
Salt-tolerant animal species
Adaptations of aquatic macroinvertebrates
Salt in humans
Taste buds
Salt taste limits
Perspiration
Salt tolerance
Salt in the diet
Human dietary limits
Excretion
Kidney
Tears
Blood
Dehydration

Environmental concepts
Water cycle
Rainfall
Catchment
River types
Freshwater ecosystem
Biodiversity
Riparian zone
Aquatic pollution indicator species
Land clearing
Rising water tables
Salt indicator species
Salt scalds
Irrigation and salinity
Salt and agricultural productivity
Sustainable farm production
No-till agriculture
Salt and coal mining
Salt and quarries
Marine ecosystem
Freshwater meets ocean water
Rocky shore community
Estuarine community
Mangrove community
Saltmarsh community

Waterwatch and the three pedagogical dimensions of the NSW Quality Teaching Model

DIMENSION	ELEMENT	HIGH QUALITY TEACHING ATTRIBUTES
Intellectual quality	Deep knowledge	Sustained focus on key concepts and ideas
		Clear articulation of the relationships between and among concepts
	Deep understanding	Requires students to provide information, arguments or reasoning that demonstrate deep understanding
	Problematic knowledge	Requires knowledge to be treated as socially constructed, with multiple and/or conflicting interpretations presented and explored
		Judgements made about the appropriateness of interpretations in a given context
	Higher order thinking	Students demonstrate higher order thinking. Organise, reorganise, apply, analyse, synthesise and evaluate knowledge and information
	Metalanguage	Substantial reference to and complex comments on language and how it works
	Substantive communication	Students produce an elaborate, sustained and coherent clarification of complex ideas, concepts or arguments directly related to the substance of the topic
Quality learning environment	Explicit quality criteria	Quality of work statements to assess outcomes are clear and explicit
	High expectations	Presents a serious challenge to students
		Encourage students to take risks in demonstrating their learning
	Student direction	Students determine significant aspects of the task
Significance	Background knowledge	Students' background knowledge is substantially incorporated
		Meaningful connection to out-of-school knowledge is integral
	Cultural knowledge	Substantial recognition of cultural knowledge
		All cultural knowledge valued equally
	Knowledge integration	Substantial and meaningful connection within and between subject areas
	Connectedness	Recognise and explore connections between classroom knowledge and situations outside the classroom
		Connections to create personal meaning in order to highlight the significance of the knowledge
		Require students to engage with and/or influence an audience beyond the classroom
	Narrative	Substantial use of narrative integral to the requirements of the task

Source: NSW Department of Education and Training, *Quality teaching in NSW public schools: discussion paper*, May 2003

10.4 Stage 2 HSIE outcomes

Waterwatch provides students with first-hand learning experiences. This develops knowledge and understanding, skills, attitudes and values consistent with the sustainable use of our natural resources. These Stage 2 programs can be incorporated into a broader study of catchments or other units of work developed within the school.

The Stage 2 programs include:

- pre-fieldwork activities
- activities at the waterway
- follow-up activities for the classroom.

Waterwatch supports schools that are committed to integrating environmental studies within the curriculum. The resources developed are to support these schools.

Waterwatch is flexible, and work sheets and activities can be used to meet the age group and outcomes required within the context of school programs and priorities.

> ***i*** **A wide range of work sheets, classroom activities and field assessment sheets have been provided in this teachers' guide and in the *Junior Waterwatch Field Manual*.**

Stage 2 HSIE outcomes: Environments

ENS2.5 – Patterns or Place and Location

Describes places in the local area and other parts of Australia and explains their significance.

Waterwatch provides opportunities for students to:

- investigate and describe natural, heritage and built features in their community using direct experiences such as excursions to the local waterway
- give their opinion of how and why they value features in their community
- compare the features of their own community with those of other communities
- locate and map their local area using maps and globes.

ENS2.6 – Relationships with Places

Describes people's interactions with environments and identifies ways of interacting with environments.

Waterwatch provides opportunities for students to:

- evaluate current uses of their local environment and consider possible future use and issues
- investigate and evaluate why particular natural and built features in Australia are significant, considering different points of view
- evaluate management plans and examine possible strategies for the protection of key sites in the local area
- participate in events and activities to promote environmental awareness and care
- participate in school and community activities and programs such as Waterwatch, water bug surveys, Water Week.

Values and attitudes promoted in the HSIE syllabus

Social justice:

- taking responsibility for one's own actions.

Ecological sustainability:

- appreciating the environment, one's personal relationship with it and one's responsibility for its future
- recognising the interdependence of people and the environment
- showing commitment to ecologically sustainable development and lifestyles
- being environmentally responsible.

Democratic processes:

- respecting different viewpoints and choices, and showing commitment to peaceful ways of resolving conflict
- showing commitment to ethical behaviour and to equitable participation in decision-making
- using democratic means to become agents of change for the improvement of society
- participating actively and responsibly in society as individuals and members of groups.

Lifelong learning:

- being curious and being willing to participate in learning about people, society and environments
- making connections between what one knows and what one is learning
- appreciating the importance of lifelong learning in a constantly changing world.

i **The following pages contain suggested Waterwatch activities linked to specific learning outcomes and indicators within the Stage 2 HSIE syllabus.**

Stage 2 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Locating natural features in the local area

TASK:
To locate the natural built and heritage features of the local area.

Materials required

Map of the local area, pencils, map, work sheet.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Locate the river on a map of the local area, such as a road map or tourist map. Establish the location of the river in relation to other significant sites in the local area. Mark the significant sites on the map. Use directions to trace your path from the school to the river. Visit the local waterway and make a list of the natural and built features of the river environment. Brainstorm the different people who would use the river to meet their needs. Use senses to establish your feelings about the river environment. Evaluate feelings about this environment – positive and negative. (Students will be aware that there are positive and negative aspects of both natural and human-made features.)	**ENS2.5** Describes places in the local area and other parts of Australia and explains their significance • draws accurate sketch maps of a known area and includes a title, key, scale and direction • uses geographical terminology and tools to locate and investigate environments. **ENS2.6** Describes people's interactions with environments and identifies responsible ways of interacting with environments • explains the effect of human change on an environment, evaluating the positive and negative aspects of change.

Stage 2 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Features of the creek/river/estuary environment

TASK:
To identify the natural built and heritage features of the local creek, river or estuary environment.

Materials required

Map of the local area, string, hoops or rope, clipboard, pencils.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Enlarge a map of the local area, such as a road map or tourist map. Use string and lay it on top of the river on the map to define its shape. Explore the differences between a river and other features (wet, narrow, moves, continues on, etc.). Draw the shape of the river on a piece of paper and use this shape to draw in features at the local waterway. Visit the local waterway and create a map to describe its features: • use a landscape viewer to observe this environment • draw the plants in the water and along the edge • investigate plants (use leaf and bark rubbings, estimate height, special features, etc.) • spot birds and animals in your viewer and draw them in their habitat on your map • observe people, plants and structures built by humans • use a key to mark these features on your map. Observe the environment by closer inspection: • use a hoop or rope tied together to randomly select a small area to investigate • observe and draw leaf shapes, textures, mini beasts, etc. • participate in a treasure hunt. **Waterway follow-up** Create a class map of the natural and built features	**ENS2.5** Describes places in the local area and other parts of Australia and explains their significance • draws accurate sketch maps of a known area and includes a title, key, scale and direction • uses geographical terminology and tools to locate and investigate environments • describes the natural and built features of the river environment. **ENS2.6** Describes people's interactions with environments and identifies responsible ways of interacting with environments • identifies human use and change on the river environment • conducts a variety of first-hand assessments to record the features of the natural environment • develops skills in observation, assessment and recording information from the environment.

Stage 2 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Investigation at the local creek/river/estuary

TASK:
To investigate the human impact on the local creek, river or estuary.

Materials required

Clipboards, pen/paper, student recording sheets, *Water Bug Detective Guide*.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Look at pictures of healthy and unhealthy waterways. Brainstorm the ways water can be polluted. Visit the local waterway over a period of time to monitor and assess human impact. **Water quality assessment** Conduct a water quality assessment using the Waterwatch kit. The assessment can include: • temperature, pH, salinity, turbidity, flow. Record the results and determine the human impact on the water quality of the river. **Water bug survey** Use dip nets to catch water bugs. Sort the species. Identify pollution-sensitive and pollution-tolerant bugs. Analyse the health of the creek by the types of bugs caught. **Litter Survey** Identify natural and human-made litter. Investigate which litter can be recycled to make a new product, recycled to make compost or reused. Rate the visible pollution at the creek/river/estuary and record the results.	**ENS2.6** Describes people's interactions with environments and identifies responsible ways of interacting with environments • explains the effect of human change on an environment, evaluating the positive and negative aspects of change • conducts a variety of first-hand assessments to record the features of the natural environment • develops skills in observation, assessment and recording information from the environment • relates water quality data to human use of the area • rates the water quality and human impact on the waterway based on first-hand experiences • demonstrates responsibility in the care of the environment.

Stage 2 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Caring for the local creek/river/estuary

TASK:
To investigate ways to protect and care for the local creek, river or estuary.

Materials required

Clipboards, pens/pencils, materials needed for action plans.

Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.

Teaching/learning sequence	Outcomes and indicators
Express a personal view about the care of the creek, river or estuarine environment: • How do you feel about the creek? • What rules would you make to protect the creek? (e.g. no litter, stay on tracks, don't throw stones, etc.) Make a poster to tell people about the need to care for the waterway. Monitor water quality by joining the Waterwatch program. Raise awareness of water quality issues by writing about your local river and sending information to your local paper or Waterwatch coordinator. Report on your Waterwatch activities at the school assembly and in the school newsletter. Participate in local events, such as Water Week, to promote environmental awareness and care for the environment.	**ENS2.6** Describes people's interactions with environments and identifies responsible ways of interacting with environments • participates in the maintenance and improvement of an environment • evaluates and justifies best solutions for environmental problems • develops skills in the assessment and monitoring of the local waterway • reports on the local environment in oral and written form.

10.5 Stage 2 Science and Technology outcomes

Waterwatch provides students with first-hand learning experiences. This develops knowledge and understanding, skills and attitudes and values consistent with the sustainable use of our natural resources. These Stage 2 programs can be incorporated into a broader study of catchments or other units of work developed within the school.

Waterwatch provides students with the opportunity to learn about and engage in:

- the process of investigating
- the process of designing and making
- the use of technology.

Waterwatch develops skills in observation, measurement, analysis and recording, which can be conducted in the classroom and the real world. Waterwatch can be integrated into existing work units or a unit of work can be developed to fulfil syllabus outcomes.

> ***i*** **A wide range of work sheets, classroom activities and field assessment sheets have been provided in this teachers' guide and in the *Junior Waterwatch Field Manual*.**

Investigating INV S2.7

Conducts investigations by observing, questioning, planning, predicting, testing, collecting, recording and analysing data and drawing conclusions.

Using Technology UT S2.9

Selects and uses a range of equipment, computer-based technology, materials and other resources to meet the requirements and constraints of investigation and design tasks.

Designing and Making DM S2.8

Develops, implements and evaluates ideas using drawings, models and prototypes at appropriate stages of the design process.

Living Things LT S2.3

Identifies and describes the structure and function of living things and ways in which living things interact with other living things and the environment.

Values and Attitudes

VA1 Demonstrates confidence in their own ability and a willingness to make and implement decisions when investigating, designing, making and using technology.

VA2 Exhibits curiosity and responsiveness to scientific and technological ideas and evidence.

VA3 Initiates scientific and technological tasks and challenges and perseveres with them to their completion.

VA4 Gains satisfaction from their efforts to investigate, to design, to make and to use technology.

VA5 Works cooperatively with others in groups on scientific and technological tasks and challenges.

VA6 Shows informed commitment to improving the quality of society and the environment through science and technology activities.

The following pages contain suggested Waterwatch activities linked to specific learning outcomes and indicators within the Stage 2 Science and Technology syllabus.

Stage 2 Science and Technology Waterwatch activity: investigating the Earth and its surroundings

TASK:

To investigate water in our world and the factors which influence changes in water quality in different seasons.

Materials required

Globe ball, Waterwatch kit, pencils, digital camera.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Pre-fieldwork experiences **Investigate the water cycle** Design a model to show the water cycle processes, such as evaporation, condensation, infiltration, runoff. Conduct an experiment to demonstrate the effect of temperature on water. AND/OR **Investigate the groundwater cycle** Design and make a groundwater model. Make predictions and draw conclusions based on a groundwater model. **Visit the site** Play the globe ball warm-up activity and estimate the amount of water on the globe and the percentage of fresh water. Record the temperature and season. Make a note of whether there has been rain recently. Make observations at the site about the river height (use an object to note the height and width each time) and/or water table height. Use the site observation sheet to record features of the non-living environment at the site. Take photographs at the site using a digital camera. Regularly monitor water quality using the Waterwatch kit and include temperature, turbidity, pH, salinity and flow. **Fieldwork follow-up** Record measurements on the Waterwatch online database. Use photographs taken with a digital camera to develop a photographic display of the river in different seasons and under different climatic conditions, e.g. floods and droughts. Conduct an experiment and predict and verify relationships between weather and pollution levels. Relate changes in results to climatic and other factors.	**Designing and Making DM S2.8** Develops, implements, evaluates ideas using drawings, models, prototypes at the appropriate stages of the design process • works collaboratively in a group to design and make a water cycle and groundwater model • draws conclusions about the effects of water volume on pollution. **Investigating Inv S2.5** Conducts investigations by observing, questioning, predicting, testing, collecting, recording, analysing data, drawing conclusions • observes, measures and records features of the non-living environment • records information on a diagram • relates information to the local catchment and waterway. **Using Technology UT S2.9** Selects and uses a range of equipment, computer-based technology, materials and other resources with developing skill to enhance investigations and design tasks • demonstrates skills in measuring and recording features using appropriate equipment • uses the internet to record data • uploads and uses digital images to create a photographic display • uses word processing to record information collected in the field.

Stage 2 Science and Technology Waterwatch activity: living things at the waterway

TASK:

To identify and describe living things at the waterway and their interaction with other living things and the environment.

Materials required

Water bug survey equipment, magnifying glass, *Water Bug Detective Guide*.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets. Having students make a water bug net and bug dial would be particularly useful activities. Refer to Sections 9.11 and 9.12 in this teachers' guide for details.**

Teaching/learning sequence	Outcomes and indicators
Pre-fieldwork Design and make a net to catch water bugs for a survey. OR Make a bug dial to identify the features of freshwater bugs at the waterway. **Visit the waterway to investigate a micro-environment** Observe and record the main features of this environment by using a variety of senses. Conduct surveys (such as a water bug survey), to identify the living things in this microenvironment. Use a magnifying glass to examine the structure of living things in this environment. Assess water quality based on the results of the water bug survey. **Fieldwork follow-up** Devise and implement a fair test to find out about the impact of water pollution on plants. Draw and label a plan and refine ideas for making a diorama, to show food chains for the river environment. OR Design and construct a model of a water bug and include materials used and how it will be shaped and joined and how it will move. Make your model larger than life to show its features. AND Design and make a diorama of an environment different to the river environment for your bug. How will this bug need to be adapted to live in its new environment? Use the internet and CDs to research living things at the waterway. www.bugsurvey.nsw.gov.au Email an expert to find out about living things at the waterway. Participate in spring and autumn water bug surveys – register via the internet and upload results to the internet site. www.bugsurvey.nsw.gov.au	**Designing and Making DM S2.8** Develops, implements, evaluates ideas using drawings, models, prototypes at the appropriate stages of the design process • designs and selects common household materials to make a net fit for the purpose of catching water bugs • follows a procedure to make a model for a particular use. **Investigating Inv S2.5** Conducts investigations by observing, questioning, predicting, testing, collecting, recording, analysing data, drawing conclusions • participates in a water bug survey • identifies the features of living things from a field guide • draws conclusions about water quality based on the results of the survey • uses equipment which enhances identification of living things. **Designing and Making DM S2.8** Develops, implements, evaluates ideas using drawings, models, prototypes at the appropriate stages of the design process • designs and builds a model which incorporates creativity, while showing real features • selects and uses a range of materials to make a diorama or model water bug. **Using Technology UT S2.9** Selects and uses a range of equipment, computer-based technology, materials and other resources with developing skill to enhance investigations and design tasks • uses the internet to record information in a database, communicate and register for an event.

10.6 Stage 3 HSIE outcomes

Waterwatch provides students with first-hand learning experiences. This develops knowledge and understanding, skills and attitudes and values consistent with the sustainable use of our natural resources. These Stage 3 programs can be incorporated into a broader study of catchments or other units of work developed within the school.

The Stage 3 programs include:

- pre-fieldwork activities
- activities at the waterway
- follow-up activities for the classroom.

Waterwatch supports schools that are committed to integrating environmental studies within the curriculum. The resources developed are to support these Waterwatch schools.

Waterwatch is flexible, and work sheets and activities can be used to meet the age and outcomes required within the context of the school.

> ***i*** **A wide range of work sheets, classroom activities and field assessment sheets have been provided in this teachers' guide and in the *Junior Waterwatch Field Manual*.**

Stage 3 HSIE outcomes: Environments

ENS3.5 – Patterns or Place and Location

Demonstrates an understanding of the interconnectedness between Australia and global environments and how individuals and groups can act in an ecologically responsible manner.

Waterwatch provides opportunities for students to:

- explore changes in their local environments.

ENS3.6 – Relationships with Places

Explains how various beliefs and practices influence the ways in which people interact with, change and value their environment.

Waterwatch provides opportunities for students to:

- clarify and reflect on various perspectives about environmental use, including negative aspects, e.g. changes in water quality due to human use
- gather information about the need for ecologically sustainable development and lifestyles
- participate in activities such as water quality monitoring that contribute to environmental sustainability
- clarify and discuss the responsibility of all Australians towards the conservation of environments
- investigate through first-hand experience, the diversity of animals and plant species within catchments

- participate in school-based activities such as the auditing of school water resource use and its impact on water quality and catchment health
- develop a Waterwatch group within the school and work with other community groups, in programs such as Landcare, to demonstrate a commitment to the protection and care of the environment
- investigate catchments as environments within Australia
- identify environmental patterns
- locate features on maps, including political boundaries, latitude and longitude, major cities, etc.

Values and attitudes promoted in the HSIE syllabus

Social justice:

- taking responsibility for one's own actions.

Ecological sustainability:

- appreciating the environment, one's personal relationship with it and one's responsibility for its future
- recognising the interdependence of people and the environment
- showing commitment to ecologically sustainable development and lifestyles
- being environmentally responsible.

Democratic processes:

- respecting different viewpoints and choices, and showing commitment to peaceful ways of resolving conflict
- showing commitment to ethical behaviour and to equitable participation in decision-making
- using democratic means to become agents of change for the improvement of society
- participating actively and responsibly in society as individuals and members of groups.

Lifelong learning:

- being curious and being willing to participate in learning about people, society and environments
- making connections between what one knows and what one is learning
- appreciating the importance of lifelong learning in a constantly changing world.

i **The following pages contain suggested Waterwatch activities linked to specific learning outcomes and indicators within the Stage 3 HSIE syllabus.**

Stage 3 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Locating your local catchment

TASK:
To identify the natural and human features of the local creek, river or estuary.

Materials required

Map of the local area, student work sheets.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Look at a map of your local area (it could be an aerial photograph, topographic map, road map or tourist map). Divide the class into groups and provide each group with a map of a different part of the catchment of the local creek, river and estuary. Draw a sketch map of part of the catchment: • show the location of the river and the natural features and land use • use symbols to show the main features • draw up a key for your part of the map. Include directional points on the map. Each group discusses the features of their section of the river and writes a brief summary. Display the different parts of the catchment on the class noticeboard. Each group presents an oral report. Brainstorm the natural and human features of the catchment and list them beside the sketch maps. Locate the main human land uses near the creek on the cross-section provided. Draw the features of the riparian zone on the cross-section provided.	**ENS3.5** Demonstrates an understanding of global environments and ways in which individuals and groups can act to maintain or improve those environments • draws accurate sketch maps of a known area and includes a title, key, scale and direction • uses geographical terminology and tools to locate and investigate environments.

Stage 3 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Changes in the local catchment

TASK:
To investigate changes in the catchment by conducting a questionnaire.

Materials required

Paper, pens, tape recorder (optional).

Teaching/learning sequence	Outcomes and indicators
Divide the class into groups and brainstorm questions which could be asked in a questionnaire to residents of the area. Include in the questionnaire general questions about the occupation, age and gender of those interviewed. Develop a set of common questions such as: • How long have you lived in the area? • What was the creek like when you were a child? • How did you use the creek? • What changes have occurred at the creek? • What would you like to see happen to the creek in the future? Each group will allocate 2 interviews to each student. Each group must interview a range of people of different occupations, age and gender, e.g. grandparents, neighbours, etc. Each group will discuss the individual findings and present a group report to the class as an oral and/or poster presentation. Class discussion of how the creek has changed. This could include questions such as: • In what ways has the catchment changed in 10, 20, 30 or 40 years? • How did people feel about the creek? • How did it feel to learn about the creek from other people? • What were the greatest concerns that people had about the creek? Construct a timeline to show the significant changes in the creek.	**ENS3.5** Demonstrates an understanding of global environments and ways in which individuals and groups can act to maintain or improve those environments • uses geographical terminology and tools to locate and investigate environments • explains the effect of human change on an environment, evaluating the positive and negative aspects of change • locates and describes patterns of human involvement in environmental areas of Australia, e.g. human use of rainforest areas or river systems such as the Murray Darling Basin. **ENS3.6** Explains how beliefs and practices influence the ways in which people interact with, change and value their environment • examines factors that may give rise to different views about the care of places, e.g. economic circumstances, occupation, age, gender, interest in heritage.

Stage 3 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

An investigation at the local creek/river/estuary

TASK:
To investigate the human impact on the local creek, river or estuary environment.

Materials required

Clipboards, pen/paper, water bug survey equipment (optional), water testing equipment (optional), student work sheets.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Draw a sketch map of the creek/river. Include a title, key, scale and direction. Observe the creek and comment on the character of the waterway. List the natural things and those put there by humans. Identify the positive and negative aspects of human presence in the environment. Conduct a range of assessments to investigate the environment: **Habitat assessment** (a) Look at the pictures of a healthy creek and determine the health of your creek or stream. (b) Draw a picture showing features of the banks of the creek. (c) Use the plant identification chart to identify the plants you can see at the creek. (d) Observe any changes in the plants of the area, such as withering leaves, trampled branches, weeds, etc. (e) Draw a picture of a water plant you can see. **Fauna assessment** (a) Determine whether there is evidence of native animals in the area by the presence of: • scats • paw prints • carcasses • scratchings • other. (b) Record the results on the fauna assessment sheet.	**ENS3.5** Demonstrates an understanding of global environments and ways in which individuals and groups can act to maintain or improve those environments • draws accurate sketch maps of known areas and includes a title, key, scale and direction • uses geographical terminology and tools to locate and investigate environments • explains the effect of human change on an environment, evaluating the positive and negative aspects of change • locates and describes patterns of human involvement in environmental areas of Australia, e.g. human use of rainforest areas or river systems such as the Murray Darling Basin.

Teaching/learning sequence	Outcomes and indicators
Water bug survey (a) Conduct a water bug survey, including: • using dip nets to catch macroinvertebrates • sorting the species • identifying pollution-sensitive and pollution-tolerant bugs • analysing the health of the creek by the types of bugs caught. (More information is available at www.waterwatch.nsw.gov.au)	
Water quality assessment (a) Conduct a water quality assessment using the Junior Waterwatch kit. The assessment can include: • temperature • flow • electrical conductivity • pH • turbidity. (b) Record the results.	
Litter survey (a) The survey can include: • natural and human-made litter • the type of rubbish on or near the water. Investigate which litter can be recycled to make a new product, recycled to make compost or reused. (b) Rate the visible pollution at the creek/river. (c) Record the results.	

Stage 3 HSIE Waterwatch activity: investigating your local creek, river or estuary environment

Caring for the local creek/river/estuary

TASK:
To investigate ways to protect and care for the local creek, river or estuary environment.

Materials required

Student work sheets, clipboards, pens/pencils, materials needed for action plans.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Draw signs you can see at the creek, river or estuary on the student work sheet. Identify who put up the signs, e.g. landholder, council, Catchment Management Authority, etc. Express a personal view about the care of the creek, river or estuary environment: • How do you feel about your site? • What rules would you make to protect the site? Identify the main problems at the creek and develop an action plan for the area. Participate in the maintenance or improvement of the creek, river or estuary environment. This may involve: • cleaning up rubbish • planting trees • participating in water bug surveys or Waterwatch • making a poster to display at school or the local shopping centre about the creek • writing letters to the local press or council.	**ENS3.5** Demonstrates an understanding of global environments and ways in which individuals and groups can act to maintain or improve those environments • participates in the maintenance and improvement of an environment • evaluates and justifies best solutions for environmental problems. **ENS3.6** Explains how beliefs and practices influence the ways in which people interact with, change and value their environment • expresses a personal point of view on an environmental issue and provides supporting evidence • examines issues associated with differing values about the natural and built environment, using a variety of sources, including the media.

10.7 Stage 3 Science and Technology outcomes

Waterwatch provides students with first-hand learning experiences. This develops knowledge and understanding, skills and attitudes and values consistent with the sustainable use of our natural resources. These Stage 3 programs can be incorporated into a broader study of catchments or other units of work developed within the school.

Waterwatch provides students with the opportunity to learn about and engage in:

- the process of investigating
- the process of designing and making
- the use of technology.

Waterwatch develops skills in observation, measurement, analysis and recording, which can be conducted in the classroom and the real world. Waterwatch can be integrated into existing work units or a unit of work can be developed to fulfil syllabus outcomes.

> ***i*** **A wide range of work sheets, classroom activities and field assessment sheets have been provided in this teachers' guide and in the *Junior Waterwatch Field Manual*.**

Investigating INV S3.7

Conducts investigations by observing, questioning, planning, predicting, testing, collecting, recording and analysing data and drawing conclusions.

Earth and its Surroundings ES S3.6

Recognises that the Earth is the source of most materials and resources, and describes phenomena and processes, both natural and human, that form and change the Earth over time.

Using Technology UT S3.9

Evaluates, selects and uses a range of equipment, computer-based technology, materials and other resources to meet the requirements and constraints of investigation and design tasks.

Designing and Making DM S3.8

Develops and resolves a design task by planning, implementing, managing and evaluating the design process.

Living Things LT S3.3

Identifies, describes and evaluates the interactions between living things and their effects on the environment.

Skills

Students will be able to:

- investigate natural phenomena and human-made environments
- design and make products, systems and environments to meet specific needs
- select, assess and use a range of technologies.

Values and Attitudes

VA 1 Demonstrates confidence in their own ability and a willingness to make and implement decisions when investigating, designing, making and using technology.

VA 2 Exhibits curiosity and responsiveness to scientific and technological ideas and evidence.

VA 3 Initiates scientific and technological tasks and challenges and perseveres with them to their completion.

VA 4 Gains satisfaction from their efforts to investigate, to design, to make, and to use technology.

VA 5 Works cooperatively with others in groups on scientific and technological tasks and challenges.

VA 6 Shows informed commitment to improving the quality of society and the environment through science and technology activities.

i **The following pages contain suggested Waterwatch activities linked to specific learning outcomes and indicators within the Stage 3 Science and Technology syllabus**

Stage 3 Science and Technology Waterwatch activity: investigating the impact of the built environment on the Earth and it surroundings

TASK:

To discover the properties of water and the impact of built environments on catchment processes and water quality.

Materials required

Clipboards, pens, Waterwatch equipment, materials for models and experiments, Waterwatch procedure and recording sheets.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
Pre-fieldwork experiences Conduct experiments to determine the properties of water, e.g. solution, suspension. Conduct experiments to relate these properties to water pollution at the creek/river, e.g. turbidity, salinity, pH, temperature. Compare and contrast natural and human-made environments. Relate these activities to the local waterway. **Visit the local waterway** Use equipment to monitor the water quality, e.g. pH, temperature, turbidity, salinity. Use a thermometer to record the air temperature and observe changes in water flow and height. Record changes in the creek environment with a digital camera over a period of time. **Fieldwork follow-up** Record fieldwork data on the Waterwatch online database. Compare the data with past tests and other sites. Communicate with the Waterwatch coordinator by email or fax. Use a word processor to write an article for the local newspaper or invite the local newspaper to report on your water monitoring activities. Design a safe and functional device to reduce the water pollutants in the built environment, such as a device to raise awareness of or prevent pollutants entering a waterway from the built environment, e.g. trash rack, constructed wetland, etc. OR Design a water filter to increase water quality for urban users. OR Design a drain stencil to increase awareness that the 'drains are just for rain'. Develop a plan for the school playground to reduce runoff to stormwater drains.	**Investigating Inv S3.7** Conducts their own investigations and makes judgements based on the results of observing, questioning, planning, predicting, testing, collecting and analysing data and drawing conclusions • understands the difference between pollutants which are dissolved and those suspended • develops skills in measuring and recording data • identifies the impact of the built environment on natural processes. **Designing and Making DM S3.8** Develops and resolves a design task of planning, implementing, managing and evaluating design processes • designs and makes models to demonstrate catchment processes • researches, plans and designs a model to reduce water pollution caused by the built environment • uses models to conduct experiments. **Using Technology UTS3.9** Evaluates, selects and uses a range of equipment, computer-based technology, materials and resources to meet the requirements and constraints of the investigation and design tasks • demonstrates skills in measuring the pollutants in water • uses computers to record data, write a report and communicate with others.

Stage 3 Science and Technology Waterwatch activity: investigating living things at the waterway

TASK:

To investigate living things, the interactions between living things and their effect on the environment.

Materials required

Clipboards, pens, equipment, magnifying glass, binoculars, *Water Bug Detective Guide*, water bug recording sheet.

i **Refer to the relevant sections of this teachers' guide and the *Junior Waterwatch Field Manual* for further information and work sheets.**

Teaching/learning sequence	Outcomes and indicators
At the waterway Observe living things at the creek using a variety of senses. Conduct a water bug survey. Undertake a detailed study of a water bug using a magnifying glass, to determine its features. Use the water bug detective guide to calculate a pollution index for the creek. Use binoculars and a magnifying glass to help identify living things at the creek. **Fieldwork follow-up** Bookmark websites which provide information about the adaptation of living things to the creek environment, e.g. www.bugsurvey.com.au Research the requirements of water bugs and observe changes through their life cycles. Register and upload data for the spring and autumn water bug surveys via the online database. Conduct a fair experiment to identify the impact of a pollutant on living things, e.g. salinity on plant growth. Set up a fish tank in the classroom as a habitat for water bugs. Research their requirements and observe changes through their life cycles.	**Investigating Inv S3.7** Conducts their own investigations and makes judgements based on the results of observing, questioning, planning, predicting, testing, collecting and analysing data and drawing conclusions • conducts first-hand investigations to record the features of living things • develops skills in observation, assessment and recording information from the environment • observes and conducts first-hand investigations to determine relationships between the non-living environment and living things. **Using Technology UTS3.9** Evaluates, selects and uses a range of equipment, computer-based technology, materials and resources to meet the requirements and constraints of the investigation and design tasks • uses technology to research information about living things. **Designing and Making DM S3.8** Develops and resolves a design task of planning, implementing, managing and evaluating design processes • sets up a fish tank by taking consideration of the needs of these bugs, including habitat, food, etc. • demonstrates responsibility in caring for living things.

Incorporating studies at the waterway into existing Science and Technology work units

Topic	Activities
Mini Worlds	**Investigate the river/creek as a microenvironment:** • Observe and record living and non-living things at the river/creek. • Conduct a survey of animals/plants at the waterway. (This may involve a water bug survey, scats, etc.) • Design and use a database to record information about selected animals. • Play a simulation game, such as 'Macroinvertebrate Mayhem', to develop an understanding of food chains and webs. • Regularly monitor water quality and make predictions about the impact of water pollution on water bugs. • Use technology to enter data onto the Waterwatch water quality and water bug databases. • Investigate the features and behaviour of a water bug. Use the internet, email and CDs to research information. • Make a model of a water bug, showing its features. Note: The study of water bugs is particularly suited to this topic.
Cycles in Our World	**Investigate cycles found in nature, e.g. the water cycle:** • Design and construct a model of the water cycle. • Conduct experiments to demonstrate water cycle processes. • Regularly monitor water quality to record changes over time. Relate changes to seasonal and weather patterns. • Use technology to enter data onto the Waterwatch database. • Conduct experiments to show how seasonal and weather variations can impact on water quality. • Use drawings to show how climate has changed over time – relate to current environmental problems such as salinity. • Relate changes in natural cycles to the impact on water quality and living things. • Use a digital camera to develop a pictorial record of changes at the waterway due to weather and seasonal variations. **Design and use a method to record a life cycle of an animal:** • Select an animal/water bug observed at the waterway. • Research the requirements of water bugs and set up an aquarium in the classroom to observe the life cycle of water bugs. • Record the appearance, movement and needs and changes in their life cycle.
Our Australia	**Investigate specific Australian environments including flora, fauna and geographical features:** • Identify the natural and human-made features of the river environment using a variety of senses. • Conduct surveys to determine the character of living things in this environment, e.g. plant, scat, water bug survey, etc. • Conduct a water bug survey and use a magnifying glass to identify the characteristics of animals and plants which live in this environment. • Propose explanations of how they satisfy their needs. • Monitor water quality to determine the pollutants which impact on the waterway at this site. • Relate changes in water quality to living things, e.g. use the water bug pollution index, to conduct a biological assessment at the waterway.
Material World	**Design and make a structure or device to perform a given task:** • Design a habitat for a bird or animal which lives in or near the waterway. Consider the materials and needs of the living thing. • Design and make a net to catch macroinvertebrates at the waterway.

Waterwatch student investigations

Waterwatch involves investigations in the field. The river and the river environment provide the context for student investigations. Waterwatch provides the equipment and skills that promote scientific investigations.

Students can be encouraged to pose the following questions and outline their answers prior to beginning a field investigation:

1. What am I going to investigate?

2. What do I think might happen?

3. Why do I think it will happen?

4. What will I need?

5. How will I make it a fair test?

6. What happened?

7. Was this what I expected?

8. Why did it happen?

9. How could I improve this investigation?

10. How can I use this knowledge to improve the heath of the waterway?

10.8 Linking Waterwatch to Connected Outcomes Groups

The Stage 3 Waterwatch program for HSIE and Science and Technology provides a sequence of learning experiences that fits with the NSW Department of Education and Training (DET) Connected Outcomes Group (COG) unit, Interconnecting Growth and Change.

Waterwatch may complement this COG or can be used as alternative content for this COG.

Waterwatch can engage students by their:

- interpreting and drawing maps
- understanding catchments and their contribution to healthy catchments
- investigations at the waterway using scientific methodology
- working in groups to achieve outcomes
- reflecting on how human activity affects the water quality and recreational activities
- action planning to enhance the river/creek environment
- communicating actions to the school and broader community.

This can be achieved through linkages between the Key Learning Areas:

HSIE

ENS3.5

Demonstrates an understanding of global environments and ways in which individuals and groups can act to maintain or improve those environments.

ENS3.6

Explains how beliefs and practices influence the ways in which people interact with, change and value their environment.

This may include the following outcomes:

- examines factors that may give rise to different views about the care of places, e.g. economic circumstances, occupation, age, gender, interest in heritage
- locating your school within catchments
- understanding the interconnectedness of the local catchment with larger catchments such as the Murray Darling Basin
- develop an understanding that Aboriginal beliefs and customs can influence the way people interact with their environment
- understanding human use and change and the impacts and issues affecting natural resources within catchments.
- investigating your local creek or river and the changes caused by human use over time.

Science and Technology

Investigating INV S3.7

Conducts investigations by observing, questioning, planning, predicting, testing, collecting, recording and analysing data and drawing conclusions.

Earth and its Surroundings ES S3.6

Recognises that the Earth is the source of most materials and resources, and describes phenomena and processes, both natural and human, that form and change the Earth over time.

Using Technology UT S3.9

Evaluates, selects and uses a range of equipment, computer-based technology, materials and other resources to meet the requirements and constraints of investigation and design tasks.

Designing and Making DM S3.8

Develops and resolves a design task by planning, implementing, managing and evaluating the design process.

Living Things LT S3.3

Identifies, describes and evaluates the interactions between living things and their effects on the environment.

Skills

Students will be able to:

- investigate natural phenomena and human-made environments
- design and make products, systems and environments to meet specific needs
- select, assess and use a range of technologies.

Values and Attitudes

VA 1 Demonstrates confidence in their own ability and a willingness to make and implement decisions when investigating, designing, making and using technology.

VA 2 Exhibits curiosity and responsiveness to scientific and technological ideas and evidence.

This may include the following outcomes:

- investigate water quality and biodiversity within catchments
- develop a hypothesis for investigation
- collect and record data at the creek or river based on water quality testing, water bug surveys and/or habitat assessments
- develop an understanding of the interconnectedness of water quality and biodiversity at the site
- analyse and draw conclusions based on the data you have collected
- identify threats to the health of the waterway
- use the information collected to develop an action plan for your creek or river
- communicate your efforts to your school and community.

HDPE

Interpersonal relationships

IRS3.11 Describes roles and responsibilities in developing and maintaining positive relationships

- identifies their roles and responsibilities within groups, e.g. family, friends, team, class.

Personal Health Choices

PHC 3.11 Explains the consequences of personal lifestyle choices

- identifies the effects of their decisions on themselves, others and the environment
- researches current global issues affecting the environment using information from the internet
- uses safety devices and protective equipment in relevant situations.

Safe Living

SLS3.13 Describes safe practices that are appropriate to a range of situations and environments

- demonstrates ways to improve unsafe environments, e.g. at the waterway
- devises strategies to respond to risky and dangerous situations
- formulates and practises action plans for accident and emergency situations in the local environment
- plans how to take responsibility for their own safety and that of others.

Waterwatch provides the opportunity for students to:

- work in groups, recognising their role and responsibility to others in the group
- identify and understand the dangers associated with activities at the waterway and the need for rules
- demonstrate the safe ways of working at a waterway and the importance of a 'buddy' system
- involve students in a risk assessment at the waterway and devise strategies to minimise the risk of dangerous situations
- identify the need for personal protective equipment and use personal protective equipment at the waterway when required
- recognise the need to protect the waterway for health (water quality) and recreational reasons
- ensure that they leave the waterway in a clean and safe way for other users. This includes the removal of rubbish and the safe disposal of wastes used at the site
- understand local issues and conduct research using the internet about these issues and whether they occur in other places in Australia and on a global scale.

Creative Arts

Water and the environment provide mediums for music, art and dance. Waterwatch promotes creativity through visual arts, music and drama, and may include:

- making musical instruments from natural materials found at the waterway
- making models of catchment and aquatic bugs
- drawing in the environment
- representing an environmental theme through music and dance.

SECTION 11

Glossary

Acid	a substance that releases a positive hydrogen ion in solution – acidic solutions have a pH of less than 7
Action plan	a plan that identifies a goal and the steps needed to reach it
Aerobic	organisms and processes that require oxygen
Algal blooms	extensive growth of algae in a body of water, which occurs due to climatic conditions or as a result of excess nutrients in the water
Alkalinity	the presence of bicarbonates, carbonates and occasionally borates, silicates and phosphates – a solution with a pH below about 5 contains no alkalinity
ANZECC Guidelines	Australian and New Zealand Environment Conservation Council guidelines for fresh and marine water quality
Aquatic	something that lives in water
Aquatic ecosystems	groups of plants and animals that live in water
Bank	sloping ground beside a river, stream or lake
Bank vegetation	plants that live on the sloping ground beside a river
Biodiversity	all plants, animals and micro-organisms
Bird's eye view map	a sketch map drawn as if features were viewed from above
Calibrate	to check and set the accuracy of an instrument such as an EC meter
Carnivore	an animal that feeds on other animals
Catchment	a natural drainage basin where all runoff water flows to a low point
Catchment Management Authorities	organisations established to set local priorities in natural resource management by the development of catchment action plans
Catchment stress	a measurement of how much a stream or waterway has changed from its natural physical state
Climate change	the changes occurring in temperature and rainfall at a site over a long period of time
Community	a group of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another
Community monitoring	the collection of information by the community about the health of their local ecosystem – may include both quantitative and qualitative assessments

Corrode	to wear away or destroy gradually, such as the impact of salt on objects
Data	numerical value or facts of any kind
Data confidence	the reliability of data as demonstrated by testing quality control samples – quality control results that fall within the designated tolerable error range for a parameter indicate that the monitoring data collected by a group can be treated with a high level of confidence
Data confidence program	the total integrated program for assuring the reliability and accuracy of monitoring data – includes quality control procedures
Decomposition	the breakdown of organic materials by micro-organisms
Deionised water	water that has had all the ions (atoms and molecules) other than hydrogen and oxygen removed
Detection limit	the lowest concentration that your testing method will report as positive
Detritus	small pieces of dead and decomposing plants and animals
Dilute	to make less concentrated
Discharge area	an area where groundwater reaches the soil surface
Dissolved oxygen	the volume of oxygen that is contained in water
Distilled water	pure water, free from dissolved salts
Dual range EC meter	an EC meter that can measure both high levels (mS/cm) and low levels (µS/cm) of electrical conductivity
EC	abbreviation of electrical conductivity
EC meter	a meter that measures salinity by passing an electrical current through the water sample
Ecosystem condition	the current or desired status of health of an ecosystem, as affected by human disturbance
Effluent	liquid flowing out
Electrical conductivity	the ability of a water or soil solution to conduct an electric current
Electrodes of EC meter	the conductor through which an electric current enters or leaves an electrolytic cell, electric arc, electric valve or tube
Environment	the sum total of all influences acting on an organism
Estuaries	coastal bodies of water, typically at the mouth of a river, which are open to the sea, allowing fresh water from inland to mix with salt water from the sea
Eutrophication	the enrichment of a water body by inorganic plant nutrients – may occur naturally or may be accelerated by human activities (e.g. fertilisers or sewage disposal) – can lead to algal blooms
Evaporation	the change of state from a liquid to a gas

Exotic species	introduced, non native species
Fauna	the animal life inhabiting a particular area or environment
Feedlot	an intensive method of raising animals in a confined area
Fertiliser	any substance, natural or manufactured, which is added to the soil to supply nutrients for plant growth
Filter feeder	any marine or freshwater animal that feeds on microscopic organisms by using a filtering mechanism to trap particles out of water
Floodplain	the flat part of the valley bordering a river resulting from the deposition of silt during times of flood
Food chain	a chain of organisms through which energy is transferred – each organism feeds on and obtains energy from the organism preceding it and in turn is eaten by and provides energy for the one following it (e.g. plant eaten by herbivore, then herbivore eaten by carnivore)
GPS	global positioning system that can be used to identify a site's location in latitude and longitude
Grazer/scraper	an animal that consumes algae and other material on the surface of submerged plants
Groundwater	water found and stored beneath the surface of the land
Gullying	a type of soil erosion caused by water continuously cutting channels on hillsides
Habitat	a place which provides suitable shelter and food for an organism
Headwater	the upper tributaries of a river
Heavy metals	elements that can contaminate water and sediment, causing damage to some forms of life
Herbivore	an animal that feeds solely on plant matter
High range EC meter	an EC meter that can measure high levels of electrical conductivity in millisiemens per centimetre (mS/cm)
Indicators	key measures that summarise the condition, trends and changes in the health of a waterway and the environment
Indigenous	originating in a particular region or country
Invertebrate	an organism that has no backbone
Irrigation	the artificial addition of water to crops to supplement rainfall
Lagoon	a small pond-like body of water
Larva (larvae)	the second developmental stage of an insect which proceeds from egg to larva to pupa to adult

Latitude	the angular distance north and south from the equator of a point on the Earth's surface
Logarithmic scale	a scale of measurement in which an increase of one unit represents a tenfold increase – the scale on a turbidity tube is a logarithmic scale
Longitude	the angular distance east and west of Greenwich of a point on the Earth's surface
Low range EC meter	an EC meter that measures low levels of salinity in microsiemens per centimetre (µS/cm)
Lower catchment	the part of a river where the landscape is flat and the river travels slowly and deposits large amounts of sediment
Macroinvertebrate	an animal without a backbone which is large enough to be seen with the unaided eye
Macrophyte	a large aquatic plant (e.g. rushes) that can be seen with the unaided eye
Marsh	land which is waterlogged
Micro-organism	a single-celled organism that is invisible or barely visible to the unaided eye (e.g. bacteria, fungi)
Microsiemens per centimetre	a measurement of salinity
Middle catchment	the section of the river which meanders through floodplains and where occasional flooding is important for maintaining the health of wetlands
Milligrams per litre	a measurement that equates to 1 part per million
Millisiemens per centimetre	a measure of salinity – 1 mS/cm x 1000 = 1 µS/cm
ML	abbreviation of megalitre – one million litres – one Olympic-sized swimming pool of water
mL	abbreviation of millilitre – one-thousandth of a litre
Monitoring	the regular observation and measurement of natural resource condition over time, usually to detect change
Monitoring frequency	how often monitoring will take place
Monitoring objectives	the reasons why monitoring takes place
mS	abbreviation of millisiemens
MSDS	Material safety data sheets (MSDS) are designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance – include information such as physical data, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment and spill/leak procedures
Natural resource condition	the health or condition of a natural resource measured against acceptable guidelines

Nephlometric turbidity units	the unit of measurement for turbidity
Nitrogen	a nutrient used primarily by plants and animals
NTU	abbreviation of nephlometric turbidity units
Nutrient	any substance used or required by an organism for food
Nymph	the young, immature stage of certain insects, usually similar to the adult form
Occupational health and safety	a workplace policy designed to minimise and avoid risks – Waterwatch incorporates OH&S procedures such as the use of personal protective clothing and site risk assessments prior to volunteer monitoring
Omnivore	an animal that eats both plant and animal matter
Organic	derived from or showing properties of a living organism
Organism	any living animal or plant
Osmosis	the force with which a solvent moves from a solution of lower solute concentration to a solution of higher solute concentration
Outfall	the site of a discharge of liquid from a pipe (e.g. the point at which a sewer discharges to a treatment works)
Overclearing	the removal of plant cover which results in accelerated erosion by wind and water
Overgrazing	continued grazing of grass or pasture at a level that leads to land degradation
Oxygenation	the process of adding dissolved oxygen to a solution
Parameter	a measurable or quantifiable characteristic or feature
Pasture	land that is covered in grass or herbage
Pesticide	a substance or mixture of substances used to kill unwanted species of plants or animals
pH	a value that represents the acidity or alkalinity of an aqueous solution – defined as the negative logarithm of the hydrogen ion concentration of the solution
Phosphorus	a nutrient essential to the growth of plants and animals
Photopoints	identified locations at a site where photos can be taken to show change over time
Photosynthesis	the conversion of carbon dioxide to carbohydrates in the presence of chlorophyll, using light energy
Phytoplankton	microscopic floating plants, mainly algae, that live suspended in water bodies
Plankton	plants (phytoplankton) and animals (zooplankton), usually microscopic, floating in aquatic systems
Point source pollution	a source of pollution that can be pinpointed to a particular source or pipe

Pollution	the introduction of unwanted components into water, air or soil, usually as a result of human activity (e.g. hot water in rivers, sewage in the sea, oil on land)
Pool	a still, deep place in a stream, separated by shallow gravelled areas on straight sections between meanders
Potable water	water suitable for drinking
Primary contact	activities involving direct contact with water, bodily immersion/submersion (e.g. swimming)
Pristine	an environment that remains untouched and undeveloped
Profuse	in great amount, abundant
Pupa (pupae)	the developmental stage of an insect between larva and adult
Qualitative assessments	assessments based on human observations, insight or knowledge about local environments
Quality assurance	the degree of reliability of data based on the quality controls in place
Quality controls	the routine application of procedures for measuring the standard of performance of sampling and testing
Quantitative assessments	the measurement of physical, chemical and biological parameters that provide numerical data about the health of a waterway
Raid biological assessment	a form of biological assessment, best developed using stream macroinvertebrate communities, that uses standardised, cost-effective protocols to provide rapid sample processing, data analysis, reporting and management response
Rate of flow	the speed at which water moves in a river or stream
Recharge area	a place where surface water infiltrates the soil and groundwater system
Reference site	a site used for comparison
Regulated river	a river where the flow is regulated by structures such as dams and weirs
Respiration	the intake of oxygen and the release of carbon dioxide (in aerobic organisms)
Riffle zone	shallow water flowing quickly over rocks
Riparian zone	the zone alongside a riverbank and extending out to 30 metres, including the bank and verge vegetation
Risk assessment	an assessment of the risks of an activity with a view to minimising or avoiding them
River health	a measurement of the functioning and resilience under stress of an ecosystem – can be measured by parameters such as water quality
Runoff	water that flows across the land surface and does not flow into the ground
Salinisation	excessive amounts of soluble mineral salts in the soil, making the land unsuitable for agriculture

Salinity	the presence of soluble salts in or on soils or in water
Salts	compounds that dissolve in water and can conduct an electrical current (e.g. sodium, potassium, calcium)
Saturation	a point at which a solution contains enough of a dissolved solid, liquid or gas so that no more will dissolve into the solution at a given temperature and pressure
Scalding	bare patches lacking vegetation – can be the result of erosion or salinity
Scat	an animal dropping
Scavenger	an animal that feeds mainly on other dead animals or on the products of larger animals
Secondary contact	activities involving some direct contact with the water but where ingestion is unlikely (e.g. boating)
Sediment	unconsolidated mineral and organic particulate material that settles to the bottom of an aquatic environment
Sewage	waste matter which passes through sewers
Sewerage	the pipes and fittings carrying sewage
Silt	a fine deposit of mud or clay in a water body
Snapshot monitoring	monitoring that takes place at a certain time in many places to allow comparison between sites
Soluble	dissolves in solution, usually water
Standard calibration solution	the usual solution supplied by a laboratory to calibrate equipment such as an EC meter in different ranges
Stormwater	rainwater which runs off the land, frequently carrying various forms of pollution such as rubbish, animal droppings and dissolved chemicals – is carried in stormwater channels and discharged directly into creeks, rivers, the harbour and the ocean
TDS meter	an instrument that measures total dissolved salts in water
Temperature	a measure of how hot or cold the water is in degrees Celsius
Terrestrial	living on land
Thermal pollution	when the temperature of the water body is significantly warmer or cooler than normal environmental conditions, temperature is considered to be a pollutant
Thermometer	an instrument used to measure temperature
Tolerance	the ability to survive and grow in the presence of a normally toxic substance (e.g. heavy metals)
Tolerant water bug	an aquatic macroinvertebrate that can be found in either clean or dirty water as it has the ability to withstand adverse environmental conditions such as water pollution

Topographic map	a map showing landform as contour lines, and other natural and human features
Total dissolved solids	a measure of the inorganic salts (and organic compounds) dissolved in water
Toxic	harmful, destructive or deadly to organisms
Toxin	a poisonous product generated by an organism
Transect	a line between two points that allows changes to be observed along it
Transpiration	the evaporation of water from plant leaves and stems
Tributary	a small stream or river flowing into a larger one
Trigger values	the concentrations (or loads) of key indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur
Turbidity	a measure of the cloudiness or muddiness of water
Turbidity tube	a tube used to measure the level of turbidity in nephlometric turbidity units
Unregulated river	a river where the flow is not impeded by human-made structures such as dams
Upper catchment	the source of a river
Vegetation	the plant cover of an area
Verge vegetation	the vegetation on an area up to 30 metres wide adjacent to a stream, including trees, shrubs and grasses
Water quality guidelines	a recommended value or range for a parameter (e.g. pH, turbidity, dissolved oxygen) – water quality guidelines can be adapted to different uses (e.g. environmental, recreation, drinking)
Water quality stressor	a change in a water quality parameter that puts stress on an ecosystem
Water velocity	the speed at which water moves in a river or stream
Watercourse	a channel having defined beds and banks where water flows on a permanent or semi-permanent basis
Waterwatch	a community program that provides a framework for involvement in water quality monitoring
Waterwatch Plan	a strategy that sets out the purpose, frequency and sites for monitoring, and the equipment and interpretation of information collected as part of the plan
Wetlands	a general term applied to open water habitats and seasonally or permanently waterlogged land areas (e.g. rivers, marshes and estuaries)

SECTION 12

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