Creekwatch

Adopt- a-creek Information Guide

Image: Macroinvertebrate monitoring

ACKNOWLEDGEMENT

Townsville City Council acknowledges the Wulgurukaba of Gurambilbarra and Yunbenun, Bindal, Gugu Badhun and Nywaigi as the Traditional Owners of this land. We pay our respects to their cultures, their ancestors and their Elders – past and present – and all future generations and value the traditions, culture and aspirations of the first Australians of this land. We acknowledge and hold in great significance the valuable contribution that Traditional Owners have made and continue to make within the Townsville Community.

The information in this guide has been adapted from information contained in the Senior WaterwatchTeachers' Guide (Department of Environment, Climate Change and Water NSW, 2010) and the accompanying Waterwatch Field Manual. Additional information was also sourced from the Queensland community waterway monitoring manual (Department of Natural Resources and Water, 2007), the River Detectives Program.

The Dry Tropics Partnership for Healthy Waters report cards and reporting parameters are acknowledged in this manual. We thank the Partnership for their contributions to improving waterway health outcomes in the Townsville region.

We thank our wonderful community for their motivation and commitment to improving waterway health and hope you enjoy the program.

Creekwatch

To get involved or provide feedback on this program please contact

OzFish Townsville

creekwatch@ozfish.org.au **or**

Townsville City Council's Creek to Coral officer
creektocoral@townsville.qld.gov.au

Published in September 2021

Author: Townsville City Council and OzFish unlimited

City of Townsville

INTRODUCTION

CREEKWATCH

Creekwatch is a community awareness and engagement program that has been running in Townsville since 2003. The program involves community volunteers in activities such as:

- Water quality monitoring
- Macroinvertebrate (waterbugs) monitoring
- Fish monitoring
- Rehabilitation of riparian vegetation
- Litter Collection
- Community events and presentations

Creekwatch empowers the local community to achieve 'local ownership' of their waterways through education and involvement in catchment management. Creekwatch activities provide environmental benefits to waterways and habitat and social benefits to volunteers. Creekwatch also aligns with other water awareness initiatives such as the Waterwatch Australia program, waterway health report cards, and the Earth Echo Water Challenge. This means there are extensive resources available for training and quality control of water quality and ecosystem health data recorded by the community. There is a list of these resources at the end of this guide.

The Adopt-a-Creek program is run in conjunction with Townsville City Council's Creekwatch delivery partner, *OzFish Unlimited* (OzFish). Creekwatch aligns with Council's Creek to Coral programme, aimed at fostering the sustainable use and management of Townsville's local coastal, marine and freshwater environments.

Townsville City Council and OzFish now offer primary schools and interested community groups the opportunity to Adopt-A-Creek. When groups nominate an eligible creek to adopt Townsville City Council will provide resources for you to undertake monitoring in that creek. Our goal is to connect as many volunteers as possible to their local waterways, where they will enhance water quality through stewardship. Adopting a creek means a yearlong (or more) commitment and stewardship towards the creek segment of your choosing. You will be supported by Townsville City Council and our Creekwatch delivery partner OzFish throughout the adoption process. In return we ask that you, share your monitoring data, tag Creekwatch and Townsville City Council in your socials where possible, and commit to at least 2 clean up events each year. If you no longer wish to continue the program you will need to let us know and return all equipment in good working order.

This guide sets out how to monitor and assess the health of waterways and supports Australian Curriculum Science strands. See links in Appendix A.

(see www.australiancurriculum.edu.au/Science/Curriculum/F-10).

The guide can be used in conjunction with other Queensland Government educational resources to help students and interested community members to learn about water and living sustainably.

These resources can be accessed on the Queensland Government website at https://www.qld.gov.au/environment/water/residence/use/education.

When you sign on to the Adopt-a-Creek program you will need to attend a briefing session and workshop to understand how to run the program with your group.

All groups must operate under their own safety policy and participate in the development of a Risk Assessment for their site. A list of roles and responsibilities for the program is contained in the table below.

Table 1: Roles and responsibilities

Adopt-A-Creek Group	Creekwatch
Operate under an existing safety policy and/or procedures and participate/sign on to a Risk Assessment for your site	Provision of monitoring equipment and supporting information for the Creek segment being adopted
Commit to the program for at least a year and attend the briefing and workshop sessions	Ongoing support
Undertake 2 litter clean ups per year	Compilation of data
Enter your data into the Creekwatch database	Recognition of stewardship through online media. Data management and reporting.
Tag Creekwatch in your socials	
Return unused equipment in good working order **NB Damaged and/or missing equipment must be replaced by the responsible school / group**	Replace consumables such as calibration fluids

MONITORING PLAN

WHY MONITOR WATERWAYS?

Healthy waterways are an integral part of the landscape, and they can provide many ecological, economic, and social benefits. Monitoring waterways allows us to assess the health of these ecosystems to ensure that they contribute to a productive and clean environment. It also allows you to connect with other likeminded individuals in your area!

Monitoring your waterways is one thing but understanding why you are getting the results you are getting is another! That is why you must first '**Know your Catchment**'. This module will set the scene for your program by helping you understand what the drivers are in your area, what the pressures are being exerted on your waterway and the current state of the waterway. Only then can volunteers understand what impacts are occurring and why, and what responses might be required. We hope that as you get to know your waterway better you might be able to identify stewardship activities that can help improve the waterway over time.

SITE SELECTION

It is important to choose suitable monitoring sites as this will affect the quality of the data you gather and how well that data meets your objective/s. But what makes a site suitable? Here are a few things to look for:

- An open flat area where the group can work
- Easy and safe access to water
- Shallow water for bug surveys
- Accessible all year round
- 100 metres downstream of any drain if possible
- Above tidal influence (unless estuarine water quality is being tested)
- Upstream of where the creek enters another water body if applicable
- Stable site that will not wash away during floods
- Has typical features of waterways in the area
- Includes a variety of habitats

Ideally, you would be able to monitor as many sites as possible to capture the environmental variability present in the creek. However, a well-sampled site is more informative than many poorly sampled sites. So be mindful of the balance between the number of sites and available resources/time.

SAFETY

SAFETY POLICY

All participating groups must carry out activities under their own safety policy, and be responsible for the safety of their own students/volunteers at all times.

RISK MANAGEMENT

Teachers/Supervisors are to undertake a risk assessment of the site to familiarise themselves with the site and the surrounding local environment and conditions. All Adopt-a-Creek activities must be undertaken in accordance with the community group or school's safety policy and/or procedures.

RISK ASSESSMENT

A risk assessment is required each time monitoring takes place. The purpose of a risk assessment is to:

- Identify potential hazards to which staff, students and volunteers may be exposed
- Assess the level of risk associated with the hazard
- Implement and enforce corrective measures to eliminate/control, or reduce the level of risk
- Regularly review the risk assessment and evaluate the effectiveness of corrective measures

The table below outlines some of the hazards you may come across outside.

Table 2 Potential hazards and risks

What can harm you: potential hazards	What can happen: consequences
UV radiation (sunlight)	Sunburn
Walking on uneven ground	Slip, trip or fall
Water hazards	Drowning, water contamination and impact onhygiene
Vegetation – long grass, weeds	Rashes/cuts
Fencing – barbed wire, star pickets, electricfences	Injury related to hazard: cuts and scratches
Hot/cold weather	Exposure to the elements - heat stroke
Wildlife – snakes, insects, and spiders	Bites and stings
Travel, transport, public places	Accidents travelling to site; strangers in publicplaces such as toilets

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 on the following page.

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
- Beware of water quality contamination and personal hygiene and protection.
- Handle water samples as little as possible. Hands should be washed after sampling
- Do not allow students who cannot swim to collect samples

MOSQUITOES

- Teachers / guides will ensure that mosquito repellent is provided and used at Creekwatch events and activities in accordance with school/group policies.

SUN SENSE

- Sunscreen should be provided when undertaking Creekwatch/water quality events and activities and hats need to be worn at field locations.

WILDLIFE HAZARDS (SNAKES, SPIDERS)

- Warnings must be given about hazards which may arise at the site.
- Teachers/guides 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

- Use the buddy system 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

- Closed-toe footwear and appropriate clothing is to be worn in the field.

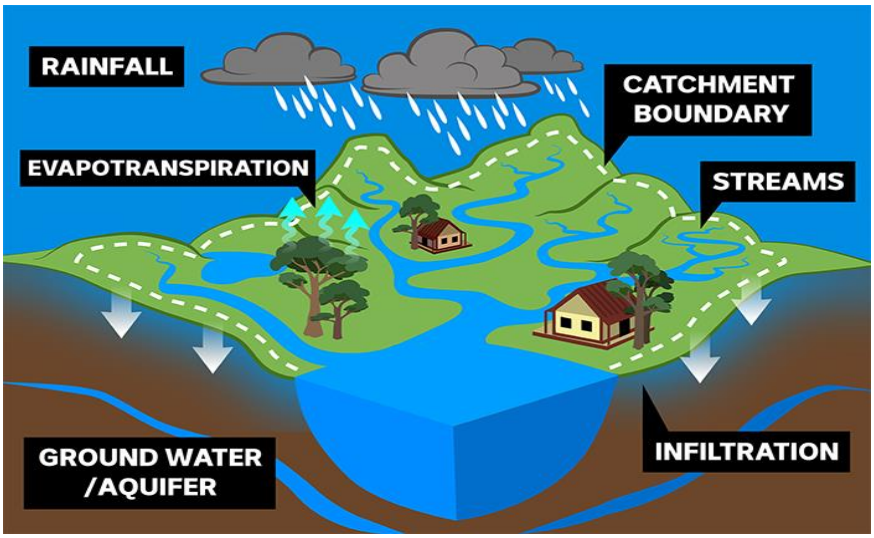
FIRST AID

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

NOTIFICATIONS

- Townsville City Council must be notified *immediately* of any incident causing serious harm whilst undertaking the Adopt-a-Creek program or other Creekwatch activity.

SECTION 1: KNOW YOUR CATCHMENT



WHAT IS A CATCHMENT?

A catchment is an area of land surrounded by natural features such as hills and mountains from which all water flows to the lowest point. These low points are our waterways. Water drains to these areas via rivers, creeks, lakes, groundwater, and wetlands. In urban catchments, gutters, drains, and channels direct this water to rivers and the sea. We all live in a catchment.

VALUES OF A CATCHMENT

Within the catchment, soil, plants, animals and water all function together. What happens in one part of the catchment is likely to affect another area downstream from that point. So, no matter how far away you live from a waterway our actions still have an impact on them. The health of the catchment is vital for human existence, the food we eat and the water we drink comes from a catchment near you. Catchments are part of our life support systems and sustain the lives of all plants and animals.

THREATS TO A CATCHMENT

Human activity has altered the natural environment over time, leading to changes in water quality and aquatic ecosystems. Activities such as farming, mining and urban development have led to a loss of biodiversity, an increase in sedimentation and pollution, and the spread of invasive pest plants and animals.

Urban areas: In towns and cities, the natural environment has been replaced with buildings and hard surfaces such as concrete and tar. Rainfall no longer soaks into the ground and becomes runoff, flowing through drains and pipes into local waterways. This water is not filtered and is called stormwater. Stormwater entering our lakes and rivers effects aquatic plants and animals. This is because stormwater is not just rainwater, it may be contaminated with pollutants you can see, and pollutants you can't see. These pollutants include litter, nutrients, dirt, bacteria, oil, fuel and other chemicals.

Rural areas: In rural areas, agricultural land used for growing crops and grazing animals can have an effect on water quality. The use of fertilisers on farming land, or a reduction in native plant cover means 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.

MANAGING CATCHMENTS

Managing a catchment is balancing the use and conservation of natural resources as a whole. All catchment areas have their own unique traits and qualities, so each needs to be understood and managed according to the natural features of the landscape, such as soil type, vegetation, rainfall, and climate. We need to understand the threats caused by land use and human habitation in order to best manage these practices and use natural resources sustainably.

CATCHMENT ASSESSMENT

IDENTIFY YOUR CATCHMENT AREA

The Townsville urban area extends across the Ross, Bohle and Black catchments. Surface water, stormwater and groundwater flows from hydrological connections across the Ross, Bohle and Black catchments.

You will be provided with some resources relating to your creek which will contain information about your catchment area including;

- Contours of the land which can show which way the water flows
- Maps with infrastructure stormwater network diagrams (Water, stormwater and wastewater networks)
- An understanding of the current state of the waterway provided by a Waterway health report card

Spend some time brainstorming with your students what sort of land use occurs in the catchment, and therefore what kind of threats might be present. You can look through the Dry Tropics Partnership for Healthy Waters website and waterway health report cards to gain an understanding of the current state of the waterway. You may also like to look at the story maps for the catchment you are in.

What type of waterbody are you studying? Is it a drain, creek, river or wetland? What position does it take in the catchment? Is it positioned in the upper, middle or lower sections? Are there tributaries to your waterbody? Is it prone to flooding?

From here you can consider why your catchment might display certain characteristics and later this will help you to interpret your results. It will also help you to brainstorm ways you could respond best to manage waterway health.

Some management ideas might include;

- Litter clean ups
- Weed removal
- Revegetation
- Sharing information with your community
- Or any other clever initiatives you may come up with as a group

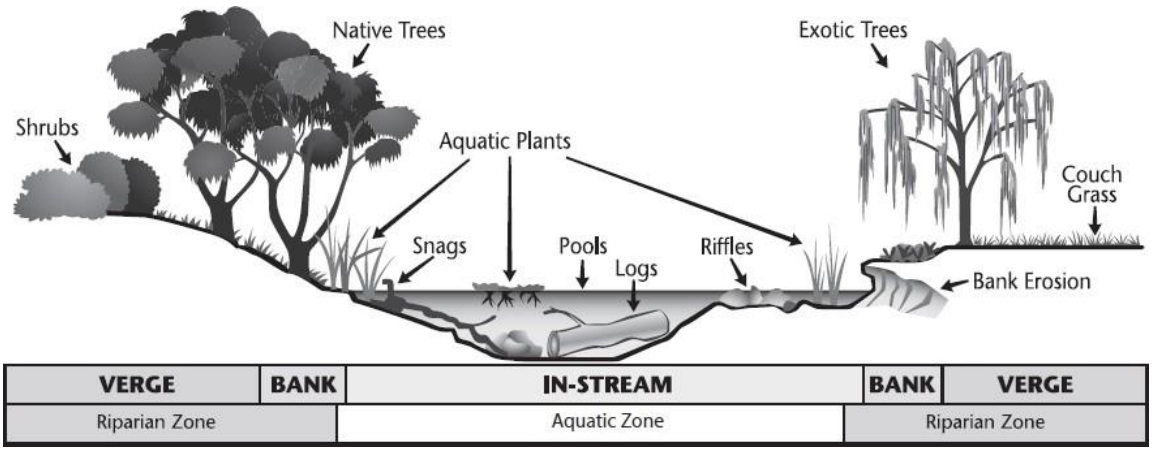
HEALTHY HABITATS

WHAT IS A HABITAT?

A habitat is a place that provides food and shelter for living things. A waterway has two main habitats pictured in the diagram below (a riparian zone and an aquatic zone):

The aquatic and riparian zones are interlinked and these linkages are integral to the health of the waterway. Changes in one zone will impact on the other. Erosion or revegetation of the banks directly impacts 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.



Source: Waterwatch Field Manual (NSW)

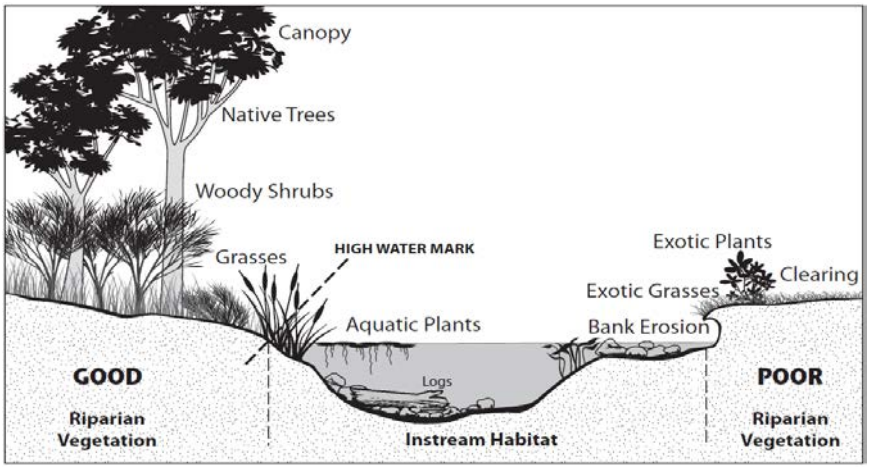
THE RIPARIAN ZONE

The riparian zone is the habitat that extends along the banks of a creek or river, separating the watercourse from the land. This area includes aquatic and semi-aquatic plants, as well as tree and shrub vegetation.

The riparian zone is an important link between the aquatic environment and the adjoining land. The native vegetation is an important source of food, shelter, and breeding habitat for aquatic, semi-aquatic, and land animals. When riparian vegetation is lost, many animals can no longer survive due to loss of habitat and food source.

Riparian vegetation is also important to protect the waterway from erosion and prevent pollutants entering the stream. The vegetation acts as a filter by trapping nutrients and sediments before they reach the waterway. A lack of plants along the banks may cause poor water quality by increasing turbidity, which will affect aquatic life.

Riparian Zone



Source: Waterwatch Field Manual (NSW)

THE AQUATIC ZONE

The aquatic zone is the in-stream habitat formed 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

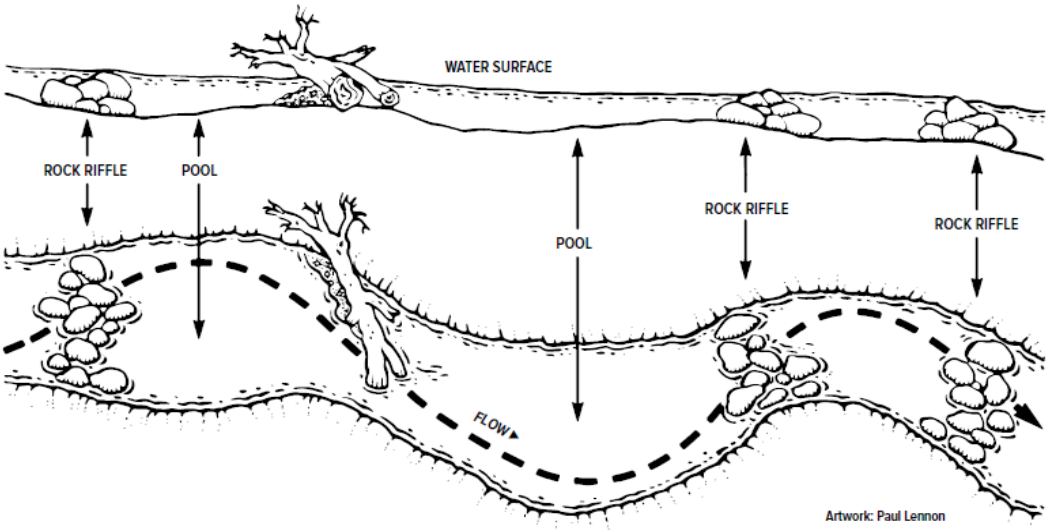
Runs – links between pools and riffles, with deep flowing water and little or no turbulence

Snags – fallen branches and washed-in shrubs

logs and rocks

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

Diagram of a pool and riffle sequence



The health of 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, providing food and shelter. 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.

HABITAT ASSESSMENT

Conduct a habitat assessment, studying the four elements below, to understand the value of the area around your monitoring site and compare changes over time. Use the habitat assessment data sheet in Appendix B in the field. Then log your findings in the online database.

Bank vegetation: trees, shrubs, grasses growing on the bank, providing food and shelter for aquatic organisms (fallen leaves, twigs)

Verge vegetation: section of land up to 30m from the bank, providing important habitat for aquatic and terrestrial animals. It can stabilise banks and acts as a buffer to surrounding land-uses by filtering/absorbing run-off

In-stream cover: as listed above under aquatic zone

Bank erosion and stability: streams naturally erode, usually on bends. Look for signs of erosion, bank stability.

SECTION 2: WATER QUALITY

WHY TEST WATER QUALITY?

Water quality is the 'suitability' of water for particular purposes. Human activities can have a major effect on water quality.

As part of the Adopt-a-Creek program you will be provided with equipment that will provided some insight into the quality of water in your creek. There is a range of equipment that can improve your results and the number of parameters monitored, though the kits provide a good starting point. The workshop will provide you with hands on experience in collecting samples and how to analyse results.

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 aquatic environment.

When the quality of the water declines, it is said to be polluted.

INTERPRETING RESULTS

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.

The following table details good and bad values for water quality parameters. Results require scrutiny! There are many factors that can affect your results including a poorly calibrated probe, flow rates, tidal influences, interactions with groundwater tables, and/or surrounding land uses (to name a few!) . The below table provides a basic reference for interpreting results, suited to primary school aged children.

A NOTE ON FLOW

In the dry tropics flow drops right off during the dry season and this can have a big impact on results. This is completely natural for our local environment and tells it's own story! Often we find during this time dissolved oxygen decreases and the stagnation results in increased algal growth. These will increase if there is adequate light which can lead to an algal bloom. Salinity and water temperature may also increase to values that can affect the biota in the waterway. You might want to talk with students about the underground rivers that persist long after surface flows have disappeared.

Table 3: Ranges of water quality parameters

Parameter	Result	Rank
pH	4	1 [Poor]
	5	1 [Poor]
	6	3 [Good]
	7	4 [Excellent]
	8	3 [Good]
	9	1 [Poor]
	10	1 [Poor]
Turbidity	0 NTU	4 [Excellent]
	>0 to 40 NTU	3 [Good]
	>40 to 100 NTU	2 [Fair]
	>100 NTU	1 [Poor]
Water Temperature °C	25-26	2 [Fair]
	27	4 [Excellent]
	28	3 [Good]
	28-30	2 [Fair]
	30 +	1 [Poor]
Conductivity	Site dependent	

PROCEDURE

TAKING A WATER SAMPLE

- Sample from the same place on each occasion and at approximately the same time of day if possible.
- Collect the water sample in the clean jug. Rinse the jug in the creek water you are sampling from.
- Try to sample about 20cm below the surface if possible (can be difficult in the dry tropics!). The sample should be taken in the main current.
- Position the jug upstream of where you are standing so that you take the sample facing into the current.
- Record each sample as soon as possible or within one hour of collection.

COLLECTION PROCEDURE FOR CREEK TESTING

1. Wear protective gloves. Rinse the jug 2-3 times with the creek water.
2. Hold the container and plunge it into the water with the opening downward below the water surface.
3. Turn the submerged container into the current (if current is available) and away from you.
4. Allow the water to flow into the container for 30 seconds.
5. Remove it from the creek and over to your flat surface for students to observe.

WATER QUALITY MONITORING PROBE

Water quality monitoring equipment requires calibration prior to monitoring. This should be undertaken only by the coordinator or teacher in charge. Details on how to perform calibrations are contained in the water quality probe case. Calibrations should be recorded in the calibration and equipment maintenance record in Appendix G.

Record all of your findings in the water quality data sheet in Appendix C whilst in the field. Then transfer all of your data to the online database.

USING THE PC60 PROBE TO TEST WATER QUALITY PARAMETERS

1. Short press the power button to turn on the device
2. Remove the protective cap and place the tip of the probe into the water sample
3. Short press the MODE button to cycle through to the desired parameter (pH, conductivity etc.)
4. Hold the tip of the probe in the water sample until the numbers stabilize and a 'smiley-face' symbol appears on the screen
5. Record the reading onto the data sheet and short press MODE to cycle through to the next parameter
6. Repeat steps 4 and 5 until all desired parameters have been recorded
7. Record the temperature reading from the bottom right hand corner of the screen
8. Long press the power button to turn off the device

PARAMETERS

WATER 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 andtraps sediment
- Turbidity – high turbidity warms the water and smothers aquatic plants and habitat
- Stormwater and urban runoff from hard surfaces such as streets and footpaths
- Cold water releases from dams

ELECTRICAL CONDUCTIVITY

WHAT IS ELECTRICAL CONDUCTIVITY?

Electrical conductivity is used to measure salinity. Different types of salts (ions) are salty and conduct electricity more readily than pure water. These may include potassium, chlorides, sulphates, sodium, carbonates, magnesium and calcium.

Electrical conductivity is measured in microsiemans per centimetre (µS/cm)

WHY IS IT IMPORTANT?

Appropriate concentrations of salts are vital for aquatic plants and animals. Salinity that is beyond the normal range for a species may stress or even kill them. Salinity also effects plant's ability to uptake nutrients. At very high concentrations salts can increase water clarity.

Salts can cause gradations in water columns as it makes water denser.

THINGS THAT AFFECT ELECTRICAL CONDUCTIVITY

Electrical conductivity can be affected by a great many things so results should always be interpreted with caution. The range for your waterway should be relatively consistent. So once the range has been taken it can be used to compare future results. Significant changes can indicate that a discharge or some other contaminant has entered the waterway.

Things effecting EC might include;

- Geology and soils
- Land use
- Flow (EC is generally low during high flows and increases as flow decreases. Extreme levels can be observed in stagnant pools.
- Run off
- Ground water inflows
- Temperature
- Evaporation and dilution

Some electrical conductivity ranges are provided below in Table 5 for reference.

Table 5: Electrical conductivity of common substances

Water type	Electrical conductivity (µS/cm)
Deionised water	0.5-3
Pure rainwater	<15
Freshwater Rivers	0-800
Marginal river water	800-1600
Brackish water	1600-4800
Saline water	>4800
Seawater	51,500
Industrial waters	100-10, 000

Source: Suttar S., Ribbons of Blue Handbook. Scitech, Victoria, 1990

PH

WHAT IS PH?

pH is a measure of the acidity or alkalinity of a substance. The pH scale ranges from 0 to 14, 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.

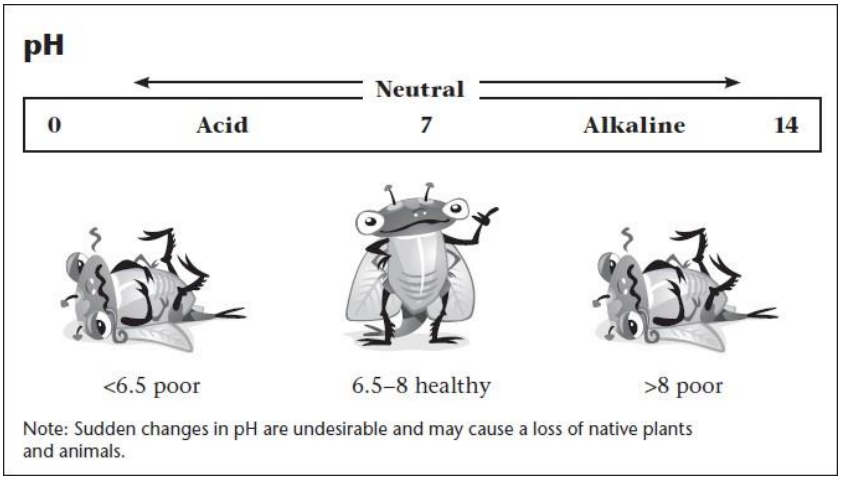


Figure 4 Scale of pH values

THINGS THAT 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, agricultural 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) duriTortPlastic ng 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 acid affected water.

HOW ALKALINITY AFFECTS WATERWAYS

If the water is too alkaline, fish and other aquatic species again may suffer skin irritations, tumours, ulcers and impaired gill functioning. Alkaline water can also cause skin or eye irritations in humans.

PH OF SOME COMMON SUBSTANCES

The approximate pH reading for each of these substances is in contained in Table 4 below.

Table 4: pH of common substances

Acid	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

TURBIDITY

WHAT IS TURBIDITY?

Turbidity is the cloudiness or muddiness of water. Particles of clay, silt, sand, algae, plankton and other substances increase turbidity. It can be expected to change between seasons (but not too much!). It can also be caused by animals, removal of vegetation, building and development sites, industrial discharges, and residents.

Turbidity is measured in Nephelometric Turbidity Units (NTU). Nephela is the Greek word for cloudy.

'Blackwater' is discolouration due to natural dyes in wetland/aquatic plants or caused by leaf litter as it breaks down. Blackwater can also increase turbidity. Turbidity is a measure of the totral material suspended in the water (called total suspended solids TSS).

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 thetemperature
- Oxygen levels, which decrease as water temperature rises
- Visual clarity of water

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 water ways, particularly livestock, leading to erosion
- 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

TURBIDITY PROCEDURE

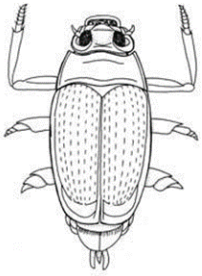
- Push the two parts of the tube together so that they form one cylinder; making sure that they fit squarely.
- Take a sample of water from the water source using the jug
- Hold the tube in one hand near the bottom and look into the open end with your head about 10 to 20 centimetres above the tube, so that you can clearly see the black circle, cross or other marking on the bottom of the tube.
- Slowly pour the water sample into the tube, waiting for air bubbles to rise if necessary, until the mark on the bottom of the tube just disappears.
- Stop pouring the water sample into the tube and look at the level of water in the tube. For turbidity tubes which have a turbidity scale marked on the side, read the number on the nearest line to the water level. This is the turbidity of the water. Record this number in NTU in your data sheet in Appendix C.
- After use, wash the tube in clean water and store the two parts of the tube where they cannot be damaged. Note: The tube will become difficult to read over time if it gets scratched.

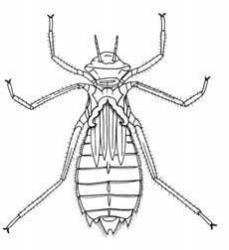
SECTION 3: WATER BUGS

INTRODUCTION TO WATER BUGS

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.





WHY MONITOR WATERBUGS?

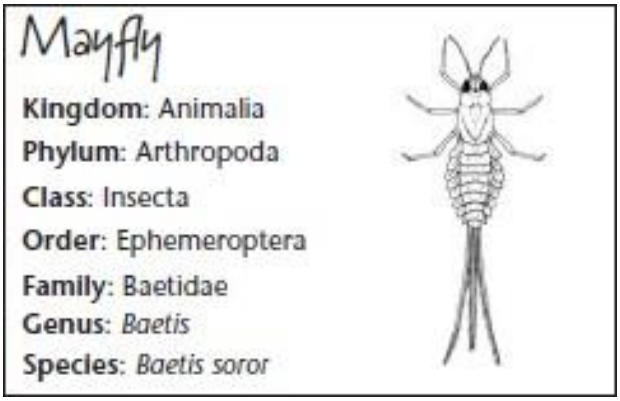
As part of the Adopt-a-creek program you will be provided with all the equipment you need to undertake water bug monitoring. The workshop will provide a hands-on opportunity to understand how, and where to sample along with identification tips. Water bugs provide a biological indication of the health 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 thenormal functioning of a water body. Macroinvertebrates occupy a central position in the food webs of rivers and streams.

TYPES OF MACROINVERTEBRATES

All living things are classified according to a hierarchical system that provides increasing detail about each organism as you move down the hierarchy. There are seven main levels in the hierarchy from top to bottom: kingdom, phylum, class, order, family, genus and species. Macroinvertebrates are part of the animal kingdom and identification for the purposes of waterway monitoring occurs at the class, order or family level. Examples of common aquatic macroinvertebrate classes include Gastropoda (snails), Arachnida (spiders and mites), Crustacea (crustaceans), Insecta (insects), Turbellaria (flatworms) and Oligochaeta (segmented worms).

At the species level, an animal is classified by both its genus and species (Department of Environment, Climate Change and Water NSW, 2010). For example, one type of mayfly, a common aquatic invertebrate, is known as Baetis soror. Note that both the genus and species names are written in italics and the genus always begins with a capital letter while the species begins with a lower case letter.



WATER BUG HABITAT

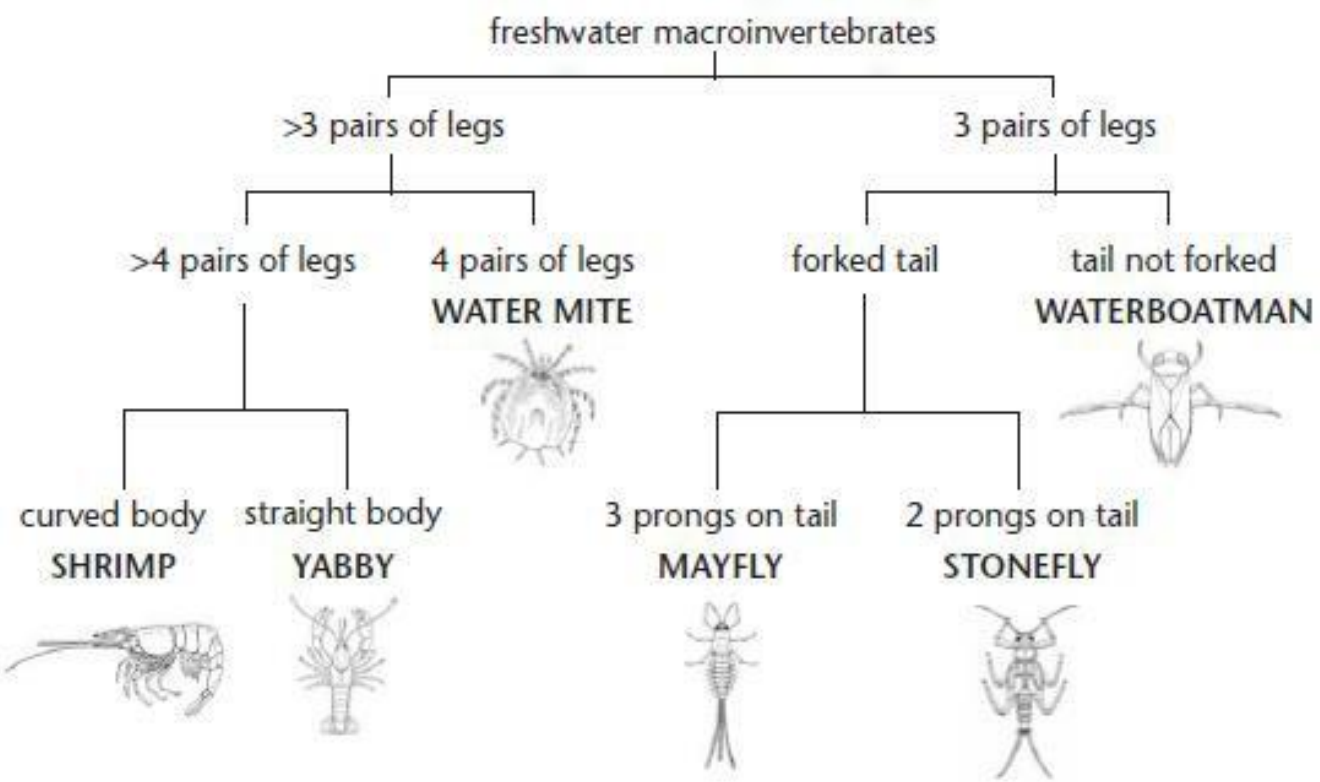
HABITATS OF WATER BUGS

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 type	Macroinvertebrates
Still water (edge and water surface), including overhanging vegetation frombanks	Fast moving bugs and beetles and freshwatershrimp
Bottom mud, sand, silt, gravel and rocks	Worms and fly larvae, mussels and clams
Aquatic plants (under the surface as wellas 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 flowsfaster around bends	Gripping insects, caddisflies, beetle larvae thathave burrowed into logs and under rocks, mayfly and stonefly nymphs

IDENTIFICATION

FRESHWATER MACROINVERTEBRATE KEY



Source: Senior Waterwatch Teachers' Guide (NSW)

IDENTIFICATION RESOURCES

- Aquatic Macroinvertebrate ID Key from the South Australian Murray- Darling Basin Waterwatch program www.naturalresources.sa.gov.au
- Water Bug Detective Guides -www.nswwaterwatch.org.au
- The Waterbug app (for Androidand Apple) - www.waterbugblitz.org.au
- The Waterbug Book (Gooderham& Tsyrlin, 2002)

Source: www.naturalresources.sa.gov.au

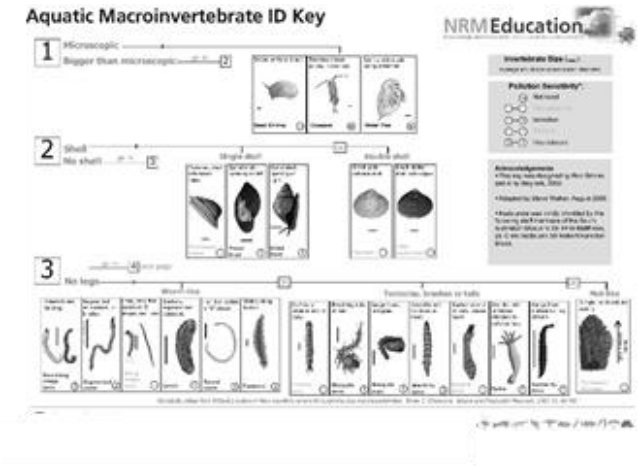
EQUIPMENT

EQUIPMENT LIST

You will need:

- Sweep net with long handle
- Large bucket
- Large trays, preferably white
- Ice cube trays, preferably white
- Spoons and pipettes
- Magnifying glass
- Waders or rubber boots
- Aquatic Macroinvertebrate ID Key laminates
- Field data sheet

Source: www.entosupplies.com.au



SAMPLING PROCEDURES

WHERE SHOULD I SAMPLE IN THE STREAM?

Within the stream, sample a range of habitats, including under stones, logs, fringing vegetation and pools and riffles. Sample in roughly the same place each time you visit so that comparisons can be made between data collected at different times.

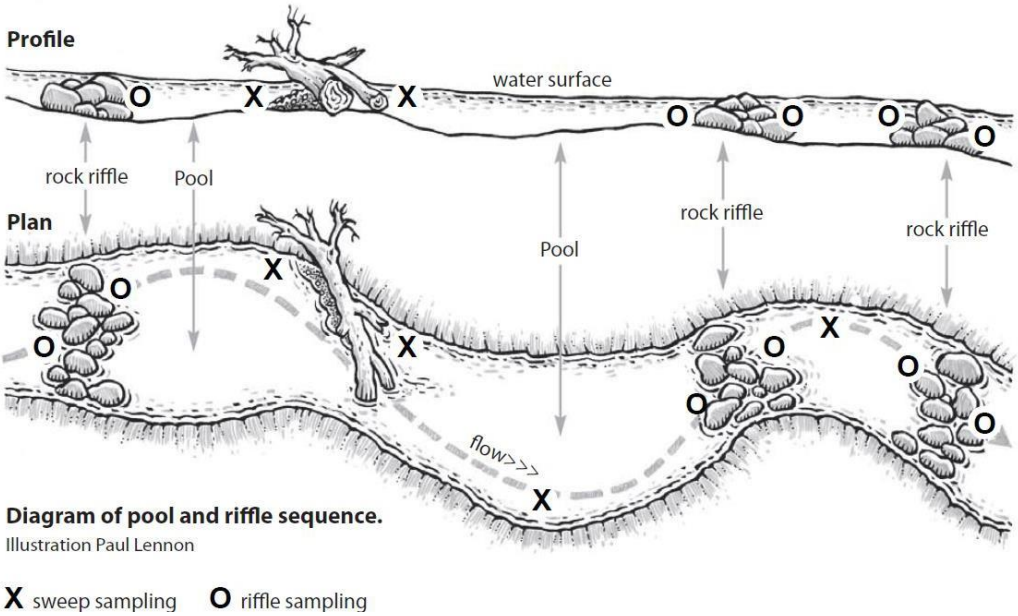


Diagram of pool and riffle sequence.
Illustration Paul Lennon

HOW TO COLLECT WATER BUGS

There are two basic methods used to collect samples of water bugs.

- Sweep sampling can occur along the edge of the stream and should include a range of habitats such asunder logs and tree roots, and in fringing vegetation.

- Kick sampling occurs in riffles. Wearing rubber boots, stand in calf to knee deep water facing downstream. Hold the net in front of you with the opening facing upstream. Disturb the rocks underfoot by vigorously shuffling and kicking. The current will sweep dislodgedmacroinvertebrates into the net.

Source: Text & pictures adapted from the Waterwatch Field Manual (NSW)

PROCEDURES

Sampling – 10 minutes

1. Use a bucket to pour clear stream water into a large sorting tray to about 2 cm deep
2. Use a short upward-sweeping motion to sweep the net through the stream or use kick sampling in riffles

3. Stop regularly to transfer the macroinvertebrates gently into the tray
4. Spread the sample out in the tray and allow the water to settle so small macroinvertebrates can be seen

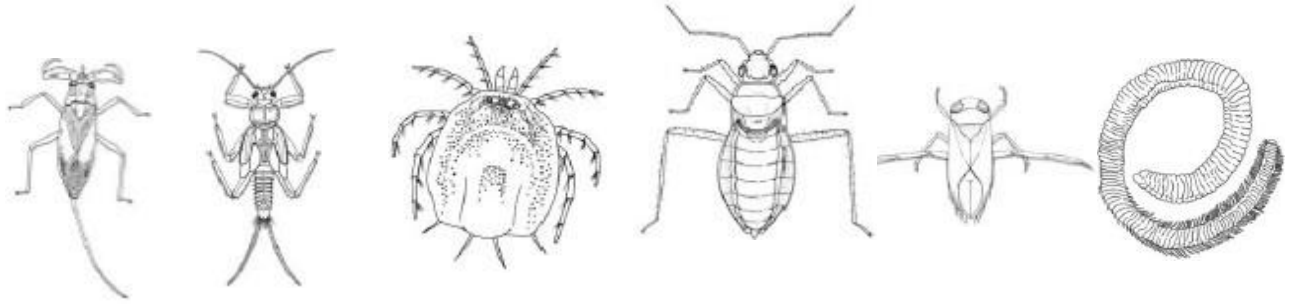
Sorting – 30 minutes

1. Fill an ice block tray with a small amount of water
2. Observe the water bugs in the large white sorting tray
3. Transfer bugs to the ice block trays using plastic spoons and pipettes
4. Sort the macroinvertebrates into the cubes in the tray using a different cube for each type of bug

Identifying bugs & recording results

1. Use the Aquatic Macroinvertebrate ID Key to help you identify the species
2. Count the number of macroinvertebrates and the number of types
3. Record the information on the recording sheet provided (see following section)
4. Gently return the macroinvertebrates to the water once you have finished

IMPORTANT NOTE: All equipment should be thoroughly washed down and cleaned before it is stored or used at a different site. This is to prevent contamination of future samples, and to help stop the spread of aquatic weedsor pests.



Source: Text & pictures from the Waterwatch Field Manual (NSW)

SIGNAL 2 AND THE STREAM POLLUTION INDEX (SPI)

A system called SIGNAL2 has been developed to score the 'health' of the water, using water bugs. SIGNAL2 stands for Stream Invertebrate Grade Number Average Level. SIGNAL2 gives each type of macroinvertebrate a sensitivity rating from 1-10 to indicate their level of pollution tolerance. This sensitivity rating, together with the number of types of bugs found, is used to create a Stream Pollution Index (SPI) for the river, creek or pond.

By using the SPI score and considering the number of macroinvertebrate types found at your site, SIGNAL2 can provide an indication of the types of pollution and other physical and chemical factors that are affecting the macroinvertebrate community.

To calculate your Signal 2 Score, follow the instructions on the field data sheet. For further information please refer to the SIGNAL 2 user manual 'SIGNAL 2.iv – A Scoring System for Macro-invertebrates ('Water Bugs') in Australia Rivers'.

SECTION 4: FISH

WHAT FISH NEED TO SURVIVE

Freshwater fish are those that spend some or all of their lives in fresh water, such

as rivers and lakes. These environments differ from marine conditions in many ways, the most obvious being the difference in levels of salinity. Freshwater fish differ physiologically from salt water fish in several respects. Their gills must be able to diffuse dissolved gasses while keeping the salts in the body fluids inside. Their scales reduce water diffusion through the skin: freshwater fish that have lost too many scales will die. They also have well developed kidneys to reclaim salts from body fluids before excretion. There are many things these freshwater fish need to survive, this includes:

- Food. This can vary depending on the species, but fish can eat macroinvertebrates, algae, other fish, frogs, or birds.
- Good water quality. This related back to the environmental parameters of pH, turbidity, salinity, temperature and dissolved oxygen levels.

FISH SAMPLING TECHNIQUES

There are many ways to conduct fish surveys. Techniques and equipment range from relatively simple such as using small nets or traps, to highly advanced such as eDNA or electrofishing. For Creekwatch activities, you will use box traps. This net has funnels on either side allowing fish to swim into the trap but also makes it difficult for them to swim out.

FOR SAMPLING FISH YOU WILL NEED

- Box traps
- Bait for the traps such as dry cat food
- A clear container or bucket
- A small net
- Fish ID guide

INSTRUCTIONS

1. Unravel the string from around the net and unclip the sides allowing it to open.
2. Open the small zip and place bait into the small pouch. Zip up the pouch and ensure the large zip is also closed.
3. Lower the net into the water so that the entire trap is submerged. You may choose to place your nets in varying locations (e.g. one in the shade, one in sun, one near habitat such as fallen trees etc.) and observe which net collects the most fish.
4. Tie the string to a nearby plant or place it under a rock so it doesn't fall into the water.
5. Once all traps have been deployed, step away from the waterbody and leave them for a minimum of 20minutes.
6. Before pulling the traps in, ensure you have a clear container with water to place any caught fish.
7. Pull the trap in slowly, being mindful that you don't know what's in there.
8. Open the large zip and place all caught fish into the clear container.

9. Once all traps have been pulled in and emptied, you can identify and count the fish caught. One person should identify the fish, and one person should use the biological datasheet to record how many of each species are caught.
10. To identify fish, use a small net to scoop out one fish at a time and identify it using the identification key. Once you have identified a fish, return it to the waterway.

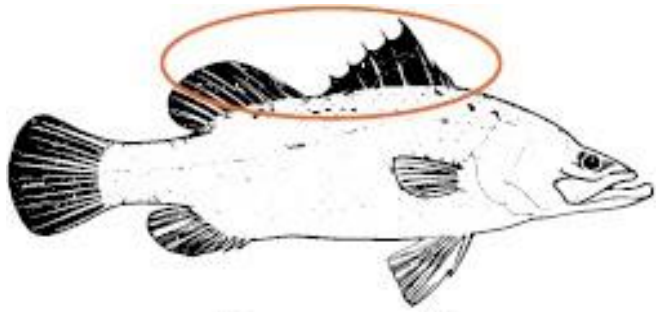
Safe Handling Note: Many native and invasive fish species have sharp spines or barbs. To avoid injury, do not handle fish directly with your hands. Instead, always use a small net. This protects you and also prevents any unnecessary stress or injury to the fish.

NATIVE VS. INVASIVE FISH

There are a lot of fish currently living in Australian waterways that have been introduced. These invasive fish can pose a threat to our native fish by outcompeting for limited resources. However, for freshwater fish there is a simple way to tell the difference between an invasive and a native fish:

NATIVE FISH

Australian freshwater native fish have **two** dorsal fins:

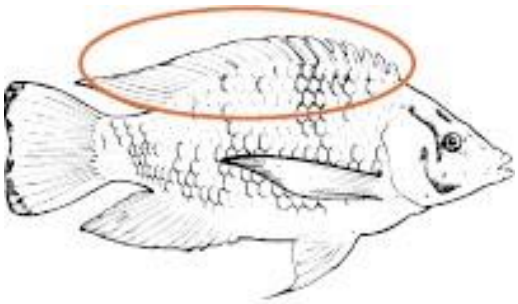


Barramundi

Source: Department of Agriculture and Fisheries

INVASIVE FISH

Introduced or invasive freshwater fish have **one** dorsal fin:

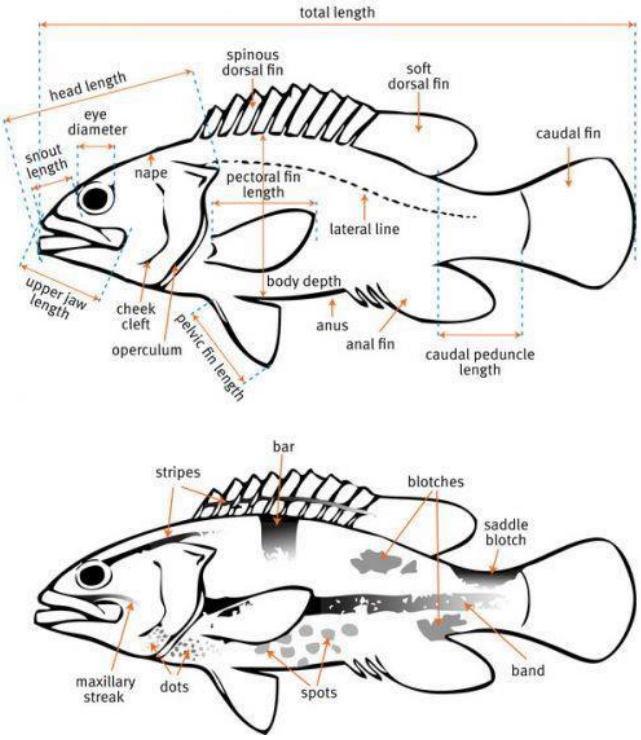


Mozambique tilapia

Source: Department of Agriculture and Fisheries

IDENTIFICATION

Fishes have many features that aid fish identification including body shape, the number, shape and position of fins, presence/absence of scales and any specific markings such as spots and stripes.



Source: Department of Agriculture and Fisheries

IDENTIFICATION RESOURCES

- Identification keys for Australia's fishes - http://fishesofaustralia.net.au/
- Freshwater Fishes of the Burdekin Dry Tropics (Carter & Tait, 2010) -

SECTION 5: IMPACTS

HUMAN IMPACTS ON WATERWAYs

Human activity has modified the natural environment, and this has led to many environmental problems, also known as environmental 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.

RUBBISH

Rubbish consists of litter and household toxic substances that are improperly disposed of on land or in water. Whether the litter is intentional or unintentional, large or small, it can drastically affect the environment for years to come.

Land litter is not hard to spot and comes in all types – cigarette butts, plastic bags, old tires, fast food wrappers and plastic and glass bottles. There are seven major sources that contribute to land litter: rubbish produced in the home, rubbish produced by businesses, collection areas, loading docks, construction and demolition sites, uncovered trucks, and lastly motorists and pedestrians. Litter isn't just unsightly: it can cause vehicle accidents and injuries, smother plants, start fires and harm or kill animals. It also attracts rats and harmful bacteria to the environment. Plastic products are particularly bad as they will not break down with natural forces but instead break down into smaller and smaller particles until they are no longer visible to the human eye.

SAFETY NOTE

When collecting litter the utmost care must be taken to avoid danger to the volunteer. This means direct supervision of young children at all times. Needlestick injuries and hazardous sharp edges may present as a real threat. Gloves must be worn at all times during clean ups.

Whilst clean ups are an integral part of the program and we look forward to seeing our waterways improved through your efforts, data collection is completely optional. For those that have the resources to contribute to data collection, a data collection sheet is provided in Appendix C.

METHOD

Five main litter categories have been identified through the Dry Tropics Partnership for Healthy Waters due to their ability to demonstrate whether management actions aimed at curbing these litter streams are successful. The identified items are;

- plastic bags, which aligns with the plastic bag ban in Queensland,
- plastic bottles and drink containers, which aligns with the bottle container recycling scheme,
- single use plastic disposable cutlery, which align with the straws no more, plastic free campaigns, and Queensland Government directives
- cigarette butts, which to align with bans and restrictions on smoking

A total amount of litter count should be undertaken as well as including the numbers in each of the five categories.

Initially litter items may be quite high though should dissipate over time. If your data indicates otherwise you should brainstorm with your students, why this might be. What is the upstream land use? Is there a shopping centre or commercial area upstream of your site? Or is your creek the end point of a large catchment?

Encourage student enquiry and a sense of pride in your achievements for disrupting this pervasive impact on our aquatic environment.

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 Townsville, and the world.

Climate change will impact 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.

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

Climate change will impact on both aquatic and terrestrial ecosystems. Creekwatch groups can monitor these changes through the ongoing sampling of macroinvertebrates and riparian condition and think of ways that we can help our environment to cope with the changes.

APPENDIX A
AUSTRALIAN CURRICULUM

Science		
Year	**Code**	**Description**
F	ACSSU002	Living things have basic needs, including food and water.
1	ACSSU017 ACSSU211 ACSHE021 ACSHE022	Living things have a variety of external features. Living things live in different places where their needs are met. Science involves observing, asking questions about, and describing changes in, objects and events. People use science in their daily lives, including when caring for their environment and living things.
2	ACSSU030 ACSSU032 ACSHE034 ACSHE035	Living things grow, change and have offspring similar to themselves. Earth's resources are used in a variety of water. Science involves observing, asking questions about, and describing changes in, objects and events. People use science in their daily lives, including when caring for their environment and living things.
3	ACSSU044 ACSHE051 ACSIS057 ACSIS215	Living things can be grouped on the basis of observable features and can be distinguished from non-living. Science knowledge helps people to understand the effect of their actions. Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends. Compare results with predictions, suggesting possible reasons for findings.
4	ACSSU072 ACSSU073 ACSSU075 ACSHE062	Living things have life cycles. Living things depend on each other and the environment to survive. Earth's surface changes over time as a result of natural processes and human activity. Science knowledge helps people to understand the effect of their actions
5	ACSSU043	Living things have structural features and adaptations that help them to survive in their environment
6	ACSSU094	The growth and survival of living things are affected by physical conditions of their environment

Creekwatch Habitat Assessment

Habitat Assessment Data Sheet (A)

Bank

Which of the following three best describes your site?

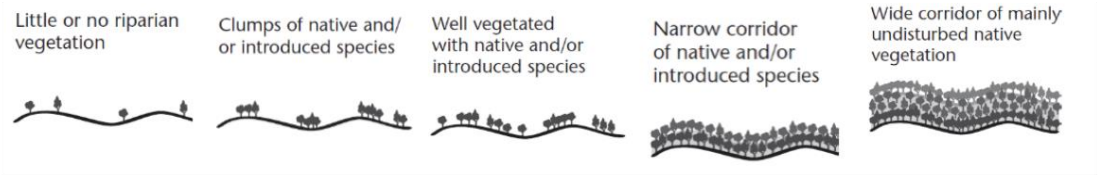
- ◯ Extensive erosion. No plants.
- ◯ Erosion occurring. Limited plants
- ◯ No erosion. Lots of plants

Tick from the list what you can see (bank stability factors and erosion control).

Stock crossing/access		Roads/jetty/bridges	
Vehicle tracks		Concrete-lined channel	
Unfenced riverbanks		Fenced riverbanks	

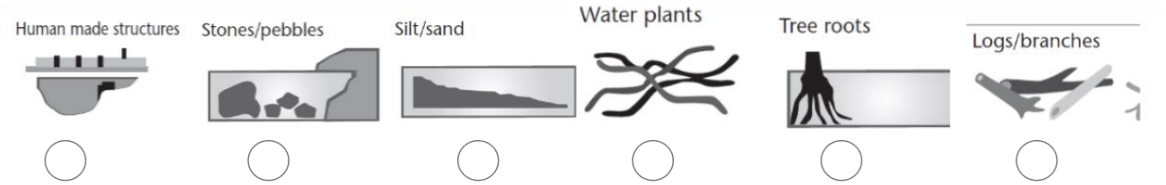
Vegetation

Circle the image that matches left bank (label L) and the right bank (label R)



Instream habitats

Tick the following instream habitats if present.



Stream flow

Tick the flows that you can see present from your sampling area.

Land use

What type of land uses are in the immediate area?

_____

_____

City of Townsville

Habitat Assessment Data Sheet (B)

Habitat	Very Poor	Poor	Fair	Good	Excellent
Bank Erosion	Extensive erosion. Very unstable banks with little vegetation.	Evidence of erosion occurring now/recently. Extensive areas of bare banks.	Erosion occurring in specific areas. Good vegetation cover.	Erosion only in small spots. Gentle bank slopes. Good vegetation cover	No erosion evident. Lower banks covered with grass, reeds or shrubs
Score	1	2	3	4	5
Bank Vegetation	Bare ground. Occasional tree. Concrete lined channel.	Introduced ground cover. Little native vegetation.	Medium cover of native/introduced plants. Variation between sides- one cleared, one undisturbed.	Mainly native vegetation. Little disturbance to bank	Mainly undisturbed native vegetation.
Score	2	4	6	8	10
Instream cover	No snags, boulders or vegetation over water. Could be rock or concrete lining.	Occasional snag. No overhanging vegetation.	Some snags and boulders present and some vegetation in and over water.	Lots of snags, logs, boulders and considerable area of in stream and overhanging vegetation.	Frequent snags, logs, boulders. Extensive amount of aquatic and overhanging vegetation.
Score	2	4	6	8	10
Riffles/pools /bends (flowing water only)	Uniform habitat. Straight stream, all shallow riffle or pool of uniform depth e.g irrigated channel	All riffle or pools with only slight variation in depth of water.	Occasional riffle or bend and variation in depth	Variation in depth in pools and riffles. Variety of habitats (i.e at least 2)	Riffles and pools of varying depths. Bends present.
Score	1	2	3	4	5
Verge Vegetation	Bare or pasture/grass cover next to water.	Narrow area of native or introduced vegetation.	Wide corridor of mixed native and exotics. Or one side cleared and other wide with native vegetation.	Mainly native but some introduced vegetation. Wide corridor area.	Mainly native vegetation on both sides. >30m verge width.
Score	2	4	6	8	10

Total score:	(8-11)	(12-19)	(20-28)	(29-35)	(36-40)
Site rating:	**Degraded**	**Poor**	**Fair**	**Good**	**Excellent**

City of Townsville

Creekwatch Water Quality Data Sheet

Investigate your waterway by recording the following information				
Date and time		School Group Name		
Waterway		Location		
Weather Conditions	Sunny	Cloudy	Windy	Raining
Rainfall estimate (last 48hr)	mm	Stream depth	cm/m (approx)	
		Stream width	cm/m (approx)	
Water quality tests		Rating use your rating sheet in your kit	Comments	
Air temperature	°C			
Water temperature	°C			
pH				
Turbidity	NTU			
Electrical conductivity	µS/cm			
Water flow (please circle one)	Permanent wetland/lake	Stagnant continuous channel but no flow	Pools intermittent pools	Dry no water
	Low minimum flow in channel	Medium normal flow/typical flow	High high flow in channel	Flood/overbank high flow, water level exceeding capacity
Water appearance	Clear	Scummy	Smelly	
	Foamy/Frothy	Stained Green	Stained Brown	
	Muddy	Oily	Other:	
Is there a drain with water flowing?	Y	N	Comments	
Comments about site visit Eg. vegetation type/health, wildlife observed, disturbances, changes from last visit				

Creekwatch Fish Monitoring Data Sheet

Date (dd/mm/yyyy) ☐☐ ☐☐ ☐☐☐☐ Start time (24 hr) ☐☐:☐☐ Finish time (24 hr) ☐☐:☐☐ ☐ Data confidence (1-5)

Monitor(s) _____ Team Leader _____

Site code _____ Site name _____

Fish survey

	Gambusia holbrooki / Gambusia affinis	*Tilapia mariae / Oreochromis mossambicus*	Other exotic fishes	Native fishes
Number of fish caught in **TRAPS**				
Number of fish caught in **DIP NETS**				
Total number of fish captured				

Time traps were in water _____ Number of traps used _____

Time spent dip netting: _____

Are there any signs of disease in captured fishes? Y / N

Details (eg. ulcers, fungus) _____

Notes _____

City of Townsville

Creekwatch

Water Bug Data Sheet

Investigate your waterway by recording the following information

Date and time			School Group Name		
Waterway			Location		
Weather Conditions	Sunny	Cloudy	Windy	Raining	
Rainfall estimate (last 48hr)	mm		Stream depth	cm/m (approx)	
			Stream width	cm/m (approx)	

Common name	Signal	Present
Very sensitive waterbugs		
Toebiters	10	
Stonefly nymphs	10	
Mayfly nymphs	9	
Free-living caddisfly larvae	8	
Cased caddisfly larvae	8	
Sensitive waterbugs		
Water mites	7	
Water pennies	6	
Marsh Beetle larvae	6	
Cranefly larvae	6	
Black fly larvae	5	
Tolerant waterbugs		
Blackfly larvae	5	
Cranefly larvae	5	
Water flea	5	
Biting Midge larvae	4	
Dragonfly larvae	4	
Damselfly larvae	4	
Freshwater Prawns	4	
Water strider	4	
Whirligig beetle	4	
Whirligig beetle larvae	4	
Yabby	4	

Common name	Signal	Present
Very tolerant waterbugs		
Crawling water beetle	3	
Creeping water bug	3	
Damselfly nymph	3	
Dragonfly nymph	3	
Freshwater Shrimp	3	
March Fly larvae	3	
Needle Bug	3	
Non-biting Midge larvae	3	
Roundworm	3	
Sideswimmers or scuds	3	
Small water strider	3	
Diving Beetle	2	
Fishing spider	2	
Water Boatman	2	
Backswimmer	1	
Freshwater Snail	1	
Leech	1	
Mosquito larvae, pupae	1	

Total of SIGNAL values		
Number of different waterbugs		

Overall waterway health

=

Add the SIGNAL value of different waterbugs found

Number of different waterbugs

Your score _____

> 6 clean water **5 to 6** mild pollution **4 to 5** moderate pollution **<4** severe pollution

City of Townsville

APPENDIX F

LITTER COLLECTION DATA SHEET

Creekwatch

Litter Clean Up Data Sheet

First Litter Clean Up			
Date and time		School Group Name	
Waterway		Location	

Common Litter Items		Comments about site
Plastic Bags		
Plastic bottles and drink containers		
Single use plastic disposable cutlery		
Cigarette butts		
Straws		
Total litter items		

Second Litter Clean Up			
Date and time		School Group Name	
Waterway		Location	

Common Litter Items		Comments about site
Plastic Bags		
Plastic bottles and drink containers		
Single use plastic disposable cutlery		
Cigarette butts		
Straws		
Total litter items		

City of Townsville

APPENDIX G
MAINTENANCE AND CALIBRATION SHEET

Date	Reason for calibration	Inspector	Next Due Date	Notes
25.2.22	*Unused for 3 months*	*Ellie S.*	*25.5.22*	*Device in good working order*

APPENDIX H: RESOURCES

Water Quality Website Resources

Australian and New Zealand Guideline for Fresh and Marine Water Quality

https://www.waterquality.gov.au/anz-guidelines/guideline-values/default

Reef 2050 Water Quality Improvement Plan

https://www.reefplan.qld.gov.au/

Black Ross Water Quality Improvement Plan

https://www.townsville.qld.gov.au/__data/assets/pdf_file/0013/4270/Black-Ross-Water-Quality-Improvement-Plan.pdf

Environmental Protection (Water and Wetland Biodiversity) Policy 2019

https://environment.des.qld.gov.au/management/water/policy

Creek to Coral program

http://www.creektocoral.org/

The Dry Tropics Partnership for Healthy Waters annual report cards

https://drytropicshealthywaters.org/

Black Catchment Wetland Catchment Story

https://qgsp.maps.arcgis.com/apps/MapJournal/index.html?appid=9de3ab123cc64b0aa762ab949d1a20a4

Ross Catchment Wetland Catchment Story

https://qgsp.maps.arcgis.com/apps/MapJournal/index.html?appid=e82b0feafd2b45ee9a9bb559b75b5082

Plants

A Field Guide to Assessing Australia's Tropical Riparian Zones – Ian Dixon & Michael Douglas, 2006 https://www.hort360.com.au/wordpress/uploads/Run%20Off/Buffer%20Riparian/Field%20Guide%20Assess%20Tropical%20Riparian%20Zones.pdf

Weed Free booklet (NQ Dry Tropics, 2016) – www.nqdrytropics.com.au/publications Wetland Plants of the Townsville-Burdekin Flood Plain (Calvert & Liessmann, 2014) www.nqdrytropics.com.au/publications

Coastal Plants of the Burdekin Dry Tropics (Maddigan, Allan & Eds, 2008) www.nqdrytropics.com.au/publications

Macroinvertebrates

Aquatic Macroinvertebrate ID key - www.naturalresources.sa.gov.auWater Bug Detective Guides - www.nswwaterwatch.org.au

The Waterbug app - www.waterbugblitz.org.au

The Waterbug Book (Gooderham & Tsyrlin, 2002)Sampling equipment – www.entosupplies.com.au

How to make your own dip net factsheet – www.qld.gov.au/environment/water/use/education

Fish

Identification keys for Australia's fishes - http://fishesofaustralia.net.au/

Freshwater Fishes of the Burdekin Dry Tropics (Carter & Tait, 2010) - http://gergs.net/wp-content/uploads/2016/11/Freshwater-Fishes-of-the-Burdekin-Dry-Tropics.pdf

Field Guide to the freshwater fishes of Australia (Allen, 1942)

Identifying invasive freshwater animal – invasive fish - https://www.qld.gov.au/environment/plants-animals/animals/pests-diseases/invasive-fish/identifying

APPENDIX I

References

Australian Government, 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Water Quality Guidelines, Canberra.

Chessman, B 2003, SIGNAL 2: a scoring system for macroinvertebrates ('water bugs') in Australian rivers, Monitoring River Heath Initiative technical report no 31, Department of the Environment and Heritage, Canberra.

Department of Environment, Climate Change and Water NSW (2010) Senior Waterwatch Teachers' Guide. Sydney.

Department of Environment, Climate Change and Water NSW (2010) Waterwatch Field Manual. Sydney.

Department of Natural Resources and Water (2007) Queensland community waterway monitoring manual. Queensland Government, Brisbane.

River Detectives (2022) A Victorian Catchment Management Authorities initiative, Victoria

Suttar S., Ribbons of Blue Handbook. Scitech, Victoria, 1990

APPENDIX J: ADOPT-A-CREEK AGREEMENT AND INVENTORY LIST

Item Name	Qty
White tray	4
Ice cube tray	3
Apera Water quality test kit PC60	1
Sample jars	5
Petrie dish	1
Forcep tweezers	2
Turbidity tube	1
Mega bug viewer	1
Hand sanitiser	1
Aquatic net	1
Micro pipettes	8
Paintbrush	3
Spoons	0
Cat food	1
Fish nets	1
Bait traps	3
Cat food scoop	1
Bin liners	1
Gloves	2
Field manual	1
Pocket Guides	4
ID chart	1
Clip board folder	1

I _____(insert name) agree that I have received each of the items listed in the below inventory.

_____(School/Group name) will replace any damaged or lost items and return the box in good condition if the program ceases to operate.

Delegated Responsible School Representative

Name _____

Signed _____

City of Townsville

creektocoral@townsville.qld.gov.au

Creekwatch

Fish POWERED BY BCF