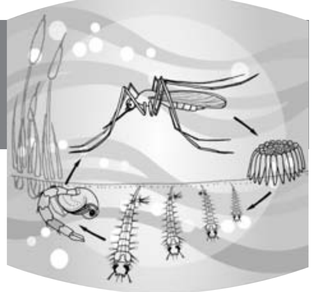
SECTION 10



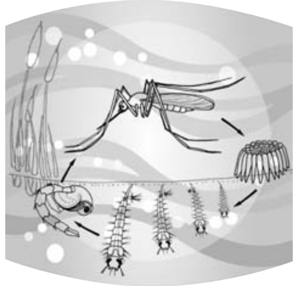
Water bug (macroinvertebrate) survey

Water bugs, or macroinvertebrates, are small creatures with no backbone that can be seen with the naked 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 macroinvertebrates.

Regular water bug surveys take place in Spring and Autumn. You can take part in these and use the results to ascertain the health of your creek or river and contribute valuable data on the changes in the health of our waterways.

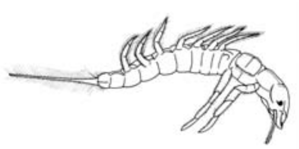
Note: **The *Senior Waterwatch Teachers' Guide* and the *Community/Land Manager Waterwatch Guide* contain further background information relating to macroinvertebrates and their usefulness as an additional indicator of water quality.**

10.1 Doing a water bug (macroinvertebrate) survey

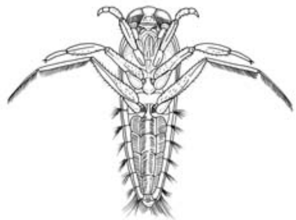


What are water bugs?

Water bugs, or aquatic macroinvertebrates, are small creatures that have no backbone and can be seen with the naked 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.



> **Note: Macro = visible to the naked eye**
> **Invertebrate = animal without a backbone**



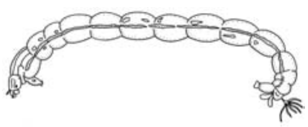
Macroinvertebrate sampling can provide a rapid assessment of the condition of a site at a particular time. When compared to other locations, these studies can provide useful information about the health of the aquatic ecosystem.

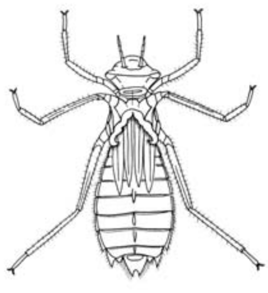
Designing a macroinvertebrate study

Step 1: Identify the sampling objectives

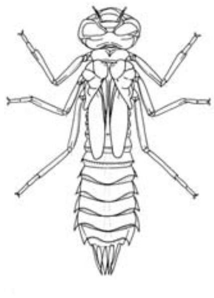
Identify the purpose of your study as this will determine sampling sites and methods. Some studies may be conducted to:

- gain a better understanding of the different types of macroinvertebrates
- compare the site with other sites in their natural condition
- estimate changes over time in the composition and abundance of water bugs
- compare changes in macroinvertebrates over time following management actions.





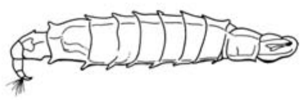
Step 2: Monitoring plan



Where in the catchment should I place my monitoring sites?

Select sites that meet the objectives of your study. This may involve the selection of more than one site if comparative studies are required.

Where should I sample in the stream?



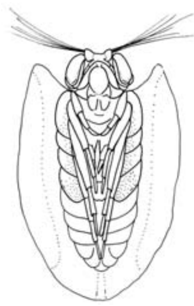
Within the stream, sample a range of habitats, including under stones, logs, fringing vegetation and pools and riffles.

Sample in roughly the same place each time you visit so that comparisons can be made between data collected at different times.

What equipment should I use?

Waterwatch prefers nets with a triangular frame and fine net dip bag. See tips for students at the end of this section.

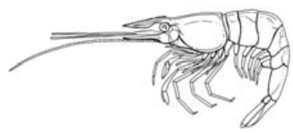
When should I sample?

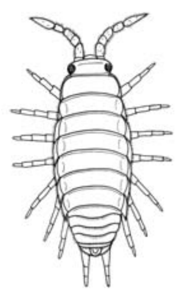


Sampling should occur twice a year, preferably in spring (October) and autumn (March).

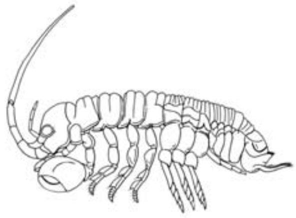
Step 3: Type of sampling

There are two basic methods used to collect samples of water bugs: sweep sampling and kick sampling. Sweep sampling is generally done from the water's edge, while kick samples are taken from riffles. Refer to more detailed procedures below.





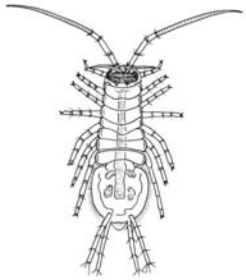
Collecting and identifying macroinvertebrates



Collecting a sample

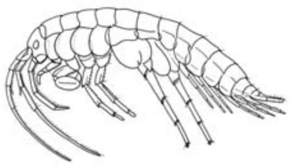
General procedure for both sweep and kick sampling

Time: 5–10 minutes



1. Pour clear stream water into a large white sorting tray to about 2 cm deep and put the tray close to the edge of the water.

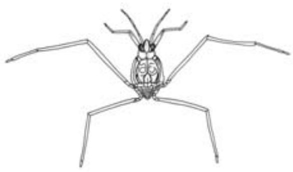
Note: Where is it difficult to lie the tray flat at the water's edge, use a bucket and transfer the water into trays after sampling.



2. Use a short upward-sweeping motion to sweep the net through the stream.

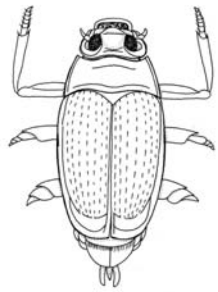
3. Stop regularly to transfer the macroinvertebrates gently into the tray. Turn the net inside out and wash its tip in the tray to transfer the bugs.

4. Rinse any mud or fine silt from your net. The sample should be free of sediment prior to sorting.



5. Spread the sample out in the tray and allow the water to settle so small macroinvertebrates can be seen.

> *i* **Testing tip:** **Make sure nets are disinfected with bleach and water between sampling events to prevent the transfer of sediment, seeds, bacteria, viruses or other unwanted materials between sites.**



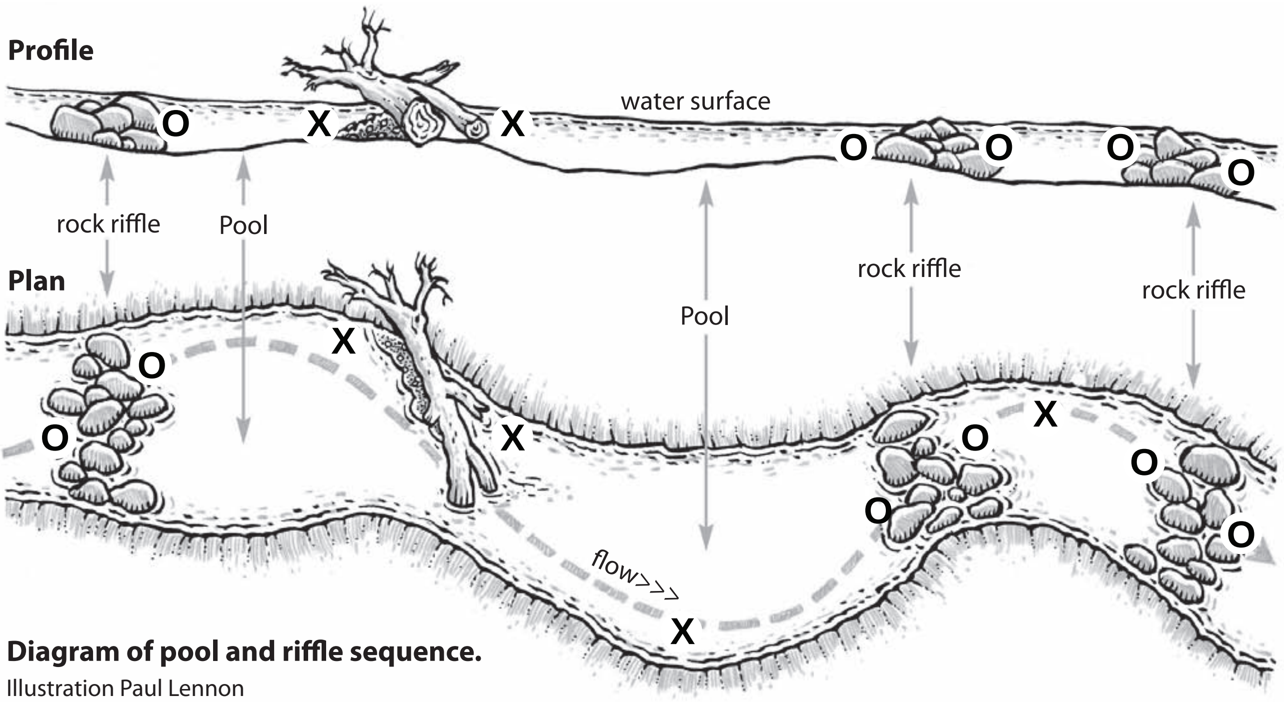


Diagram of pool and riffle sequence.
Illustration Paul Lennon

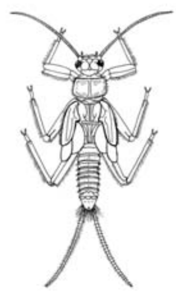
X sweep sampling **O** riffle sampling

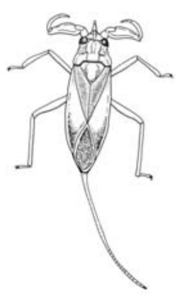
Procedure for sweep sampling

Sweep sampling can occur along the edge of the stream and should include a range of habitats such as under logs and tree roots, and in fringing vegetation. Sample the top, edge and bottom of the water along at least 10 metres of stream.

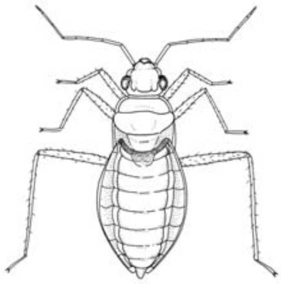
Procedure for kick sampling

In riffles, use a technique called kick sampling. 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 dislodged macroinvertebrates into the net. Move slowly upstream while you do this to sample a 10 metre length of the streambed.





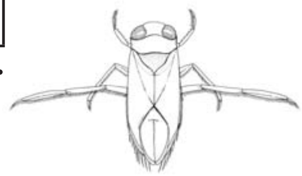
Sorting the sample



Time: 30–40 minutes

1. Observe the water bugs in the large white sorting tray.

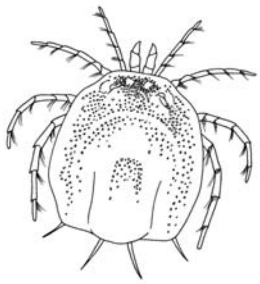
> *i* **Testing tip:** **Aim to collect at least 50 macroinvertebrates per sampling area and as many types as possible.**
> **It is not possible to calculate the stream pollution index unless you have at least 50 macroinvertebrates.**



2. Each group should fill an ice block tray with a small amount of water.

3. Transfer bugs to the ice block trays using plastic spoons, pipettes and paint brushes.

4. Sort the macroinvertebrates into the cubes in the tray using a different cube for each type of bug.



Identifying the species and recording the results

1. A person trained in macroinvertebrate identification should be invited to assist. This may be a Waterwatch coordinator, professional person such as a CMA or local government staff member, or a teacher trained in water bug identification.

2. Use the *Water Bug Detective Guide* to help you identify the species.

3. Count the number of macroinvertebrates and the number of types.

4. Record the information on the recording sheet provided (refer to Section 10.3). This will give an indication of the health of your waterway based on the scores provided for each bug type and the number of macroinvertebrate types collected. The sensitivity score provides an indication of the tolerance of each macroinvertebrate to pollution and is sometimes called a SIGNAL score.

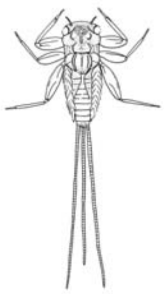
5. Gently return the macroinvertebrates to the water once you have finished, as close to the collection site as possible.

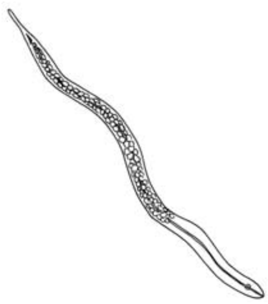
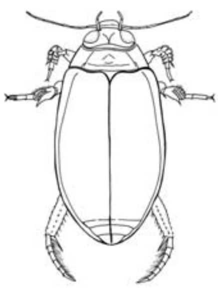
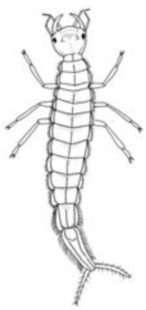
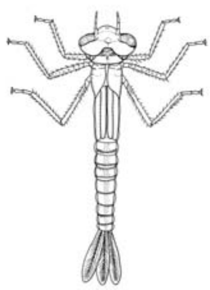
Classification of common macroinvertebrates

Phylum	Class	Order (suborder)	Family	Common name
Arthropoda	Insecta	Coleoptera	Elmidae	Riffle beetles
			Dytiscidae	Diving beetles
			Hydrophilidae	Scavenger water beetles
			Gyrinidae	Whirligig beetles
			Psephenidae	Water pennies
		Odonata (Zygoptera)		Damselflies
		(Anisoptera)		Dragonflies
		Hemiptera	Notonectidae	Backswimmers
			Corixidae	Water boatmen
			Nepidae	Water scorpions
			Hydrometridae	Water measurers
			Gerridae	Water striders
			Veliidae	Small water striders
		Diptera	Simuliidae	Black fly larvae
			Culicidae	Mosquitoes
			Chironomidae	Chironomids
			Ceratopogonidae	Biting midges
			Tipulidae	Craneflies
		Plecoptera		Stonefly larvae
		Ephemeroptera		Mayfly nymphs
		Trichoptera		Caddisfly larvae
		Megaloptera		Dobsonflies/ Alderflies
	Collembola			Springtails

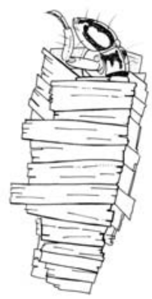
Phylum	Class	Order (suborder)	Family	Common name
Arthropoda (continued)	Crustacea	Decapoda	Parastacidae	Freshwater crayfish
			Atyidae	Freshwater shrimp
			Palaemonidae	Freshwater prawn
			Sundathelphusidae	Freshwater crab
		Amphipoda		Sideswimmers
		Isopoda		Freshwater slater
	Arachnida	Acarina		Water mites
Annelida	Hirudinea			Leeches
	Oligochaeta			Segmented worms
Mollusca	Gastropoda			Snails
			Ancylidae	Limpets
	Bivalvia			Bivalve mussel
Platyhelminthes	Turbellaria			Flatworms
Nematoda				Roundworms
Cnidaria		Hydrozoa	Hydridae	Hydra

Source: Chessman 2003

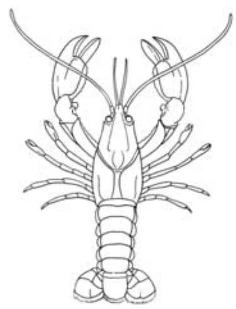
What do your results mean? – SIGNAL 2 and the stream pollution index (SPI)



The water quality of a river, creek or pond, sometimes called its ‘ecological health’ or ‘river health’, can be assessed on the basis of the presence or absence of animals living in the water. This indicates the ability of the water to sustain animal life.

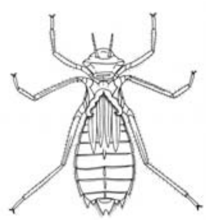
A system called SIGNAL2 has been developed to score the ‘health’ of the water, using aquatic macroinvertebrates (or water bugs). SIGNAL2 stands for Stream Invertebrate Grade Number Average Level. SIGNAL2 gives each type of macroinvertebrate a sensitivity rating from 1-10 to indicate their level of pollution tolerance.

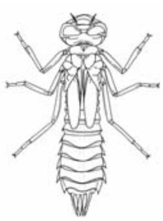
‘Pollution’ can mean high levels of salinity, turbidity, nutrients (nitrogen or phosphorus) or a decrease in oxygen. This sensitivity rating, together with the number of types of bugs found, is used to create a Stream Pollution Index (SPI) for the river, creek or pond. Sites with high SPI scores are likely to have high levels of dissolved oxygen with low levels of pollution.



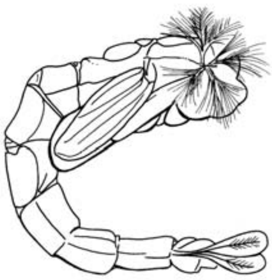
Still waters (wetlands, ponds and dams), inland and slow-flowing coastal rivers will always produce a lower SPI score because thier physical habitat and chemical levels are naturally different. Few macroinvertebrate types that are rated as very sensitive occur naturally in still waters or slow flowing lowland waters. 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. In order for an SPI score to be calculated for your site, your sample MUST have at least 50 individual ‘bugs’.

> *i* **Note: For further information about calculating the SPI, see the worked example in Section 10.4.**





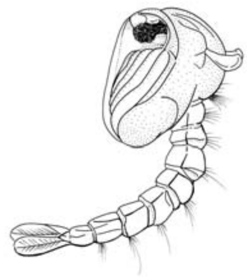

Tips for student macroinvertebrate sampling



Nets: These can be made from a kitchen strainer attached to a broom handle, stick or piece of dowel. This net is ideal for bugs as it will last many trips to the river and is inexpensive to make.

Scooping: Divide the class into groups of 4–5 students. Each group is to work in a specified location and remain there.

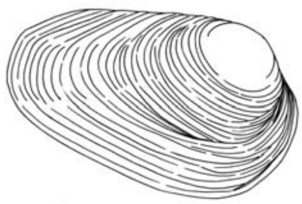
Sorting: After 10 minutes of scooping, students put the nets down and carry their trays away from the water's edge for sorting. This will ensure that students concentrate on the sorting of the bugs.



Identifying the species: Invite a trained person to assist with identification. Direct students to colour, shape, position of the legs and the number of tails. A two-way microscope or magnifying glass may assist with identification.

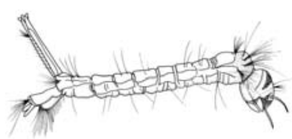
Calculating the stream pollution index (SPI): Add all group results together for a combined result. By entering the results of your bug survey on the Waterwatch website, the stream pollution index for your site and the number of macroinvertebrate types will be calculated. A description of your site will be provided **based on the macroinvertebrates you have collected**.

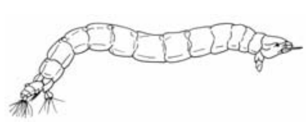
> *i* **Note: For more information check the website: www.waterwatch.nsw.gov.au**



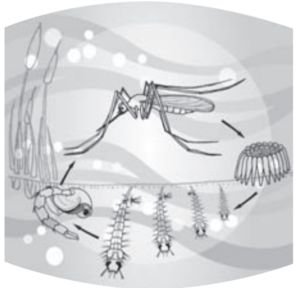
Note: Reducing the risk of spreading chytrid fungus when sampling macroinvertebrates

The chytrid fungus attacks keratin which is embedded within the sensitive skin of frogs and is often fatal. Chytrid can be transferred from one site to another by water and moist soil. It is possible to spread the fungus by contaminated nets and moist soil on car tyres and on the soles of shoes. To reduce the risk of spreading the fungus, spray nets, shoes and car tyres with a mixture of 50% bleach and 50% water to disinfect them prior to departure from a site. Never transfer water or bugs between sites.



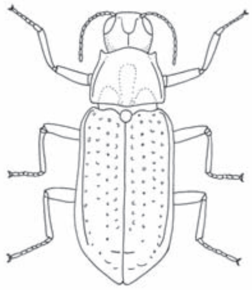


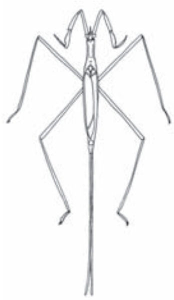
10.2 Water bug survey: teacher field checklist



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	☐
Drinking water	☐
FIELD EQUIPMENT	
Bucket	☐
Large trays	☐
Ice cube trays	☐
Spoons, pipettes, brushes	☐
Magnifying glass (optional)	☐
Macro nets	☐
RECORDING AND ID SHEETS	
Pencil case	☐
Marker pens	☐
Folder of result sheets + info	☐
Clipboards	☐
Camera	☐
Bug identification laminates	☐
Gambusia information sheet	☐





10.3 Water bug survey: SIGNAL 2 field recording sheet

Sampler group name:..

Number in group:..

Survey period: ☐ Spring ☐ Autumn ☐ Other ....

Date: .... Time: .... Time taken (hours): ....

Location of water body:

☐ western NSW river or stream <300 metres asl ☐ other rivers and streams ☐ wetland

Note: The rating of your stream pollution index (SPI) will be affected by the location of the sampling.

Habitats sampled:

Habitat *(tick the boxes where you sampled)*	**Still water**	**Moving water**
Silt and sand	☐	☐
Stones	☐	☐
Water plants	☐	☐
Leaves and twigs	☐	☐
Logs, branches, tree roots	☐	☐

Note: The more habitats sampled the greater the expected number of bug types.

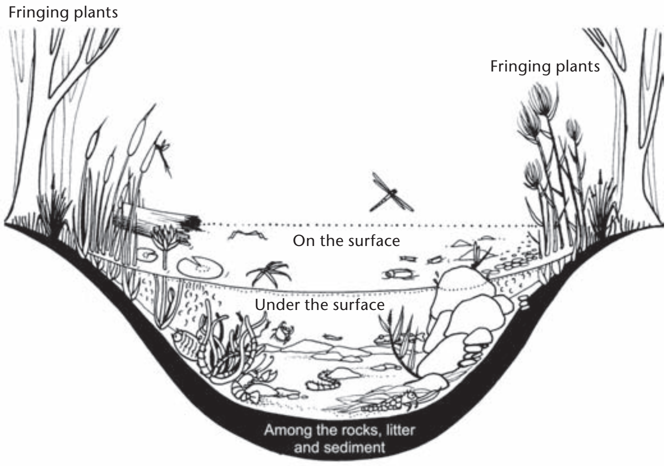
Sampling methods: *(tick the boxes)*

☐ sweep ☐ kick

Identification of bug species confirmed by a trained person: ....

....

(e.g. Waterwatch coordinator, professional staff of council or agency, experienced teacher or community member)



Water bug survey: SIGNAL2 result sheet

Survey site name: ....

Step 1: Tick the bug type if present (see the Detective Guide in Section 10.5).
Step 2. Enter the number of each bug found in Column B.
Step 3: Refer to the weight table for the correct Weight factor for the number found.
Step 4: Enter the correct Weight factor for each bug in Column C.
Step 5: Multiply the Sensitivity rating (Column A) by the Weight factor (Column C) and enter the answer in Column D.
Step 6: Add up Column C (Weight factors).
Step 7: Add up Column D (Sensitivity rating x Weight factor).
Step 8: Add up the number of bug types.

WEIGHT TABLE	
No. of each bug found (Column B)	Weight Factor (Column C)
1-2	1
3-5	2
6-10	3
11-20	4
>20	5

Water bug recording table

MACROINVERTEBRATE TYPES			A	B	C	D
Sensitivity rating	**Taxa richness (bug types)**	**Tick if present**	**Sensitivity rating**	**Number of bugs**	**Weight factor**	**Column A X Column C**
Very sensitive	Stonefly nymph	☐	10			
	Mayfly	☐	9			
Sensitive bugs	Alderfly larva	☐	8			
	Caddisfly larva	☐	8			
	Riffle beetle & larva	☐	7			
	Water mite	☐	6			
Tolerant bugs	Beetle larva	☐	5			
	Dragonfly nymph	☐	4			
	Water strider	☐	4			
	Whirligig beetle & larva	☐	4			
	Freshwater yabby/crayfish	☐	4			
	Damselfly nymph	☐	3			
	Fly larva & pupa	☐	3			
	Midge larva & pupa	☐	3			
	Freshwater mussel	☐	3			
	Nematode	☐	3			
	Freshwater sandhopper	☐	3			
	Freshwater shrimp	☐	3			
	Water scorpion/needle bug	☐	3			
Very tolerant bugs	Diving beetle	☐	2			
	Flatworm	☐	2			
	Hydra	☐	2			
	Water treader	☐	2			
	Freshwater slater	☐	2			
	Water boatman	☐	2			
	Freshwater worm	☐	2			
	Backswimmer	☐	1			
	Bloodworm	☐	1			
	Leech	☐	1			
	Mosquito larva & pupa	☐	1			
	Freshwater snail	☐	1			
	TOTALS	☐				

Did you catch *Gambusia* at your site? ☐ Yes ☐ No ☐ Did not look

10.4 Calculating the health of your site

Step 1: Count the number of bug types (taxa richness). **No. of bug types:** ☐

Step 2: Calculate the SPI = $\dfrac{\textbf{Total Column D}\ \square}{\textbf{Total Column C}\ \square} = \square$

Step 3: Classify the number of bug types and stream pollution index (SPI) as high or low based on your site description and the levels in the rating table below:

Taxa richness (number of bug types) = ☐ **High** ☐ **Low**

SPI = ☐ **High** ☐ **Low**

Bug type and SPI rating table

Site description	SPI		Taxa richness (bug types)	
	Low	High	Low	High
Wetlands	0–3.1	>3.1	0–14	>14
Western NSW rivers or streams <300 metres asl	0–3.1	>3.1	0–11	>11
Other rivers and creeks	0–3.5	>3.5	0–15	>15

Step 4: Identify the site conditions based on your bug count.

SIGNAL 2 Scoring table

SIGNAL 2 scoring	Taxa richness	Site conditions based on the macroinvertebrate sample
High	High	Good water quality and a diversity of habitats. It may be a well-managed site, natural bushland or a national park.
Low	High	Water quality may be slightly affected by human activity or natural factors. There may be higher levels of salinity and/or nutrient levels at the site.
High	Low	Water quality is affected by a pollution source upstream or there are few habitats due to harsh physical conditions.
Low	Low	Water quality is affected by human use such as urban, industrial or agricultural pollution or by the downstream effects of dams.
Unable to calculate	Unable to calculate	Unable to calculate an SPI score as there are fewer than 50 macroinvertebrates in the sample. This may indicate poor sampling technique, or that your site is under stress. There may be poor habitat diversity and/or water quality. Make sure you sample in all habitats and keep an eye on the site.

Step 5: If the table does not represent your site, what other factors may influence water quality at your site? ....

....

Note: These may change over time and may include rainfall, river flow, land use, drains, condition of banks and riparian vegetation.

Upload your results to the Waterwatch website at www.waterwatch.nsw.gov.au. The online database will calculate the stream pollution index (SPI) and provide a description of your site based on the bugs collected.

Worked example

Enter your results in the recording table and complete Column C by referring to the weight factor table (see blank recording sheet). Complete Column D by multiplying the sensitivity rating by the weight factor. For example, 3–5 bugs has a weight factor of 2. Multiply the sensitivity rating (Column A) by the weight factor (D). For stonefly in the example below, this is 10 x 2 = 20.

Extract from a water bug recording table

Bug type			A	B	C	D
Sensitivity rating	**Taxa richness (bug types)**	**Tick if present**	**Sensitivity rating**	**Number of bugs**	**Weight factor**	**Column A X Column C**
Very sensitive	Stonefly nymph	✓	10	3	2	20
Sensitive	Water mite	✓	6	20	4	24
Tolerant	Whirligig beetle & larva	✓	4	11	4	16
	Freshwater yabby/crayfish	✓	4	2	1	4
	Damselfly nymph	✓	3	5	2	6
	Freshwater shrimp	✓	3	30	5	15
Very tolerant	Water boatman	✓	2	16	4	8
	Freshwater worm	✓	2	15	4	8
	Mosquito larva & pupa	✓	1	12	4	4
	Freshwater snail	✓	1	33	5	5
	TOTALS	10		147	35	110

Calculate the stream pollution index (SPI).*

Step 1: Calculate the SPI = $\dfrac{\text{total of column D}}{\text{total of column C}} = \dfrac{110}{35} = 3.2$

Step 2: Count the number of bug types: Bug types = 10

Step 4: Classify as high or low the number of bug types using the table provided

Step 5: Based on your SPI and the number of invertebrate types, the condition of your site may be classified as:

SPI rating	Number of bug types	Site conditions based on the macroinvertebrate sample
Low	Low	Your results may indicate that water quality is affected by human use such as urban, industrial or agricultural pollution or by the downstream effects of dams.

If the table does not represent your site, what other factors may influence water quality at your site?

Note: These may change over time and may include rainfall, river flow, land use, drains, condition of banks and riparian vegetation.