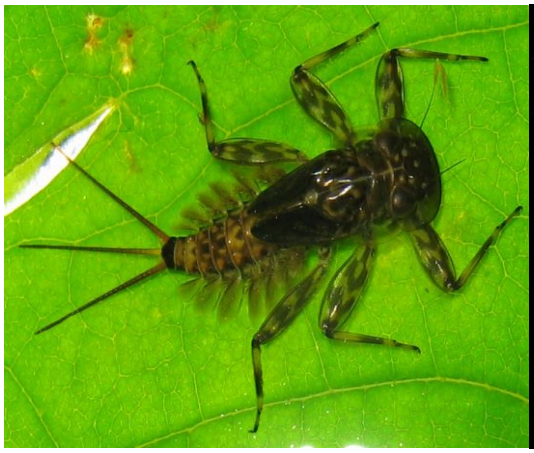
MANCHESTER 1824

The University of Manchester

AquaScience

Using aquatic organisms for pollution monitoring



TEACHER'S MANUAL

Introduction

Of the worlds water 97.75% is seawater and 2.24% in glaciers, therefore the freshwater that we rely on for drinking and survival consists of just 0.009% in lakes, and just 0.0001% in rivers. Keeping our freshwaters healthy and clean is therefore vitally important. This activity focuses on rivers, the quality of which could be affected by various sources of pollution including effluent from industries (oil and toxic chemicals), non-direct source of pollution such as leakages, sewage, combined sewer overflows, runoff from roads, and agricultural activities (fertilisers). Other causes of pollution can also be attributed to increased urbanization and the construction of dams and canals which increase flows especially in rivers. Since water plays a critical role in ecological, domestic and economic activities, it is important that they are maintained and regulated. The importance of maintaining clean river systems is now recognized at national and international level. For example, in the European Union, the Water Framework Directive seeks to ensure that all sources of water are in "good" ecological condition. In England and Wales, the Environment Agency monitors the quality of our rivers using the invertebrates that live in them. This activity is designed to give pupils a taste of how invertebrate populations can be used to monitor river quality.

River Pollution

Most river pollution is caused by the addition of organic material which is mainly sewage but can be food waste or farm effluent. The organic matter is fed on by bacteria and other microorganisms and these use up the available oxygen. In unpolluted rivers there is a high level of dissolved oxygen, and a wide diversity of aquatic invertebrates. However, as oxygen levels are reduced fewer invertebrate species are able to survive. The invertebrates can be listed according to their ability to tolerate these low levels of oxygen, for example, stoneflies and mayflies can only live in high oxygen (unpolluted conditions) while blood worms and tubifex worms can thrive in very low oxygen conditions where other invertebrates are absent.

BMWP Scoring - Measuring Freshwater Quality

We can use the number and type of species in a stream as an indicator of pollution.

One way of doing this is to use a **BMWP score**. This works by giving each family of aquatic organisms a score from 1 to 10†. Those scoring highly are sensitive to pollution, and their presence in a river indicates good conditions. Those with low scores are tolerant to pollution, and their presence is indicates highly polluted conditions.

To work out a BMWP score for a river we take a samples of invertebrates and assign each type their BMWP score (see coloured record sheet). For each type of organism (e.g mayfly)

we add the scores (so if we found three different types of mayfly they would score 3 x 10 =30). We then add up all the scores to give a total BMWP score for our sample.

We can then use the following **table 1** to work out how polluted our river or stream is:

BMWP score	Category	Interpretation
0-10	Very poor	Heavily polluted
11-40	Poor	Polluted or impacted
41-70	Moderate	Moderately impacted
71-100	Good	Clean but slightly impacted
>100	Very good	Unpolluted, unimpacted

TABLE 1

†Note that we are using a slightly simplified BMWP score. For a full BMWP score we would have to work out all the different types of invertebrate to a high level of detail (identify to families). This can be very time consuming and needs a lot of expertise, so we are going to identify the invertebrates to major groups only.

In this practical you will assess the quality of a small number of sites along local rivers/ streams. You will need to analyse them and work out a BMWP score for your sample using the attached sheet.

HEALTH AND SAFETY

Collecting invertebrate samples from flowing waters can be dangerous, as there are a number of risks associated with the activity. These include slipping on rocks, being washed away by the currents and drowning. For this reason, it is strongly recommended that teachers collect the invertebrates from the river and provide pupils with the collected samples at the laboratory. All teachers should carry out a risk assessment (a general risk assessment is provided and should be studied by the teachers)

EQUIPMENT LIST

FOR FIELD SAMPLING

- Kick Net(s)
- Waders
- Large Tubs with lids
- Sieve
- 70% IMS if inverts are to be preserved

IN THE LABORATORY

For 30 Pupils 10 places are required – each with 3 pupils

AT EACH PLACE SET OUT

1) 1 * White Tray
2) 1 * angle poise lamp --- set up to shine one over each tray
3) 3 * plastic forceps
4) 8 * disposable plastic petri dishes --- do not have to be sterile
5) 4 * plastic disposable 3ml pasteur pipettes
6) 2 * distilled water wash bottles
7) 1 * Nikon binocular dissecting microscopes (if available). If not then hanf lenses or magnifying glass.
8) 1 * blue roll
9) 2 * fine permanent marker pens
10) Disposable gloves

Copies of fold out 'The Fresh water Name Trail' by Field Studies Council

Methods

COLLECTING INVERTEBRATES IN THE FIELD

1. Get all the items you need ready for the field work
2. Label the tubs
3. At the river/stream, ensure the water level is Ok for all the pupils to get in. (Ensuring the safety, teacher or a few pupils can get into the river)
4. With your waders, stand in the river and with the river facing downstream, hold the net in the water
5. Now, you are ready to do a 'kick sample'. Set a timer for 3 minutes and vigorously disturb the river substrate. This will disturb the invertebrates in the river sediments and they will flow into the net. You can do this in 3x1 minute sessions as it is very tiring.
6. After kick sampling, empty the net contents into a large tub and add a small quantity of water (to cover the contents of the tub).
7. If necessary, this process can be repeated until enough invertebrates have been collected.
8. In addition, do a 'stone search' by turning over large stones/other substrates and look beneath them. Scrape off any invertebrates into the tub.
9. The kick sample and stone search can be repeated a number of times and at different locations until enough invertebrates have been collected for the purpose of the practical
10. Rinse the net into the tub to release any attached invertebrates
11. Head back to the laboratory.

BACK AT THE LABORATOY

1. If you wish to fix the invertebrates you can add 70% IMS to the samples (add twice as much IMS as the water in the tub). This makes the inverts easier to ID as they are not moving, but also kills them. You may prefer to leave the animals alive and ID them in a live state.
2. Sieve and wash away the excess water (and ethanol if used) in the samples. Take a sample (or portion of sample) and place it in one of the large white trays. The pupils then follow the instructions as outlined in the pupil handbook

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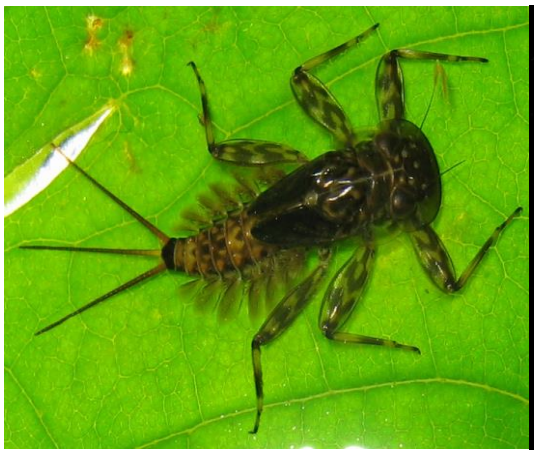

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PUPIL'S WORKBOOK

YOUR NAME .....

River Pollution

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INSTRUCTIONS

1. Search through the tray using tweezers and pointers and remove all of the invertebrates that are in the sample
2. Sort them into different groups (eg mayfly, stonefly) using the identification keys and pictures.
3. For each group count the number of types and calculate a BMWP score for that group.
4. Record your result on the record sheet.

Note that the *number of individuals* within each group does not matter – if you find 1 individual of stonefly type 'A', that scores 10 - the same as 8 individuals of type A.

For example, if your sample had

2 types of cased caddisflies =score 7 x 2 = **14**

1 type of freshwater shrimp = score 6 x 2 = **12**

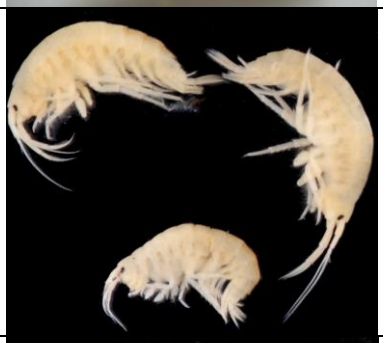
3 types of leech = score 3 x3 = **9**

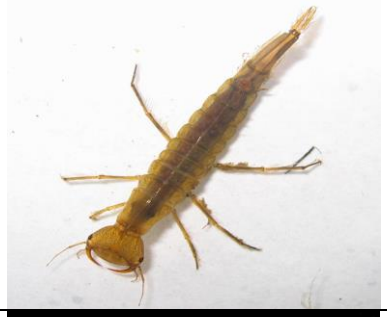
so Total BMWP score would be 14 + 6 + 9 = **29**

Using table 1, this score indicates poor water quality

RECORD SHEET

SITE _____ GROUP_____

NAME	EXAMPLE PICTURE	SCORE PER TYPE	NUMBER OF <u>TYPES</u> PRESENT	SCORE
STONEFLY		**10**		
MAYFLY/ damselflies		**10**		
CASED CADDISFLY		**7**		
FRESHWATER SHRIMP		**6**		
CASELESS CADDISFLY		**5**		

FLAT WORMS		**5**		
WATER MITES		**5**		
BEETLE LARVAE		**5**		
BLACKFLY LARVAE	 	**5**		
LEECH		**3**		
SNAIL		**3**		

WATER LOUSE		**3**		
MIDGE LARVAE		**2**		
WORM		**1**		

TOTAL SCORE ----------

From your score, how polluted is the river? ----------
(refer to Table 1)

APPENDIX

Risk Assessment

1	Danger from flowing water.	Participants made aware of risk of being near fast flowing water and that they should be aware that the rate of water movement can vary.
2	Danger of deep water	Participants advised to note depth before entering water, and that risk of sinking into the muddy substrate.
3	Risk of infection from contact with water	Participants advised to avoid ingesting water thrown up by wave action, obstacles or other students.
4	Danger from uneven and slippery terrain and river surroundings	Do not cross or climb on fence including surrounding farms. To be sensible and exercise care. Also, sensible stout footwear is recommended.
5	Danger of thorns, scratches and blisters	Warned of danger. Advised to wear appropriate clothing to protect arms, legs, hands and feet
6	Danger of treading on sharp objects	Warned of danger. Advised to wear appropriate footwear.
7	Risk of drowning	No work to be carried out in the rivers if the water is very deep. If pupils are participating, decision of attendant members of staff to be final. No student is to enter water beyond knee-depth. All work to be carried out in company. One member of group to be vigilant for safety of others at all times