



A joint environment initiative

Surveying Invertebrates to Determine Water Quality in Rivers and Canals

Duke of Edinburgh's Award Expedition Aim



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Introduction

This investigation can only be performed in freshwater river or canal environments where the water flows in one direction.

Aim of expedition

To determine the level of pollution along the stretch of water being travelled in the expedition.

Objective

To calculate the Biotic Index Score of different locations along the expedition route. The score will be calculated by collecting and identifying aquatic invertebrates that are indicator species of clean or polluted water.

Water Quality and Recreational Boating

The quality of water can be diminished through chemical changes, amount of suspended solids and lack of aeration. This can happen naturally, but human actions can cause more adverse changes by polluting and disturbing water bodies.

Recreational boating can contribute to changes in the quality of a water course in various ways. Table 1 highlights some of the causes and impacts of recreational boating on the environment.

By testing different locations in or along a watercourse it is possible to locate which areas are suffering from more pollution than others and where pollution may be entering the water. It is important to understand that if the Biotic Index Score at any site indicates poor water quality it is unlikely to have been caused by boating. However, it is important to recognise how boating can impact water quality so you and other boaters are more aware of how to minimise individual impacts.



Table 1: This table highlights some of the causes and potential impacts boating can have on the environment and provides environmental best practice for boaters. More information can be found in [‘The Green Guide to Inland Boating’](#)

Causes	Environmental Impact	Recommended Best Practice
<p>The spread of Invasive Non-Native Species (INNS). INNS are animals and plants that have been introduced by human activity (on purpose or by accident) to parts of the world where they are not normally found. All water based users have the potential to spread INNS from one area to another. These species can hitch a ride on boats and equipment. When water users move from one area to another they can unknowingly spread these species.</p>	<p>INNS can cause both environmental and economic damage in the UK:</p> <ul style="list-style-type: none"> • Outcompete native species for space and nutrients • Change the chemical and physical balance of native ecosystems. 	<p>Before and after moving boats between separate water bodies it is recommended that boaters follow the Government’s ‘Check Clean Dry’ campaign to reduce the spread of INNS.</p> <ol style="list-style-type: none"> 1. Boaters need to check their boat and equipment and remove any visible animal or plant matter. 2. They need to use tapwater to thoroughly clean parts of the boat and equipment that have come into contact with the water. 3. Where possible dry equipment and clothing before coming into contact with water at the next destination.
<p>Oil and fuel spills from engine leaks, when refuelling or when transferring from one container to another for example.</p>	<p>When oil or fuel enter the water it floats on the surface creating a thin film. This film can harm wildlife when ingested, smother bird feathers which restricts flight, block fish gills limiting respiration or reduce the amount of sunlight entering the water which plants need to grow.</p>	<p>Boaters should do the following to reduce oil and fuel spills:</p> <ul style="list-style-type: none"> • Regularly maintain their fuel lines, connections and seals to prevent leaks. • Remove oil from bilge water before pumping it out by using an absorbent sock. • When refuelling have a spill kit handy and use fuel spouts and funnels to catch drips and blowback.
<p>Antifoul and other paints entering the water.</p>	<p>By their very nature, antifouls are toxic to aquatic life. When applying and removing antifoul, it ends up entering the water and build up over time resulting in a more severe impact.</p>	<p>When removing or applying antifoul and paint take the following precautions:</p> <ul style="list-style-type: none"> • Prevent paint spills and drops entering the water or drains. • Place a tarpaulin under your boat to capture any paint drops or flakes of paint. • Dispose of used brushes and paints into hazardous waste bins
<p>River bank disturbance</p>	<p>When launching and landing boats on river beaches or banks sediment and habitats can be eroded or disturbed especially if done frequently in one place. The sediment can make the water murky and prevent sunlight from penetrating.</p>	<ul style="list-style-type: none"> • Keep a safe and reasonable distance from the bank. • Slow down when close to banks if there are waves at the bow or stern of the boat. • When launching and going ashore use recommended landing places.

What is the Biotic Index?

Water pollution can be measured by looking at the types of animals that are inhabiting the aquatic environment. The animals that are best indicators of pollution levels are invertebrates. Some invertebrates such as a Mayfly Nymph can only survive in water that is clean and has high levels of oxygen. These species are useful in helping us to determine whether a stretch of freshwater is being polluted as their numbers will be low or non-existent.

The pollution level can be measured by calculating the Biotic Index Score, whereby each invertebrate found is given a score. Invertebrates which are sensitive to pollution are given high scores whereas invertebrates that can tolerate pollution are given low scores. For example a Stonefly Nymph will score 10 whereas a more pollution-tolerant species such as a Sludgeworm will score 1. Table 2 provides scores for a variety of animals. If a species does not exist in the Biotic Index Score table it is ignored as it is not a key indicator species of water quality.

Table 2: The biotic score for individual species

Animal Name	Score	Animal Name	Score
Freshwater crayfish	10	Greater water boatman	5
Burrowing mayfly nymphs	10	Lesser water boatman	5
Flattened mayfly nymphs	10	Caseless caddis larvae	5
Stonefly nymphs	10	Water beetles	5
Freshwater limpet	8	Cranefly larvae	5
Demoiselle nymphs	8	Blackfly larvae	5
Dragonfly nymphs	8	Flatworms	4
Cased caddis larvae	7	Water mites	4
Swan mussels	6	Alderfly larvae	4
Freshwater shrimps	6	Leeches	3
Swimming mayfly nymphs	6	Snails	3
Other damselfly nymphs	6	Pea cockles	3
Water measurer	5	Water hoglouse	3
Pond skaters	5	Rat-tailed maggots	3
Water scorpion	5	Non-biting midge larvae	2

Methodology

Data Collection Sites

Prior to the expedition and as part of the planning stage teams must identify where they will be collecting their data from. Data must be collected in a feasible and safe location. Whilst performing a recce of the route to be travelled these locations can be identified by leaders and/or participants.

Equipment Needed

- 1 x Kick Sample Net
- 1 x Stop watch (most digital watches or mobile phones will have this)
- 1 x White sample tray
- 2 x Viewing Jars
- 1 x Magnifying glass
- 1 x Plastic Spoon
- 1 x Large Pipette
- 2 x Field Studies Council (FSC) Freshwater invertebrate identification Key
- 1 x Hand sanitizer
- 1 x Methodology and recording booklet
- 1 x Camera

Data Collection in the Field

For each of the 8 testing sites perform the following:

1. Fill White tray with water from the river and place on river bank.
2. A member of the team will take the Kick Net and stand in the water facing downstream. They will place the kick sample net downstream of their feet and ensure the net is resting on the riverbed. They must gently kick the riverbed for **1 minute** in front of the net in order to dislodge (but not harm) invertebrates from rocks (see image 1). The invertebrates and loose debris will then flow downstream into the net.



Image 1: Visual of how to take kick sample.

3. Another team member will time the minute using a stopwatch and communicate to the net holder when to start and stop kicking.
4. Another team member can take a photograph of the sample area to refer back to later when analysing the results.
5. Remove the net from the water and carry the contents over to the bank or shoreline and empty contents into the white sample tray.
6. Wait for sediment to settle and using the identification key start to gently move debris and try to identify invertebrates that are ONLY found in the Biotic Index table. To see individual species more clearly in order to identify them, use the spoon to collect them from the tray and place in one of the viewing jars.
7. Write down the name of each type of invertebrate found on the recording table (found on page 7) and give each its corresponding Biotic Index Score. Even if you find 40 Stonefly nymphs you only write a score of 10, if you find 10 flatworms you will only record a score of 4.
8. Wash your hands or use hand sanitizer after handling invertebrates and water.
9. Add up all the scores to get a total score for the sample site.
10. Using this total score you can now calculate an average score by dividing the total score by the number of different invertebrates found. The final number is the Biotic Index Score. See example recording table and calculations on page 8 to get a clearer understanding.



Recording Table – Record your findings in the table below

Location Grid Ref.	Site Number	Names of Species																Total Biotic Score	No. of different types of species	Biotic Index Score
		e.g. Caddisfly Nymph																		
	1	10																		
	2																			
	3																			
	4																			
	5																			
	6																			
	7																			
	8																			
	9																			
	10																			



Analysing Your Results

Example results: Location 1

Site 2 has a lower biotic Index indicating that the quality of water maybe poorer than site 1.

Grid Ref.	Site Number	e.g. Caddisfly Nymph	Freshwater crayfish	Burrowing mayfly nymphs	Freshwater limpet	Demoiselle nymphs	Dragonfly nymphs	Cased caddis larvae	Swimming mayfly nymphs	Other damselfly nymphs	Total Biotic Score	No. of different species	Biotic Index Score
	1	10	10	10	8	8	8	7	6	6	73	9	8.11
	2	-	10	-	8	8	-	7	6	6	47	6	7.8

How to calculate the Biotic Index Score for each site

$$\text{Total Score} \div \text{No. of different animals} = \text{Biotic Index}$$

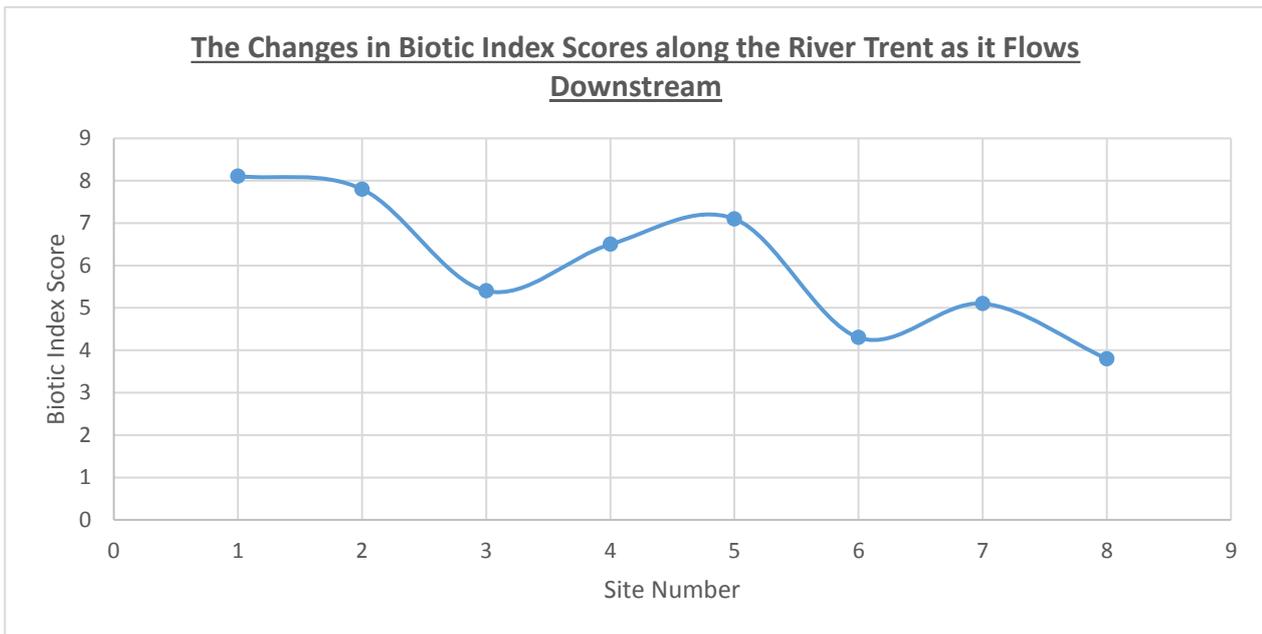
$$73 \div 9 = 8.11$$

The higher the Biotic Index Score the better the water quality

Table 2: This table shows the quality of water based on the Biotic Index Score.

Biotic Index Score	Water Quality	Degree of Organic Pollution
8.51 – 10.00	Excellent	No organic pollution
7.51 – 8.50	Very Good	Slight organic pollution
6.51-7.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
4.51 – 5.50	Fairly Poor	Significant organic pollution
3.51 – 4.50	Poor	Very significant organic pollution
0.00 – 3.50	Very Poor	Severe organic pollution

Graph Showing the Biotic Index Score of Eight sample Sites Along the River Trent



The graph helps to show changes in the biotic index of the river as it flows downstream. In this example investigation eight sample sites were tested. It indicates that overall the Biotic Index Score declines as the river flows downstream from site 1 to 8. This implies that the water quality is also declining.

Using a map and photographs taken of each sample site, reasons for low or high biotic scores can be deduced. For example in an area with a low Biotic Index, surrounding land uses may be influencing the water quality such as urbanised areas where vehicle fuel can be washed off into nearby waterways.

Questions to help participants start to think about what their results show

1. Which site had the lowest Biotic Index Score and why might this have been?
2. Which test site(s) had the highest Biotic Index Score and why might this have been?
3. Your results might indicate that every site tested had excellent or very good water quality. Despite the numerical results was there any visual evidence that boating could be having an impact on the stretch of water that was travelled?

How to Present Your Findings

What you could include:

- **What were the aims of the expedition?**
 - Why is it important to determine the level of water quality along a stretch of water? You can determine areas of a waterway that have poor water quality (be it from boating or other sources) and how this could impact boaters' health and their boating environment.
 - Explain why you wanted to determine the impacts boating can have on the environment and what actions you and other boaters can take to reduce these impacts.
- **How did identifying different invertebrates help you to determine water quality?**
 - Explain the Biotic Index Score and how you calculated it.
- **What did you find out?**
 - Present your Biotic Index Scores for all sites you tested (use graphs and images to help present your findings).
 - If water quality was poor for certain sites – explain what may have caused this and whether boating could have contributed.
 - Remember that you only took one sample of invertebrates in a specific location, at a specific time of day and year. This means your results will not show a clear representation of that part of the river all year round. Some species exist in lower numbers at certain times of the year due to natural cycles. It is important to be aware of these limitations and acknowledge that your results are just a brief indication of what might be happening to water quality in that specific part of the river.
- **Environmental best practice for boaters**

Despite whether your results indicated poor or good water quality you can provide information on what individual boaters and clubs can do to help reduce their environmental impacts on water courses similar to the one you travelled.

Come up with 5 top tips to help inland boaters be more environmentally sustainable and explain how these tips will protect the inland boating environment. Examples of environmental best practice can be gained from

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The Green Blue is a joint environment programme created by the Royal Yachting Association and British Marine.

The Green Blue helps the UK recreational boating sector to minimise its impact on the environment.



A joint environment initiative

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