A joint environment initiative

Water Quality Testing

Duke of Edinburgh's Award Expedition Aim for Inland Waters

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Introduction

Aims of Expedition

- To determine water quality along a stretch of water e.g. canal or river.
- To identify and explain how recreational boating can impact water quality and provide solutions.

Objectives

- Undertake water testing for one or more of the following water quality measures at eight sites along the expedition route: acidity (pH level), dissolved oxygen, nitrate, phosphate and turbidity levels.
- Learn about the impacts boating can have on the environment and how boaters can reduce their individual impact.

Water Quality and Recreational Boating

Water quality can be diminished through chemical changes, amount of suspended sediment (increasing turbidity) and lack of aeration (decreasing dissolved oxygen). This can happen naturally, but human actions can cause more negative changes by polluting and disturbing water bodies.

Recreational boating can contribute to changes in the quality of a watercourse in various ways. Table 1 highlights some of the causes and impacts that recreational boating can potentially have on the aquatic environment.

By testing different locations along a watercourse it is possible to locate areas that are suffering from more pollution than others and sometimes determine the source of the pollution. It is important to understand that if the tests indicate poor water quality it may not have been caused by recreational boating.

Table 1: The Causes and Impacts Boating can have on Water Quality

Causes	Impact on the Environment	Chemical Factor Effected
Boats can pump out raw sewage into the water. All boats on inland waters should have a holding tank for sewage or must close off their sea toilets.	Sewage will increase water temperature and amount of bacteria. As the temperature rises and bacteria break down the sewage, the oxygen level in water declines which can impact species that rely on this for survival. If sewage is ingested by other water users e.g. swimmers or dinghy sailors they can become ill.	Increases: **Nitrate** **Temperature** Decreases: **Dissolved oxygen**
Cleaning products used on boats can wash into the water.	Many cleaning products are highly alkaline due to the phosphates they contain. Some aquatic species cannot tolerate these chemical changes. Phosphate is a plant nutrient and if additional amounts are added to the natural environment it can encourage algae blooms on the surface on water. When the algae uses up all the phosphate and dies, bacteria break down this dead algae which depletes the level of oxygen in the water.	Increases: **Phosphate** **Level of pH** Decreases: **Dissolved oxygen**
Oil and fuel spills from engine leaks, refuelling and pumping out dirty bilge water.	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 aquatic plants need for photosynthesis.	Increases: **Turbidity**
Antifoul and other paints entering the water.	By their very nature, many antifouls are toxic to aquatic life. When applying and removing antifoul, it can end up entering the water and build up over time resulting in a more severe impact. A film of paint can also reduce sunlight entering the water.	Increases: **Turbidity**
River bank disturbance.	When boats are launched and landed 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 prevents sunlight from penetrating the water as well as damaging any wildlife habitats that exist there.	Increases: **Turbidity**

Methodology for Data Collection

Identify 8 sites evenly spread along the watercourse you will be travelling that have safe areas to collect water samples. Locations can be identified on the initial recce of the expedition route.

Decide which water quality measures will be tested for at all 8 sites. One or all 4 of the following measures can be tested during the expedition; nitrate, phosphate, pH and dissolved oxygen.

Equipment Needed

1 x Monitoring Water Testing Kit (Nitrates, phosphate, pH, DO), provided by The Green Blue.
1 x litre plastic bottle to dispose of chemical test water after each test
1 x kitchen paper for drying equipment
1 x methodology and recording sheets
1 x camera
8 x pieces of scrap paper
1 x black felt pen
3 x pencils (to record results)

Taking Photographs

Take photos of any human land uses e.g. farmland, housing, industry along the expedition route. Also take a photograph at each test site. These can then be referred to later to help explain water chemical results.

Include photos of:

- Where the water sample was collected.
- Surrounding land and land uses.
- Your team using equipment to test water samples.

To help remember which photographs link to which test site, take a photo of a piece of paper with 'Site 1' written on before taking photos at this location. Then 'Site 2' for the next site and so on.

Methodology for Collecting a Water Sample at Each Site

ipment

1. Empty contents of the white testing container onto the black water proof bag. If raining ensure water does not get inside the white container or testing tubes.

2. Use plastic gloves when collecting the main water sample in case the water is very dirty or contaminated.

3. Collect the main water sample in the white container by submerging it under the water until full. Screw the white lid back onto the water sample container whilst it is still submerged to prevent loss of any dissolved gases.

4. Test water samples as soon as possible after collection as changes will occur over time.

5. Perform the turbidity test first and then the dissolved oxygen test before testing for nitrate, phosphate and pH levels for best results. See separate laminated instructions for these tests.

IMPORTANT: Ensure contents of the test tubes are poured into an empty bottle and disposed of down a sink, foul sewer or toilet and not poured into the environment where it can cause pollution. Ensure the white container and test tubes are washed and dried after each test site.

Testing for pH Levels

Instructions can also be found in the water testing kit booklet with diagrams for visual aid.

Background Information on pH:

This can be tested to determine how acidic or alkaline the water is on a scale of 1-14. The closer to level 1 the more acidic the water is and closer to pH 14 the more alkaline it is. In the centre of the scale between 5.5 - 8.5 the water is neutral, the natural state of water.

If the water is too acidic or alkaline it can affect animals and plants and erode soil and rocks over time. Changes in pH level can be anthropogenic, in other words caused by human activity. For example, many domestic and industrial cleaning products are highly alkaline and can enter watercourses if not treated first.

Instructions for Testing pH Levels:

1. Fill test tube (coded 0106) to the 10ml line with the water sample from the sealed container.
2. Add one pH Wide Range Test Tablet (Coded 6459A).
3. Cap the test tube and mix by inverting it until the tablet has dissolved. Bits of material may remain in the sample.
4. Compare the colour of the sample to the pH colour chart. Record the result as a pH number.

Recording Table for pH Results:

Site	Grid Ref	pH result	Test Site Description E.g. Is the test site near boats, a marina? What is the land use at sides of watercourse (fields, housing, industry etc)?	Comments E.g. Anything that may have impacted the results? (Human error, weather etc.)
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Testing for Nitrate Levels

Instructions can also be found in the water testing kit booklet with diagrams for visual aid.

Background Information on Nitrate:

Nitrates are inorganic and dissolve in water. All plants absorb them through their roots. If there is too much nitrate in a waterbody it will cause a growth in green algae in the water as it uses up the excess nutrients. This algae in the water reduces the amount of sunlight reaching aquatic plants which prohibits their growth.

Once the excess nutrients have been used up, the algae begins to die back and as bacteria breaks down the dead algae they use up oxygen in the water. A drop in oxygen then impacts other aquatic species that rely on this gas for survival.

An increase in nitrate levels can be caused by fertiliser runoff from farm land which contains high levels of nitrate to promote crop growth. An increase in nitrate can also be caused by raw sewage entering the water.

Instructions for Testing Nitrate levels:

1. Fill test tube (Coded 0106) to the 5ml line with the water sample.
2. Add one Nitrate Wide Range CTA Test Tablet (3703A). Nitrate tablets are sensitive to UV light so immediately slide the test tube into Protective Sleeve (0106-FP).
3. Cap the tube and mix for two minutes to dissolve the tablet.
4. Wait 5 minutes for the red colour to develop. Remove the tube from the protective sleeve.
5. Compare the colour of the sample to the nitrate colour chart. Record the result as ppm nitrate.

Recording Table for Nitrate Results:

Site	Grid Ref	Nitrate Result	Test Site Description E.g. Is the test site near boats, a marina? What is the land use at sides of watercourse (fields, housing, industry etc)?	Comments E.g. Anything that may have impacted the results? (Human error, weather etc.)
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Testing for Phosphate Levels

Instructions can also be found in the water testing kit booklet with diagrams for visual aid.

Background Information on Phosphate:

Phosphates are inorganic and dissolve in water. All plants absorb them through their roots. If there is too much phosphate in a waterbody it will cause a growth in green algae in the water as it uses up the excess nutrients. This algae in the water reduces the amount of sunlight reaching aquatic plants which prohibits their growth.

Once the excess phosphate has been used up, the algae begins to die back and bacteria break down the dead algae using up oxygen in the water. A drop in oxygen then impacts other aquatic species that rely on this gas for survival.

Boating can increase phosphate levels by discharging cleaning products into the water from sinks, showers and washing machines or from cleaning the outside of the boat.

Instructions for Testing Phosphate levels:

1. Fill test tube (0106) to the 10ml line with the water sample.
2. Add one phosphorous Test Tablet (5422A)
3. Cap and mix by inverting until the tablet has dissolved. Bits of material may remain in the sample.
4. Wait 5 minutes for the blue colour to develop. If the sample does not develop a blue colour, record the result as 0ppm.
5. Compare the colour of the sample to the phosphate colour chart. Record the result as ppm phosphate.

Recording Table for Phosphate Results:

Site	Grid Ref	Phosphate Result	Test Site Description E.g. Is the test site near boats, a marina? What is the land use at sides of watercourse (fields, housing, industry etc)?	Comments E.g. Anything that may have impacted the results? (Human error, weather etc.)
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Testing for Dissolved Oxygen Levels

Instructions can also be found in the water testing kit booklet with diagrams for visual aid.

Background Information on Dissolved Oxygen

The dissolved oxygen (DO) level indicates how much oxygen the water contains. The more oxygen the water contains the more oxygen there is available for aerobic organisms to survive. This in turn leads to a greater abundance and variety of organisms.

Dissolved Oxygen levels can be reduced when bacteria use the oxygen to break down raw sewage in the water. Dissolved Oxygen levels can also be reduced if water temperature is increased as oxygen dissolves less readily in warmer water.

Instructions for Testing Dissolved Oxygen Levels:

1. Record the temperature of the water sample by placing the thermometer four inches below the surface of the water sample container for 1 minute. Record the temperature in degrees Celsius.
2. Submerge the small tube (0125) into the water sample. Carefully remove the tube from the water sample, keeping the tube full to the top.
3. Drop two Dissolved Oxygen Test Tablets (3976A) into the tube. Water will overflow when the tablets are added.
4. Screw the cap on the tube. More water will overflow as the cap tightens. Make sure no air bubbles are present in the sealed sample.
5. Mix by inverting the tube over and over until the tablets dissolve. This will take 4 minutes.
6. Wait 5 more minutes for the colour to develop.
7. Compare the colour of the sample to the dissolved oxygen colour chart. Record the result as ppm dissolved oxygen.

Recording Table for Dissolved Oxygen Results:

Site	Grid Ref	DO Result	Test Site Description E.g. Is the test site near boats, a marina? What is the land use at sides of watercourse (fields, housing, industry etc)?	Comments E.g. Anything that may have impacted the results? (Human error, weather etc.)
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Testing for Turbidity Levels

Background Information on Water Turbidity

Turbidity is a measure of water clarity; how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances.

If the turbidity of the water is high it indicates a larger quantity of suspended solids. In these conditions less light can penetrate through the water. This reduces the amount of light aquatic plants can absorb to photosynthesise and results in their decline. Lower levels of plant growth results in less oxygen being produced and added to the water which will impact organisms that rely on this to survive.

Instructions for Turbidity Test:

The large white kit container is used to perform the turbidity test with the black and white circle stuck on the bottom.

1. Fill the white container to the turbidity fill line located on the outside of the tub.
2. Hold the turbidity chart on the top edge of the tub. Looking down into the tub, compare the appearance of the Secchi Disc icon at the bottom of the white tub to the chart. Record the result in Jackson Turbidity Units (JTU). The higher the turbidity the less clear the water is.

Recording Table for Turbidity Results:

Site	Grid Ref	Turbidity Result	Test Site Description E.g. Is the test site near boats, a marina? What is the land use at sides of watercourse (fields, housing, industry etc)?	Comments E.g. Anything that may have impacted the results? (Human error, weather etc.)
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What Do Your Results Show?

The table below informs you whether the result for each test factor indicates poor, fair, good or excellent water quality.

Test Factor	Result
Dissolved Oxygen	0 ppm (poor) 4 ppm (fair) 8ppm (Good)
Nitrate	5 ppm (fair) 20 ppm (poor) 40ppm (poor)
pH	4 (poor) 5 (fair) 6 (good) 7 (excellent) 8 (good) 9 (poor) 10 (poor)
Phosphate	1 ppm (Excellent) 2 ppm (good) 4ppm (fair)
Turbidity	0 (excellent) Between 0-40 JTU (good) Between 40 – 100 JTU (fair) >100 JTU (poor)

Questions to help participants get started on analysing the results

For each test site determine:

1. Which test results show poor water quality?
2. What could be causing these results to be poor?
3. Which test results indicate good or excellent water quality?

Taking into account all test sites determine:

1. Which site had the worst water quality overall and why might this be?
2. Which site had the best water quality overall and why might this be?

How to Present Your Findings

What you could include in your presentation

- **What were the aims of the expedition and why do you think they are important?**
    - Why is it important to determine the level of water quality along a stretch of water?

      E.g. to find out which areas of a waterbody have poor water quality and then think about what could have made the water quality drop. Then look at ways to improve the quality of the water so that wildlife and humans using the water are kept safe.

- **A map of your route and the sites where you took the water samples.**

- **What was tested and what were the results?**

  Describe what you tested for and explain what the results tell you about water quality.

  Explain how recreational boating can contribute to changes in each of these water quality measures.

- **What did you find out?**

  Provide results on level of water quality at each site (y~~Y~~ou could use graphs and images to help describe). If water quality was poor at your test sites – can you think of what may have caused this drop in quality, for example:
    - Fertiliser chemicals (nitrate and phosphates) washing into the water from adjacent farmland.
    - Urine or faeces (nitrates) from livestock entering the water from surrounding farmland.
    - There could be a sewage (nitrates) outlet upstream or near one of your test sites.
    - The watercourse passes through an urban area where pollution from roads can be washed into the water you were testing.

- **Recommending environmental best practice for inland boaters**

  Despite whether your results indicated poor or good water quality you can provide five top tips on what individual boaters and clubs can do to help reduce their environmental impact on inland waters.

  As an alternative to verbally presenting these top tips, some participants may prefer to act out examples of best practice to their audience e.g. someone carrying an unsealed oil container and dropping it on the floor and the oil goes everywhere. Then someone can act out using a spill kit to clean the spill up.

Need Support?

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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.

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Supported by: THE CROWN ESTATE

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