Faecal bacteria monitoring in rivers: a guide for community groups

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Introduction

The UK Environment Agencies do not routinely monitor faecal bacteria populations in rivers. However, community groups concerned about faecal bacteria pollution in their local rivers can conduct their own testing as long as a few simple guidelines are carefully followed.

Pathogenic faecal bacteria, such as *E. coli,* enter streams and rivers mainly from humans, via sewage works (treated and untreated), combined sewer overflows (CSOs) and septic tanks, and from farm livestock, especially cows, via slurry spills, stream bank erosion and surface water runoff.

High concentrations of these pathogenic organisms can threaten the health of people using rivers for amenity. Especially at risk are swimmers or anyone ingesting contaminated water.

At designated bathing water sites in the UK and across Europe the risk is assessed by statutory Environment Agency (EA) sampling the site at a specific location at least 20 times over the bathing water season (May to September) and analysing the samples for *Escherichia coli* (*E. coli*) and intestinal enterococci (IE).

Sites are then classified as "excellent", "good", "sufficient" or "poor" according to the threshold values for each of the two organisms. The minimum acceptable threshold is between "sufficient" and "poor". For *E. coli* this requires at least 90% of the samples taken over the course of the season to have a concentration of less than 900 colony forming units (or cfus) in 100 ml of water.

So far the two designated running water bathing sites in the UK, the Wharfe at Ilkley and Port Meadow on the Thames, have failed to meet this minimum standard.

Applications to Defra in 2022 for a further eight river sites across the country to be designated as bathing water sites have failed.

Why sample

Community groups may not have the financial resources to conduct a weekly monitoring programme of sampling and analysis such as that carried out by the EA, especially if multiple sites need to be investigated.

Nevertheless, there is much value in a citizen science approach where the primary intention is to raise awareness about suspected pollution problems in a local river and their probable cause.

This can be achieved in different, but complementary ways:

(i) **repeated sampling at a recreational site** such as one that might be the target of an application for designated bathing water status or instead one or more sites on a river not necessarily intended for designation but nevertheless important locally;

(ii) sampling **to identify individual pollution sources** such as a sewage treatment works (STW), a tributary stream, a farm or a septic tank; and

(iii) **snapshot sampling** at multiple sites along an extended stretch of stream or river channel to gauge the relative importance of different pollution sources.

Where to sample

Sampling at a **recreational site** is or should be straightforward especially if there is an obvious place where people enter the water. If the site covers a relatively long stretch of river, samples can be taken at different representative locations to assess whether there is any significant difference between them before choosing one or more sites for longer term monitoring.

Sampling to **identify pollution sources** can be more difficult. The principle is simple: take three samples from the suspected pollution source and one upstream and one downstream of the discharge to the main river. In practice this can be awkward as access may be difficult. Streams do not necessarily enter rivers at convenient places and discharges from CSOs are often hidden away. Permission will often be needed to cross private land. Pragmatic solutions are required. Sampling sites can be positioned at a distance from the target, e.g. at a convenient upstream bridge, as long as there are no other potential pollution sources between the sample site and the target site.

Snapshot sampling can be combined with either or both the approaches described above. In this case many sites spaced at regular intervals along the length of the river are sampled under the same flow conditions. Bridges and other sites where there is direct public access to a stream or river can then be used to provide a synoptic picture of faecal contamination.

When to sample

Faecal bacterial concentrations are very variable and can differ by three orders of magnitude over a short period of time or over a short length of river depending on weather conditions and proximity to pollution sources.

The EA sample a minimum of 20 times over the bathing season at designated sites and thereby capture most of the variability. An alternative for community groups is to sample repeatedly at key sites under **different flow and weather conditions**. The EA's network of river monitors is invaluable in providing a record of flow conditions. So river level at the time of sampling for each sample taken should be recorded using data from the nearest monitoring station (https://check-for-flooding.service.gov.uk/).

In addition to sampling in low, medium and high flow, it is important where possible to **sample during rainfall events**, especially prolonged or heavy rainfall events. There is considerable evidence to show that faecal bacteria concentration increases during the early stages of a rainfall event as water levels rise and wash contaminated soil from agricultural land into watercourses and as runoff from urban surfaces can overwhelm the capacity of the sewer network and cause untreated sewage to be discharged directly into the river.

Preparing to sample

Although water sampling for faecal bacteria is quite a simple procedure it is wise to prepare carefully and observe all steps of the process as rigorously as possible.

1. Acquire a cost estimate and set up an account with an accredited laboratory of your choice, such as ALS (https://www.alsglobal.com/) or Simplex Health (https://www.simplexhealth.co.uk/).

2. Assemble all needed equipment as follows:

- Sampling device. There are two possibilities, one using telescopic rods with a bucket (e.g. https://www.camlab.co.uk/burkle-telescoop-sampling-dipper-system), or second strapping a sample bottle on to a rope with a lead sash window weight (see picture). The rope can be dropped from a bridge parapet or swung into the water from the bank side. The lead weight needs to be heavy enough to hold the neck of the sample bottle underwater.

- Sterile sample bottles. These are usually provided by the company conducting the analyses. ALS Ltd, for example, will deliver 350 ml bottles to a home address given one or two days notice. Mark up the bottles with the site name and code and the date of sampling using either pre-printed labels or permanent marker pen.
- Cool bag. Samples need to be kept cool (i.e. between 2 and 8°C). This can be achieved by putting one or two bags of ice in the cool bag with the samples.
- Flagon of tap water. Tap water is sterile so can be used in the field to rinse sampling buckets or drop bottles between samples from different sites.
- Useful small items: disposable gloves, paper towel, black sacks, marker pens.
- Notebook and camera
- Maps
- Risk assessment
- Boot brush and biosecurity information
- First-aid kit

3. Select sites and carry out a site recce noting where to park, how to safely access the site bearing in mind that conditions for parking or sampling could be different on the day of sampling and add any concerns for safety into the risk assessment.

4. Acquire any permissions needed from landowners to access the site.

5. Prepare a record sheet to be used with date, site name, bottle code, lat. long. coordinates etc.

How to sample

1. Read the risk assessment for the site.
2. Have ready the **sterile sample bottle** already marked up for the site – double check it's the correct bottle from the bottle code and the site name.
3. If possible sample by wading in to the river wearing thigh or chest waders. Take care not to disturb the riverbed. Any disturbance caused should be allowed to clear downstream before sampling. Using gloves, take a deep-water mid-flow sample 15 cm below the water surface. Face upstream, invert the sample bottle, lower into place and then rotate the neck into the flow.

4. If water-levels are too high or flow too fast to wade in use a bucket on a telescopic pole or a drop/throw bottle as described above.
5. Sampling by **drop bottle from a bridge**. Make sure the collection bottle is absolutely clean by rinsing twice in sterile drinking water from the flagon. Check the bottle and weight on the rope is in the right position and firmly attached. Lower over the downstream parapet of the bridge until the weight drags the neck of the bottle below the water surface. Fill and haul up. Transfer the contents to the sample bottle. Repeat if insufficient sample has been collected first time.
6. Sampling **from the bank**. Prepare the drop bottle on the rope as above. Ensure you have firm footing. Coil up the rope in one hand (holding firmly), swing and cast the collection bottle as far as possible into the river. The weight should submerge the bottle. Allow to fill and haul back to shore. Transfer to marked sample bottle.
7. Leave an **air gap** in the neck of the bottle to allow mixing in the lab. Screw the top tightly and place sample in cool bag.
8. Fill in **the report form** before leaving the site.
9. **Take photographs** to record the person taking the sample at the exact location.
10. Before leaving the site observe biosecurity guidelines: **check, clean and dry**. Take extra water (and detergent) if necessary and use the boot brush to clean boots, especially the tread. Dry off with paper towel.
11. Leave the site clean, pick up any litter, especially plastic in the water, use a black sack.
12. Keep samples **cool and dark**, and deliver to the collection point.
13. Take pictures of your sampling and the river for use in your report.

Laboratories

We are working with laboratories to support this Citizen Science. We may be able to pay for your samples directly (there is an application process) and will put you in touch with your local lab so you can arrange collection and so you can get your results.

Reporting

We have template reports you can use to report your results to your local stakeholders.

If you are intending to undertake this citizen science then we will be providing seminars to help you understand both how to do the sampling and where.

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