Great UK WaterBlitz September Report

September 2024

Kendal (c) Johnny Gios

Contents

> We want to see data-driven change to ensure that our future rivers are healthy from source to sea.

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Thank you to all the participants of the **Great UK WaterBlitz** who made this report possible.

Executive summary

Water is the lifeblood of our planet, nourishing every living thing. An adequate supply of clean, healthy freshwater underpins the very health of our earth and the future of people and wildlife depend upon it.

Despite this, the UK's freshwater ecosystems are in a terrible state. Quite how dire the situation had become has been unclear due to incomplete or missing data. This is where citizen science comes in. Back in June of this year, 2,630 citizen scientists gathered information on the quality of their local rivers, ponds and lakes. Of the 1,380 sites investigated, 75% showed poor water quality.

The weekend of the 20th-23rd September was wet - particularly for the southern half of the UK - with Yellow National Severe Weather Warnings for thunderstorms issued from Friday to Sunday. Monday saw rain across a large swathe of England and Wales, with an area stretching from Gloucester across the Midlands to the Wash and the Humber covered by an Amber warning[1].

Despite this, 4,531 participants braved the weather to collect 2,338 datasets. **Of the 2,338 sites measured, 61% showed poor water quality**. Although this sounds like an improvement in water quality since the summer, our data suggest that while pollution concentrations decreased, pollution amounts likely did not, with 67% of sites in England still showing poor water quality.

The poor state of many waterbodies in the UK is down to a complex and interconnected range of pollution sources including sewage discharge, agriculture and urban run-off. Our rivers have been historically stressed by farming and are being pushed to the brink by outdated and inadequate sewage treatment works. There is, therefore, a pressing need for both **improvements to wastewater treatment processes and reductions in agricultural pollution** to reduce threats to vulnerable freshwater systems and species.

Through our FreshWater Watch programme, we enable communities to gather real-time water quality data. Nitrates and phosphates are present in both agricultural run-off and urban wastewater, and are indicative of other chemicals being present through these pollution sources. By partnering with Imperial College London, we've been able to investigate a number of these other pollutants, and have seen that every single water sample analysed in the laboratory contains other chemical pollutants, many of which present some level of risk to aquatic life.

Earthwatch Europe champions citizen science. We know that – **come rain or shine** – our dedicated citizen scientists gather accurate, and timely information on water conditions, providing valuable insights that complement official monitoring efforts, and ensuring transparency and accountability from all types of polluters. Once again, we urge authorities to integrate citizen science into their freshwater monitoring frameworks, and for citizen scientists to continue monitoring and advocating for their rivers.

Citizen science has the power to generate vast, accurate water quality data. With this data we can advocate for real change.

This report's key findings are:

- **61%** of data points across the UK showed poor water quality with significant regional variation.
- Our data show the Anglian and Thames river basin districts have the worst water quality in the UK: over **80%** of surveys showed unacceptable nutrient concentrations.
- The counties of **West Glamorgan** in Wales, and **Kirkcudbrightshire** in Scotland have the best water quality of those measured.
- In England, the county of **Northumberland** has the best water quality, whereas **Rutland** has the worst water quality in the UK.
- Of the samples tested for additional chemicals, 100% had further contamination; with **80%** of samples presenting some level of risk from analysed compounds to aquatic life.

An introduction to pollution and official water quality monitoring

Mill Hill back of the house

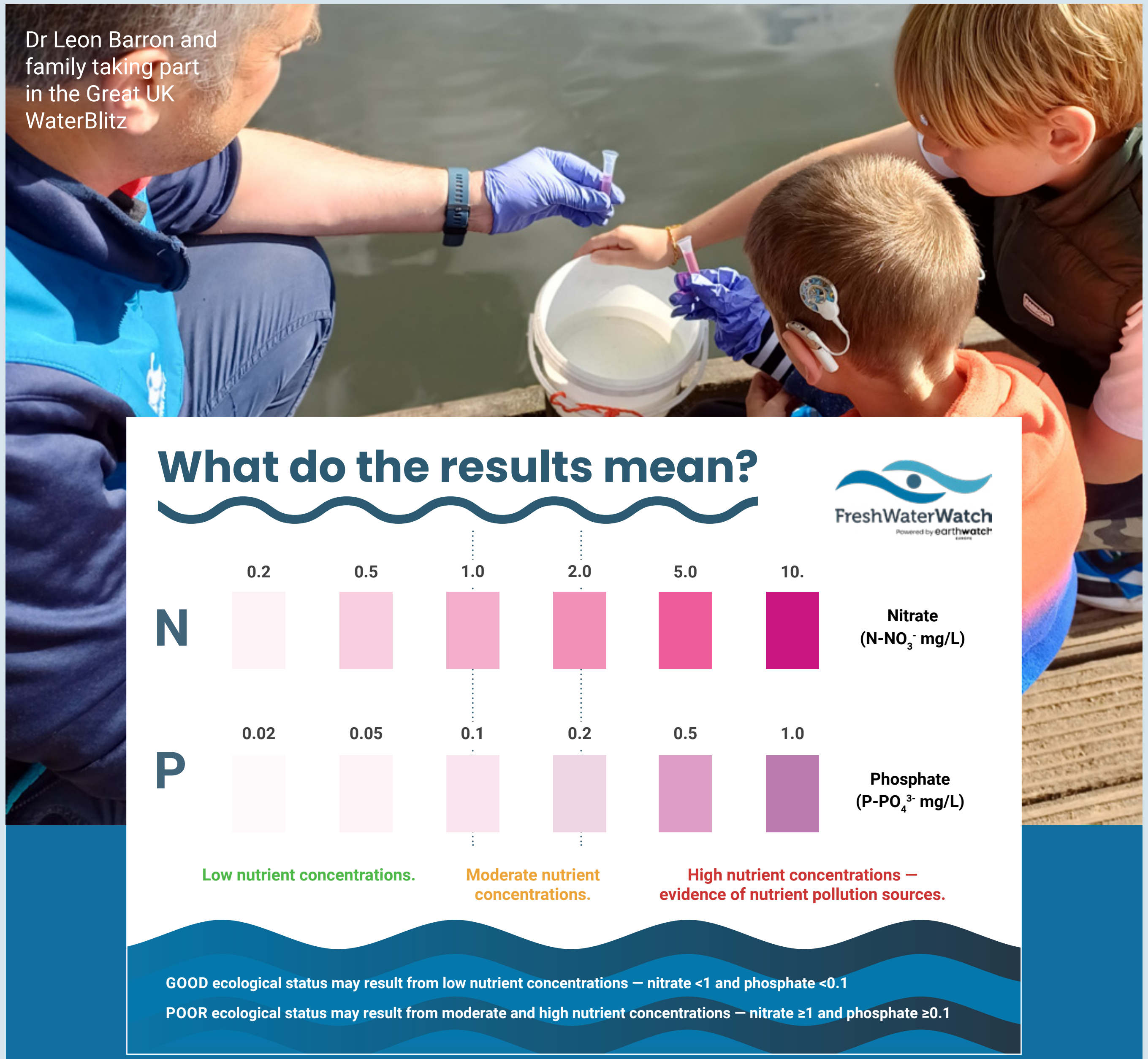
Why are nitrates and phosphates so important?

Nitrates and phosphates occur naturally in the environment and are essential for plant growth; but high concentrations trigger a process called **eutrophication.** This is where excessive plant and algal growth leads to high levels of organic matter and bacterial activity, which in turn decrease oxygen concentrations, negatively impacting aquatic plants and animals.

The excess nitrate present in our water bodies and groundwater – water found underground in the cracks and spaces in soil, sand and rock – has been driven by agricultural intensification and an increase in fertiliser use. Fertilisers can directly infiltrate groundwater and can also be washed into ditches and rivers during rainfall. This makes agricultural areas a legacy source of diffuse nitrate pollution (in contrast to pollutants that enter water courses from a particular point, such as a pipe or outflow).

Although the proportions vary from catchment to catchment depending on the surrounding land use, the Environment Agency estimates that **agriculture** accounts for **50-60%** of nitrate pollution in the water environment[2], whilst **sewage effluent** contributes about **25-30%** of nitrates nationally. Conversely, for phosphates, **urban wastewater contributes 73% of total phosphorous** to watercourses, while **agriculture contributes only 20%**[3].

In terms of nutrient pollution, our rivers have been historically stressed by farming, and are presently worsened by sewage. High nitrate concentrations are driving the poor ecological state of freshwater bodies across the UK, and elevated phosphate loads are adding additional pressures.



Dr Leon Barron and family taking part in the Great UK WaterBlitz

Figure 1. A nitrate and phosphate test card.

How is wastewater treated?

Urban wastewater, commonly referred to as sewage, is a mix of domestic wastewater from toilets, baths, sinks and washing machines, wastewater from industry, and rainwater run-off from roads and other surfaced areas. Every day in the UK, 347,000 kilometres of sewers collect over 11 billion litres of wastewater which is treated at about 9,000 sewage treatment works before being discharged to inland waters, estuaries and the sea[4]. The purpose of wastewater treatment is to remove organic substances to protect the environment: settling out the solid matter (primary treatment), using bacteria that 'digest' and break down the organic substances (secondary treatment), and removing nitrates and phosphates (tertiary treatment) through, for example, sand filtration, activated carbon filtration, and chemical oxidation.

During heavy rainfall the capacity of sewers can be exceeded, which means that sewage works could become overloaded, possibly backing up and flooding roads, open spaces, and peoples' homes. Combined sewer overflows which bypass the treatment works and discharge untreated sewage directly into the receiving waterbody were developed as 'overflow valves' to reduce the risk of sewage backing up during heavy rainfall.

How does weather affect pollution?

We've mentioned the weather a couple of times: how rain can wash fertilisers from farmland into ditches and rivers; how rainwater can run off dirty roads and pavements; and how combined sewer overflows can spill into rivers during heavy rainfall.

Does this mean that rain always increases pollution levels?

It's actually not that simple. While heavy rain and associated flooding can increase the overall amount of pollution entering freshwater bodies, the concentrations of those pollutants can vary. Some pollutants are enriched by flooding, whereas other pollutants - such as acids, salts, and nutrients like nitrate and phosphate - are usually diluted by flooding[5,6].

September's WaterBlitz weather was much wetter than June's, meaning that direct comparisons between the two datasets is complex and will vary from river to river, because rainfall will have enriched some pollutants and diluted others.

What is really important, however, is the power of citizen science to investigate the concentrations of different chemicals in our freshwater during different weather patterns. By testing in both Spring and Autumn each year, we have an important (and unprecedented) picture of pollution dynamics and water quality across the UK, **giving regulators the data they need to change the way they manage the environment across a variety of weather conditions**. This is particularly important as we prepare for the impacts of climate change.

How is water quality officially monitored?

Different government agencies are responsible for monitoring water quality across the UK. In Northern Ireland, **NI Water** has sole responsibility for water quality; in Scotland, the **Scottish Environment Protection Agency** ensures that water quality meets environmental standards; in Wales, **Natural Resources Wales** manages water resources; and in England, the **Environment Agency** is responsible for the quality of water.

The Environment Agency investigates many elements of a waterbody - biological elements (for example, fish, invertebrates and plants), chemical elements (for example, heavy metals, pesticides and nutrients), water flows and levels - as well as the characteristics of the surrounding catchment. A waterbody is assigned one of five classes: high, good, moderate, poor, or bad. Standards are based on eight samples taken over three years.

In the Great UK WaterBlitz, we combine measurements of nitrate (N) and phosphate (P) taken by citizen scientists within a river sub-basin, based on at least five samples per sub-basin. Waterbodies with **acceptable** water quality (<1.0 ppm N and <0.1 ppm P) show evidence of **low** nutrient pollution. Waterbodies with **unacceptable** water quality (>1.0 ppm N or >0.1 ppm P) show **moderate to high** levels of nutrient pollution. We apply the same criteria **nationally**, without taking into account the additional parameters that may influence water quality.

Rainbow in Kendal (c) Jonny Gios

Results

The picture of freshwater quality across the UK

Over a four day period, citizen scientists uploaded 2,338 datasets of nitrate and phosphate concentrations as well as observational..

The FreshWater Watch nitrate and phosphate tests are based on colourimetric chemical reactions that can be influenced by other components in water samples, particularly by the amount of chloride ions. The measurement approach has been calibrated for conditions where salinity is less than 1 ppt, but tidal rivers typically range between 0.5 ppt and 33 ppt. **For this reason, we advise against using FreshWater Watch kits for tidal rivers or saltwater.**

Participants were asked to select the type of freshwater body they were investigating from a pre-determined list: pond, stream, lake, river, wetland, canal, ditch or other.

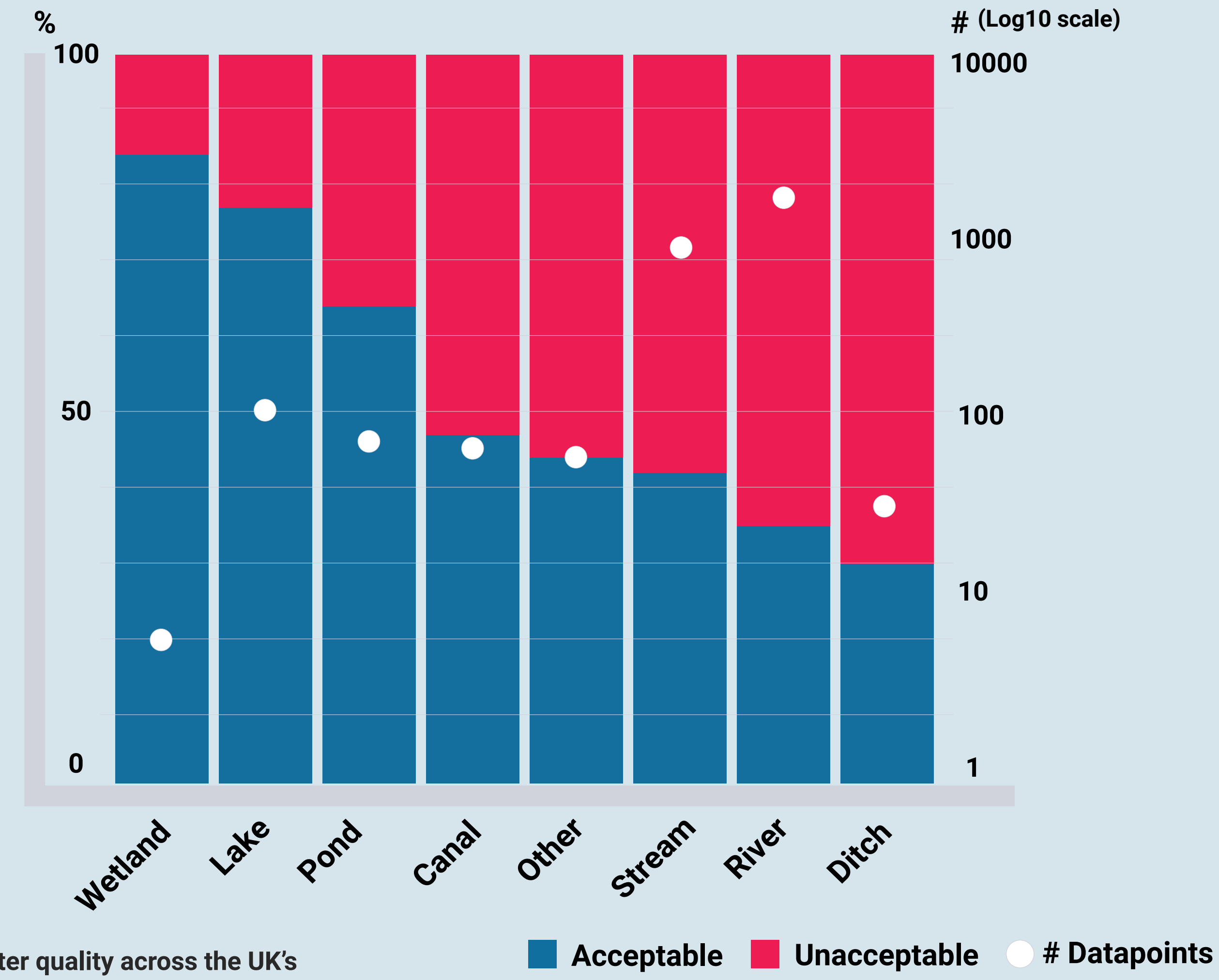


Figure 2. Water quality across the UK's freshwater bodies

Our data show that across the UK, most participants tested rivers and streams; with wetlands and other still waters being statistically under-represented despite their ecological importance. Our data also suggest that rivers are more polluted than most other freshwater bodies, with the exception of ditches (Figure 2).

How does water quality differ across countries?

River Tees

Of the 2,338 surveys, 1,979 were collected in England; 174 were collected in Scotland; 135 measurements were taken in Wales; and 50 datapoints were gathered in Northern Ireland.

The data indicate that **England has the worst water quality in the UK** (Figure 3).

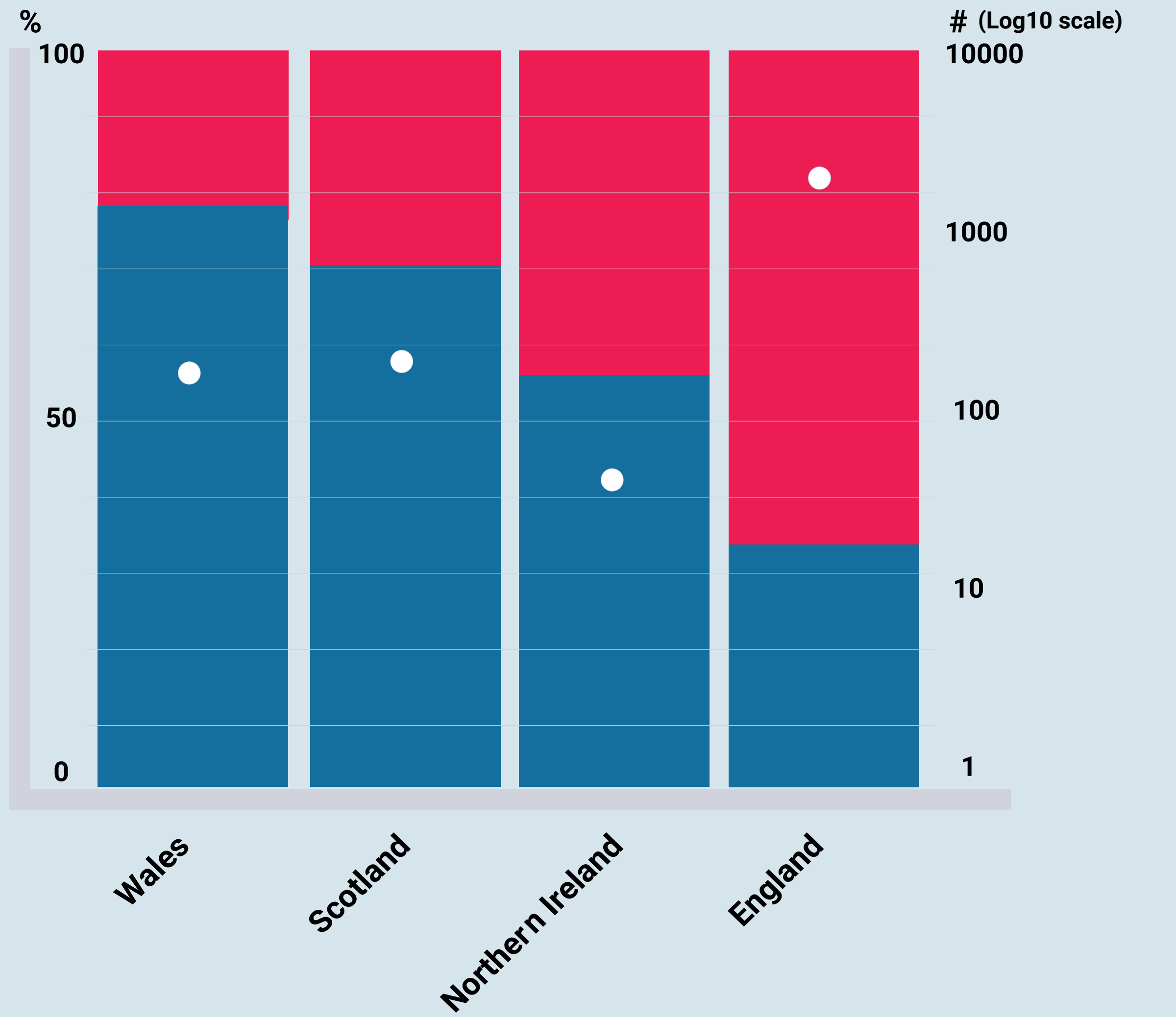


Figure 3. National overview of water quality

Buttermere, Cockermouth
(c) Johnny Gios

How does water quality across countries differ between June and September?

The comparison between the June WaterBlitz and the September WaterBlitz provides clear evidence on the role of climate conditions on water quality across the UK.

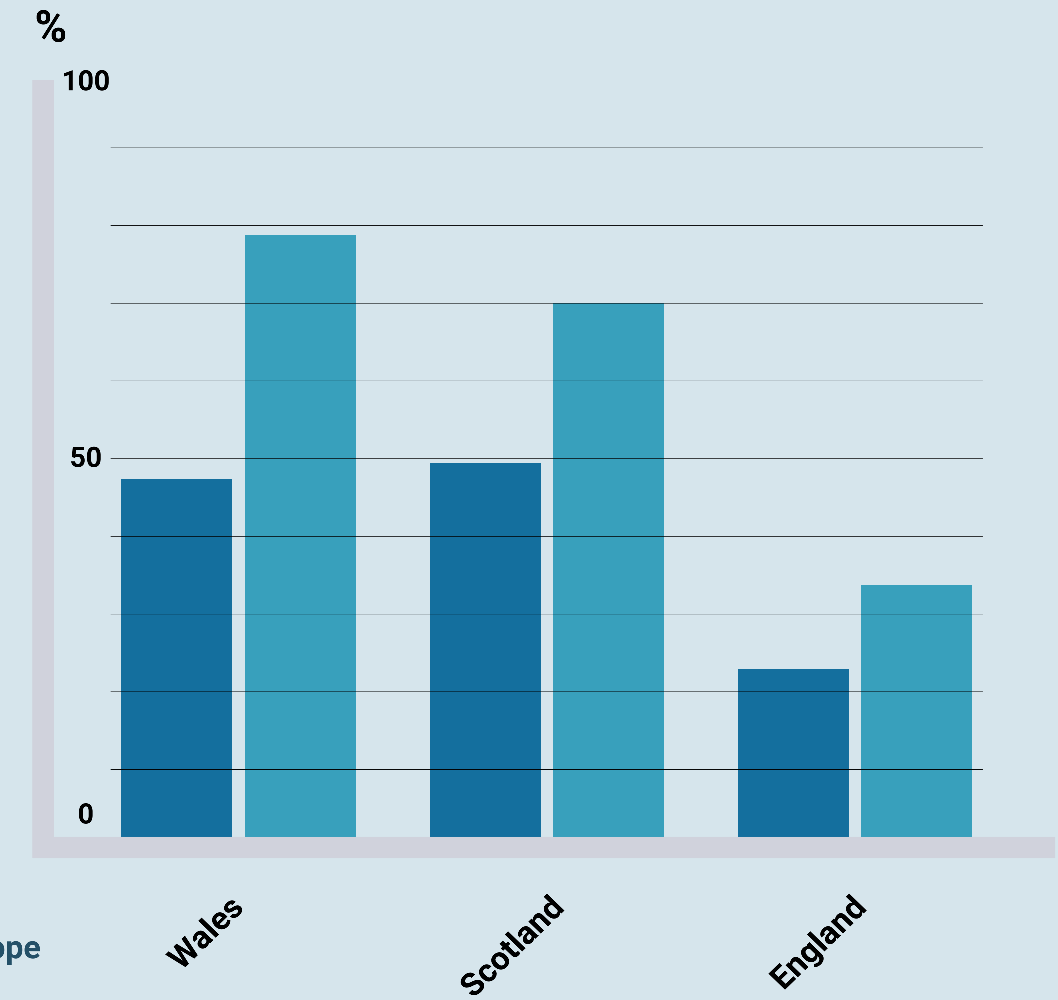


Figure 4.
% of acceptable water quality samples in June and September. N.B. In June there was not enough data to analyse from Northern Ireland.

In September, a general reduction in nutrient concentrations was observed compared with June's results throughout England, Scotland, and Wales (Figure 4), which can be attributed to the dilution effect of the heavy rainfall which increased river volumes the weekend of the WaterBlitz.

However, a reduction in nutrient concentrations does not necessarily mean that the amount of nutrients went down. The measured concentration of nutrients depends on both the amount of nutrients present, and the volume of water flowing in a river. For example, if nutrient concentrations dropped by 25% in September compared to June, but the volume of water in the river doubled, the amount of nutrients would have gone up by 50%.

Concentration explained

If you put an amount of 20 ml of orange squash in a volume of 250 ml of water, and 30 ml of squash in 500 ml of water, the second drink tastes weaker even though there is 50% more squash in it. In other words, the concentration went down, even though the amount of squash went up!

Furthermore, the analysis confirmed June's findings: that English waterbodies have higher nutrient concentrations than those in Scotland or Wales, regardless of low or high rainfall. This suggests that national differences in land use, agricultural practices, or environmental policies might contribute to differing nutrient levels.

A more complete understanding of these patterns will emerge after the Spring 2025 Blitz, which will allow us to compare season on season and provide clearer insight into the long-term impacts of climate events on nutrient pollution in waterbodies across the UK.

River Euchar

Which river basin districts are worst-hit?

A river basin, also known as a drainage basin, is the area of land around a river from which all water is drained. A river basin district includes one or more river basins. Each river basin district has a river basin management plan that outlines the objectives, standards, and measures for managing water.

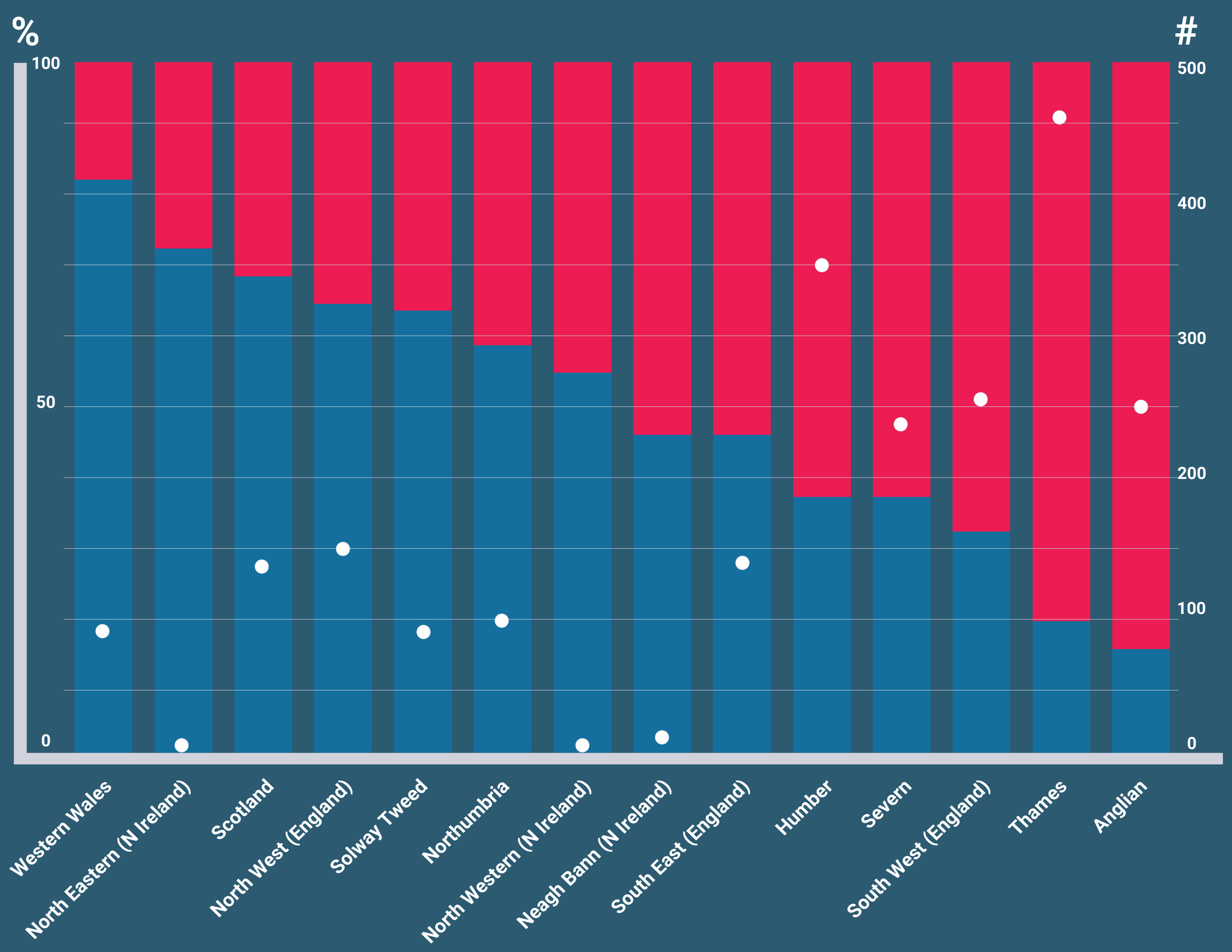


Figure 5. Water quality by river basin district

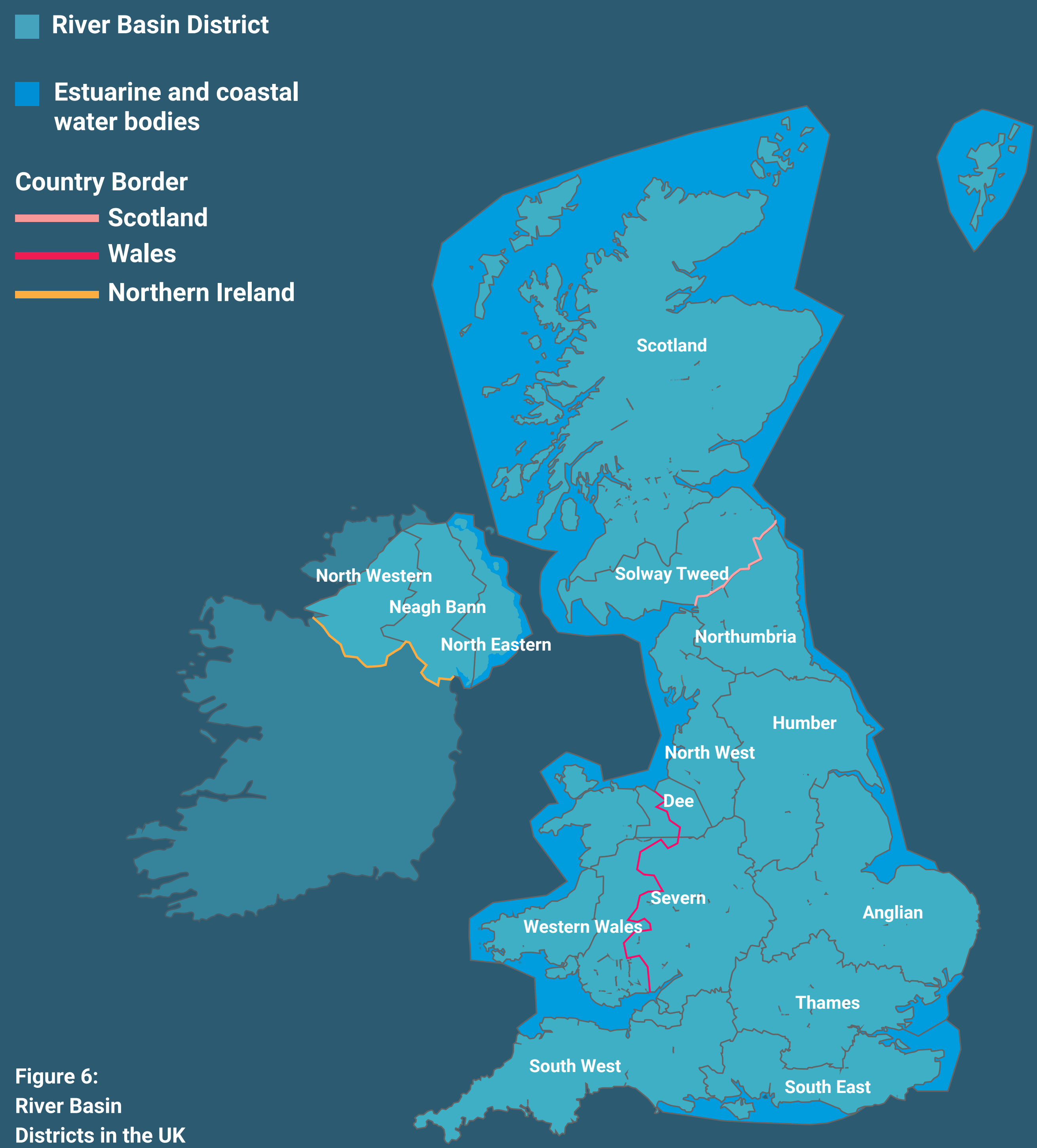


Figure 6: River Basin Districts in the UK

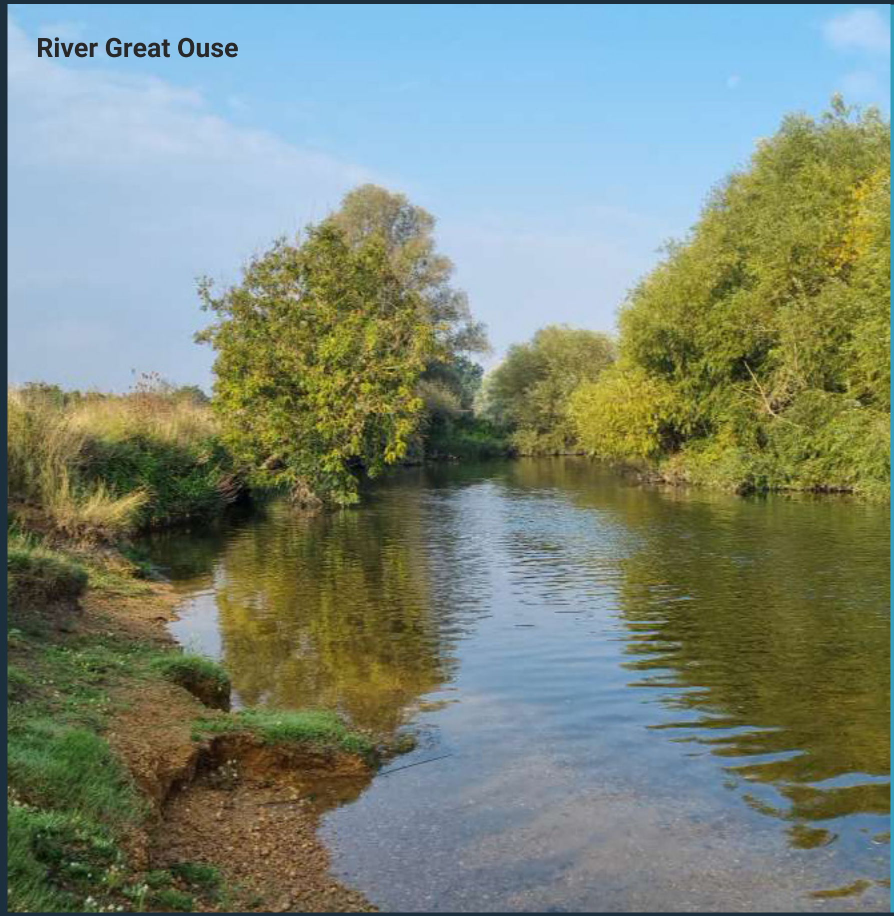
The results shown in Figure 5 suggest that the **Western Wales river basin district has the best water quality in the UK**, with 83% of measurements indicating low concentrations of nutrient pollution, and good water quality (based on 80 datapoints).

The Thames and Anglian river basin districts have the worst water quality in the UK, with less than 20% of measurements showing good water quality (based on 455 and 255 datapoints, respectively).

Which river basins are most polluted?

Delving deeper to look at specific river basins (Figure 7) we can see that in Western Wales, eight river basins for which data were available had at least 50% good water quality measurements recorded; with four of these basins having more than 80% good water quality measurements.

In stark contrast, only one (the River Loddon and its tributaries) of the river basins sampled by citizen scientists in the Thames and Anglian river basin districts had more than 40% of measurements indicating good water quality.

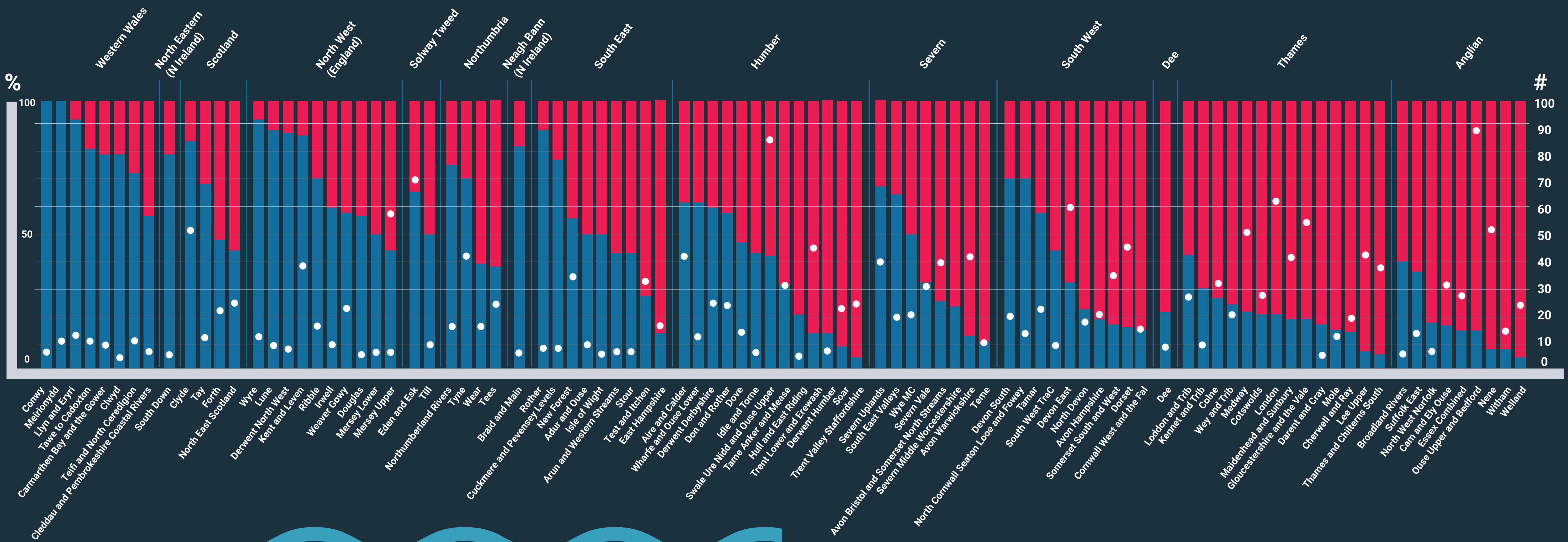


What's in a name?

There are five 'Ouses' around the UK: the Ouse Orkney, the Yorkshire Ouse, the Great Ouse, the Little Ouse and the Sussex Ouse. The Great Ouse (Ouse Upper and Bedford) in the Anglian river basin district and the Yorkshire Ouse (Swale Urr Nidd and Ouse Upper) in the Humber river basin district are the two most monitored river basins in this WaterBlitz.

The name Ouse is thought to come from the Celtic word Usa, which means 'water'. This makes 'River Ouse' a tautology, meaning 'River Water'.

Figure 7. Water quality of river basins in river basin districts



How healthy are the rivers in your county?

In this report we have used ceremonial counties because local governmental legislation counties are continually updated, with boundaries that change over time.

We have ranked counties by country and by water quality so that you can see the percentage of unacceptable water quality measurements taken in your county and how it compares to others (Figure 8).

Our data show that West Glamorgan in Wales, and Kirkcudbrightshire in Scotland have the best water quality in the UK. 100% of datapoints collected in these counties show low concentrations of nutrient pollution, indicative of good water quality (based on 10 and 7 datapoints respectively).

In England, the county of Northumberland has the best water quality (78% of the 27 datapoints collected have low nutrient concentrations); whereas the county of Rutland has the worst water quality in the UK, with 100% of datapoints showing unacceptable levels of nutrient pollution (based on 13 datapoints).

A shout out to the residents of Devon, who took the greatest number of measurements over the weekend – 112! - closely followed by participants in North Yorkshire and Hampshire.

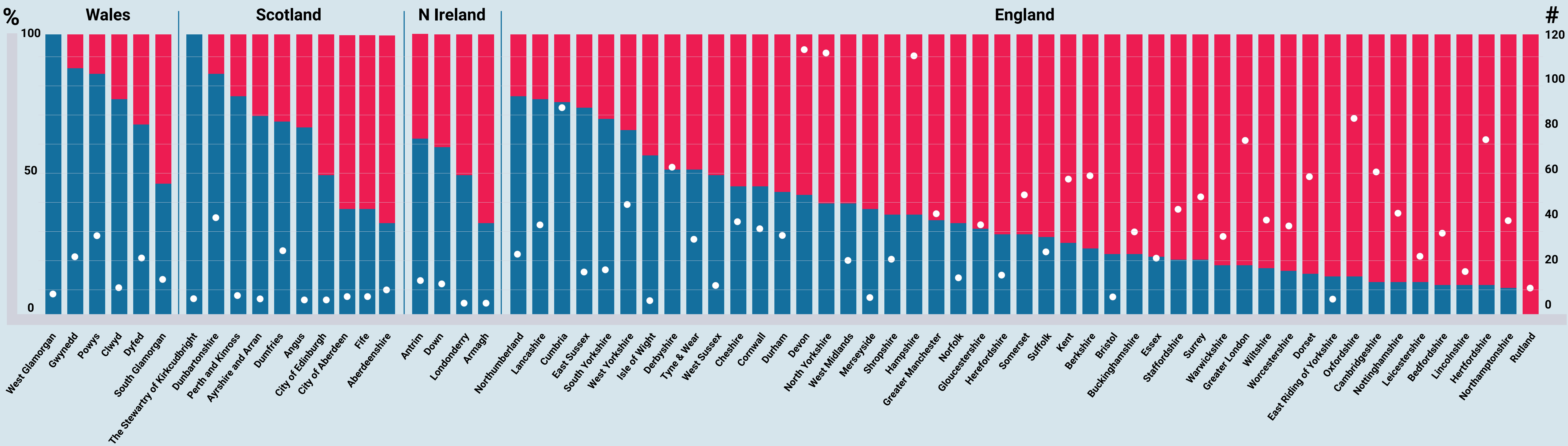


Figure 8. Water quality by county

Acceptable **Unacceptable** **# Datapoints**

~~Buttermere, Cockermouth (c) Jonny Gios~~

What else is in our rivers?

For September's WaterBlitz, Earthwatch partnered with Imperial College London to undertake additional chemical analysis of a selection of water samples. In addition to their nutrient testing, community groups collected water samples which were analysed by Dr Leon Barron and his team in the labs at Imperial.

While the full analysis of around 300 different chemicals is still underway – and will be published in a peer-reviewed journal in 2025 – we are already building a more complete picture of chemical pollution in our freshwater bodies.

Of the 91 samples already analysed, 100% contained **caffeine**, with levels in 80% of these samples presenting some risk from this compound to aquatic life. Further research would be required to determine exactly what this risk might be. **Nicotine** was found in 25% of samples, with concentrations that present some risk to aquatic life found in 7% of samples. The **antidepressant venlafaxine** was found in 30% of samples analysed. 13% of samples contained levels of venlafaxine that posed some level of risk to aquatic life. The **antibiotic trimethoprim** was found in 9% of samples, all of which were at concentrations that posed some level of risk to aquatic life. **Diclofenac**, a non-steroidal **anti-inflammatory** drug, was found in 11% of samples, all of which showed some level of risk. Interestingly, the **painkiller tramadol**, while being present in 45% of samples, was not found to be at concentrations high enough to pose any significant risk to aquatic life.

Along with the chemicals above, all of which enter our rivers and freshwater bodies through the wastewater system, 5% of samples contained the **fungicide tebuconazole**, indicative of agricultural run-off. 4% of samples contained high enough concentrations of tebuconazole to pose a risk to aquatic life. The neonicotinoid **pesticide acetamiprid** was present in 18% of samples, all showing some level of risk.

Five of these compounds - **venlafaxine**, **trimethoprim, diclofenac**, **tebuconazole** and **acetamiprid** - have appeared on EU Water Framework Directive watch lists and have been prioritised for further research.

Dr Leon Barron and team (Juditha Gurumurthy and Margarita White) analyse samples from the WaterBlitz in the lab at Imperial's White City Deep Tech Campus (CREDIT: Imperial College London / Jo Mieszkowski)


Brown Trout (c) Getty Images

Chemicals in our freshwater bodies

Caffeine

Caffeine is a natural stimulant most commonly found in tea, coffee, and cacao plants.

Despite being the most widely consumed and excreted psychoactive drug in the world, and a ubiquitous tracer of urban wastewater, caffeine's ecological effects are not well understood. Research suggests caffeine exposure associated with sewage discharge into natural waters may add to the negative impacts of other environmental factors, such as temperature change.

Nicotine

Nicotine is a substance found in all tobacco products and some e-cigarette liquids.

Nicotine's production and use as a pharmaceutical, and the disposal of cigarettes containing nicotine, may result in its release to the environment through various waste streams, including runoff from streets to drains. Cigarette filters (butts) are the single most collected item in international beach cleanups each year. Nicotine is known to be more harmful to fish than to aquatic insects.

Venlafaxine

Venlafaxine is an antidepressant and a serotonin and norepinephrine reuptake inhibitor (SNRI). It is officially approved to treat major depressive disorder (MDD), generalized anxiety disorder (GAD), social anxiety disorder, and panic disorder in adults.

Several effects on aquatic species exposed to antidepressants have been reported, including reproductive cycles and motility[7].

Diclofenac

This non-steroidal anti-inflammatory drug is used both as a human and veterinary medicine to reduce swelling and treat joint, muscle, tooth, and bone pain[8].

It is a stable and persistent substance that even at low levels may negatively affect aquatic organisms. Additionally, it has the potential to combine and interact with other substances such as metals, organic contaminants and even with diclofenac metabolites, potentially creating other contaminants[9].

Trimethoprim

Trimethoprim is an antibiotic used to treat and prevent urinary tract infections (UTIs), such as cystitis.

Like other antibiotics, the concern with trimethoprim is that once the drug has been metabolised, part of the initial dose is excreted in faeces and urine, where it enters the wastewater system. The presence of antibiotics in freshwater bodies is known to contribute to Antimicrobial Resistance (AMR), a phenomenon where microorganisms no longer respond to available antimicrobial drugs.

Tramadol

Tramadol is a SNRI that is structurally related to codeine and morphine. It is widely used to treat moderate to severe pain and frequently prescribed due to its high efficiency and low addiction properties.

In studies, tramadol has been detected in various water resources with the highest values in surface water, wastewater treatment plant influent, and wastewater treatment plant effluent, because of inefficient wastewater treatment and/or misuse. Tramadol is known to be toxic to aquatic plants and animals[10].

Tebuconazole

Tebuconazole is a broad-spectrum fungicide, used agriculturally to treat plant pathogenic fungi; used as a seed dressing and spray.

The presence of tebuconazole in freshwater bodies due to agricultural run-off may affect aquatic fungi and fungally-mediated processes[11].

Acetamiprid

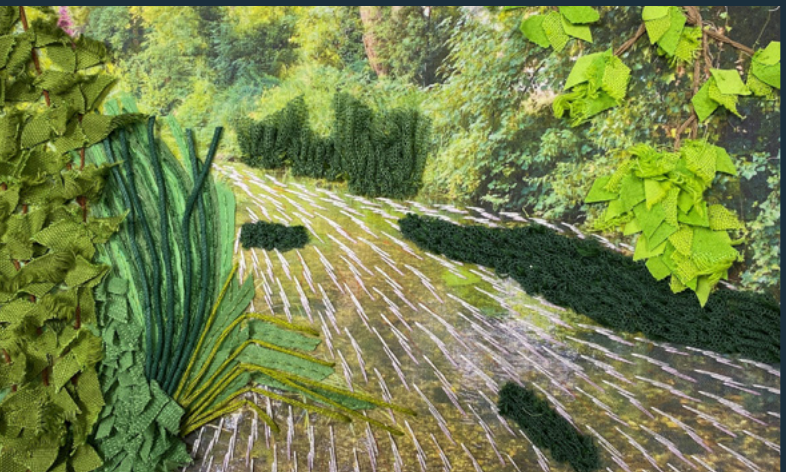
Also known as ethanimidamide and NI-25, this neonicotinoid pesticide is used to control insect pests.

Under certain conditions it may be very persistent in aquatic systems and has a high potential for bioaccumulation. A recognised irritant, acetamiprid is highly toxic to birds, and moderately toxic to most aquatic organisms[12].

What do we know about our participants' experience?

Aside from the fact that most of them got very wet?

4,531 participants took part in the WaterBlitz and 617 responded to our questionnaire about their experience. 39% of participants had not been involved in the environmental sector before the WaterBlitz and most took part because they wanted to do something for the environment (78%) or because of personal interest in a local waterbody (50%). The majority of participants agreed that their understanding of water quality issues and river health was improved through taking part in the WaterBlitz (57%); and 18% reported a positive shift in their relationship with nature, even despite the rain!



Citizen scientists in action

Elly Platt: Revealing river pollution – stitch by stitch

I'm Elly Platt. I'm a costume maker for film and television and a textile artist. I'm based in Hackbridge, South London. Due to my job, I'm spending a lot of time indoors. In my free time, I enjoy going for long walks along my local river.

I've lived along the River Wandle for about 14 years. It's got a really interesting history! From the 17th century onwards, it became essential for various industries – above all, for the textile industry. By the second half of the 20th century, other types of urban industry had taken over. A lot of the businesses used the river to dump their industrial waste. The river was declared dead at one point. However, some of the residents came up with a plan to restore the Wandle and – with the help of local authorities – managed to turn things around again.

Nowadays you would think that the river looks really clean, beautiful and idyllic.

However, this summer, there were several campaigns that have opened my eyes to what's really happening beneath the surface. One of them was Earthwatch Europe's Great UK WaterBlitz, which I first joined in June and a few months later again in September. I remember the moment the test results were ready, and I started comparing the two test tubes to the colour chart. When I looked up what's the ideal amount of nitrate and phosphate for a river, I was shocked! It's less than half of what my tests were showing.

It's really important to know about the invisible pollutants that might be affecting our rivers even when they look healthy.

Inspired by my WaterBlitz experience,

I started embroidering some of my photographs of the Wandle. Using the colour charts that Earthwatch sent me as part of the WaterBlitz, I've tried to match up the colours of my embroidery thread with the pink shades representing the different nutrient levels in the water. I embroidered the reeds and the trees to create this lovely, luscious feel of a landscape. But then the river is embroidered in a bright pink, which indicates that something isn't quite right...

I hope that my artwork will make people think about their own local environment, and that it will help bring the data to life. If I can encourage anyone to speak up for the Wandle in whatever way they choose, then it's succeeding!

Stronger together: Joining forces with the Women's Institute

For our second Great UK WaterBlitz, we were thrilled to partner with the Women's Institute (WI), who encouraged their local groups to participate in the WaterBlitz as part of their Week of River Action.

The WI's Chief Executive, Melissa Green, said: "We were delighted to support the Great UK Water Blitz during our WI Week of River Action this September. WI members care greatly about our environment and are passionate about putting an end to the disastrous pollution of our rivers. We know that not enough is happening to stop river pollution, and that we need better data, so WI members were eager to get out to their local rivers and get stuck in to contribute to a solid, up-to-date picture of this horrible situation."

A huge thank you to the 578 participants who went out with their local WI groups across the UK to complete their WaterBlitz surveys. Here are just a few of their stories:

"Herefordshire WI were the founders of the WI's own 'Clean Rivers' campaign. This year, we teamed up with our Powys neighbours to walk the River Lugg, sampling water in different locations along the way. We wanted to raise awareness of the problems facing the Lugg, but also to get to know the river, spending time exploring and being close to it. As we planned a relay from the source to the confluence with the Wye, passing a sample like a baton from WI to WI, the WaterBlitz was a great opportunity to get to grips with water testing. We were shocked by the results! It feels very useful to be better informed though, and we are beginning to understand where the surplus of nitrates and phosphates come from. We are proud to have come together to draw attention to the need for watershed-scale solutions. The WaterBlitz is a powerful collective action!" - Sue Thornton and Sandra Walker

"Christow WI members live near the River Teign and its tributaries. We were keen to find out about the health of our local river, which is central to our identity. We feel proud and privileged to live in such a beautiful area and hope to help maintain it in a healthy state for wildlife and future generations. We had great fun testing the water and felt encouraged by the results. Once we had finished the tests, our member Lesley, who hosted the event on her land, treated us to a delicious cream tea. We would like to repeat the experience!" - Philippa Cook

"We feel proud and privileged to live in such a beautiful area and hope to maintain it in a healthy state for wildlife and future generations"

Where do we go from here?

Earthwatch Europe believes in the power of data for change.

We believe in open, transparent data. It's why all our graphs have been plotted to include the number of datapoints; so that you can see how large a dataset has been used to draw conclusions. We want to see the same level of transparency and, indeed, accountability from all types of polluters: from agriculture, urban run-off and sewage overflows.

The recent Water (Special Measures) Bill aims to block bonuses for executives who pollute our waterways; bring criminal charges against persistent law breakers; enable automatic and severe fines for wrongdoing; and ensure the monitoring of every sewage outlet. While Earthwatch is supportive of legislation which seeks to empower regulators and improve transparency, we also recognise that we cannot simply legislate ourselves out of the water pollution crisis. It will take collective action from government, water companies, farmers and communities working together in order to improve the health of our freshwater.

We believe that citizen scientists can provide extensive, accurate, and timely information on water quality at a national level. We've evidenced that, no matter the weather, our participants are capable of generating robust datasets, and reliable status reports on how seasonal variations can impact pollution dynamics and water quality.

Citizen science, by facilitating a broad scope analysis of additional contaminants, also allows us to prioritise the monitoring of chemicals of emerging concern. Our data shows that tramadol, for example, while being present in 45% of samples analysed, is not present in concentrations which pose a significant risk to aquatic life; compared to a number of other compounds which do pose significant risk.

We therefore urge authorities to recognise the power of citizen science for freshwater monitoring at a national scale and recommend that citizen science generated data be integrated into their freshwater monitoring frameworks.

Finally, we call upon our citizen scientists to continue monitoring and advocating for their local rivers, streams, lakes and ponds.

Be part of the next Great UK WaterBlitz!

Please join us in April 2025 for our Spring WaterBlitz, and continue the fight for healthy freshwater.

earthwatch.org.uk/greatukwaterblitz

FreshWaterWatch Powered by earthwatch Europe

Loch Lomond (c) Gary Ellis

Methods

Participant recruitment and feedback

Citizen scientists were recruited through promotional campaigns on social media. Following the WaterBlitz, participants were sent a follow-up questionnaire to report on their experience of the WaterBlitz and their knowledge, attitudes and behaviours towards nature.

Nutrient testing

The FreshWater Watch (FWW) measurements of nitrate and phosphate are made colourimetrically in closed tubes using a standard plastic cuvette for a fixed volume of 1.5mL. Nitrate measurements are based on the Griess reaction, with a reduction reaction using zinc, which reduces the nitrate (NO^{3-}) to nitrite (NO^{2-}) and a colourimetric reaction for the determination of nitrite. PO^4 is detected using 4-amino-antipyrine with phosphatase enzyme to produce hydrogen peroxide, which then undergoes a colourimetric reaction. Both colours are compared to standard reference colour charts provided to the citizen scientists, assigning colour brightness to one of seven concentration intervals. Side-by-side measurements have shown an overall accuracy of 75% to 85% of the citizen scientist estimated PO^4 concentrations compared to concentrations measured at the same site and day by professional scientists using standard laboratory analysis [13,14]. Participants submitted data via the ArcGIS Survey123 app, the FWW platform or via paper copy. All data uploaded from the 20 September until 1.30pm on the 24 September were included in the analysis. Additional data uploaded outside of this period were not included in the analysis but could still be visualised on the public map and will form part of the overall FWW database.

Nutrient data analysis

On closing the survey, the data were exported, and quality control - including locational accuracy, and removal of incomplete and duplicate records - was undertaken. Each record/survey result was then enriched with nitrate and phosphate nutrient pollution ratings based on the measured concentrations, from which, in turn, the acceptable/unacceptable water quality classification was generated (based on the N and P thresholds mentioned earlier in the report). Lastly, our FWW narrative feedback was generated for each survey by a matrix based on the nitrate and phosphate measurements and the observed parameters.

For the spatial analysis of the data points, we enriched our data set using geospatial layers including Open OS Boundaries, WFD (Water Framework Directive) for England and Wales, and SEPA (Scottish Environment Agency) for surface water catchments.

Polygons for spatial analysis

The following polygons were used for spatial analysis:

- Country, from Ordnance Survey Boundary-Line™ consisting of the 'Country Region' shapefile and can be found at https://api.os.uk/downloads/v1/products/BoundaryLine/downloads?area=GB&format=ESRI®+Shapefile&redirect
- County, from
  - Ordnance Survey Boundary-Line™ consisting of the 'Boundaryline ceremonial counties region' shapefile for England, Scotland and Wales, which can be found at https://api.os.uk/downloads/v1/products/BoundaryLine/downloads?area=GB&format=ESRI®+Shapefile&redirect
  - Northern Ireland, County, Boundaries' shapefile. This data was collected by Ordnance Survey Northern Ireland and can be found at https://admin.opendatani.gov.uk/dataset/osni-open-data-largescale-boundaries-county-boundaries.
- River basin districts/management area (using RBID_NAME) and river basin (using MNCAT_NAME) field as defined by the WFD Surface water management catchments (Cycle 2) database:
  - Wales WFD Cycle 2 Management Catchments: https://datamap.gov.wales/layers/inspire-nrw:NRW_WFD_MGT_CATCHMENTS_C2
  - Scotland SEPA River Basin Districts: https://map.sepa.org.uk/atom/SEPA_River_Basin_Districts.atom alternate http://map.sepa.org.uk/atom/Data/SEPA_River_Basin_Districts_BNG_shp.zip
  - Northen Ireland Catchments
    - RBD: https://admin.opendatani.gov.uk/ dataset/river-basin-districts

A sample from the WaterBlitz analysis. Samples are analysed by a technique called liquid chromatography-mass spectrometry where all the chemicals in the water are separated out, detected and quantified. (CREDIT: *Imperial College London / Jo Mieszkowski*)

    - MANCAT: https://www.daera-ni.gov.uk/sites/default/files/publications/doe/localmanagementareashp.zip
  - England: https://data.catchmentbasedapproach.org/datasets/theriverstrust::wfd-surface-water-management-catchments-cycle-2/about

Datapoints per polygon

The number of datapoints per polygon was determined to assess the representativity of the data. All datapoints were included in the overall and national analyses. River basin districts with fewer than 10 points were excluded from that level of analysis. River basins and counties with fewer than 5 datapoints were excluded from analysis at those levels. For example, the polygon for the Dee as a River basin district contained only 9 datapoints (<10) and was excluded from the river basin district analysis. The polygon for the Dee as a river basin was included at that level as it had 9 (>5) datapoints.

Of the 157 river basins defined by the WFD Surface Water Management Catchments Cycle 3 polygons (see Polygons for spatial analysis above), 132 were sampled, and 108 had more than 5 data points. These river basins contained 94% of the 2,338 datapoints that were collected by citizen scientists during the WaterBlitz.

Of the 97 counties defined by boundary shapefiles (see Polygons for spatial analysis above), 90 were sampled and 67 had more than 5 data points. These counties contained 98% of the 2,338 datapoints that were collected by citizen scientists during the WaterBlitz.

Data sources

- Earthwatch - Great UK WaterBlitz September 2024
- OS Open Boundaries: https://api.os.uk/downloads/v1/products/BoundaryLine/
- SEPA River Basin Districts, Water Framework Directive (WFD) River Basin Districts Cycle 2 and WFD Surface Water Management Catchments Cycle 2:
  - Wales WFD Cycle 2 Management Catchments: https://datamap.gov.wales/layers/inspire-nrw:NRW_WFD_MGT_CATCHMENTS_C2
  - Scotland SEPA River Basin Districts: https://map.sepa.org.uk/atom/SEPA_River_Basin_Districts.atom alternate http://map.sepa.org.uk/atom/Data/SEPA_River_Basin_Districts_BNG_shp.zip
  - Northern Ireland Catchments
    - RBD: https://admin.opendatani.gov.uk/ dataset/river-basin-districts
    - MANCAT: https://www.daera-ni.gov.uk/sites/default/files/publications/doe/localmanagementareashp.zip
  - England: https://data.catchmentbasedapproach.org/datasets/theriverstrust::wfd-surface-water-management-catchments-cycle-2/about

Tools used

ESRI ArcGIS Online

ESRI ArcGIS Pro and Python Notebooks

Microsoft Excel (Microsoft Office 365)

Chemical testing

Samples were frozen before shipping to the laboratory to ensure chemicals did not degrade. Upon arrival, bags containing each sample were checked for damage and one sample was selected for analysis whilst the other kept as a spare. The code on each bottle was noted to enable it to be linked to the GPS coordinates provided by the participant who had collected the sample.

The samples were then analysed using a technique called liquid chromatography-tandem mass spectrometry (LC-MS/MS), according to Egli et al. (2023)[15]. Briefly, a 900 µL aliquot of the sample was taken to a second tube and spiked with a range of internal standards to help with quantification. The samples were then passed through a 0.2 µm filter before 10 µL was injected directly on to the LC-MS/MS in triplicate. The instrument monitored for a chemical retention time and a set of specific ion fragmentation transitions for all the chemicals we targeted and provided multiple reaction monitoring (MRM) with a minimum of two transitions per compound. The detection limit for all compounds was 3 ±5 ng/L (nanograms per litre). Comparing the retention time and MRM with those recorded for the same substances in a library allowed us to identify the substance. The intensity of the signals obtained was then used to derive the measured environmental concentration (MEC) of the substance, by comparison with a calibration series of the compounds prepared using artificial freshwater.

For environmental risk assessment, the lowest predicted no-effect concentration (PNEC) of each compound was taken from the NORMAN Ecotoxicology database (NORMAN Ecotoxicology Database (norman-network.com)[16] to calculate a risk quotient, i.e., MEC/PNEC. Risk quotients of <0.1 were considered of insignificant risk; 0.1-1.0 were low risk; 1.0-10 were medium risk and those >10 were high risk.

References

1. Met Office Press Office
2. Environment Agency (2019). 2021 River Basin Management Plan: Nitrates
3. White, P.J., Hammond, J.P., (2009). The sources of phosphorus in the waters of Great Britain. J Environ Qual, 13;38(1):13-26
4 DEFRA (2000). Sewage Treatment in the UK:UK Implementation of the EC Urban Waste Water Treatment Directive
5. Zhou, M., Wu, S., Zhang, Z., Aihemaiti, Y., Yang, L., Shao, Y., Chen, Z., Jiang, Y., Jin, C., & Zheng, G. (n.d.). Dilution or enrichment: the effects of flood on pollutants in urban rivers. https://doi.org/10.1186/s12302-022-00639-7
6. Loiselle, S., Bishop, I., Moorhouse, H., Pilat, C., Koelman, E., Nelson, R., Clymans, W., Pratt, J. and Lewis, V., (2024). Citizen scientists filling knowledge gaps of phosphate pollution dynamics in rural areas. Environmental Monitoring and Assessment, 196(2), p.220.
7. Melchor-Martínez, E. M., Jim Enez-Rodríguez, M. G., Martínez-Ruiz, M., Pe~ Na-Benavides, S. A., Iqbal, H. M. N., Parra-Saldívar, R., & Sosa-Hern Andez, J. E. (2020). Antidepressants surveillance in wastewater: Overview extraction and detection. https://doi.org/10.1016/j.cscee.2020.100074
8. NHS. (2024). About diclofenac -Brand names: Voltarol, Dicloflex, Diclomax, Econac, Motifene. National Health Service. https://www.nhs.uk/medicines/diclofenac/about-diclofenac/
9. Lonappan, L., Brar, S. K., Das, R. K., Verma, M., & Surampalli, R. Y. (2016). Diclofenac and its transformation products: Environmental occurrence and toxicity - A review. Environment International, 96, 127–138. https://doi.org/10.1016/J.ENVINT.2016.09.014
10. Ghazouani, S., Boujelbane, F., Ennigrou, D. J., Van der Bruggen, B., & Mzoughi, N. (2022). Removal of tramadol hydrochloride, an emerging pollutant, from aqueous solution using gamma irradiation combined by nanofiltration. Process Safety and Environmental Protection, 159, 442–451. https://doi.org/10.1016/J.PSEP.2022.01.005
11. Dong, B. (2024). A comprehensive review on toxicological mechanisms and transformation products of tebuconazole: Insights on pesticide management. Science of The Total Environment, 908, 168264. https://doi.org/10.1016/J.SCITOTENV.2023.168264
12. Lewis, K. A., Tzilivakis, J., Warner, D. J., & Green, A. (2016). An international database for pesticide risk assessments and management. Human and Ecological Risk Assessment, 22(4), 1050–1064. https://doi.org/10.1080/10807039.2015.1133242
13. Hegarty, S., Hayes, A., Regan, F., Bishop, I., & Clinton, R. (2021). Using citizen science to understand river water quality while filling data gaps to meet United Nations Sustainable Development Goal 6 objectives. Science of The Total Environment, 783, 146953.
14. Moshi, H. A., Kimirei, I., Shilla, D., O'Reilly, C., Wehrli, B., Ehrenfels, B., & Loiselle, S. (2022). Citizen scientist monitoring accurately reveals nutrient pollution dynamics in Lake Tanganyika coastal waters. Environmental monitoring and assessment, 194(10), 689.
15. Egli, M., Rapp-Wright, H., Oloyede, O., Francis, W., Preston-Allen, R., Friedman, S., Woodward, G., Piel, F. B., & Barron, L. P. (2023). A One-Health environmental risk assessment of contaminants of emerging concern in London's waterways throughout the SARS-CoV-2 pandemic. Environment International, 180, 108210. https://doi.org/10.1016/J.ENVINT.2023.108210
16. NORMAN Ecotoxicology Database. (n.d.). Retrieved October 11, 2024, from https://www.norman-network.com/nds/ecotox/

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